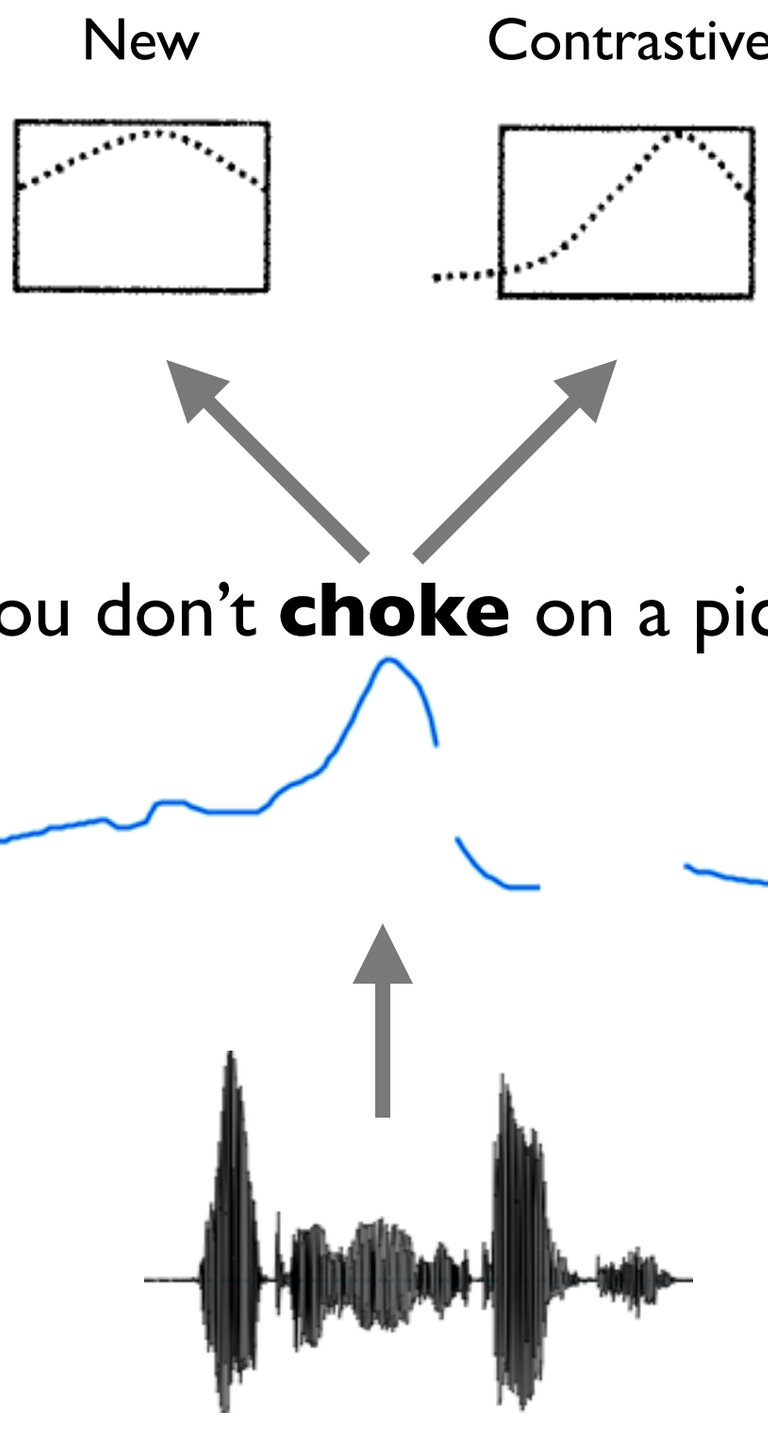
That was a question? Accommodating variability in intonation interpretation

Andrés Buxó-Lugo & Chigusa Kurumada

Intonation communicates intentions

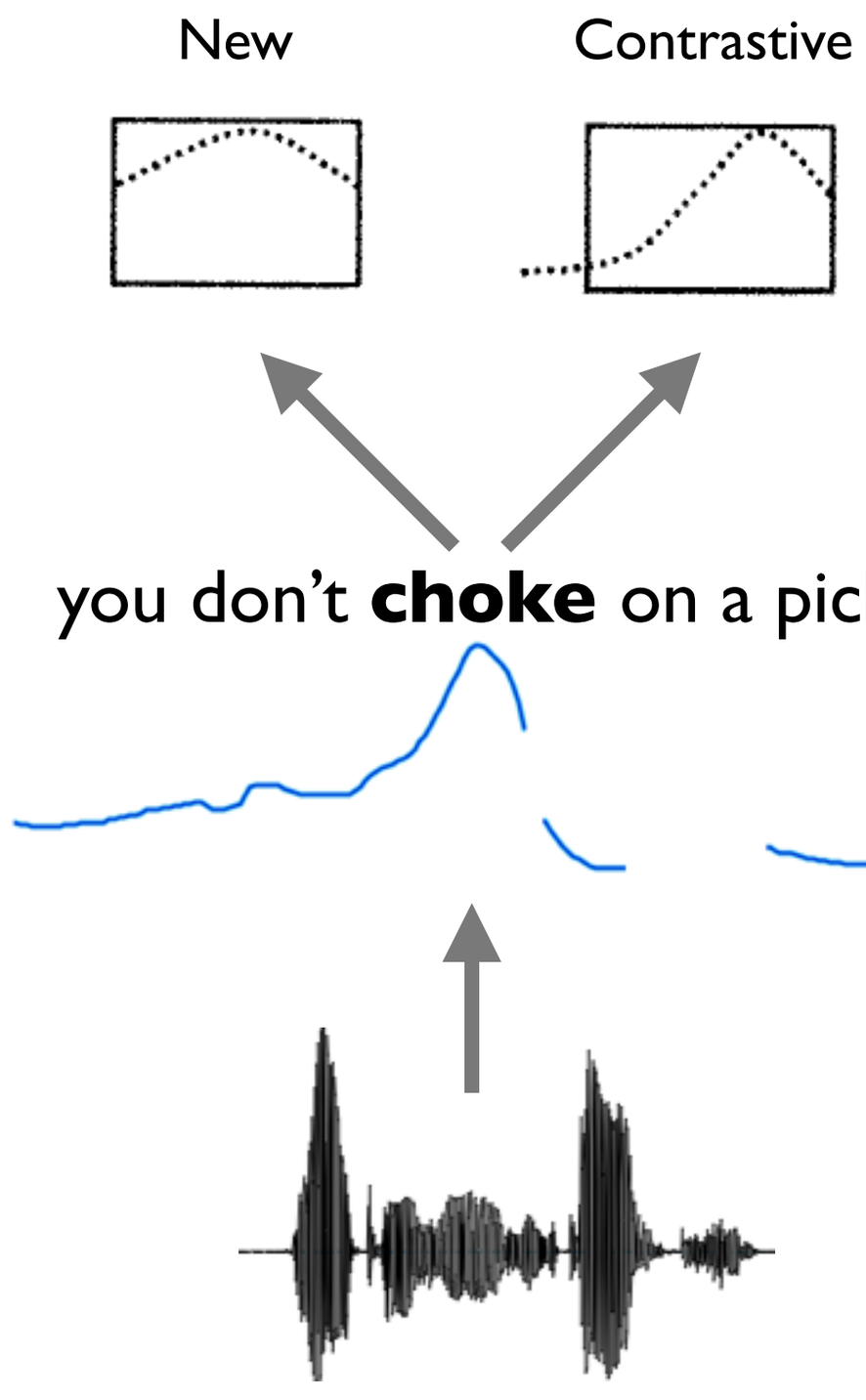


- Intonational representations cue intended meanings of utterances in context

- Low-level acoustic signal mapped onto intonational representations

(e.g., Bolinger, 1986; Cutler, 1977; Dahan, 2015; Ladd, 1983; Pierrehumbert & Hirschberg, 1990)

Puzzles related to variability



- In speech, intonational categories are realized in widely varied acoustics
  - Linguistic contexts
  - Socio-indexical features
  - Speaking conditions

(e.g., Clopper & Smiljanic, 2011; Cole, 2015; Grabe et al., 2005; Green, 2002; Holliday, 2019; Ladd, 2008; Podesva & Callier, 2015; Warren, 2016)

New vs. Contrast

- “Red, green, blue. White, **gray**, black” [New]
- “White, green, black. White, **gray**, black” [Contrast]

(e.g., Buxó-Lugo, Toscano, & Watson, 2018)

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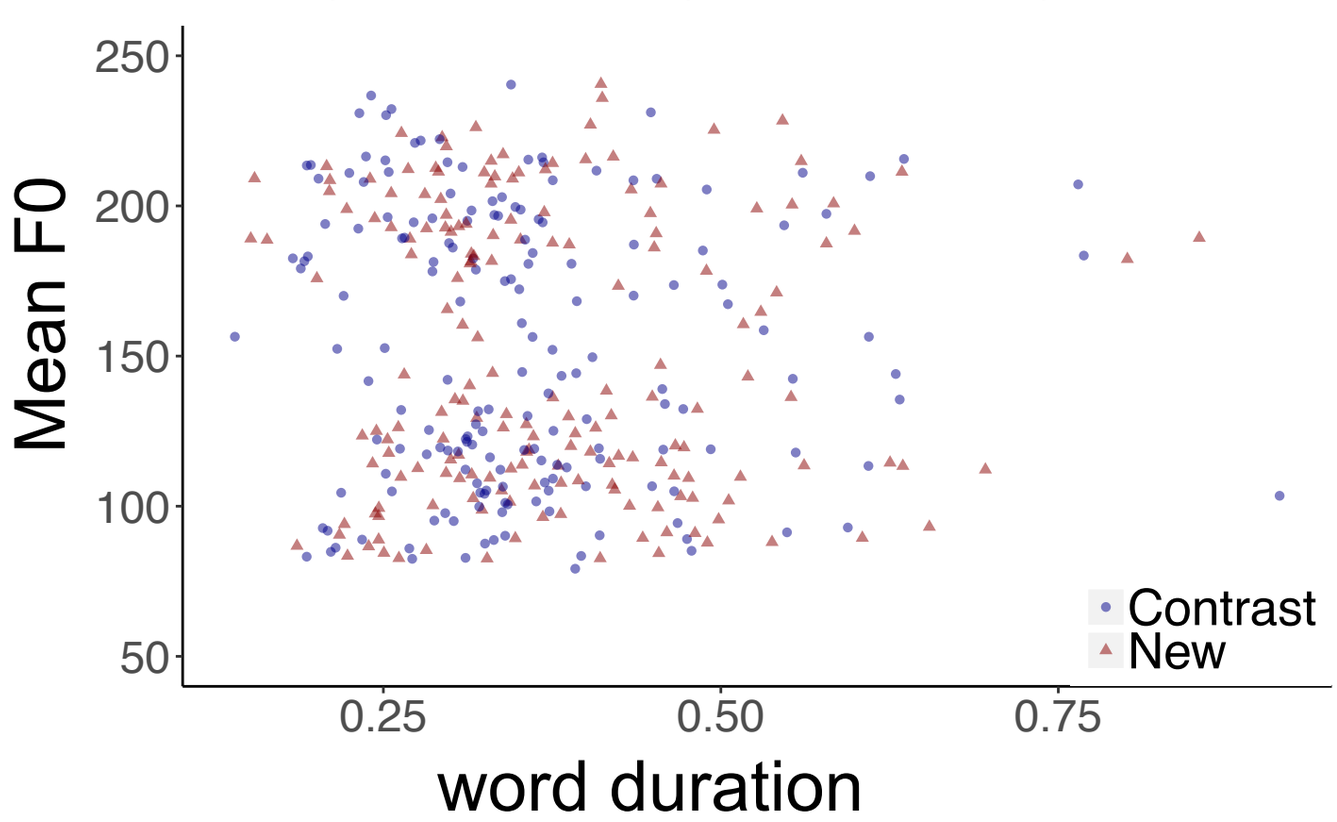

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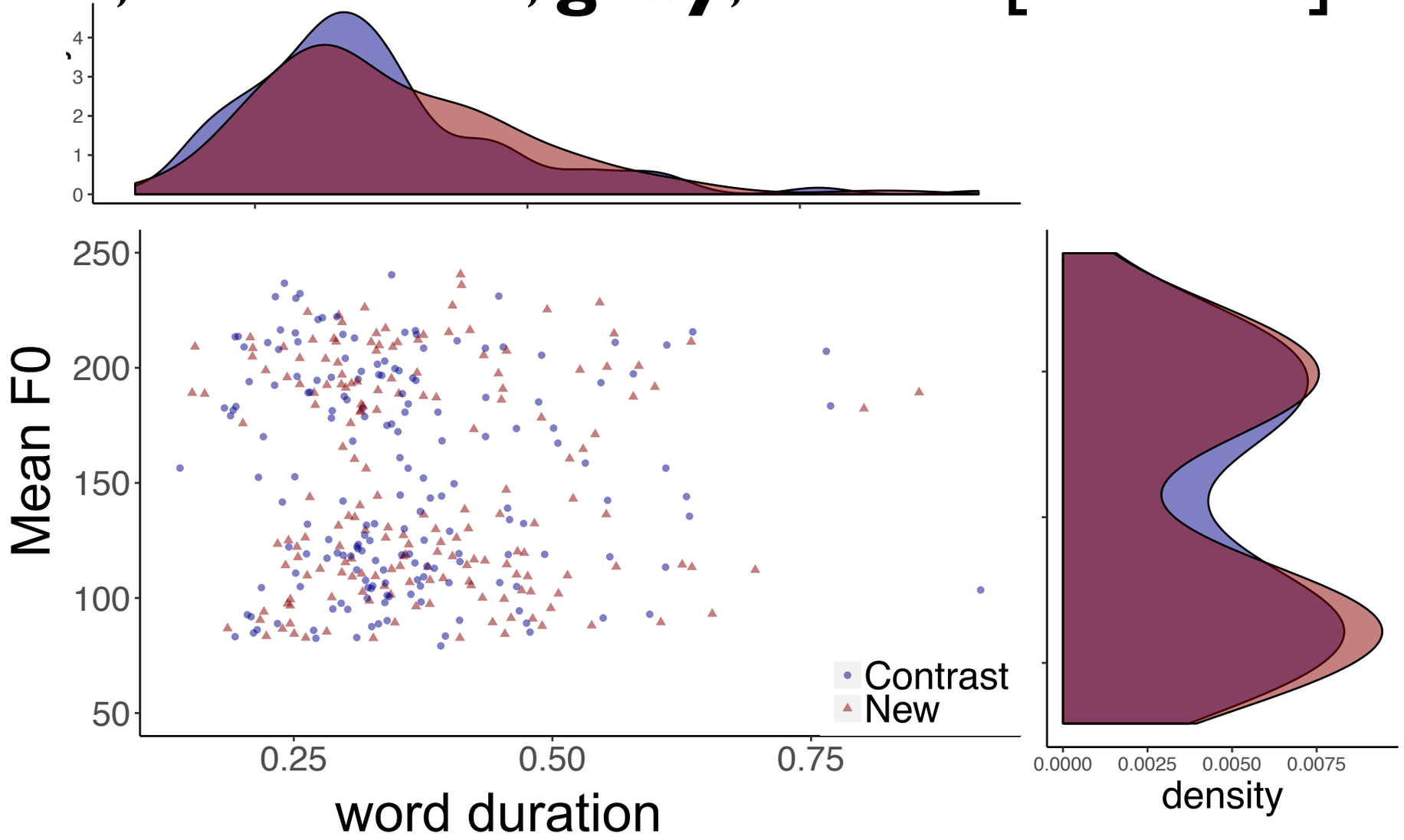

(e.g., Buxó-Lugo, Toscano, & Watson, 2018)

Accommodating variations

1) Normalization

- Interpreting acoustic variations in proportion to a contextually defined baseline

  e.g., male vs. female have different baseline pitch

2) Adaptation

- learning statistical patterns of the input particular to a given context and speaker

  e.g., individual speakers express the same intonation contour with different combinations of acoustic cues

(Cole, 2015; Dilley & Pitt, 2010; Johnson & Mullenix; 1997; Kraljic & Samuel, 2008; McMurray & Jongman, 2012; Nearey, 1978; Norris et al., 2016, Summerfield, 1981; *inter alios*)

Current study

- We investigate normalization and adaptation looking at question vs. statement intonation
  - (Thought to be) a binary classification with contrasting interpretations

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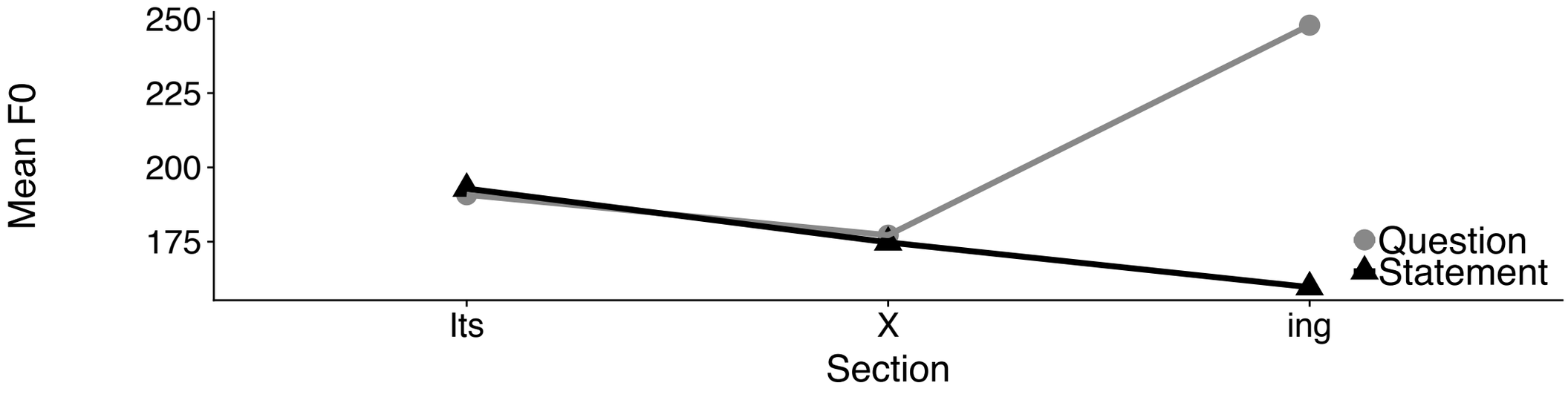
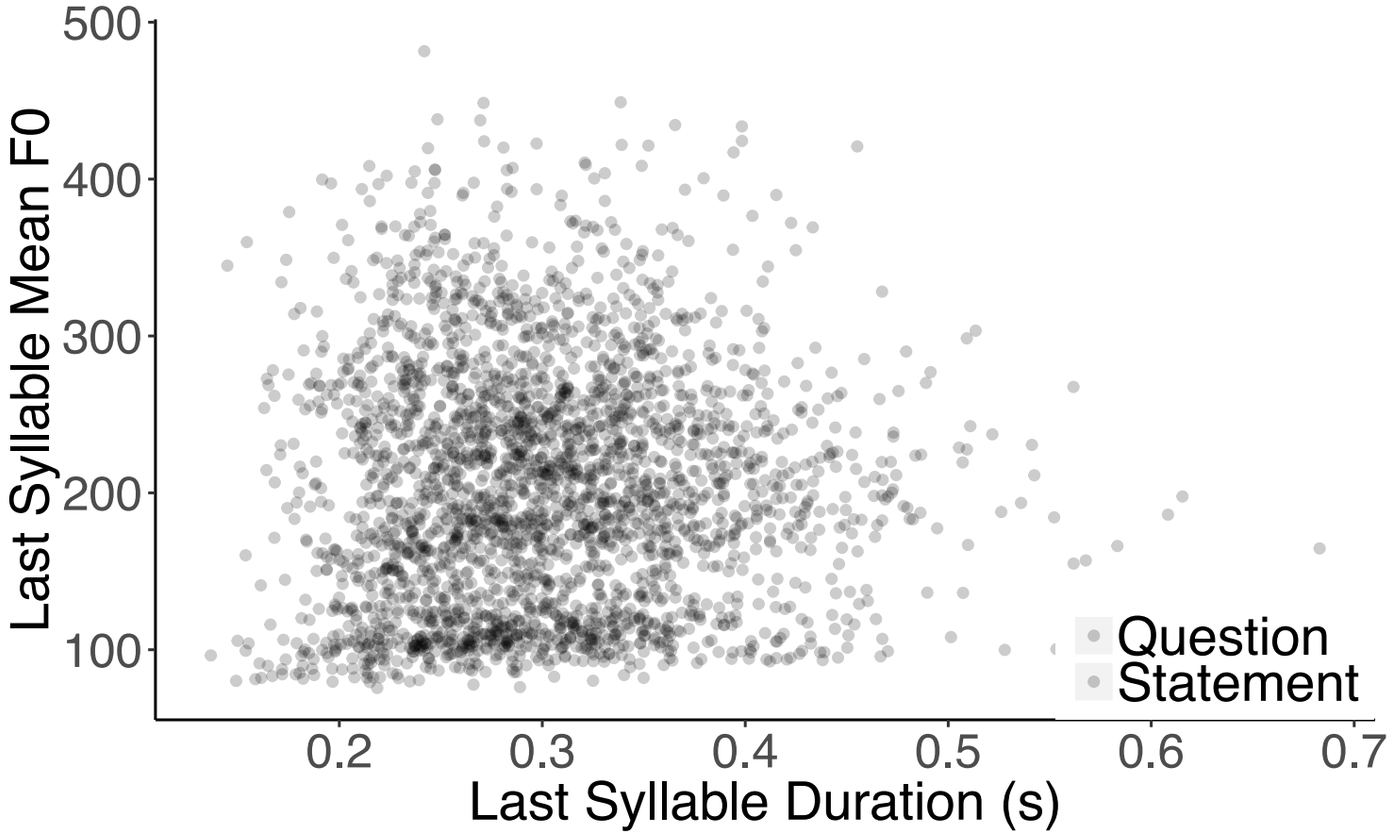
- Study 1: Production: To what extent do native speakers vary in their use of intonation?
- Study 2: Comprehension: Can native listeners adapt to speaker-specific variations of intonation?

Study 1: Production

- 59 Native speakers of American English (45 Female)
- 48 sentences
  - "It's X-ing" (e.g., It's raining)
  - 24 verb types (produced as a question vs. statement once each)



Results 1: Raw acoustic values



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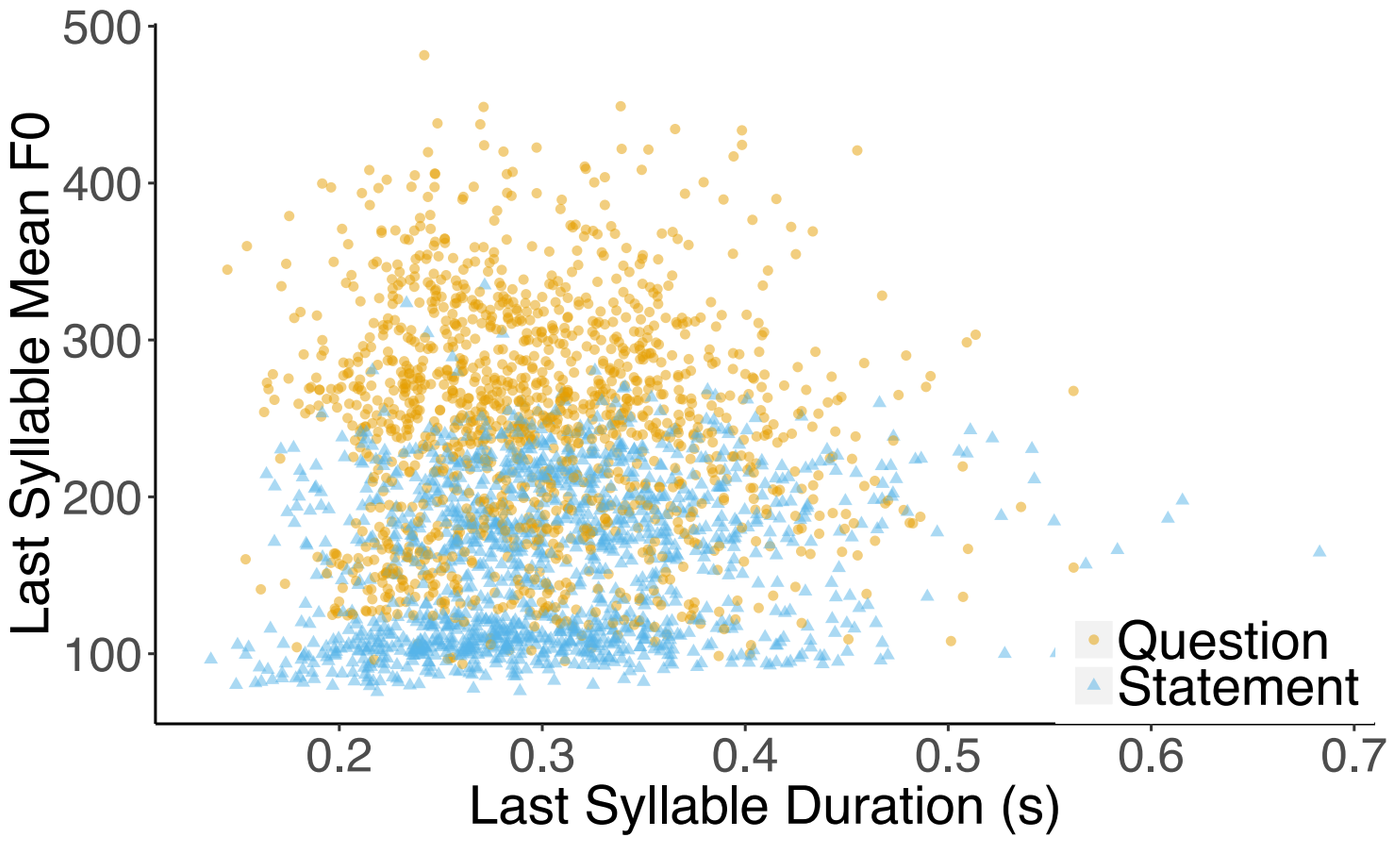

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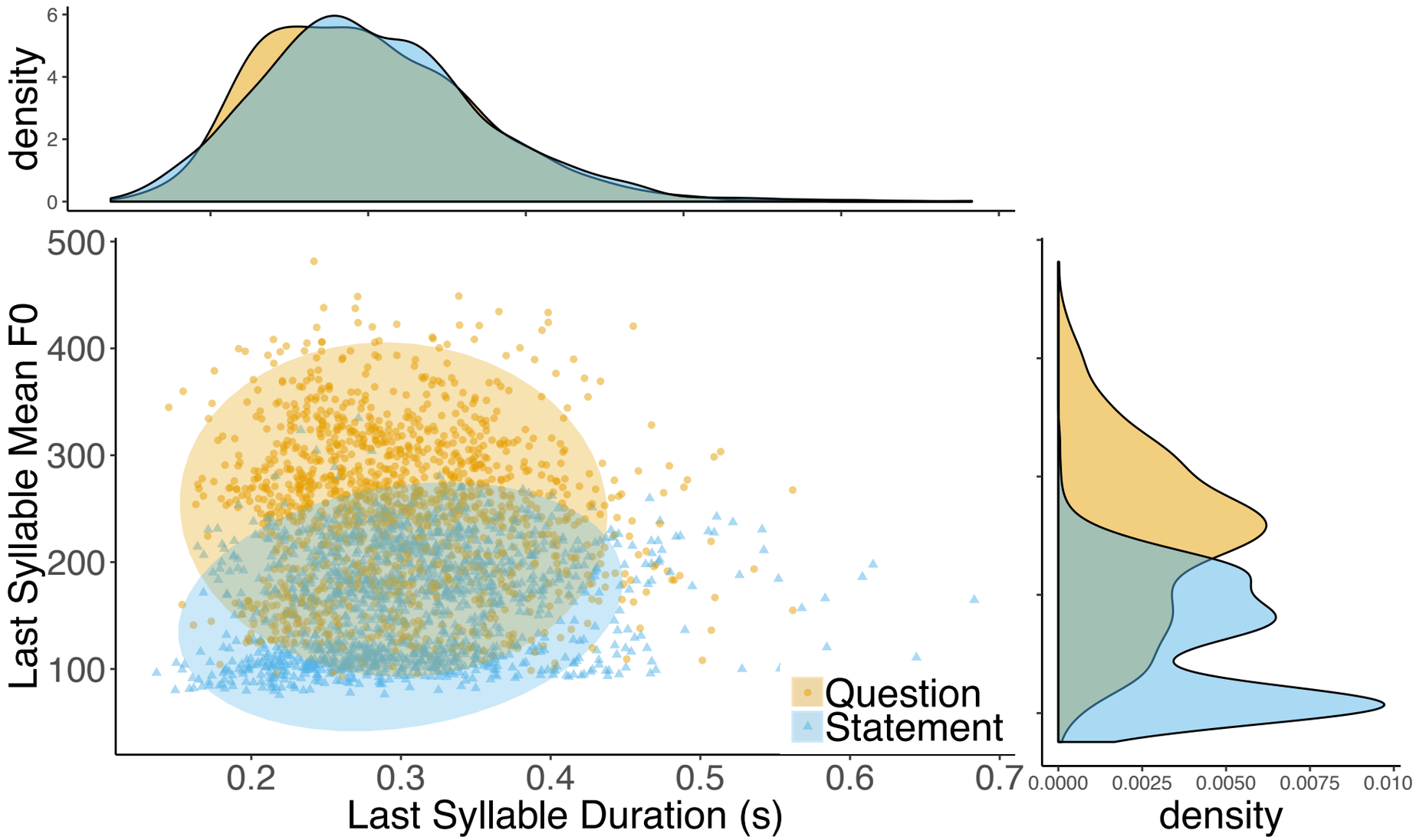
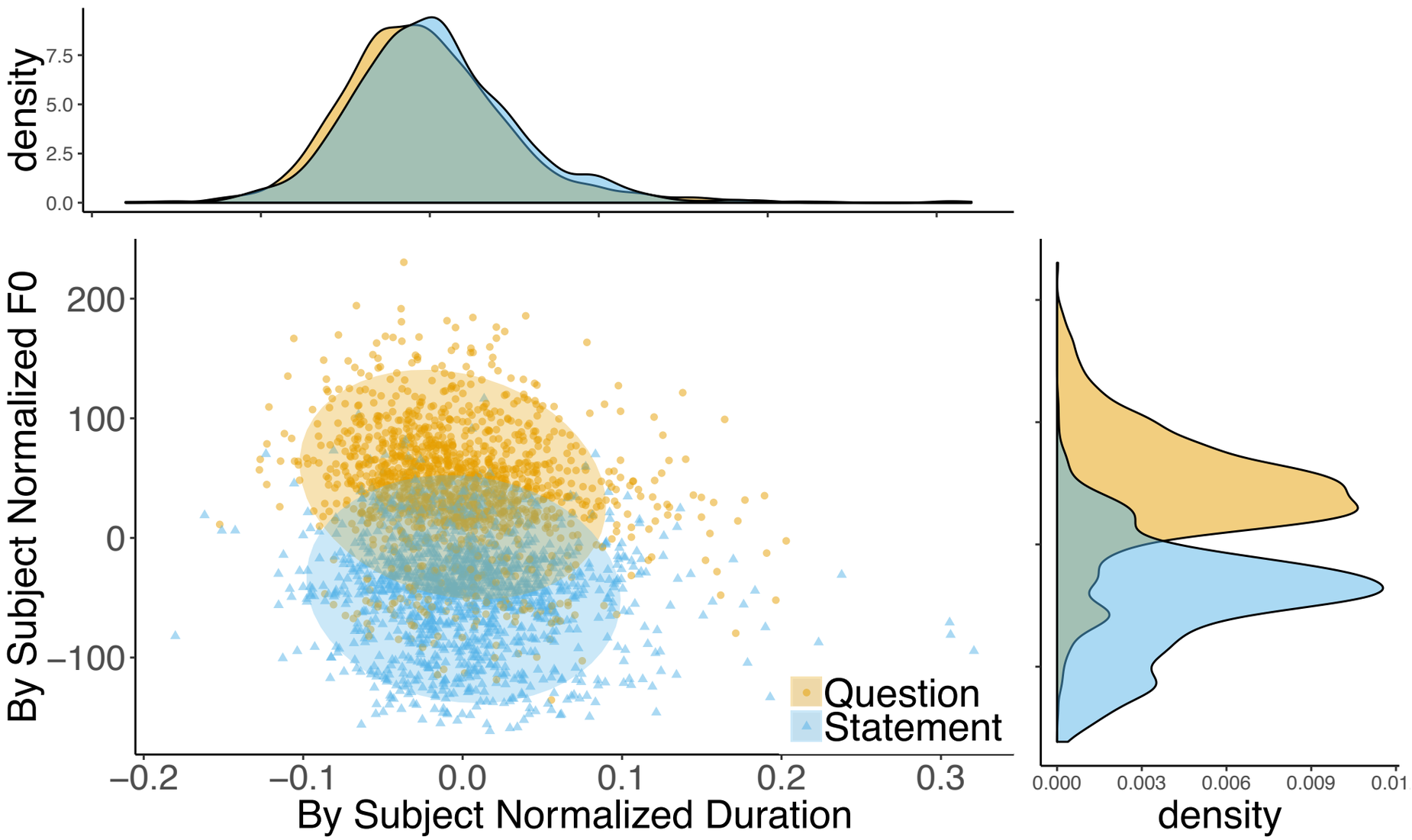


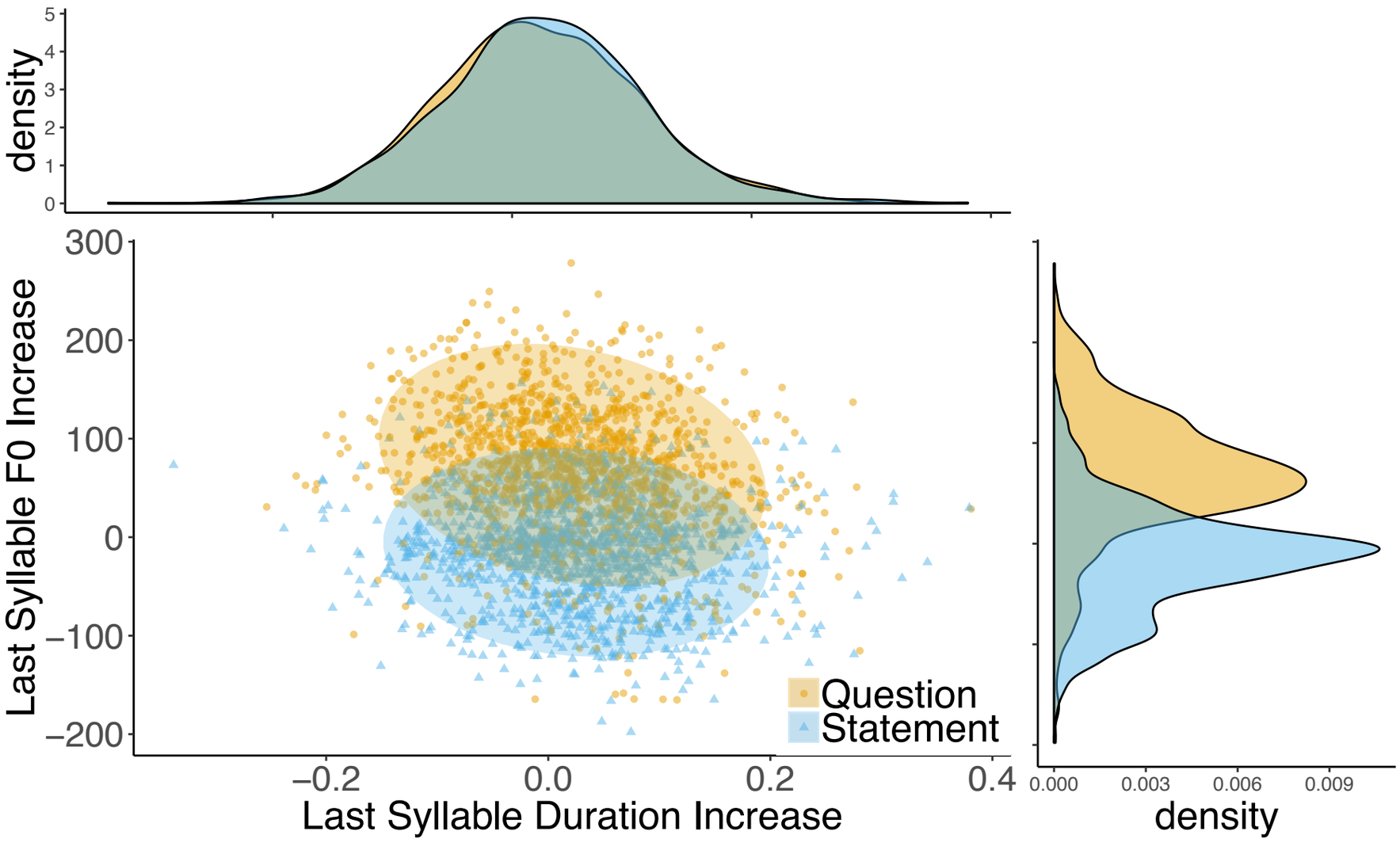
Normalized: Speaker means

- mean of all sentences produced by a given speaker.

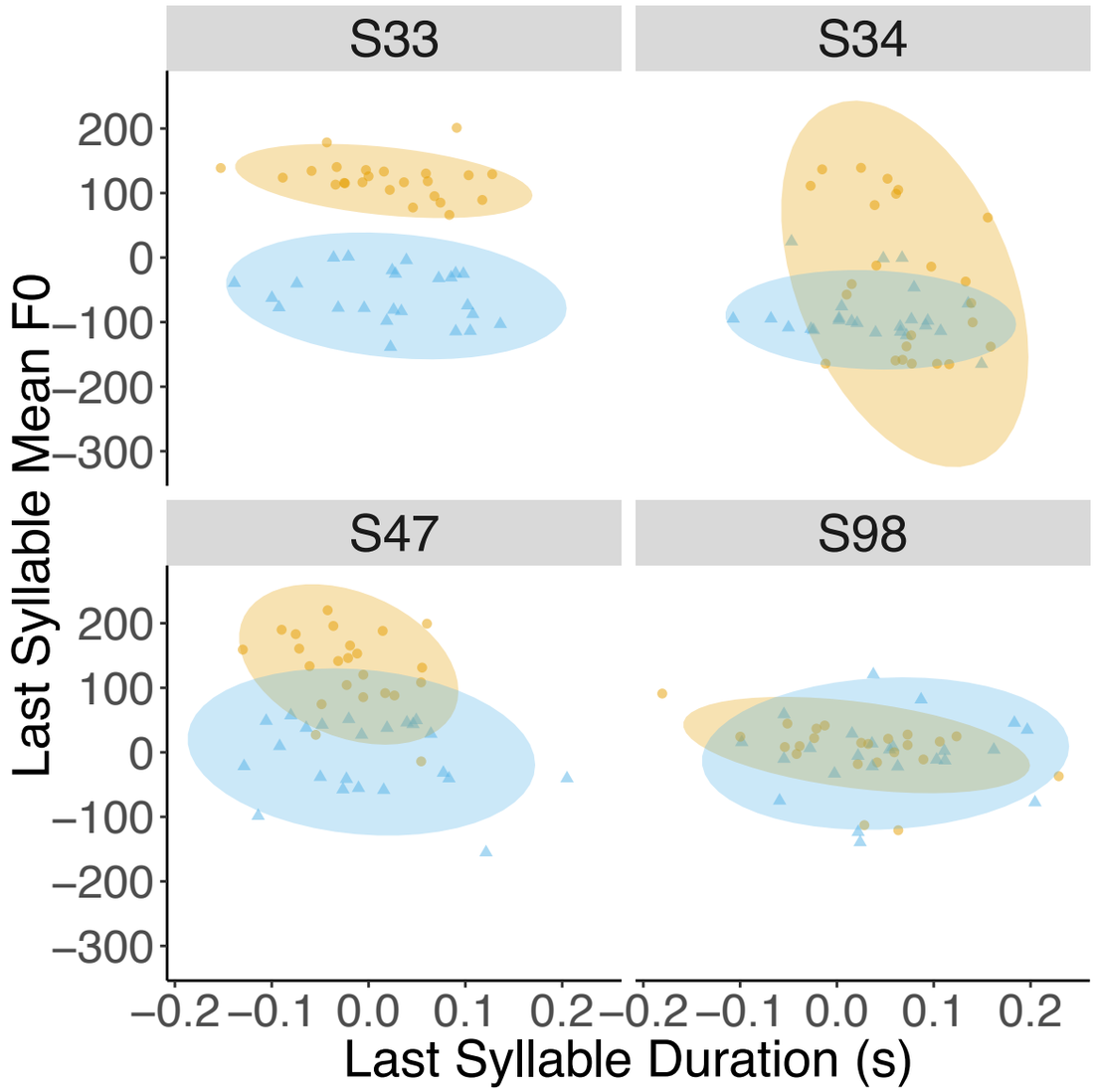


Normalized: Preceding context

- mean of the 2nd syllable (It's X-ing) in the same token



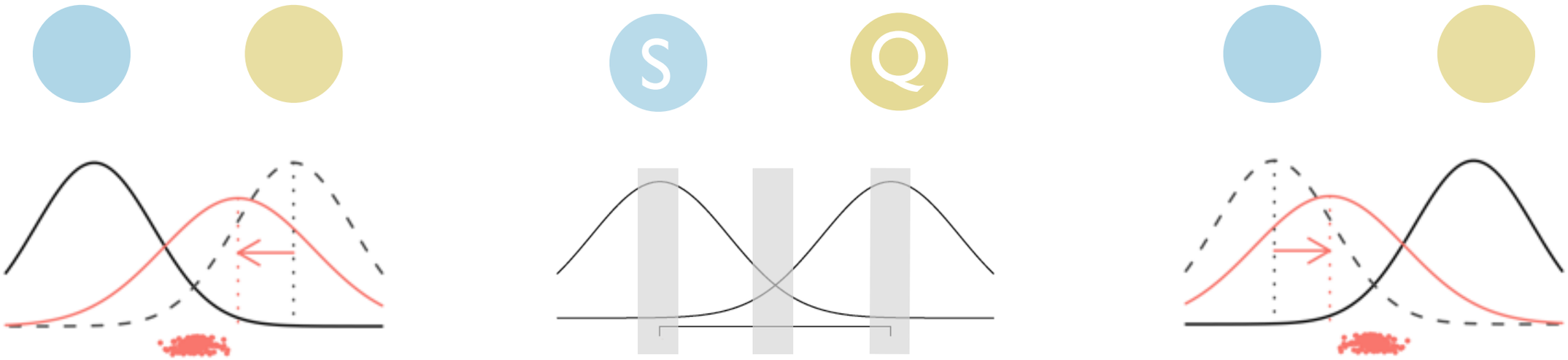
Across talker variability



- Normalization does not fully resolve the ambiguity

  → Can listeners adapt to speaker specificity?

Adaptation to speaker's intonations?

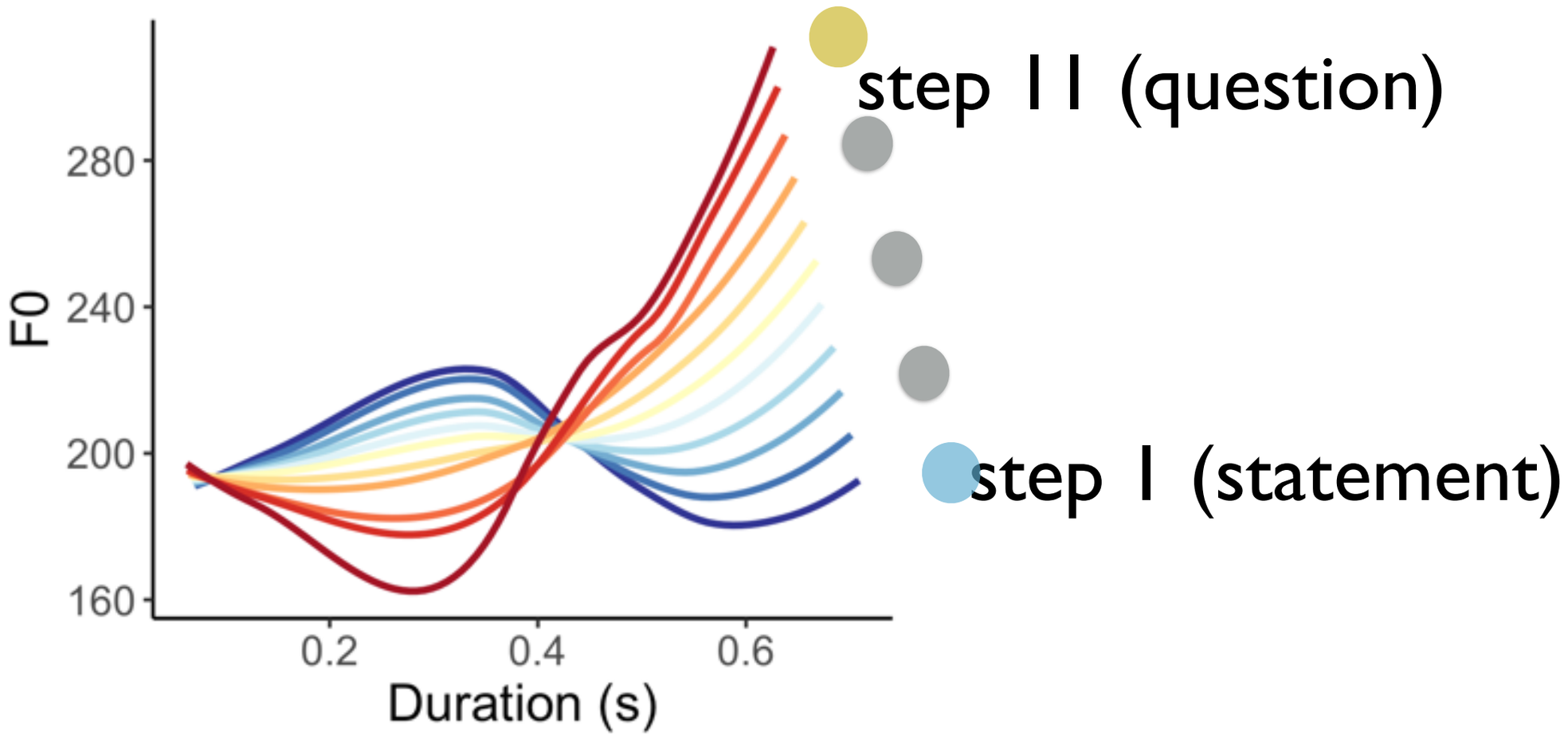


- prediction: depending on the patterns of production by a given speaker, ambiguous tokens receive opposing interpretations

(Kleinschmidt & Jaeger, 2011)

Study 2: Stimuli

"It's moving"



(Kurumada, Brown, & Tanenhaus, 2017)

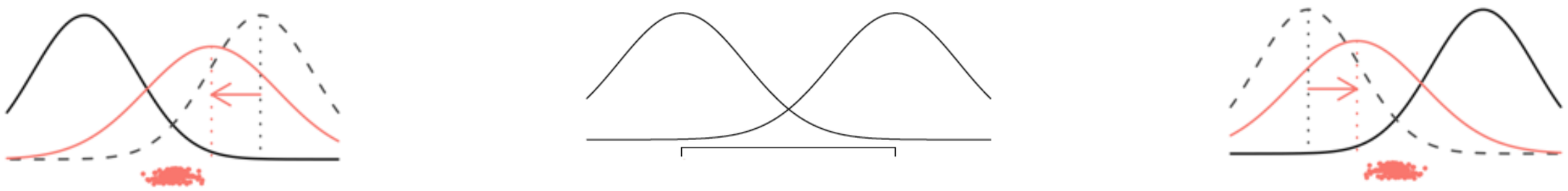
Study 2: Design (n=180)

Pre-exposure (22 trials)

- "It's cooking" sampled from Steps 1-11
- 2AFC: "Is this a question or a statement?"

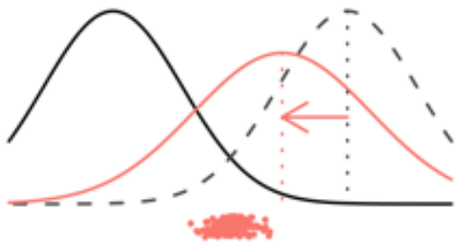
Exposure (30 trials) with feedback

- 3 between-subject conditions

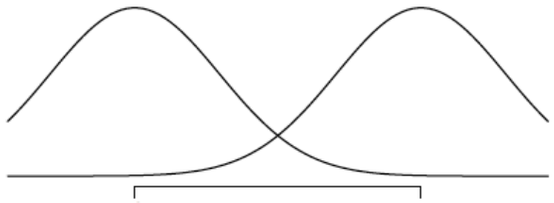


Post-exposure (22 trials)

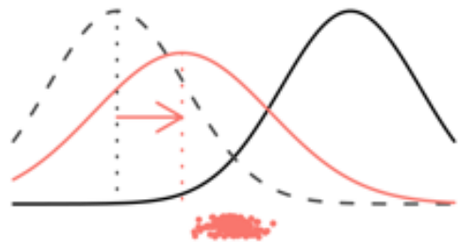
- materials and task identical to the pre-exposure



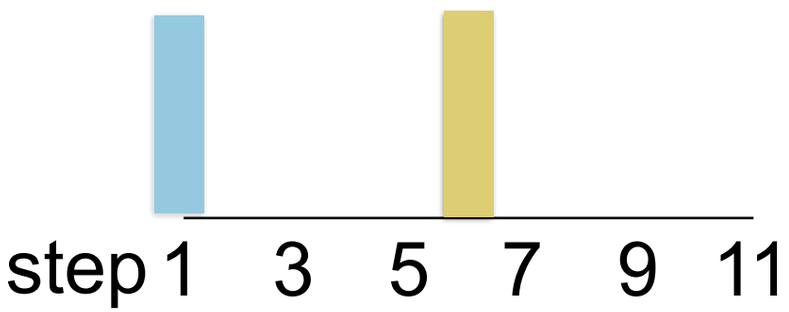
Question-biasing

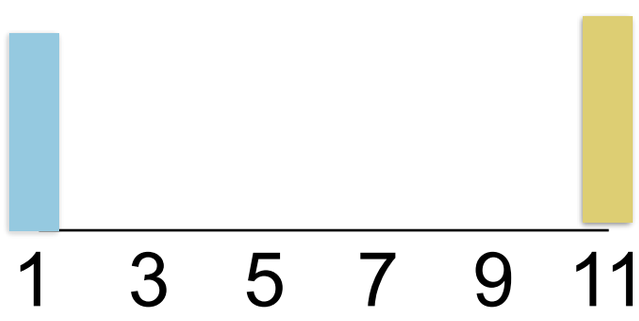


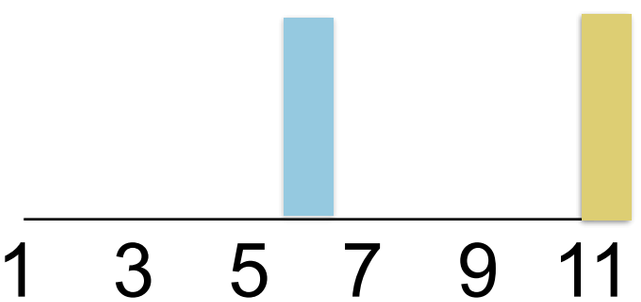
Non-ambiguous

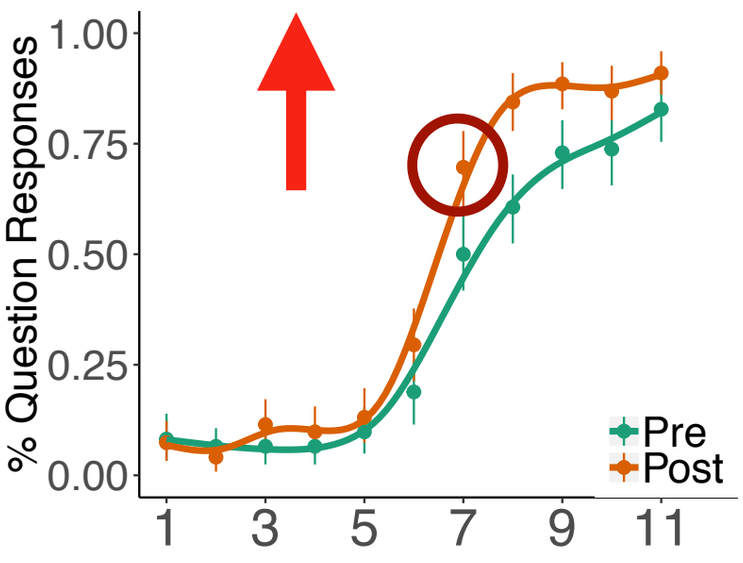


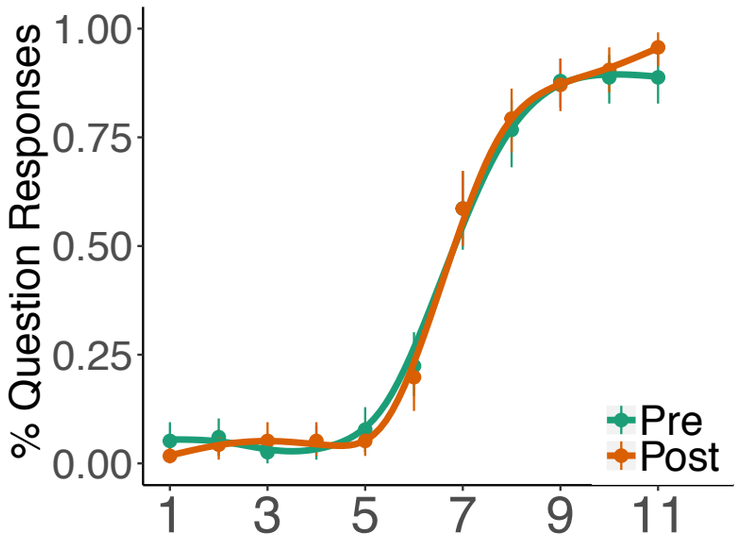
Statement-biasing





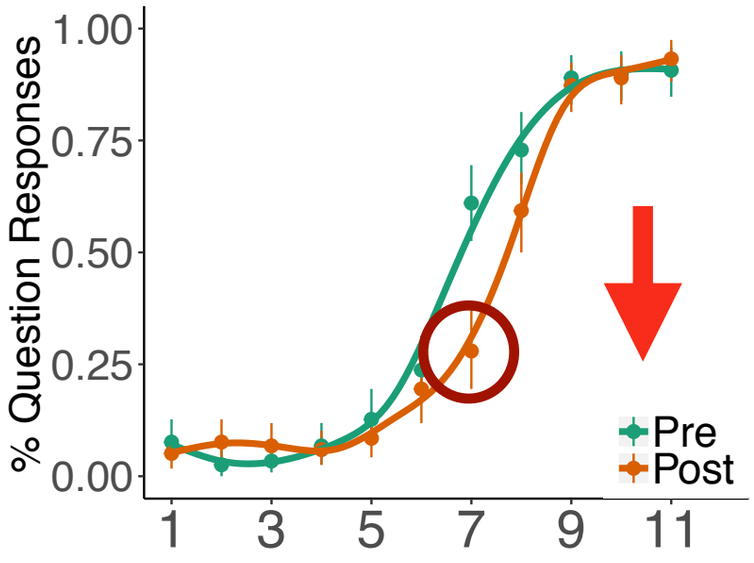




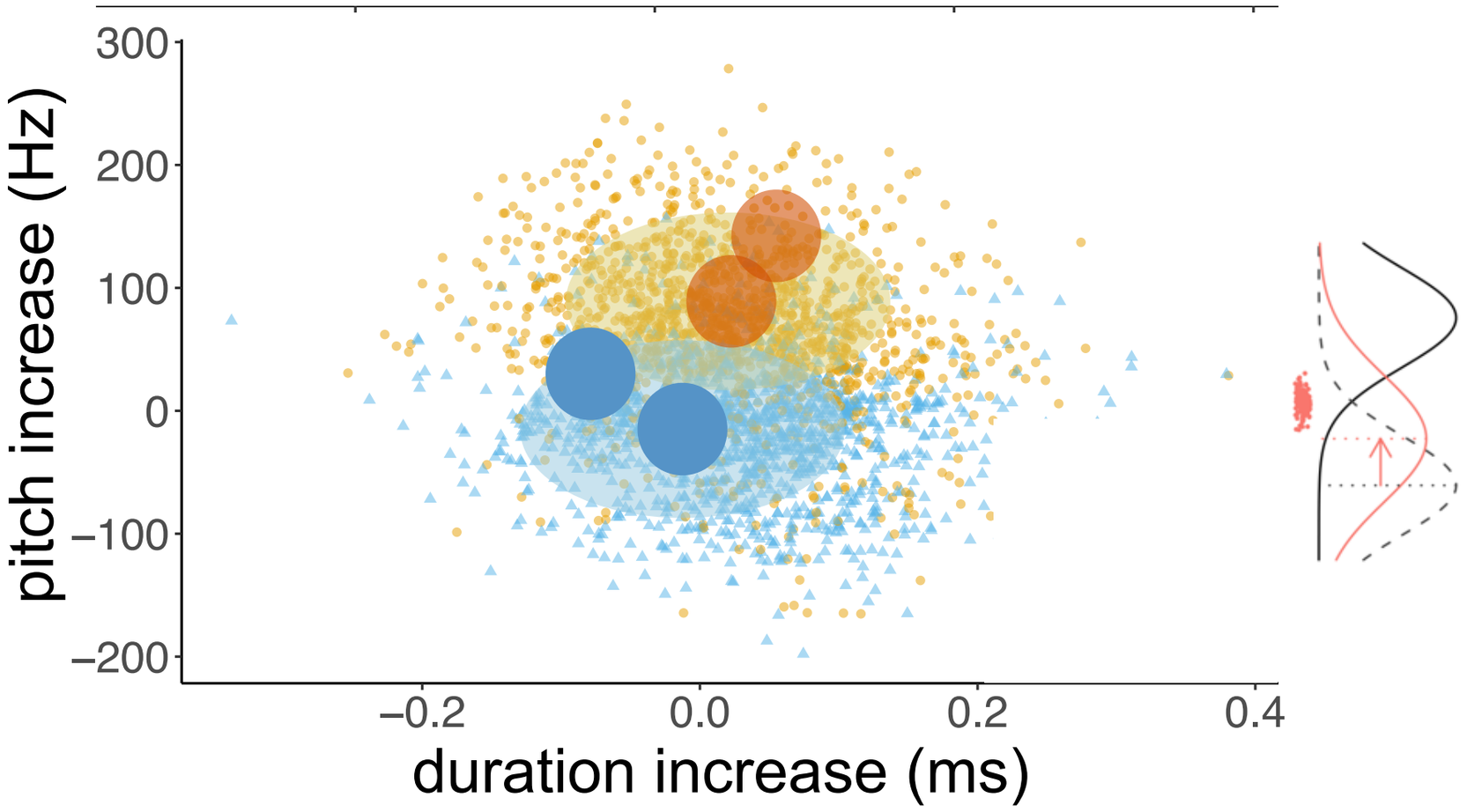


most statement-like

most question-like

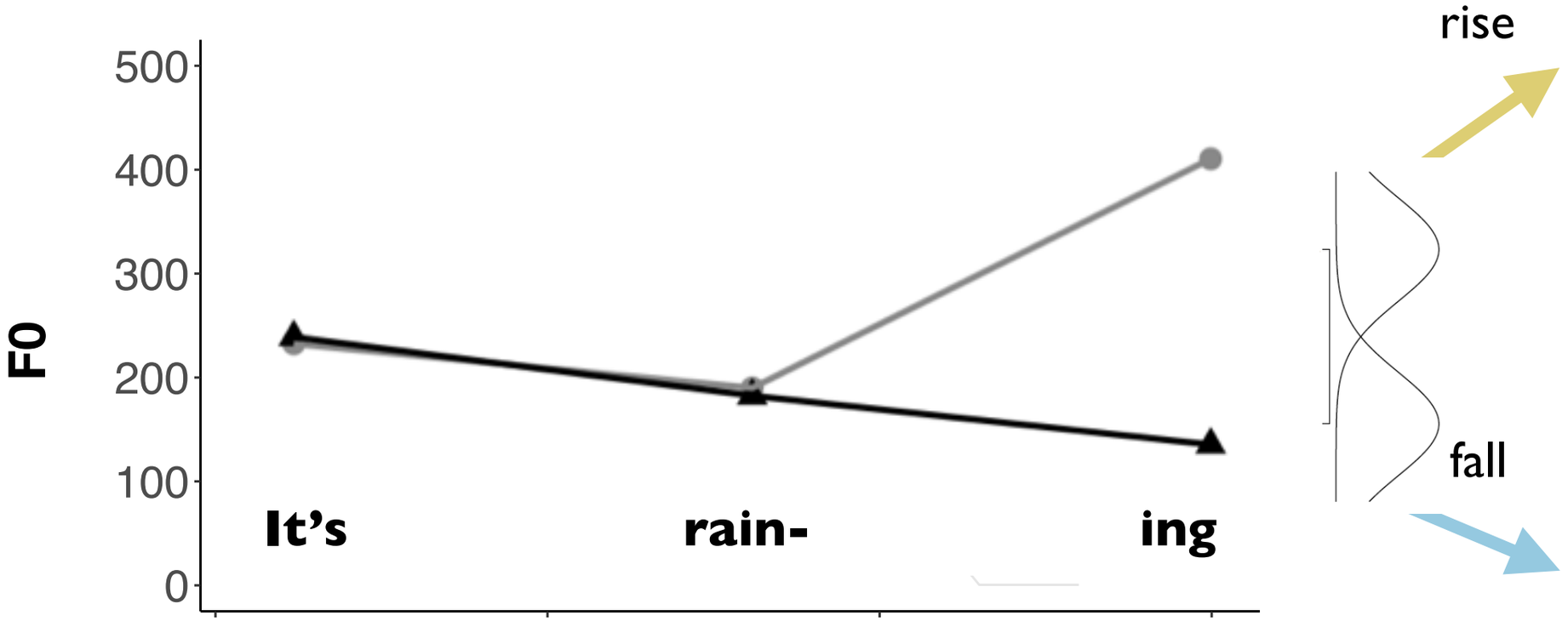


Summary



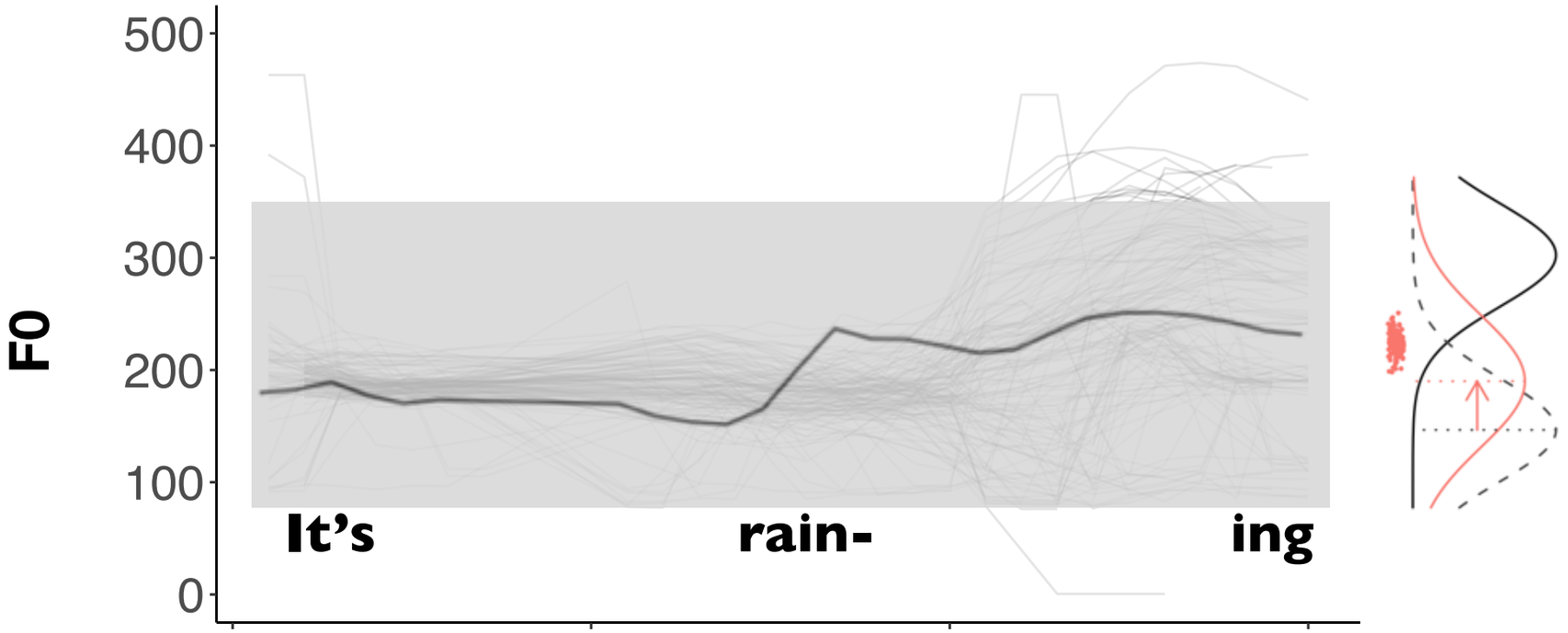
- Adapting to acoustics - intonation mappings facilitates reliable interpretations of the speaker intention

Conclusions



- There is substantial variability in acoustic realizations of intonation contours

Conclusions



- There is a substantial variability in acoustic realizations of intonation contours
- Adaptation leads to better inference over acoustics intonation mapping intended by the given speaker

Thank you!

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http://kinderlab.bcs.rochester.edu/