Tone and articulatory timing: evidence from Tibetan

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Outline

- "About me"

- Tibetan, tones, timing (dissertation and related work)

  - Introduction: intergestural timing; tone change

  - Acoustic study: VOT, F0

  - Articulatory study: tone and articulatory timing

- Summary & future directions

Approach
How I like to think about language

- Framework ← Articulatory Phonology: represents temporal coordination

  (Browman & Goldstein 1988; Nam & Saltzman 2003)

- Methods ← audio recordings, articulatory imaging; lab & field

- Perspectives:

  - Cognitive/Theoretical ← representations and processes

  - Social ← variation between speakers

  - Historical ← change over generations
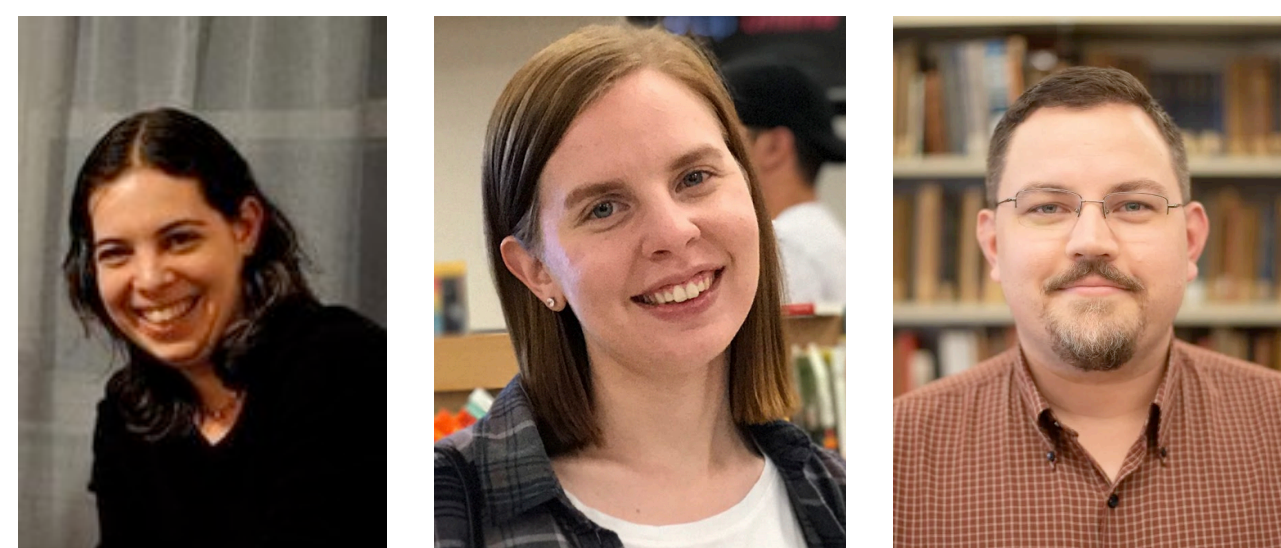
"About Me"
pre-introduction

Where I come from

- Northern New Jersey (Greater New York City)

  - *Mary* [ˈme͡ɪ.ɹi]; *marry* [ˈmæ.ɹi]; *merry* [ˈmɛ.ɹi]

  - *bite* [bəɪʔt˺]; *bide* [ba͡ɪd]; *bout* [ba͡ʊʔt˺]

- Swarthmore College, Yale University, HHU

5
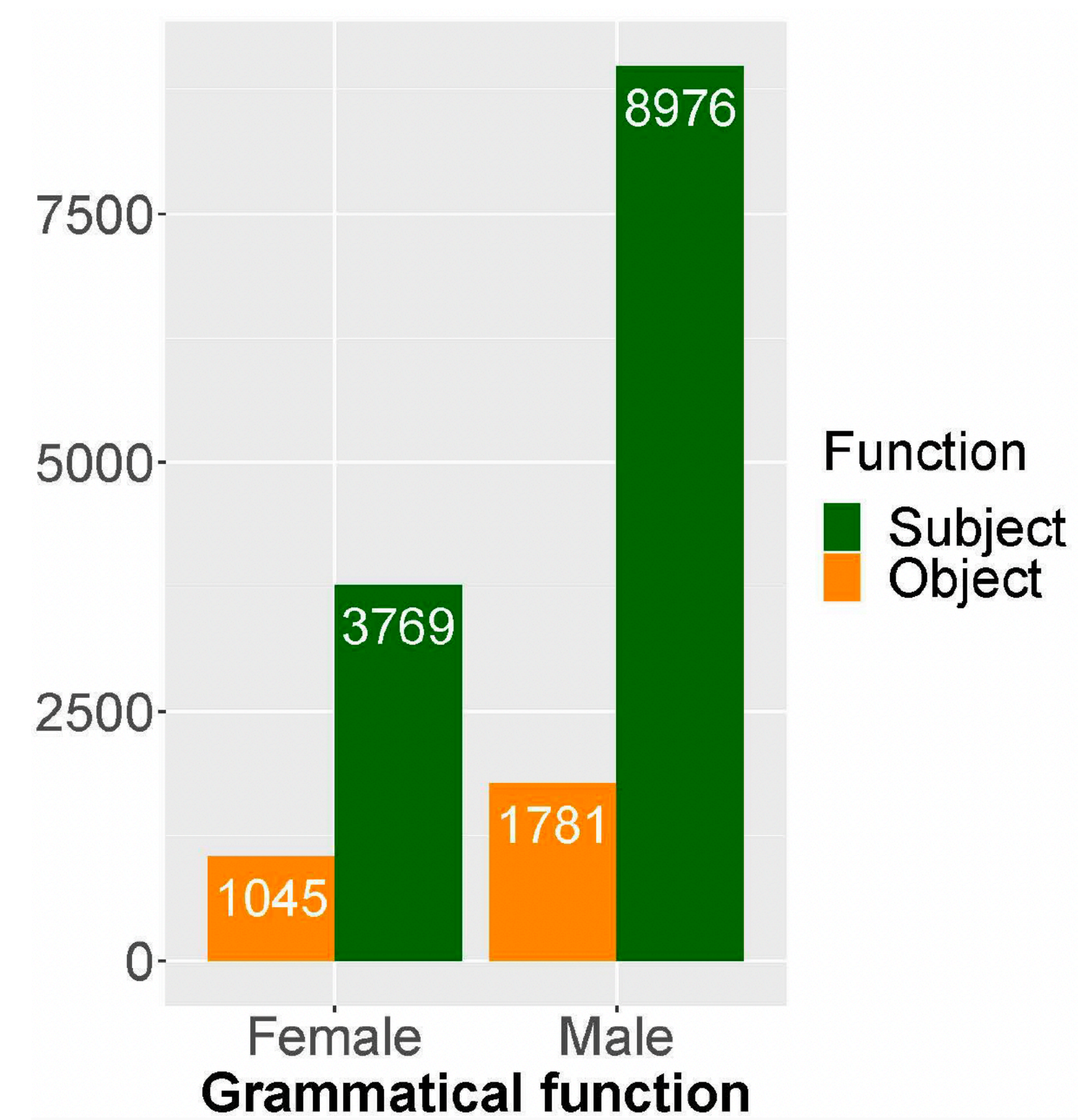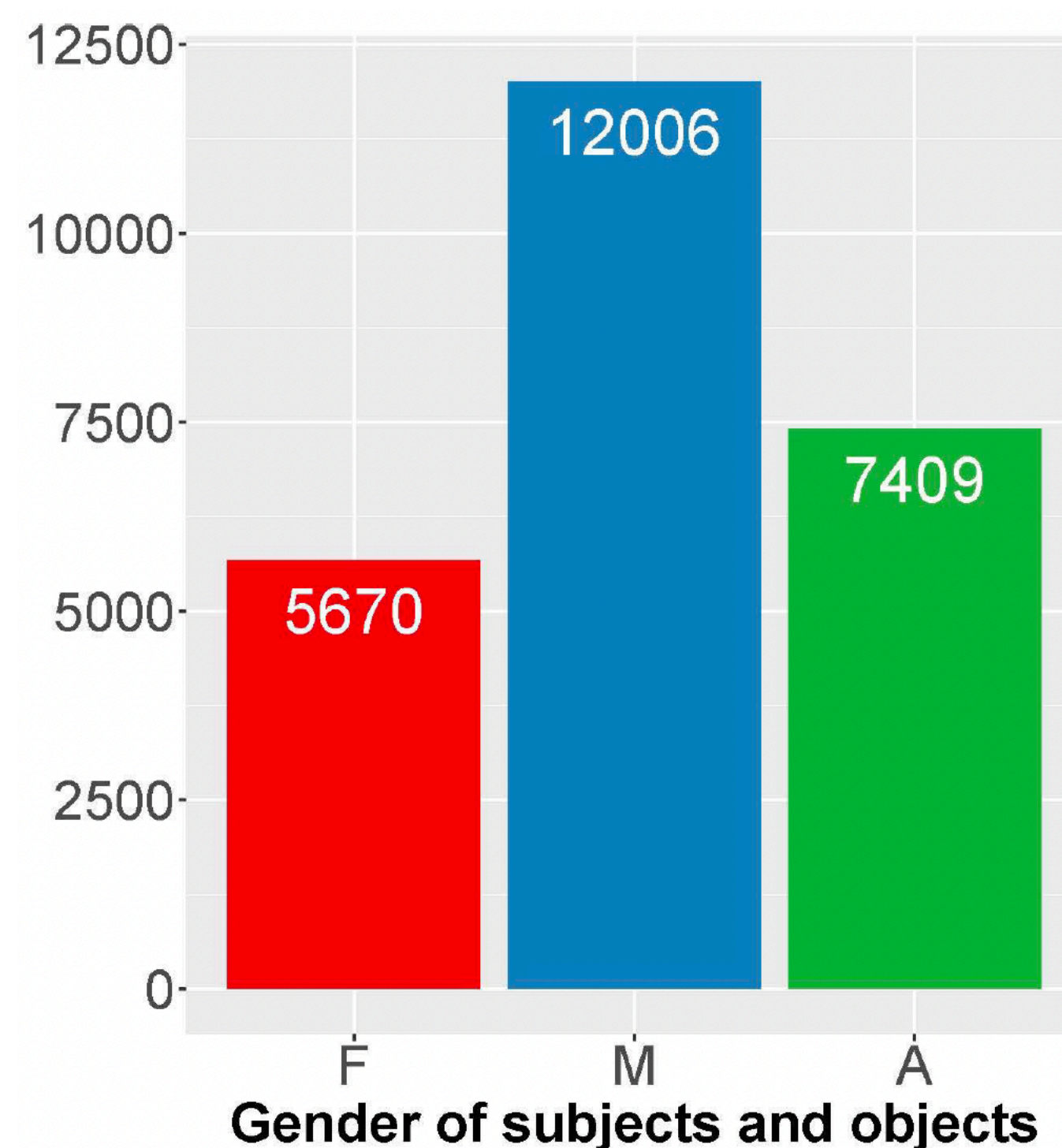
Linguistics things this talk isn't about
but that I also care about

- Scholarly teaching

  - "Ungrading"
    Backward Design
    Writing groups
    E-learning supplements

- Equity in linguistics

  - Diversität in der
    Linguistik e.V.
    https://div-ling.org

Kotek, H., Babinski, S., Dockum, R., & Geissler, C. 2020. Gender representation in linguistic example sentences. *Proceedings of the Linguistic Society of America*, 5(1), 514-528.

Introduction

**Coupled oscillators, tones, Tibetan dialects**

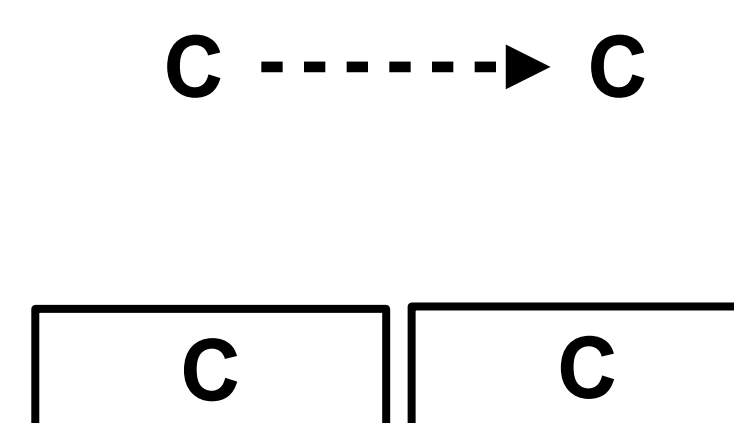# Coordinating gestures in time
Coupled Oscillator Model

- *Gesture:* dynamic movements in the vocal tract that unfold over time.

- Gestural coupling modes:

  - *In-phase coupling:* (synchronous) and *Anti-phase coupling* (sequential) are most stable

  - *Competitive coupling:* combination of in-phase and anti-phase coupling relations

  - *Eccentric coupling:* one coupling relation, just not intrinsically stable

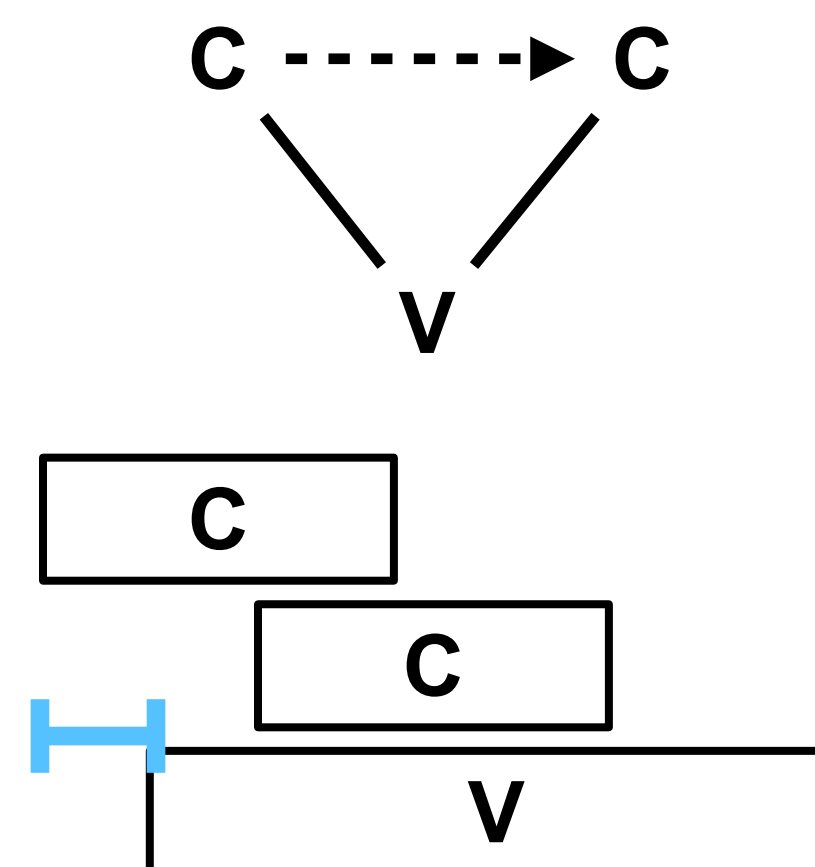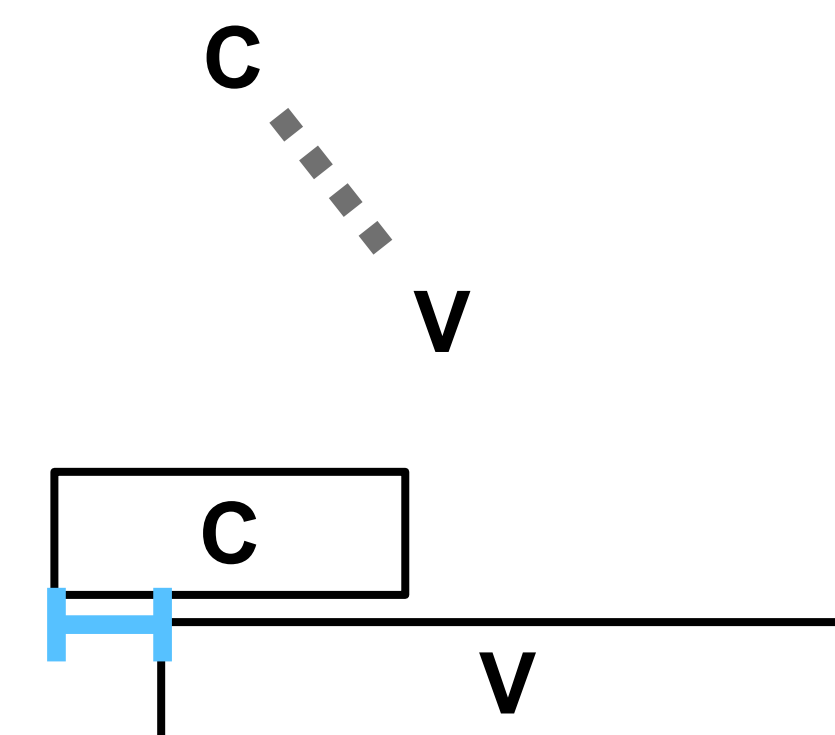*(Nam & Saltzman 2003, Nam et al. 2009, Goldstein 2011)*

In-phase

Anti-Phase

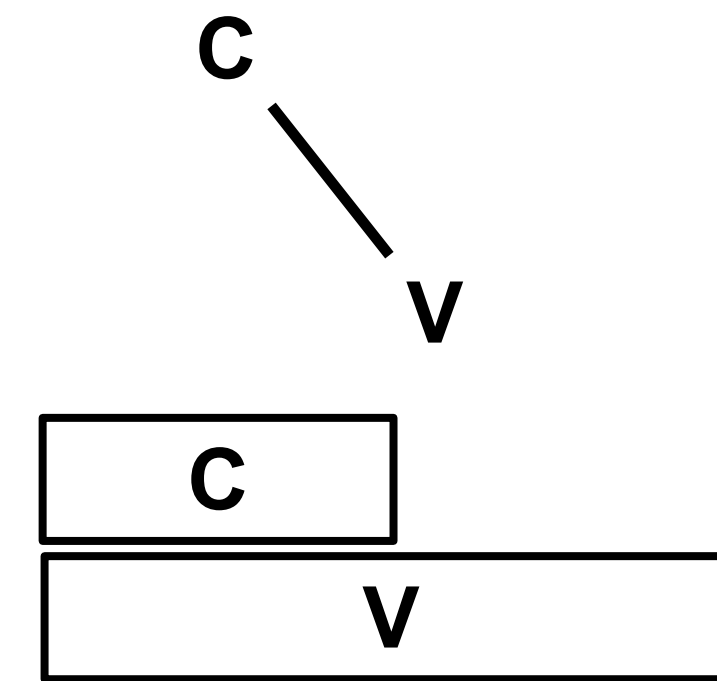**Competitive**

Eccentric

8
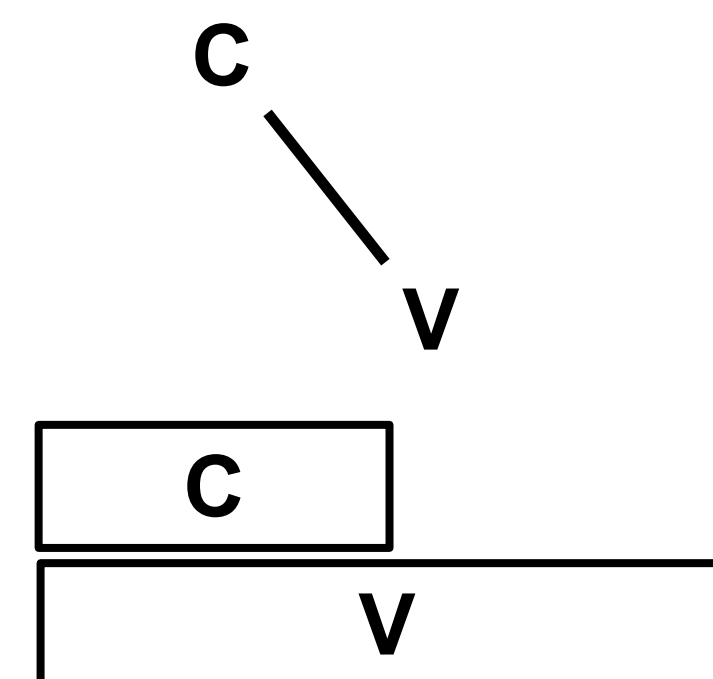
Coordinating tone gestures
Articulatory Phonology in one slide

- *Tone gesture:* treat F0 targets similar to articulatory targets

- For lexical tone languages, C-V timing has a lag suggesting competitive coupling

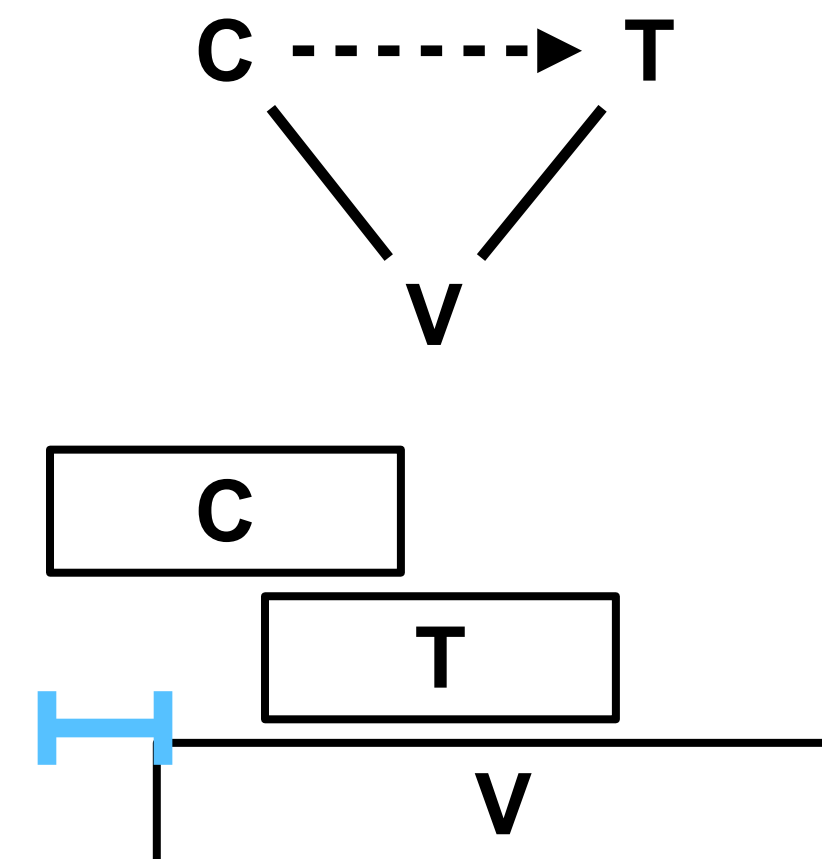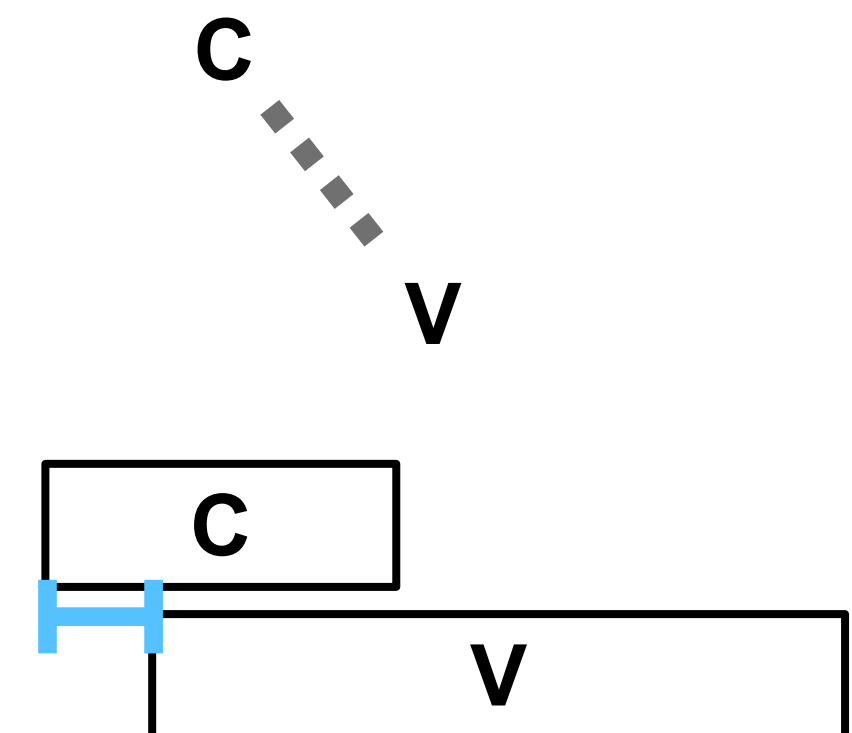 - difference between lexical tone and intonational tone…

In-phase

Anti-Phase

Competitive

Eccentric

(Gao 2008, Niemann et al. 2011, Karlin 2014)

A "Natural Laboratory"

Let's find…

- A language with variation across dialects & speakers:

  - lexical tone

  - onset consonant clusters

  - laryngeal phonology

- Tone gestures predicts that tone affects relative C-V timing. Observed in:

  - lexical tone languages (Mandarin, Thai, Lhasa Tibetan)
    (Gao 2008, Karlin 2014, Hu 2016)
  - contextually-toneless syllables (Mandarin)
    (Zhang, Geissler, & Shaw 2019)
  - across speakers of the same language…
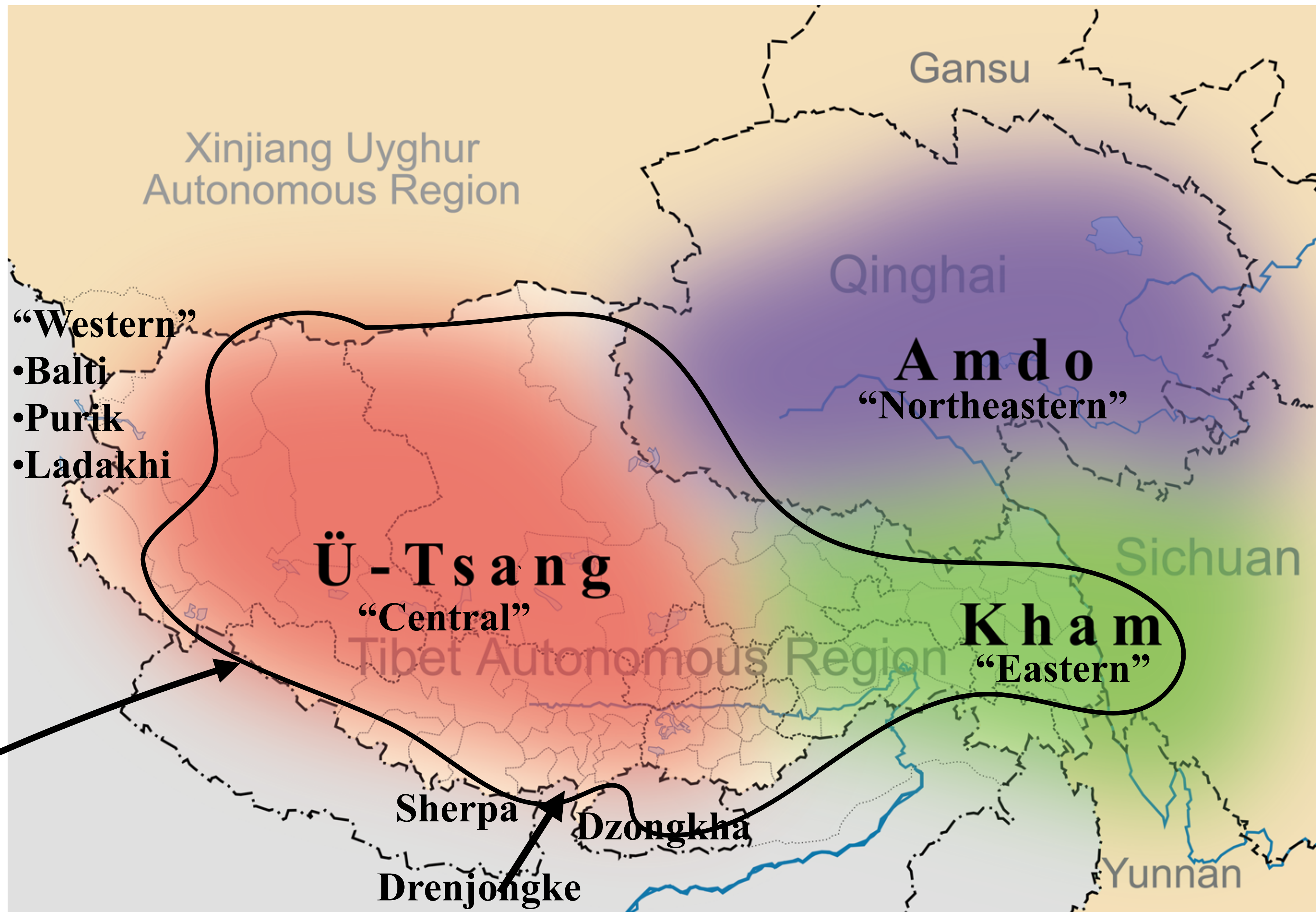
Tibetan
བོད་སྐད་

- "archaic"/"cluster"

- "innovative"/"non-cluster"

- dialect continuum

- post-1959 diaspora

"Western"
- **Balti**
- **Purik**
- **Ladakhi**

Ü-Tsang
"Central"

A m d o
"Northeastern"

K h a m
"Eastern"

Approx. extent of tone

Sherpa

Dzongkha

Drenjongke

Dialects: Natural laboratory

- tonogenesis

- laryngeal variation

- cluster simplification

- vowel shifts, spirantization, retroflexion, palatalization

- evidential, honorifics, modality, etc.

Written (Classical) Tibetan	Balti (Western)	Rebkong (Northeastern)	Tokpe Gola (Central)	Gloss
khrag	[kʂʌk]	[t͡ɕɤɣ]	[ʈʰʌ́k] ([ʈʰák])	'blood'
rtswa	[xst͡soa]	[xt͡sa]	[t͡sá]	'grass'
spyang ki	[spjaŋ.ˈku]	[xt͡ɕaŋ.ˈkʰɤ]	[t͡ʃáŋ.gú]	'wolf'
bcu bdun	[t͡ɕub.ˈdʊn]	[t͡ɕɤb.ˈdɤn]	[t͡ʃúp.tɤ̃́] ([t͡ʃúp.tɤ̃́])	'seventeen'

(Adapted from Caplow 2013)

Tonogenesis
Transphonologization(?)

- Voiceless onsets > high tone

- Voiced onsets > low tone

  - Sonorants with pre-initial > high tone

- *pʰar 'over there' > H
  *sa 'earth' > H

- *bar 'between' > L
  *za 'eat' > L
  *mar 'butter' > L

- *sman 'medicine' > H

Laryngeal contrasts over time

	Etymological onsets				Innovative features
Orthography	སྤ་	ཕ་	བ་	སྦ་	
Old Tibetan	$s^ə pa$	$p^h a$	ba	$s^ə ba$	(only voicing contrastive)
Northeastern and Western dialects	spa	$p^h a$	ba	ʁba	consolidation of clusters aspirated/unaspirated contrast
Eastern dialects	pá	p^há	pà	bà	tonogenesis cluster simplification
Central dialects (Lhasa)	pá	p^há	p^hà	pà	voiced clusters > voiceless voiced simplex > aspirated

Acoustic study

VOT, F0

Goals

- Establish facts about consonantal and tonal contrasts

  - Interspeaker variation?

  - How to tone and laryngeal contrasts co-occur?

- Inform hypotheses for controlled articulatory study

Data

- Word list presented in Tibetan orthography

  - 22 items * 2 repetitions (from 64-item wordlist)

- Data presented from 19 speakers raised in diaspora (30s or younger)

- Part of a larger study:

  - speakers from other dialects

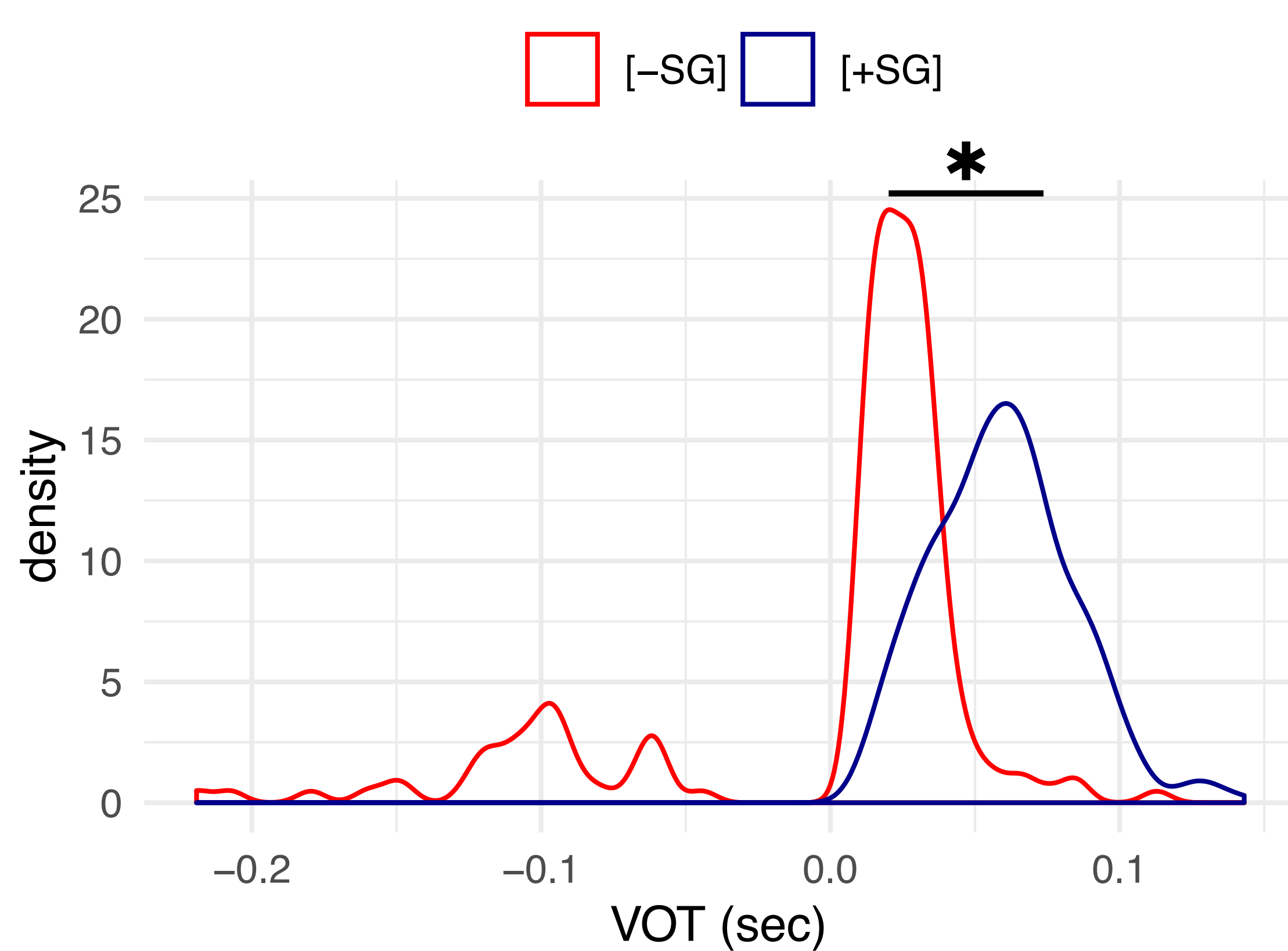 - sociolinguistic interviews with other tasks

F0-tone
F0 at onset of voicing

- H > L significant for 11/19 speakers
- no significant difference for 7/19 speakers
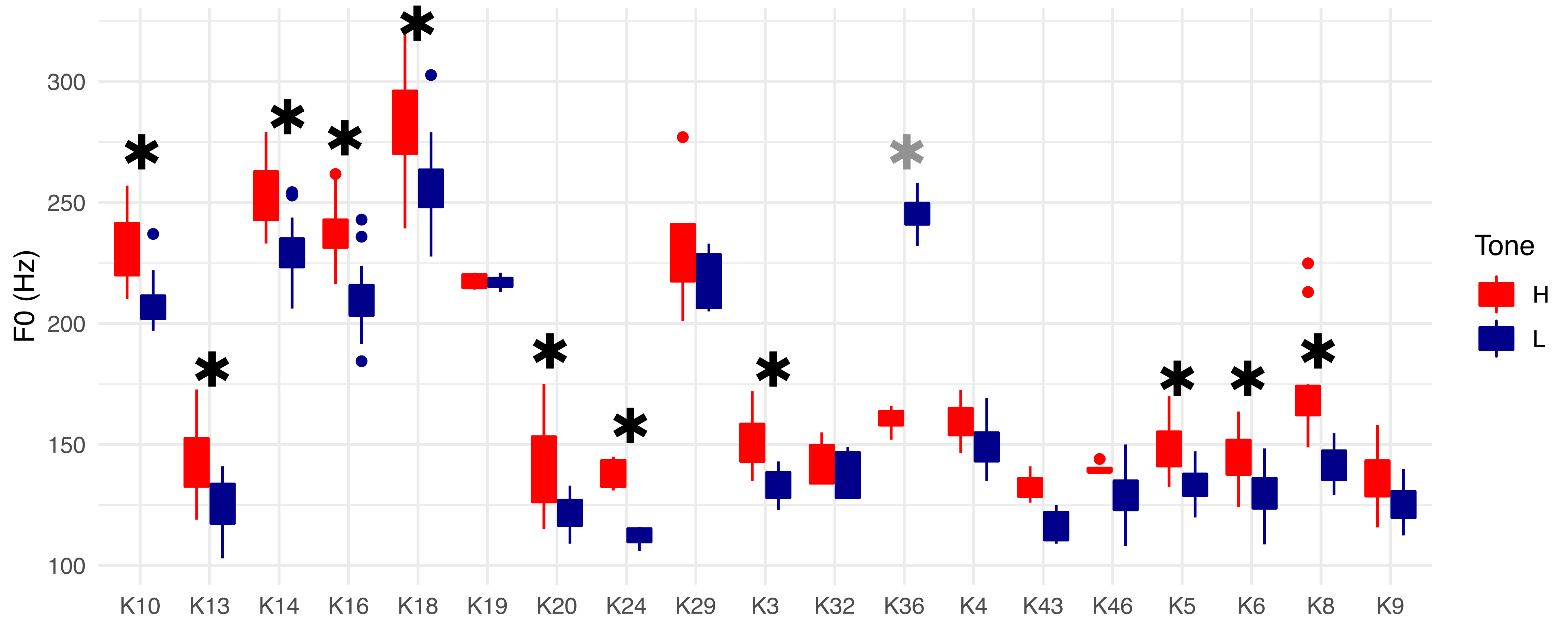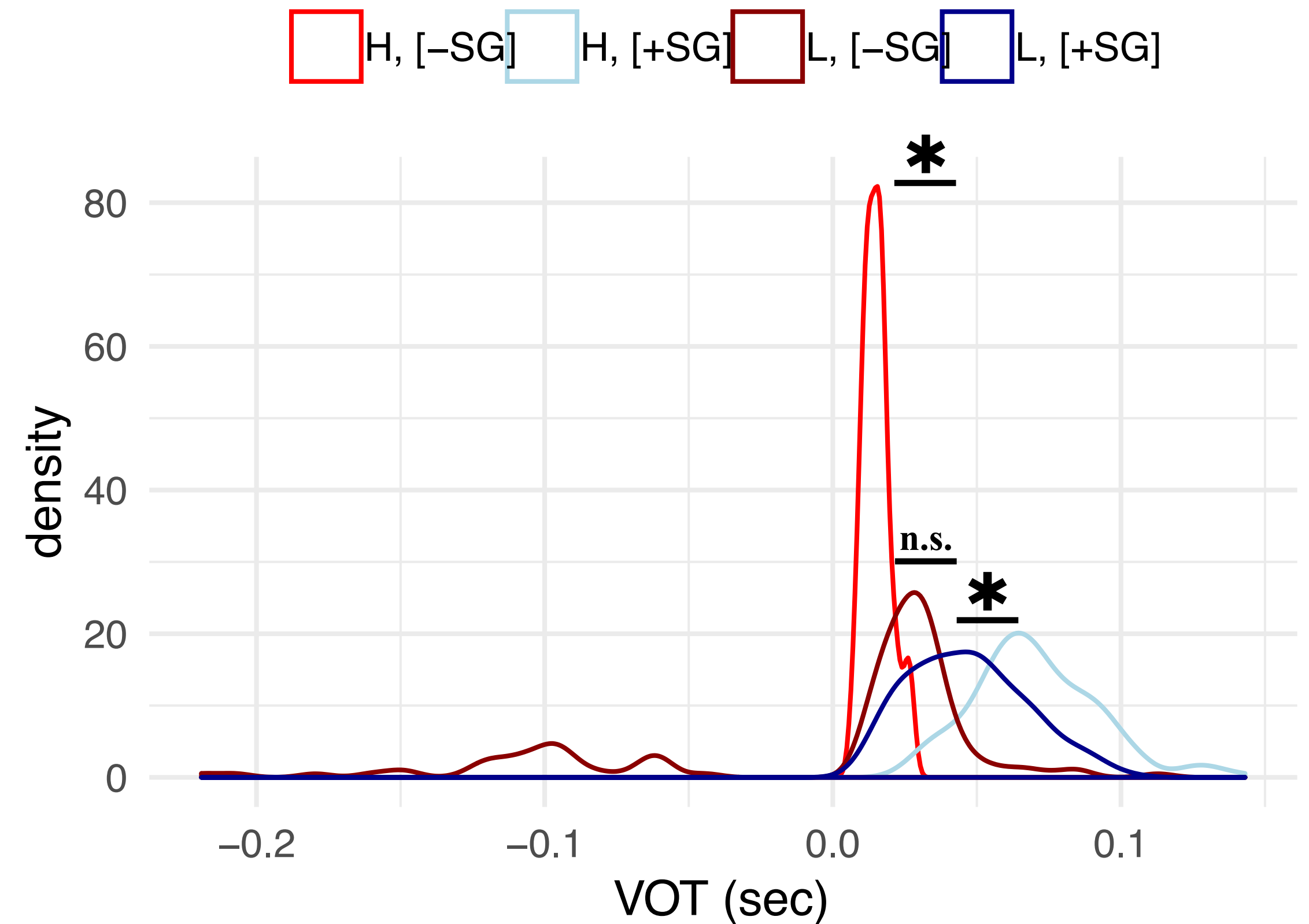
VOT and tone categories

- Unaspirated vs. aspirated

- Unaspirated vs. aspirated…
  … plus tone

Summary of corpus study

- Confirmed:

  - no clusters in diaspora speakers, etc.

- Novel findings:

  - some speakers lack tone contrast (production)

  - effect of tone on aspiration duration

  - effect of tone on prevoicing

Articulatory study

EMA, tone

Hypotheses

- H1: variation in timing conditioned by presence/absence of lexical tone

  - speakers with tone contrast will have competitive coupling (pos. C-V lag)

  - speakers without tone contrast will have in-phase C-V timing (no C-V lag)

- H2: timing convergence:

  - all speakers will have similar coordination patterns despite interspeaker variation in presence/absence of tone

- What kind of tone contrast is there?

  - If H-$\varnothing$, then difference will be visible in high vs. low tone words

  - If H-L, then no difference in timing by tone.

Electromagnetic Articultography (EMA)

- A method to track movement with high spatial and temporal resolution

- Speakers read words in carrier phrase on a screen, in Tibetan orthography

- EMA sensors on each lip and three on tongue; head movement corrected w/r/t/ three sensors on rigid points of the head

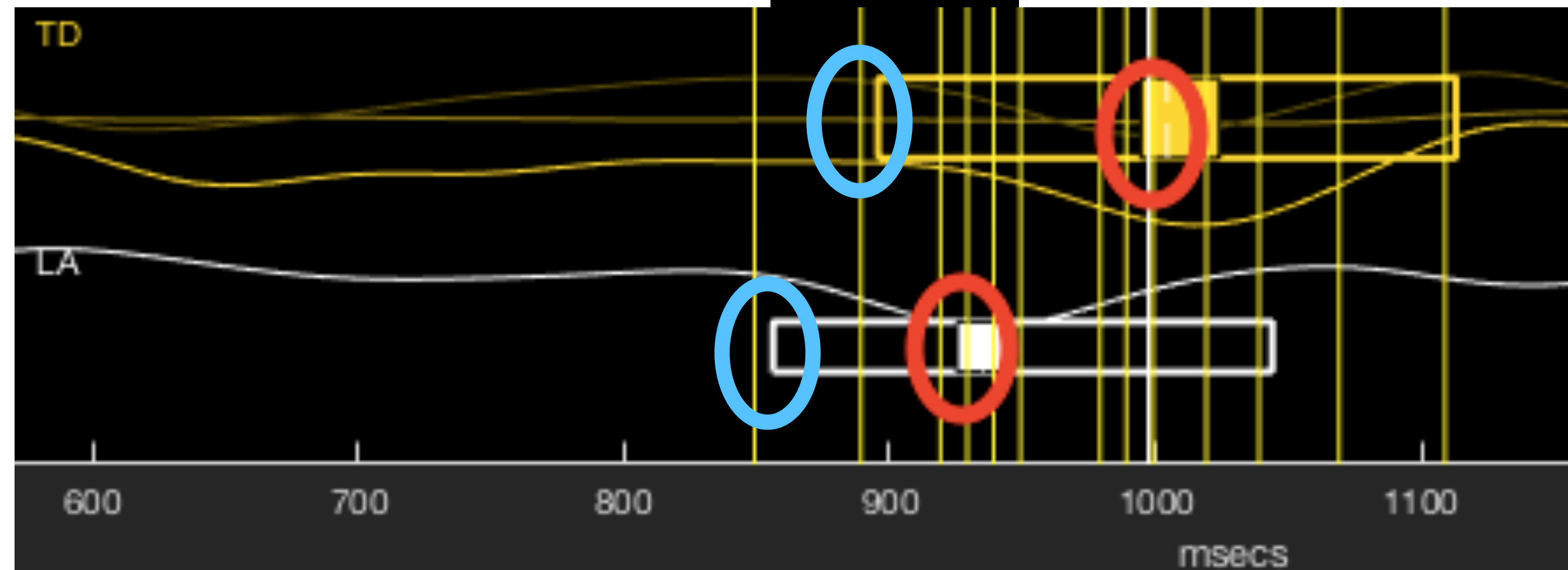- Gesture start labelled at 20% of peak velocity to target

EMA data
articulatory trajectories

- Tracks movement of sensors over time

- [p p^h m]: distance between lip sensors

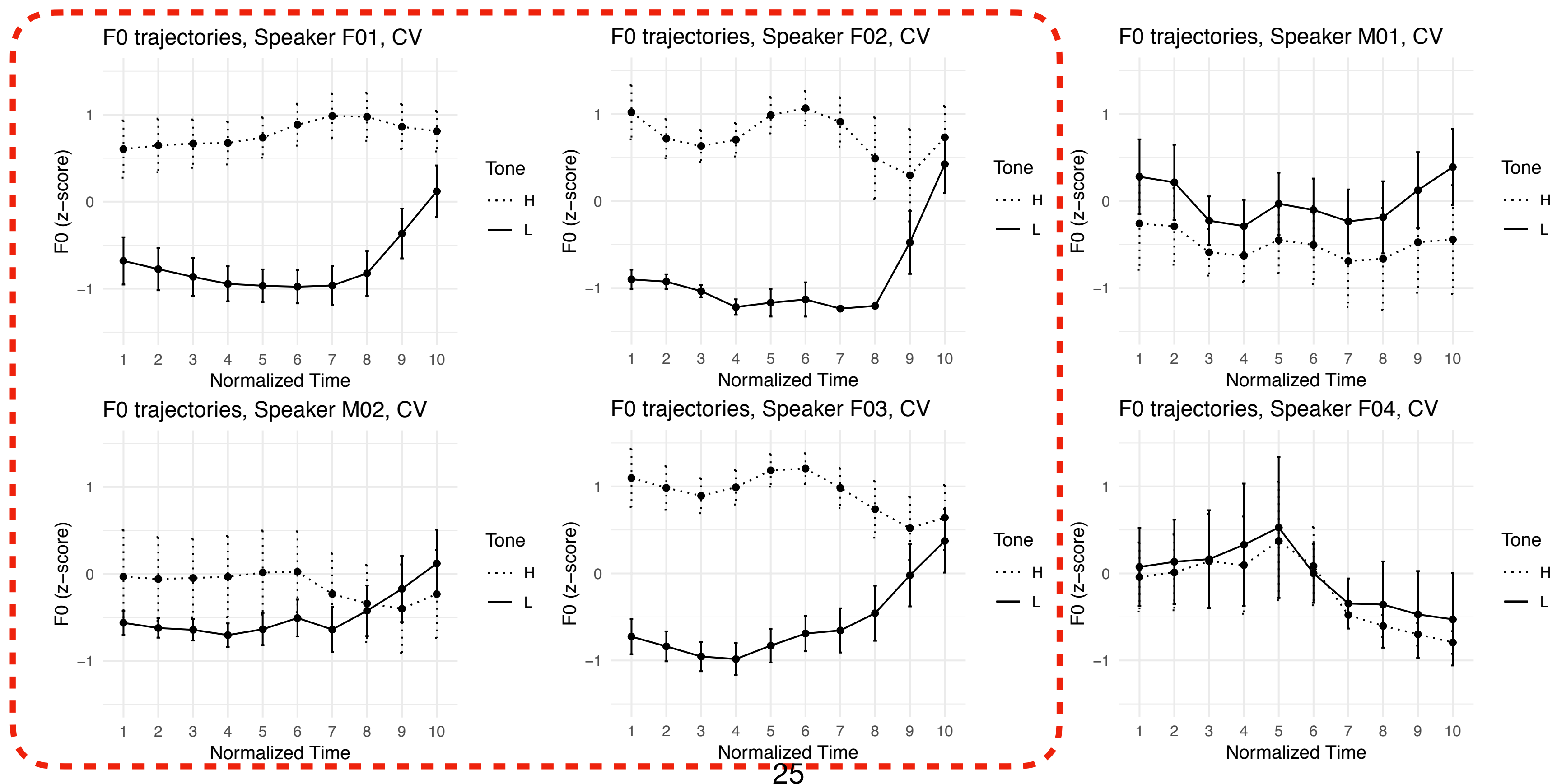- [i]→[u o a]: tongue dorsum retraction

[mu]

Tongue Dorsum: front ↓ back

Lip Aperture: open ↓ closed

TD

LA

600   700   800   900   1000   1100
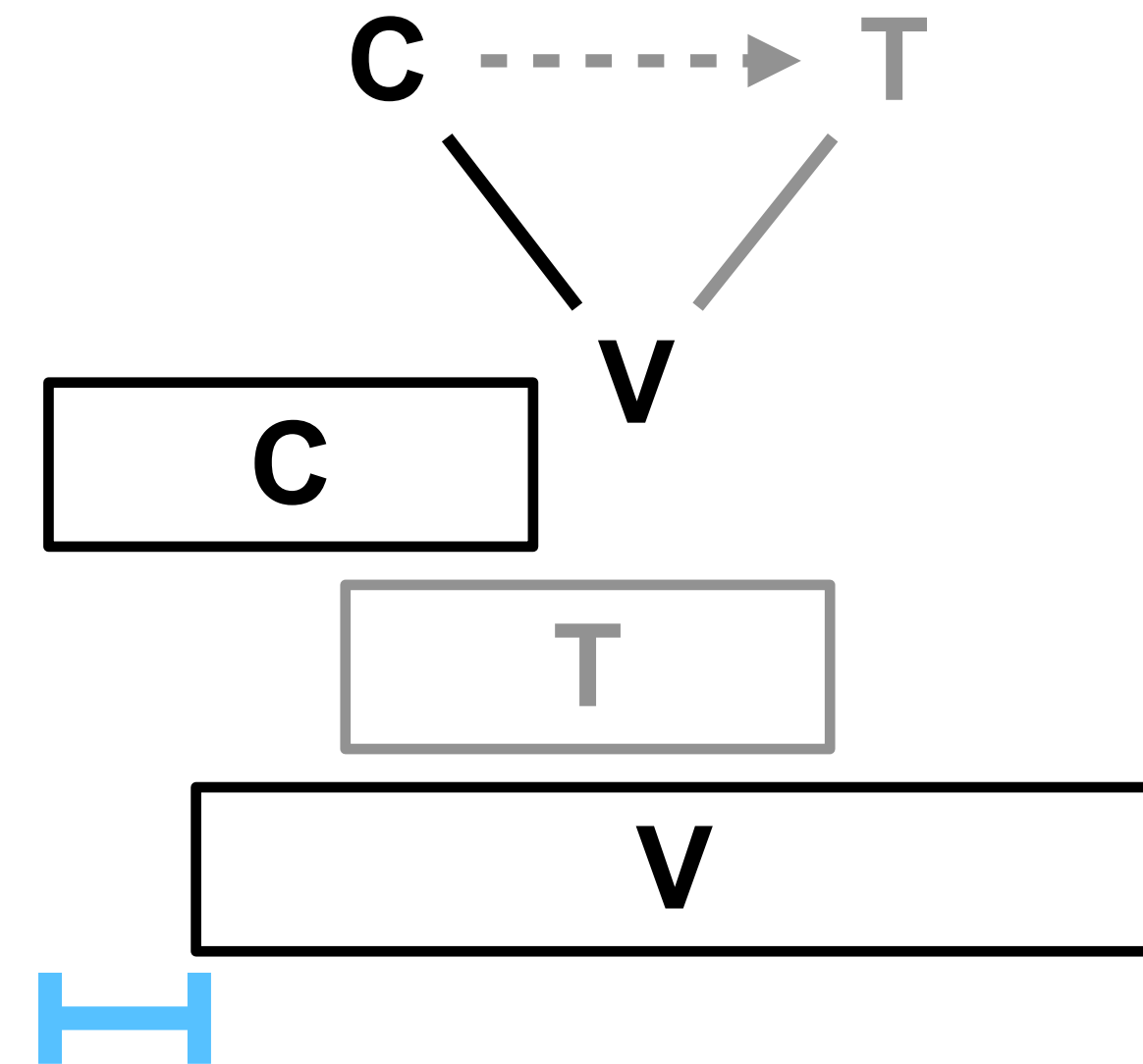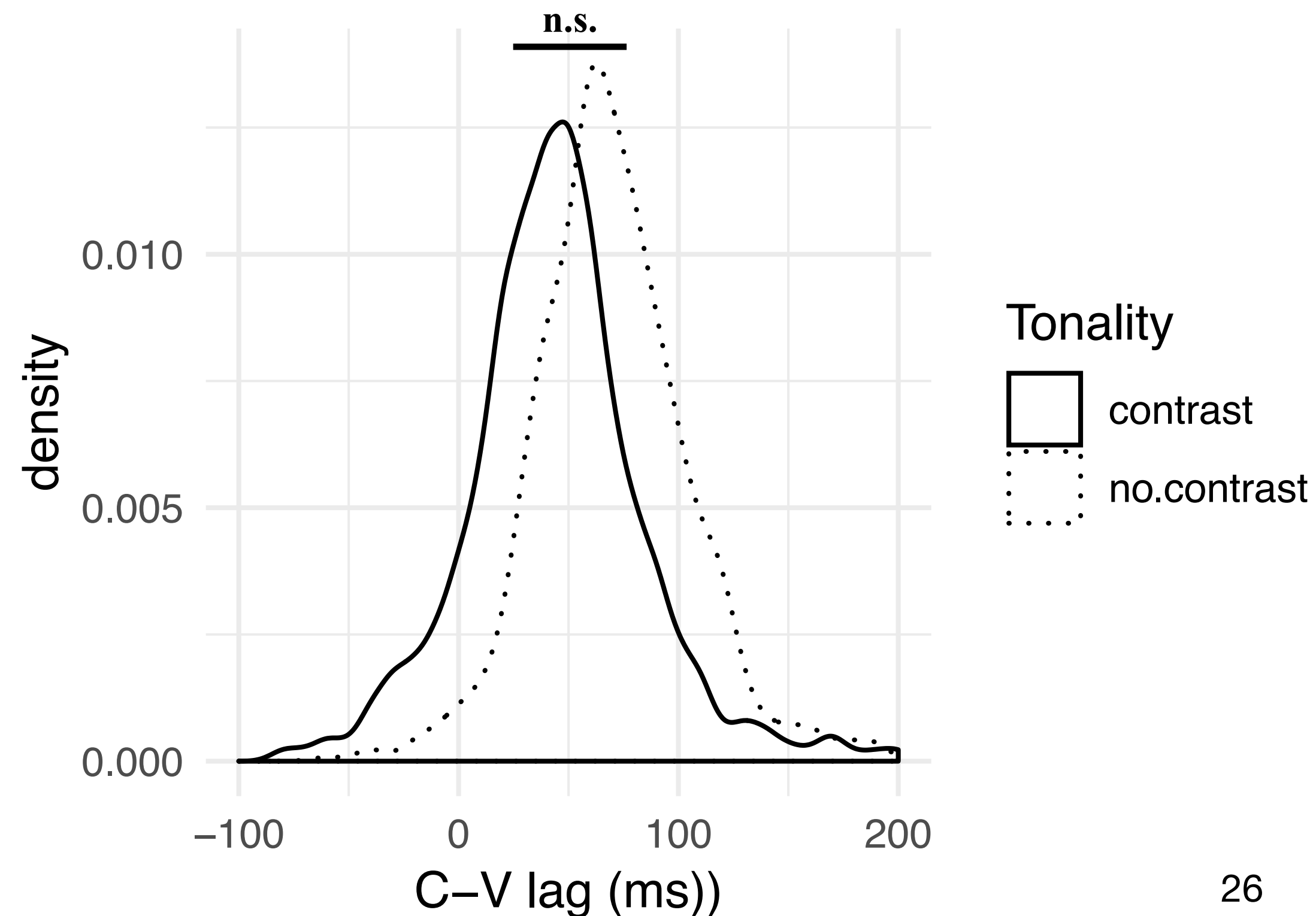
msecs

(Mview software: Tiede 2005)

Results: tone contrast

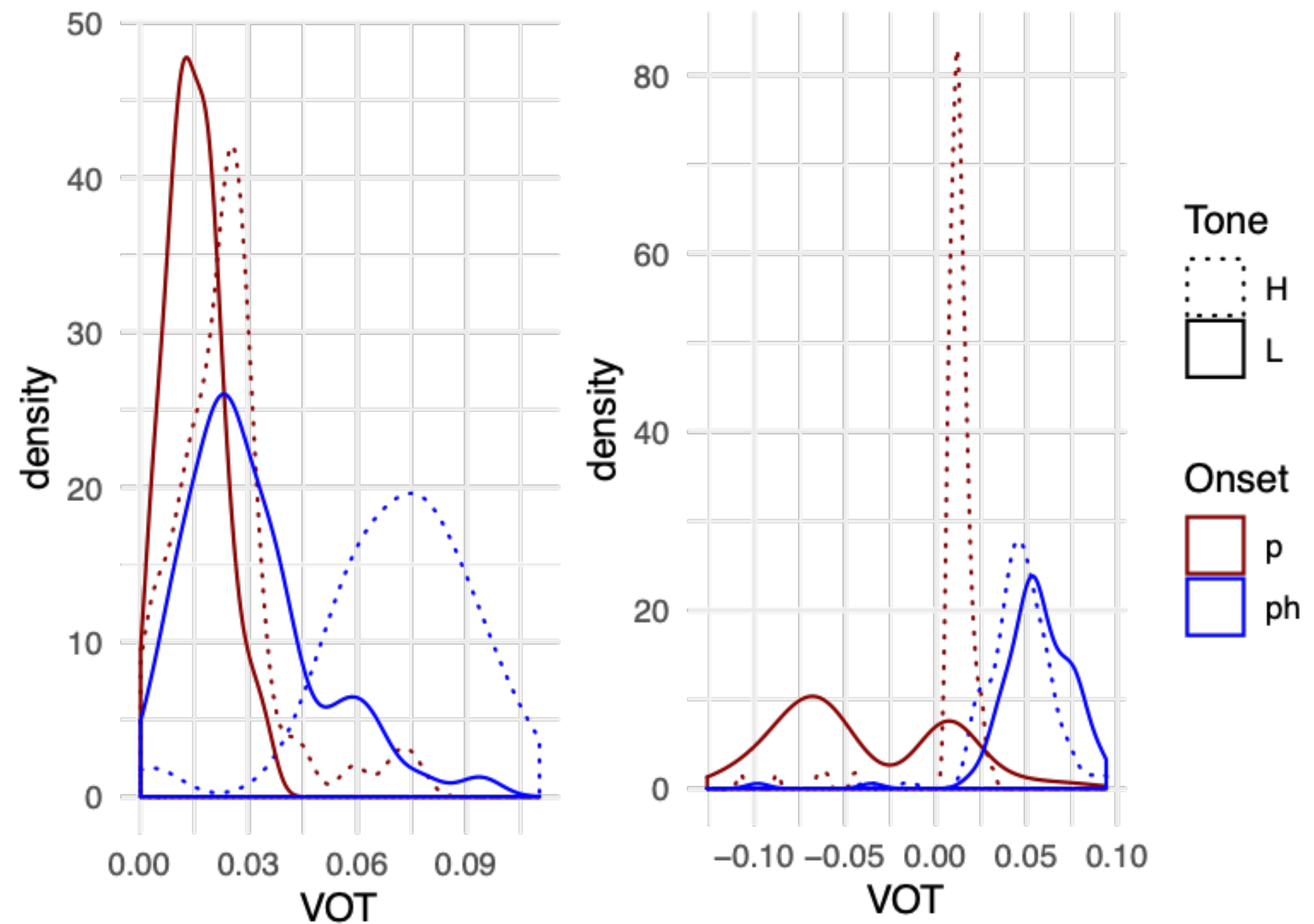- 4 speakers produce a tone contrast, two do not (on /mV/)

Results: C-V lag

- There is a positive C-V lag… for speakers with and without the tone contrast

- No significant difference between the tones

Two systems of laryngeal contrasts

- Both conditioned by tone:

- Left speaker
  - no prevoicing
  - long VOT only with H tone

- Right speaker:
  - prevoicing with L tone
  - long VOT with both tones

EMA Study conclusions

- H1: variation in timing conditioned by presence/absence of lexical tone

  - speakers with tone contrast will have competitive coupling (pos. C-V lag)

  - speakers without tone contrast will have in-phase C-V timing (no C-V lag)

- ✔ **H2: timing convergence:**

  - all speakers have similar coordination patterns despite interspeaker variation in presence/absence of tone

- What kind of tone contrast is there?

  - If H-∅, then difference will be visible in high vs. low tone words

  - ✔ If **H-L**, then no difference in timing by tone.

Summary & Future Directions

Summary of Findings

- Tibetan speakers in diaspora..

  - … vary in their phonology

    - presence/absence of tone

    - two laryngeal contrast systems

- … preserve lexical contrasts

  - tone-conditioned VOT categories persist
    even when speakers don't have tone contrast

- … maintain temporal stability in articulation
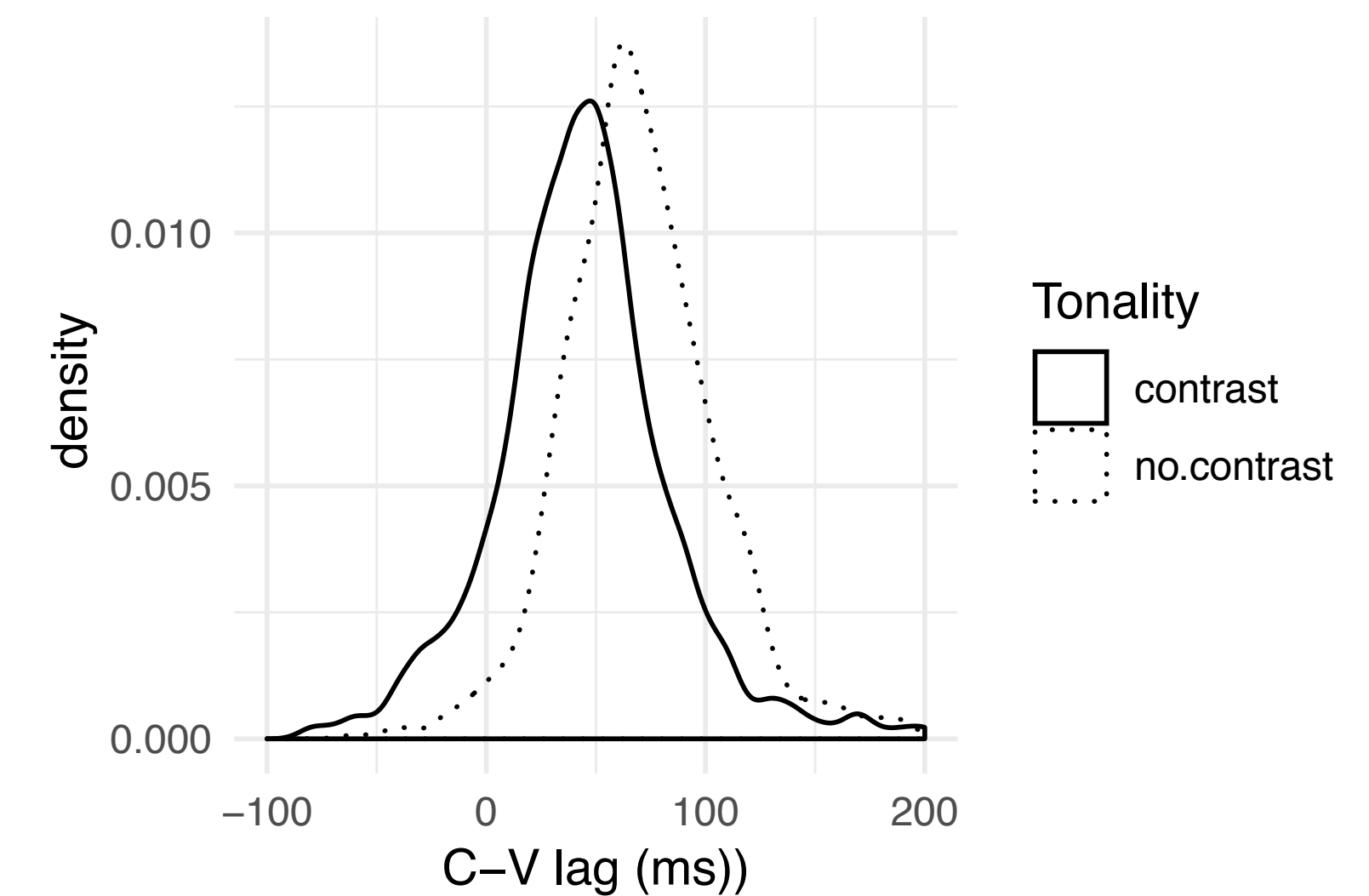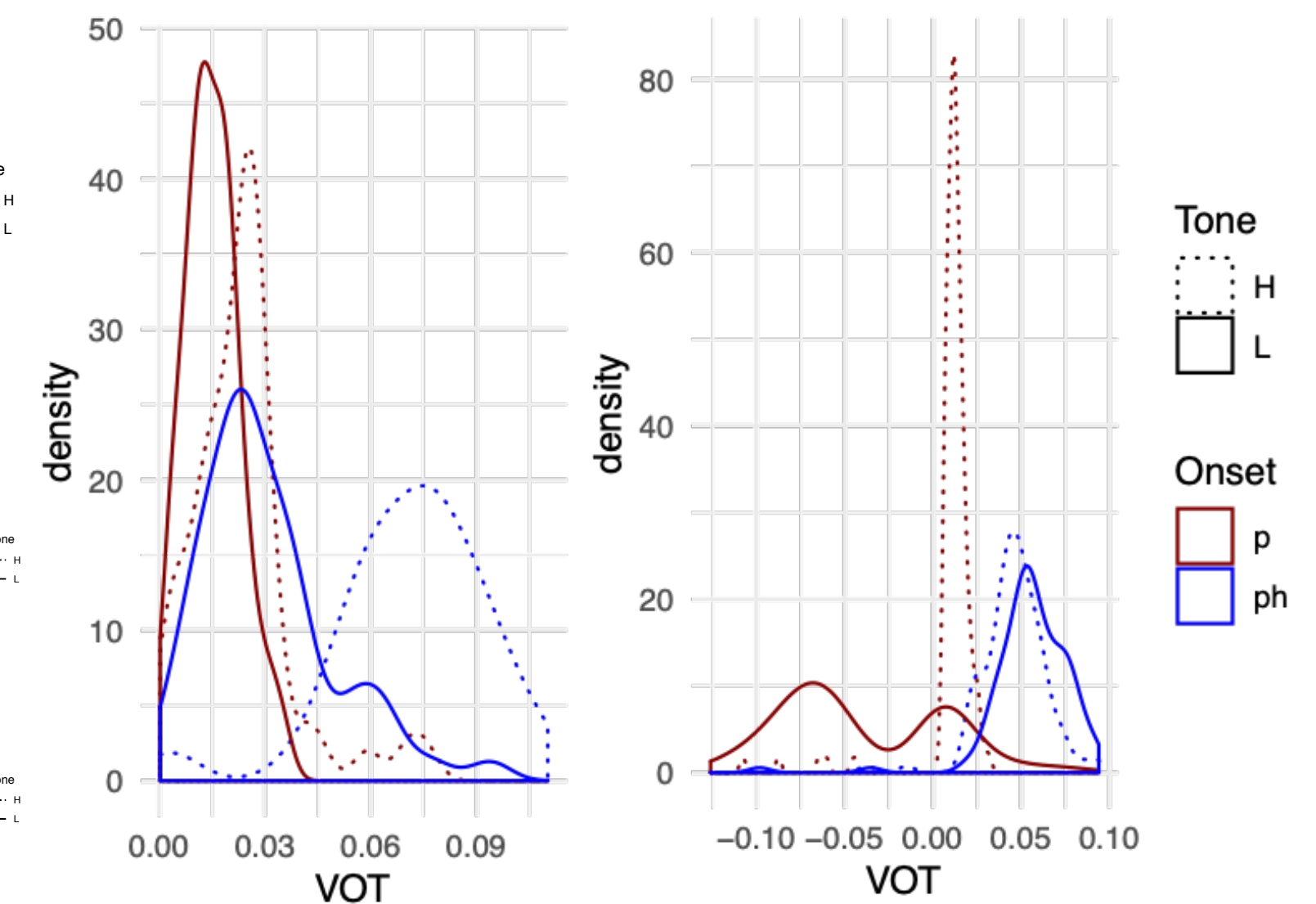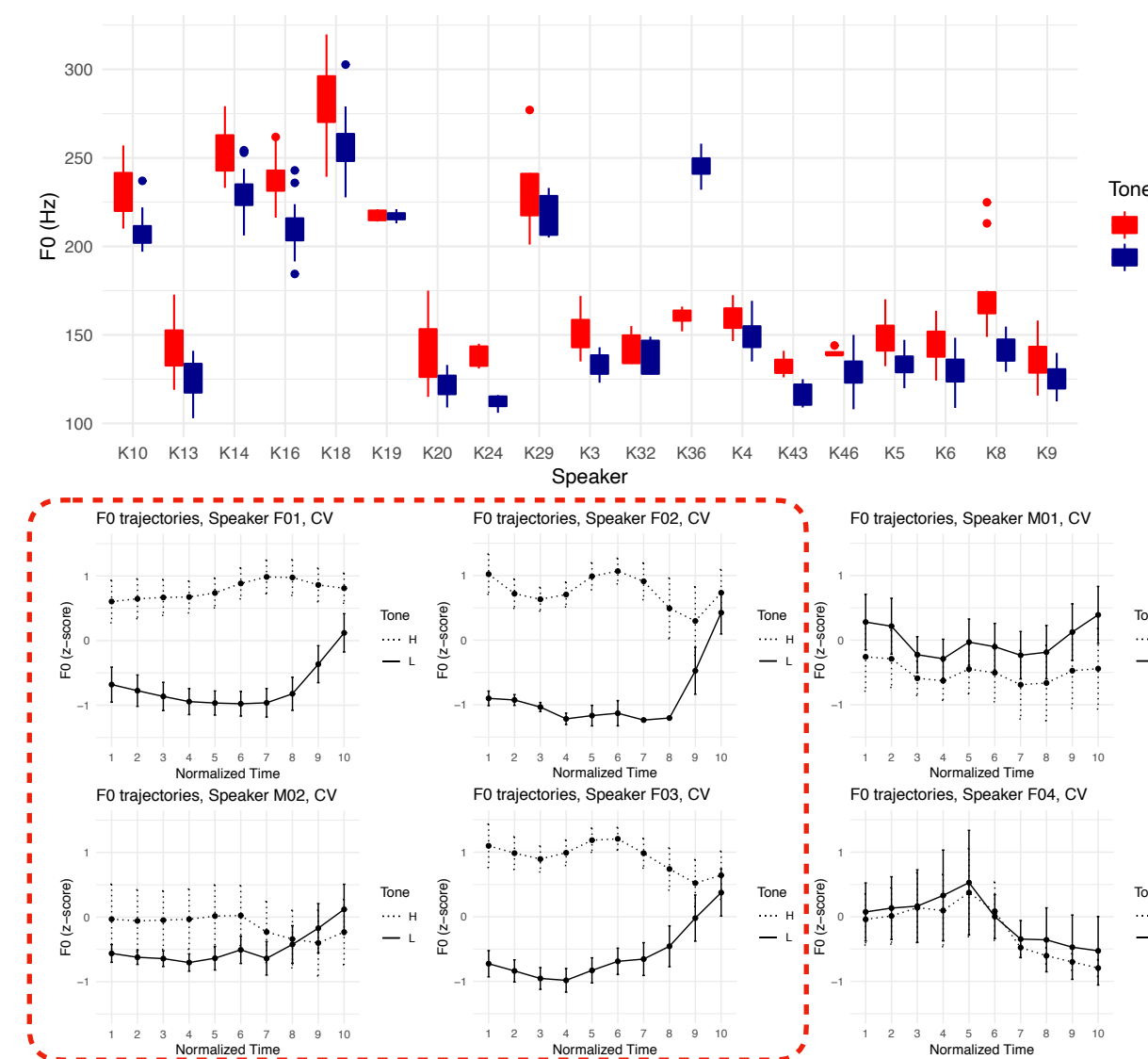
Implications

- Members of a speech community can have different phonologies

- Multi-lingual, multi-dialectal situations are *helpful* for linguistic research

- C-V lag related to tone, but not always through competitive coupling

  - at least not for non-tonal speakers

- Stable C-V timing amid variation

  - this is something we can learn

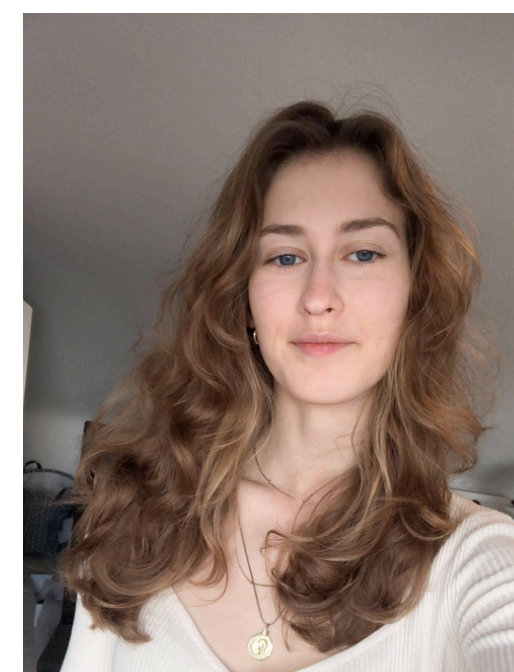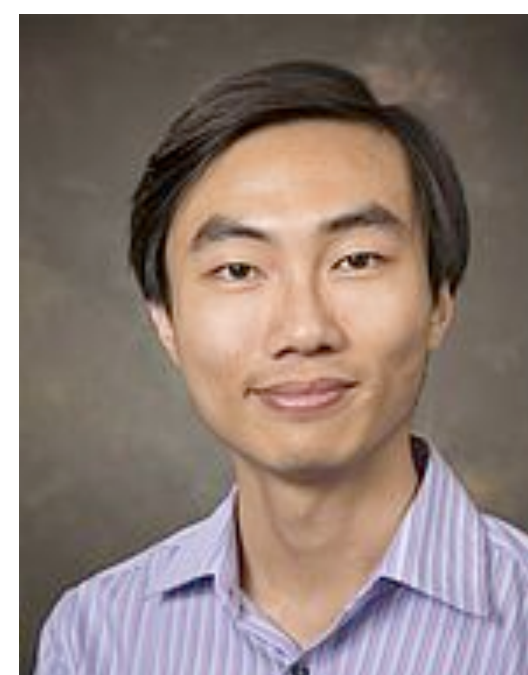 - even the "mechanical" is social
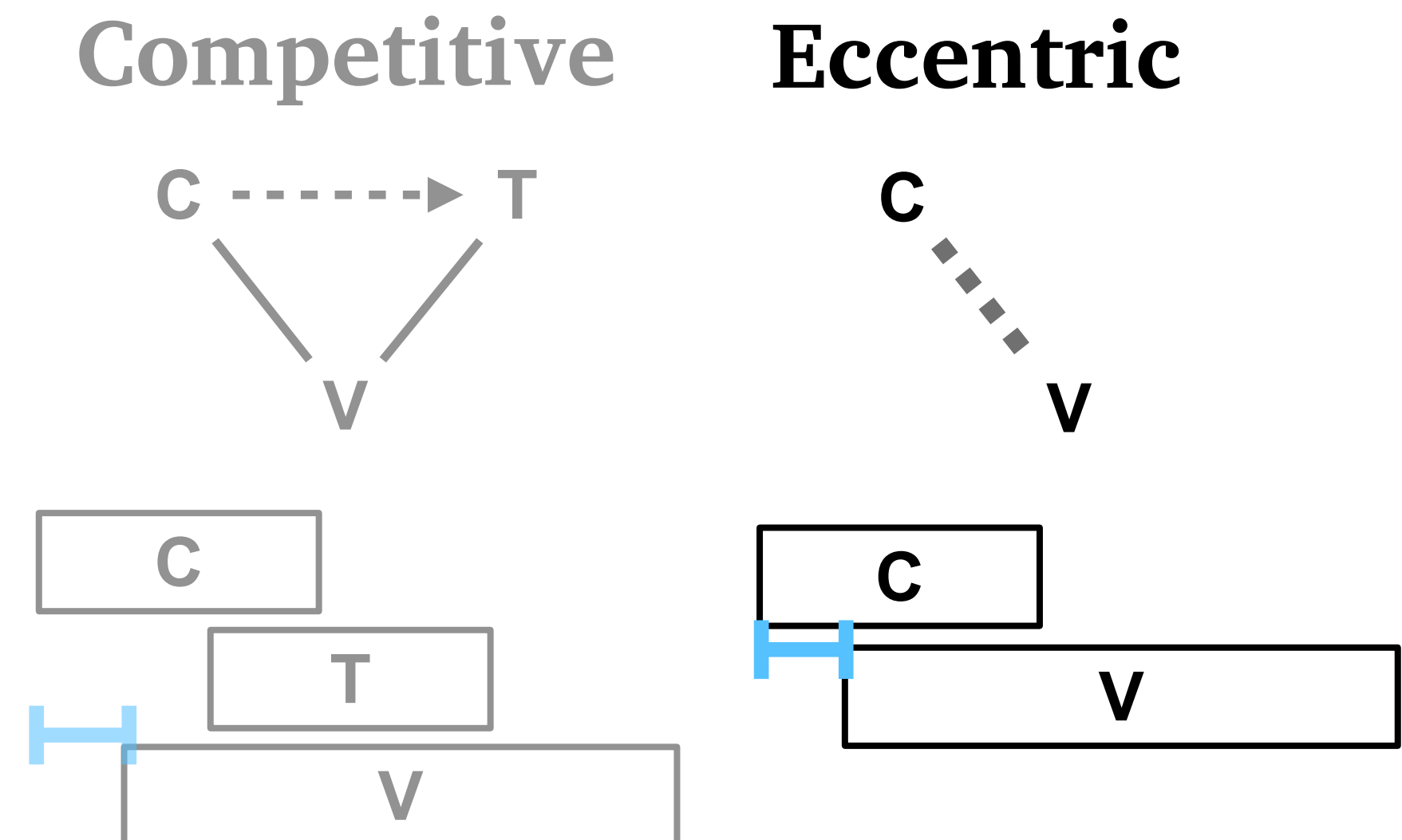
Ongoing and future work

- Annotating Tibetan recordings to make a useful corpus

  - working with: Namgyal Norbu, Jason Shaw, RAs

- Relating all this with…

  - … diachronic tone loss?

  - … dialect contact? language contact?

  - … morphological boundaries?

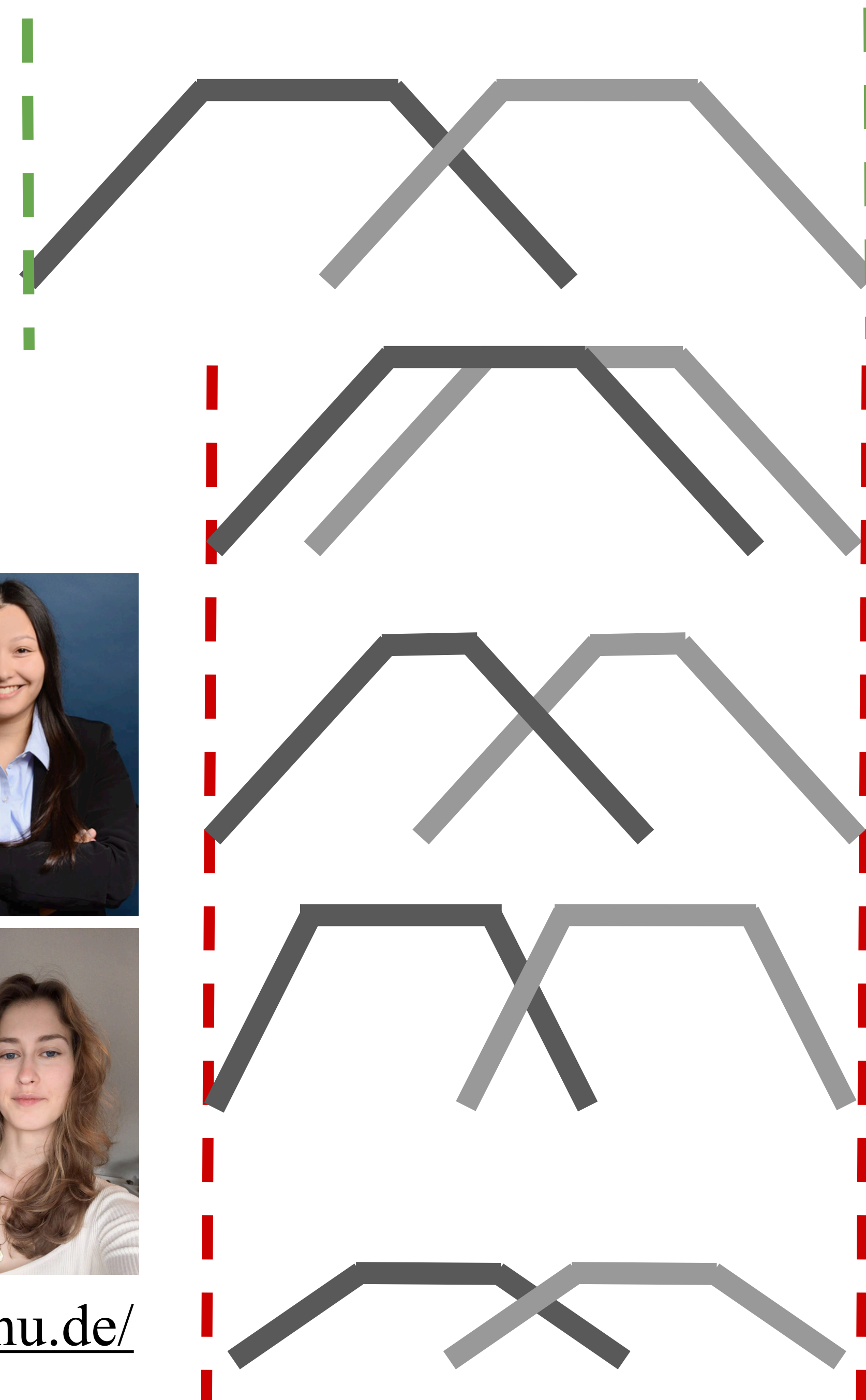 - … different types of phonetic "reduction"?

Upcoming work
Probabilistic reduction beyond duration

- Language modeling:

  - effects of frequency, predictability, informativity

  - most previous work: acoustic duration

- Phonetic data from:

  - TADA synthesis

  - XRMB, EMA datasets etc.

  - new EMA experiments🤞

https://slam.phil.hhu.de/

ཐུགས་རྗེ་ཆེ།

Thank you!