# 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
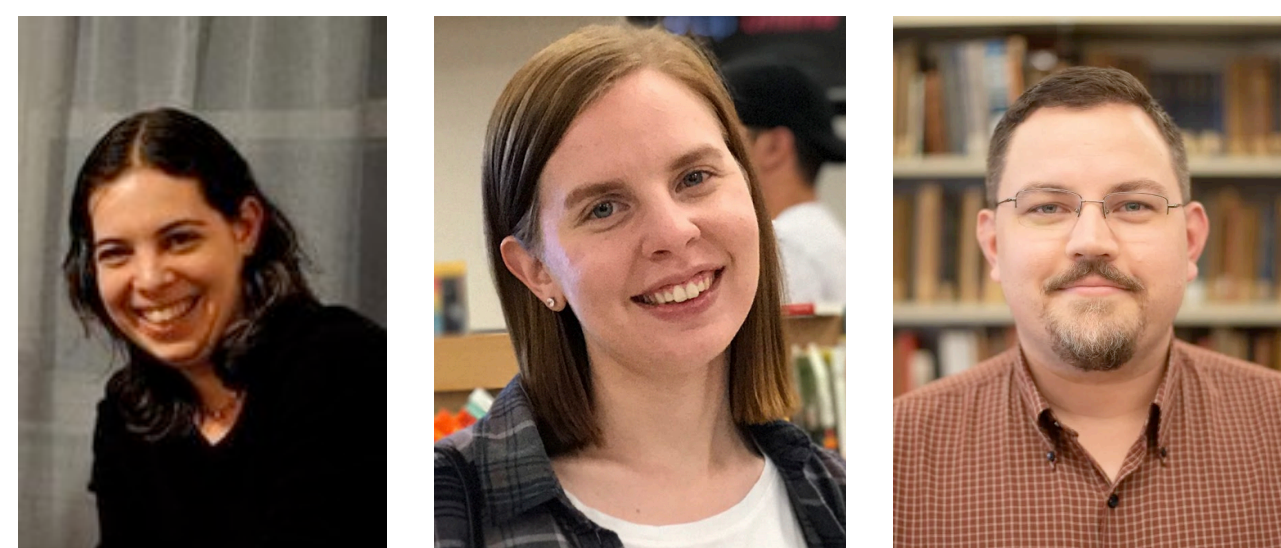
# "About Me"

**pre-introduction**

# Where I come from

- Northern New Jersey (Greater New York City)

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

  - *bite* [bəɪˀt˺]; *bide* [ba͡ɪd]; *bout* [ba͡ʊˀt˺]

- Swarthmore College, Yale University, HHU

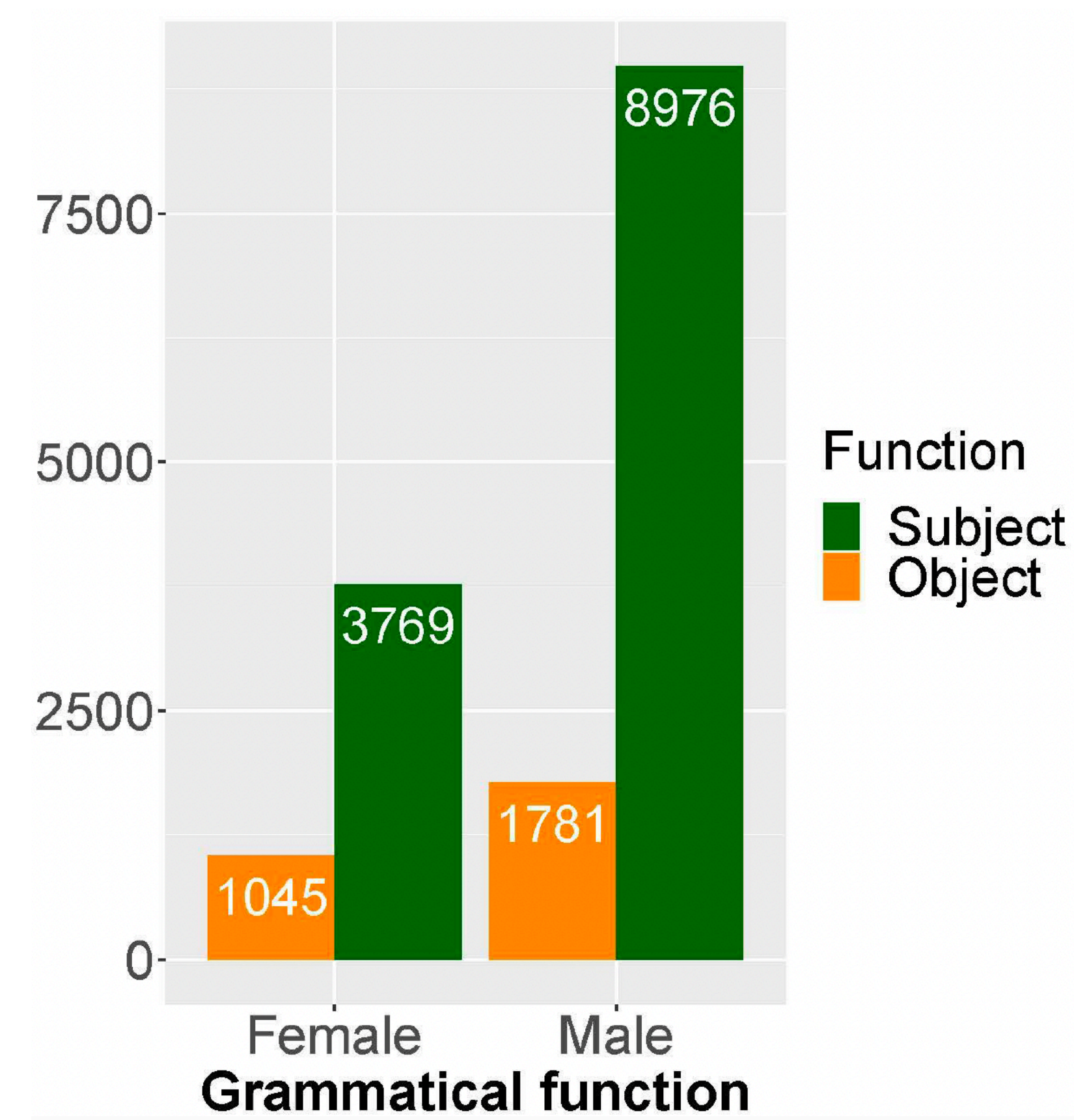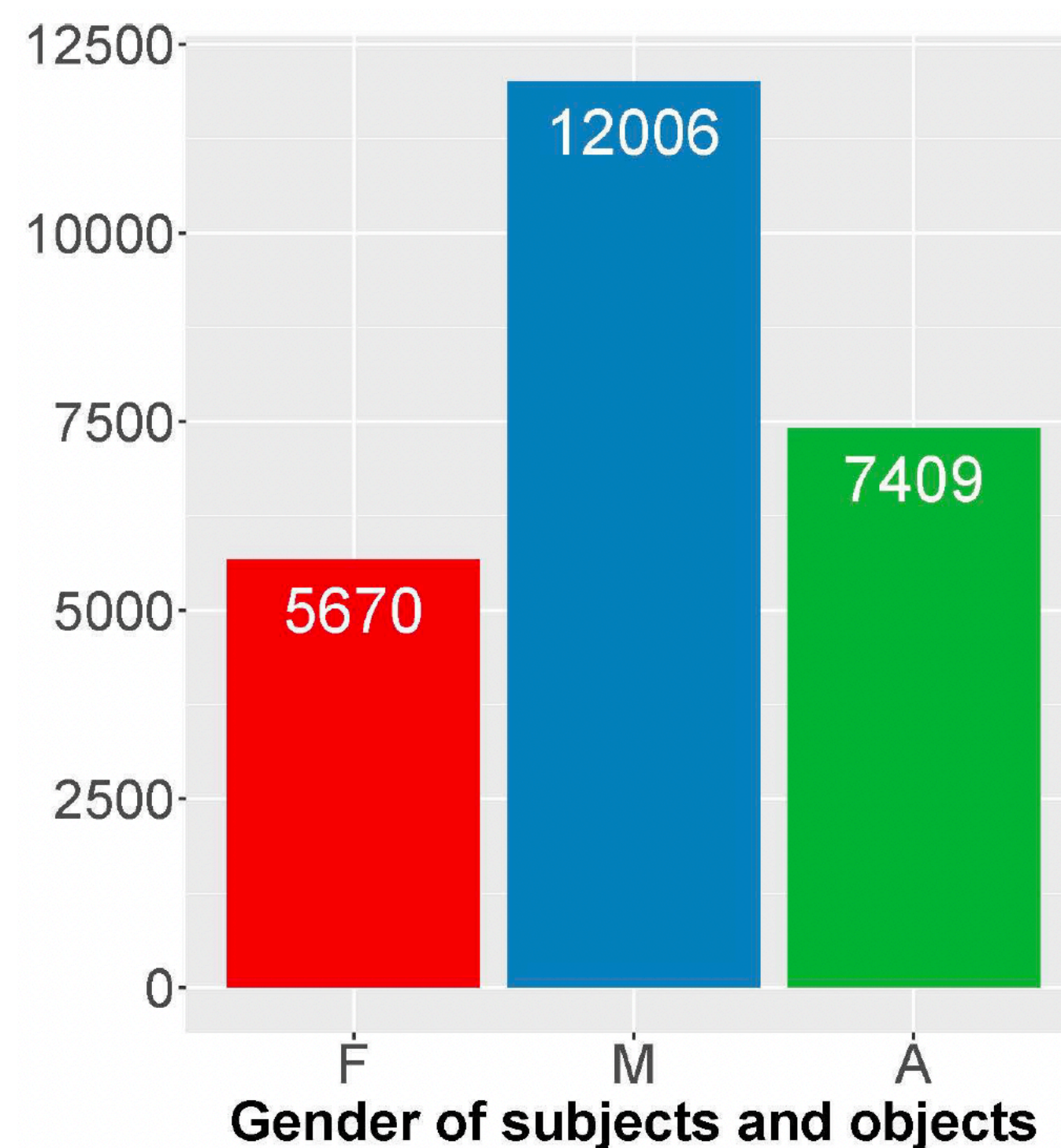# Linguistics things this talk isn't about
## but that I also care about

- 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.



**Gender of subjects and objects**

F: 5670
M: 12006
A: 7409



Function
Subject
Object

Female: Object 1045, Subject 3769
Male: Object 1781, Subject 8976

**Grammatical function**

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# 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

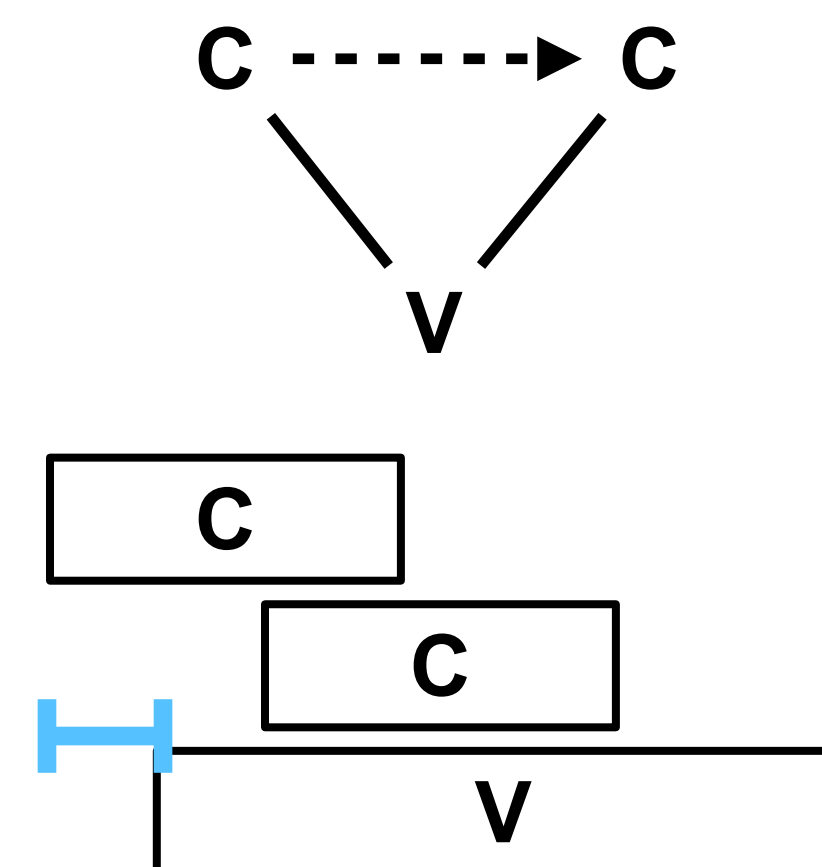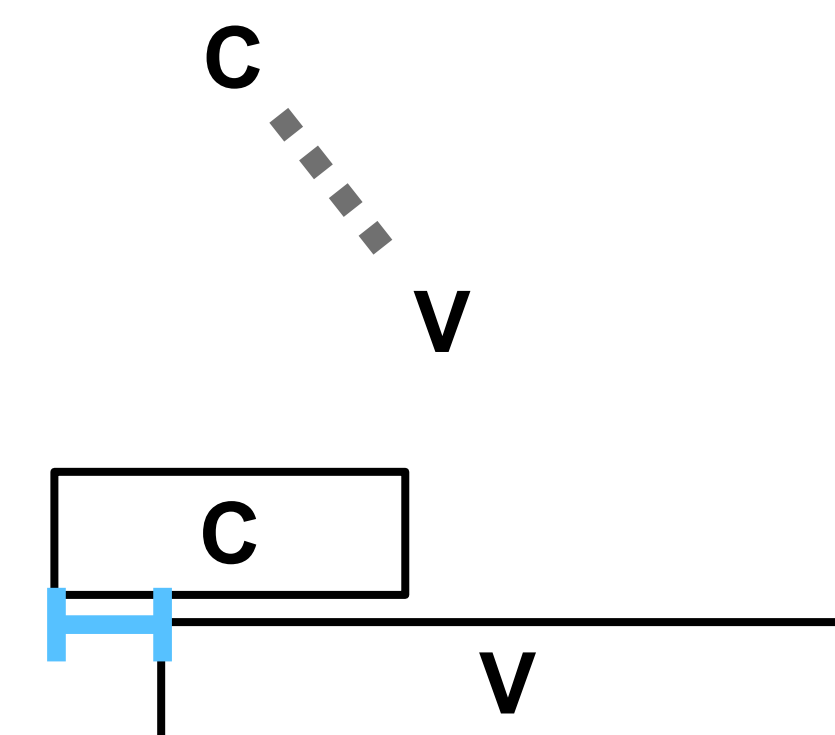*(Nam & Saltzman 2003, Nam et al. 2009, Goldstein 2011)*

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**In-phase**
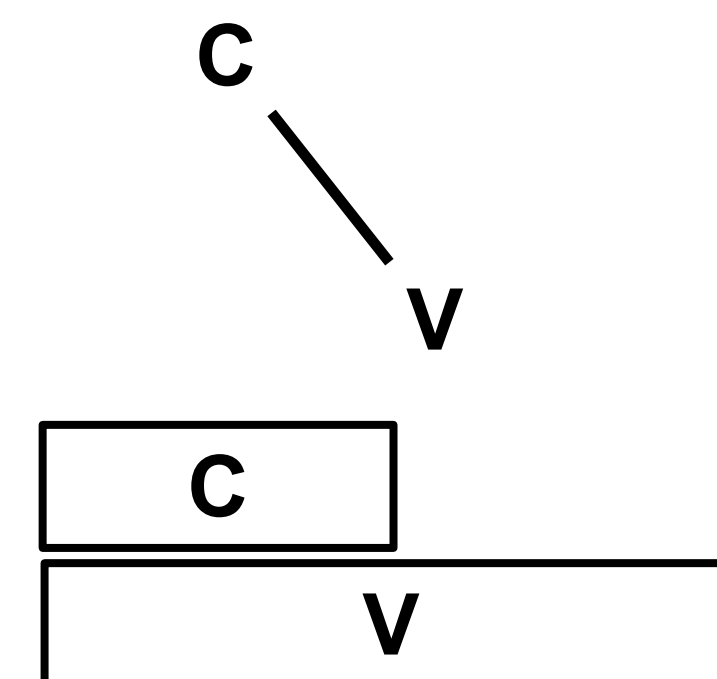
**Anti-Phase**
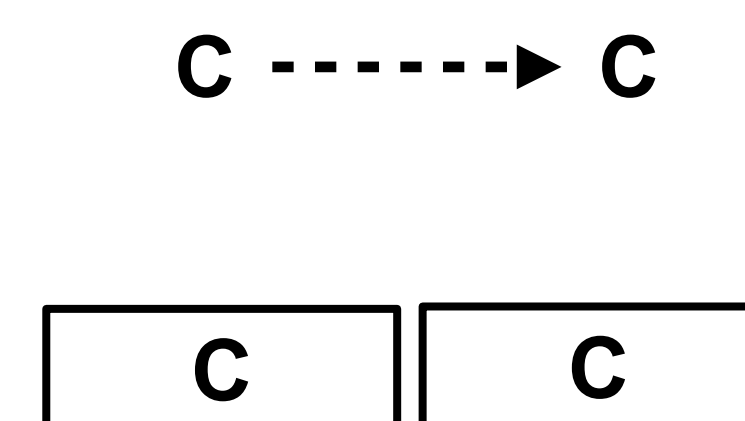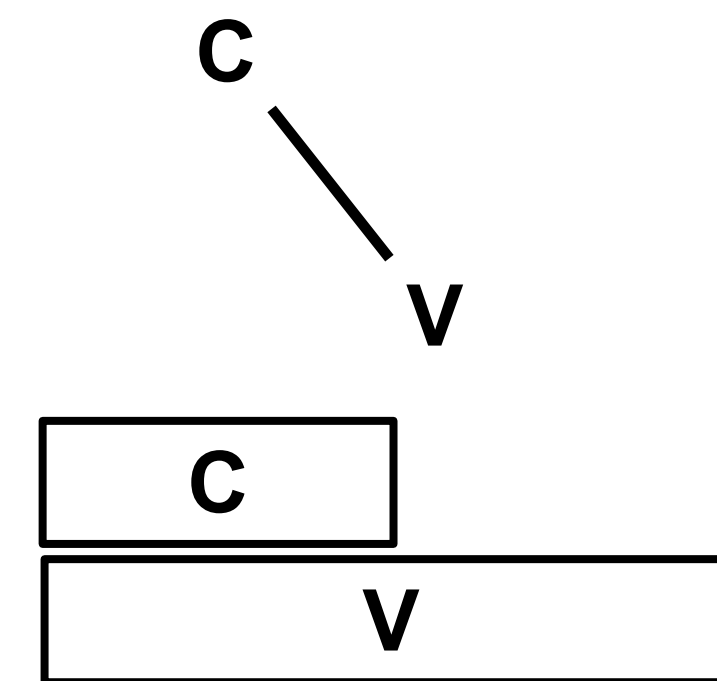
**Competitive**

**Eccentric**

# 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**
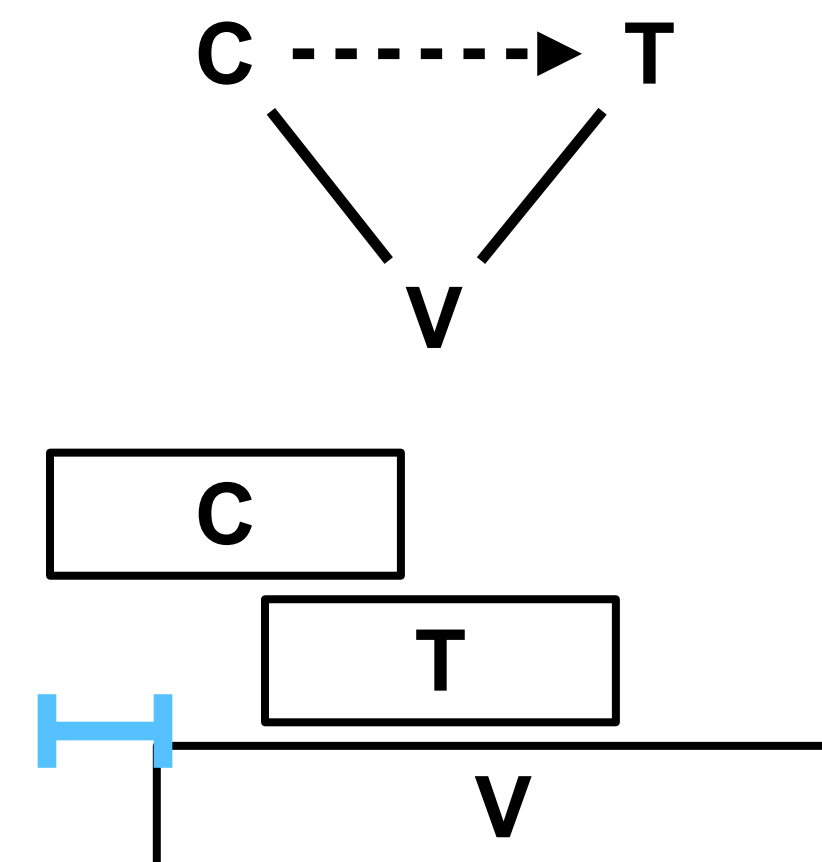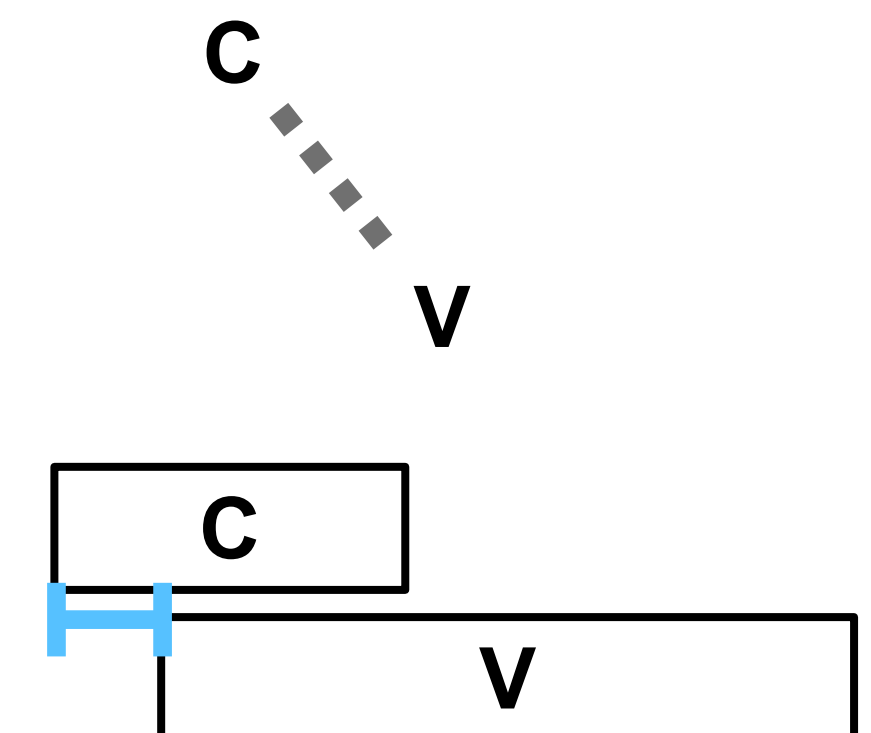
**Anti-Phase**

**Competitive**

**Eccentric**

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

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# A "Natural Laboratory"
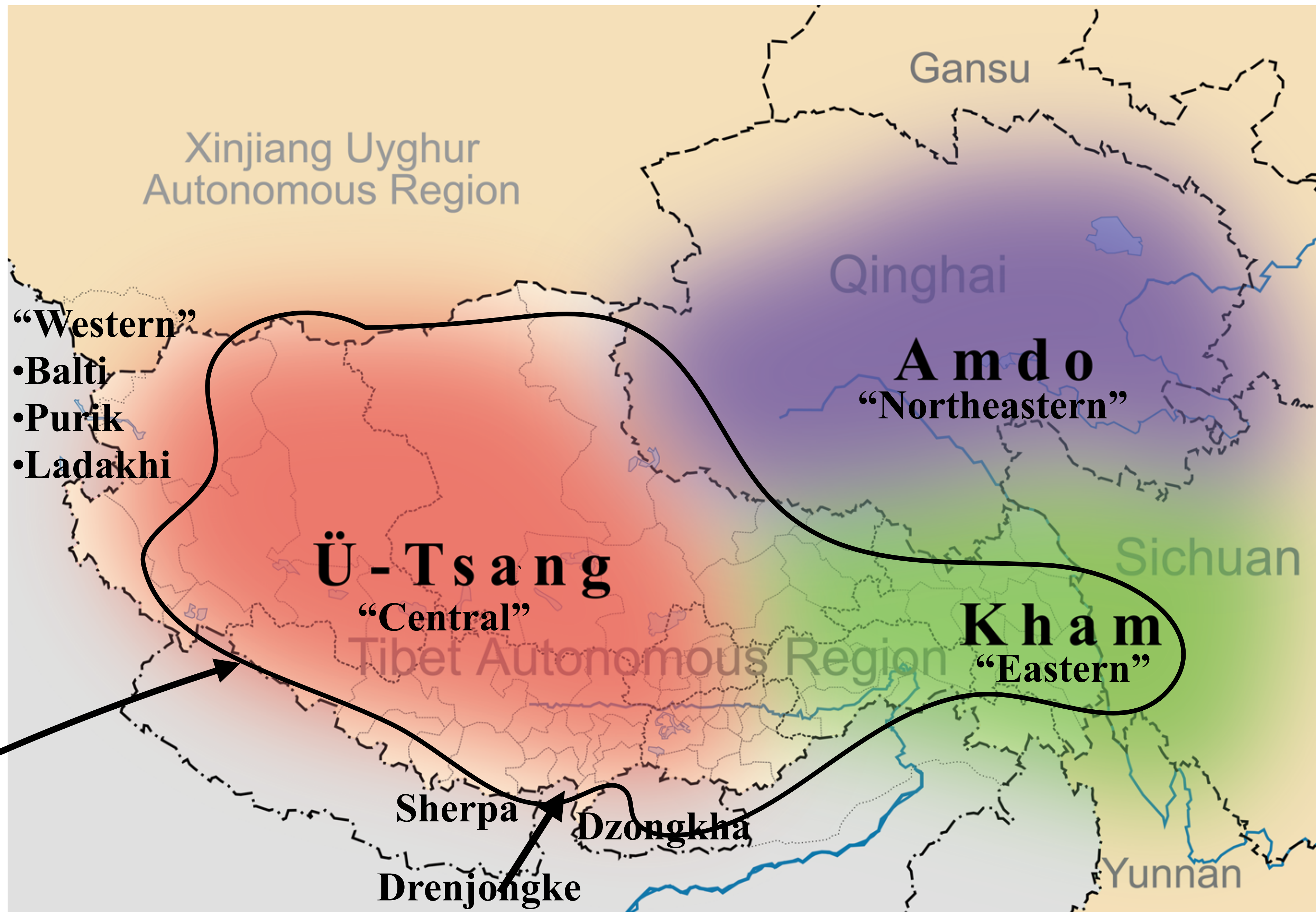
## Let's find…

- 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

Approx. extent of tone

"Western"
- Balti
- Purik
- Ladakhi

**Ü-Tsang**
"Central"

**Amdo**
"Northeastern"

**Kham**
"Eastern"

Sherpa

Dzongkha

Drenjongke

Gansu

Xinjiang Uyghur Autonomous Region

Qinghai

Sichuan

Tibet Autonomous Region

Yunnan

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# 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] | [xtsa] | [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 | pʰa | ba | ʁba | consolidation of clusters aspirated/unaspirated contrast |
| Eastern dialects | pá | pʰá | pà | bà | tonogenesis cluster simplification |
| Central dialects (Lhasa) | pá | pʰá | pʰà | 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
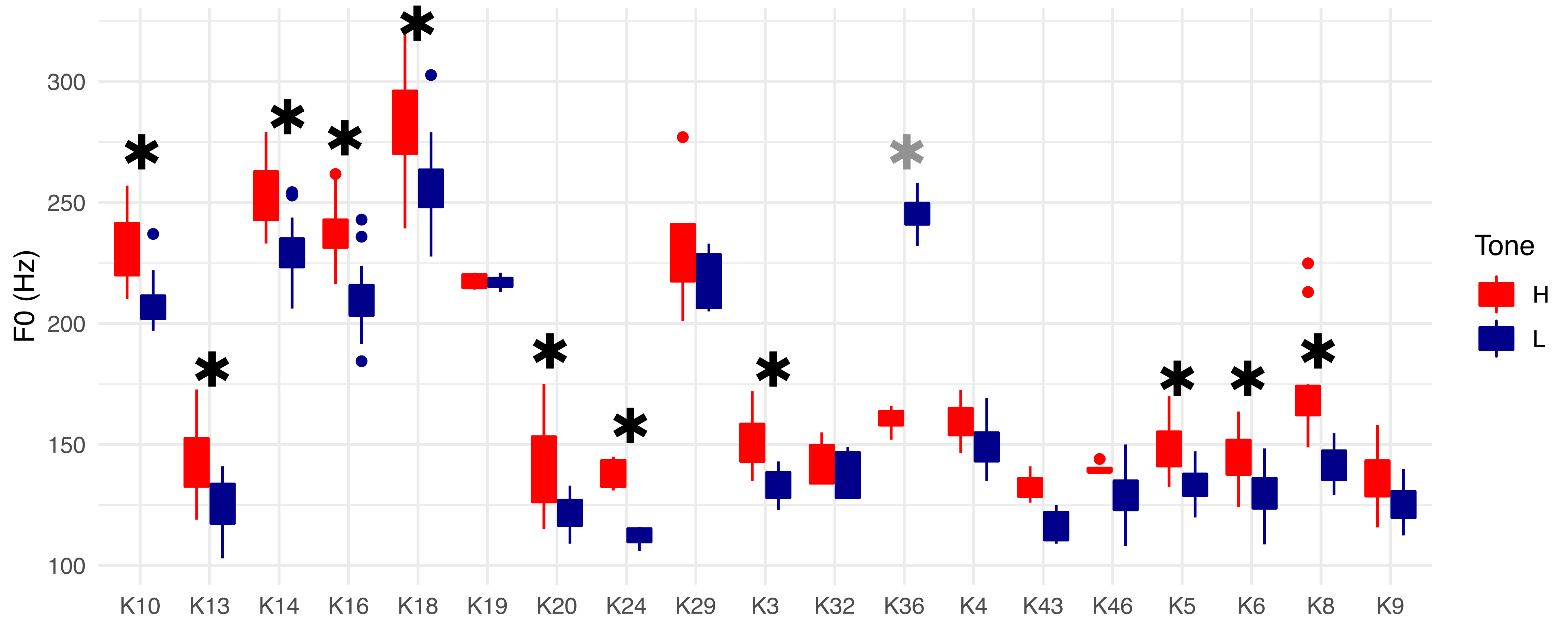
# VOT and tone categories
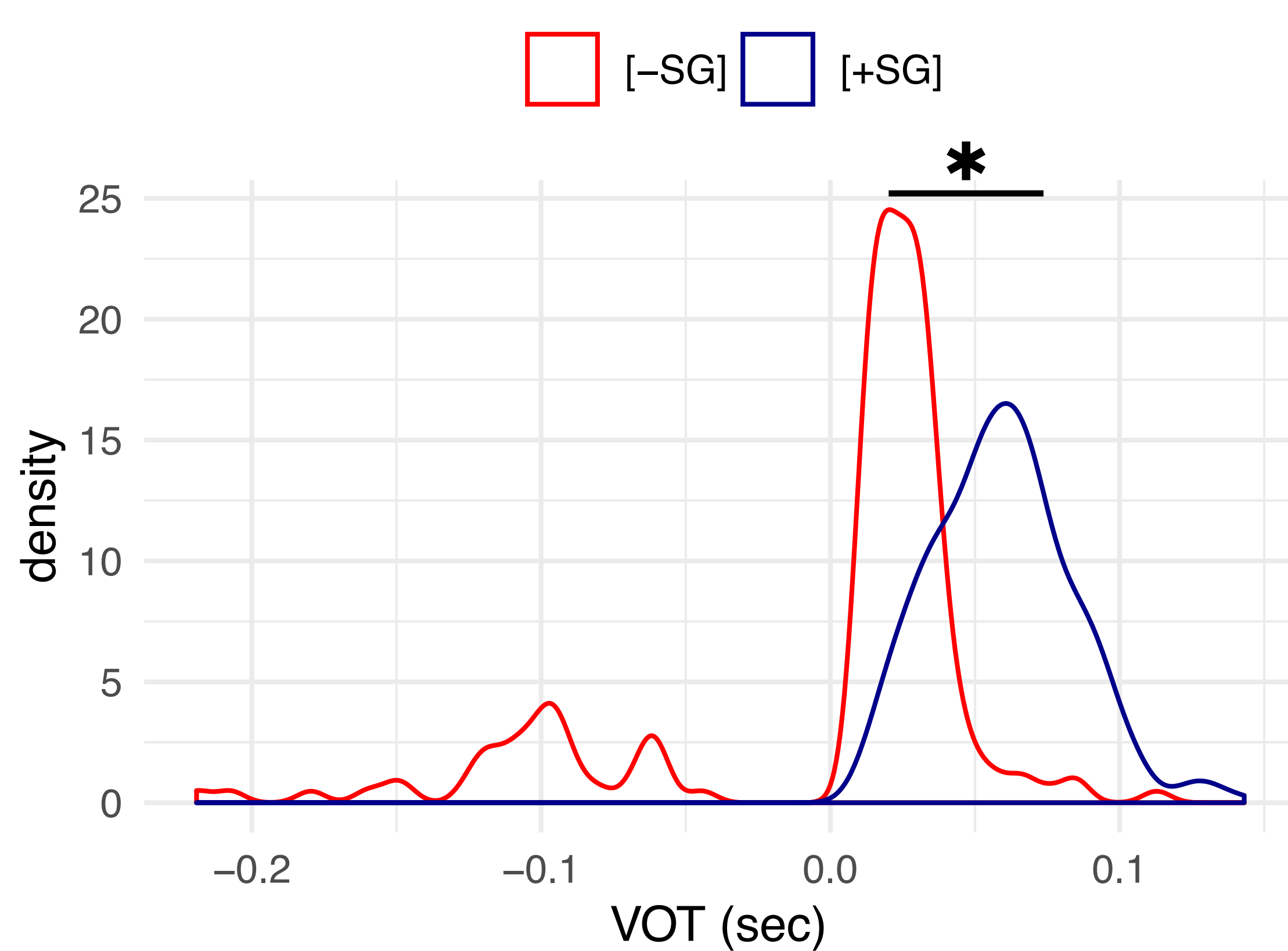


- Unaspirated vs. aspirated
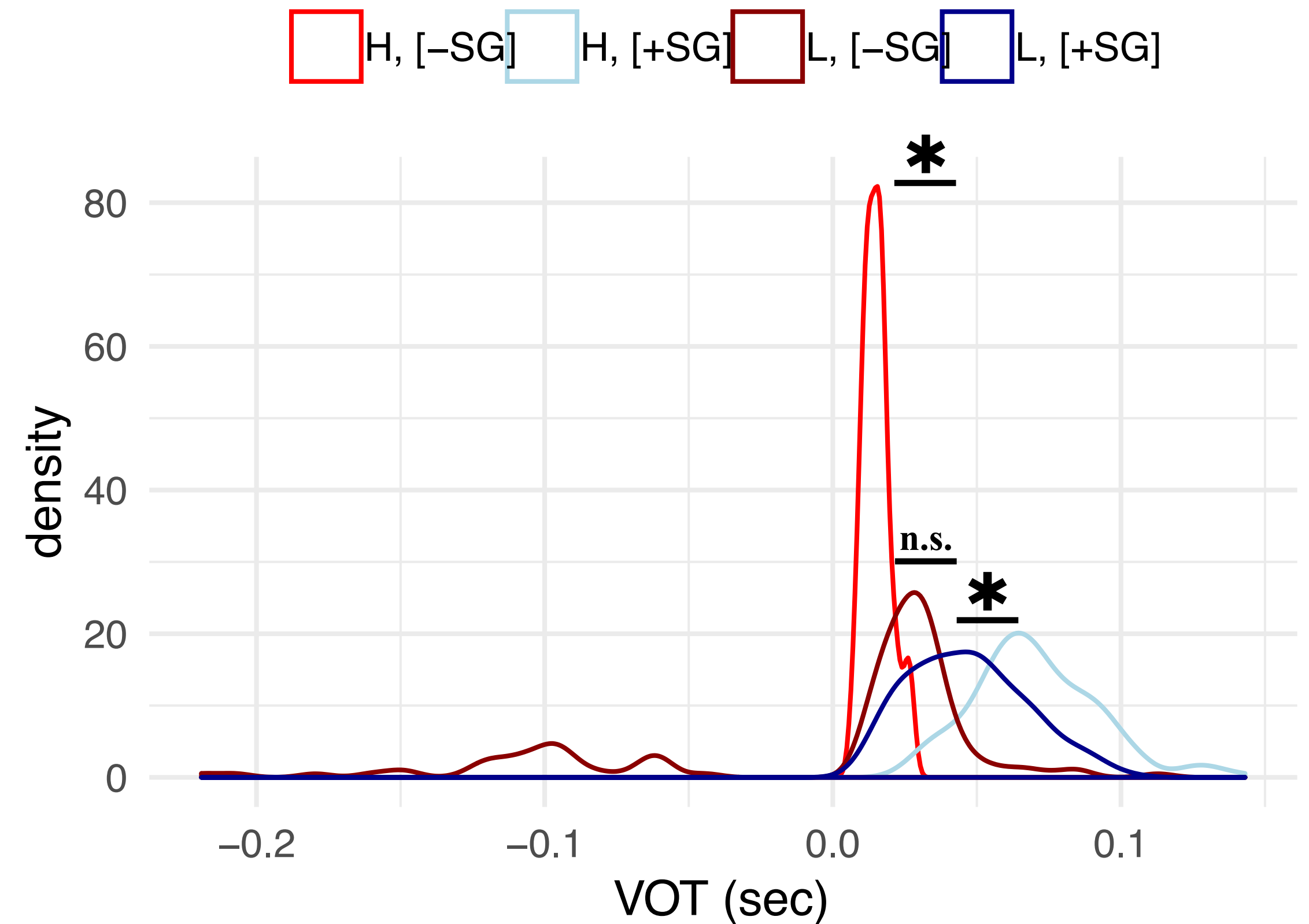
- Unaspirated vs. aspirated…
  … plus tone

# 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

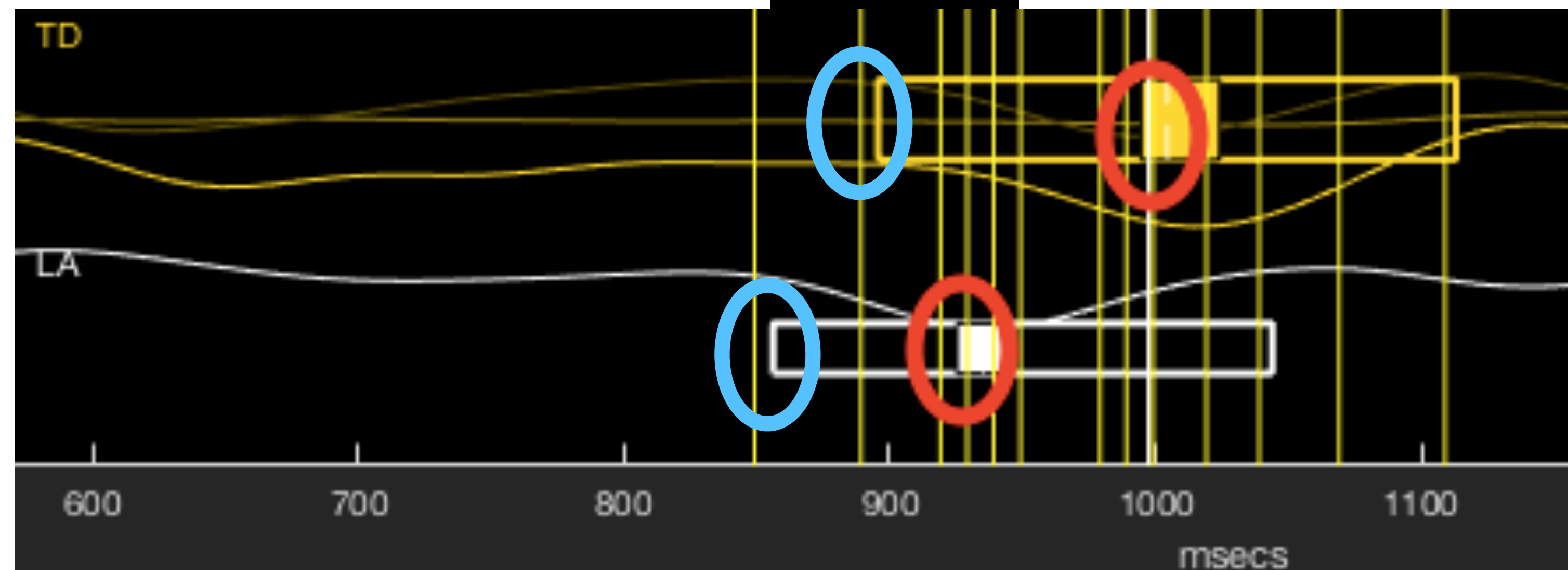- Gesture start labelled at 20% of peak velocity to target

# EMA data
## articulatory trajectories

- Tracks movement of sensors over time

- [p pʰ m]: distance between lip sensors

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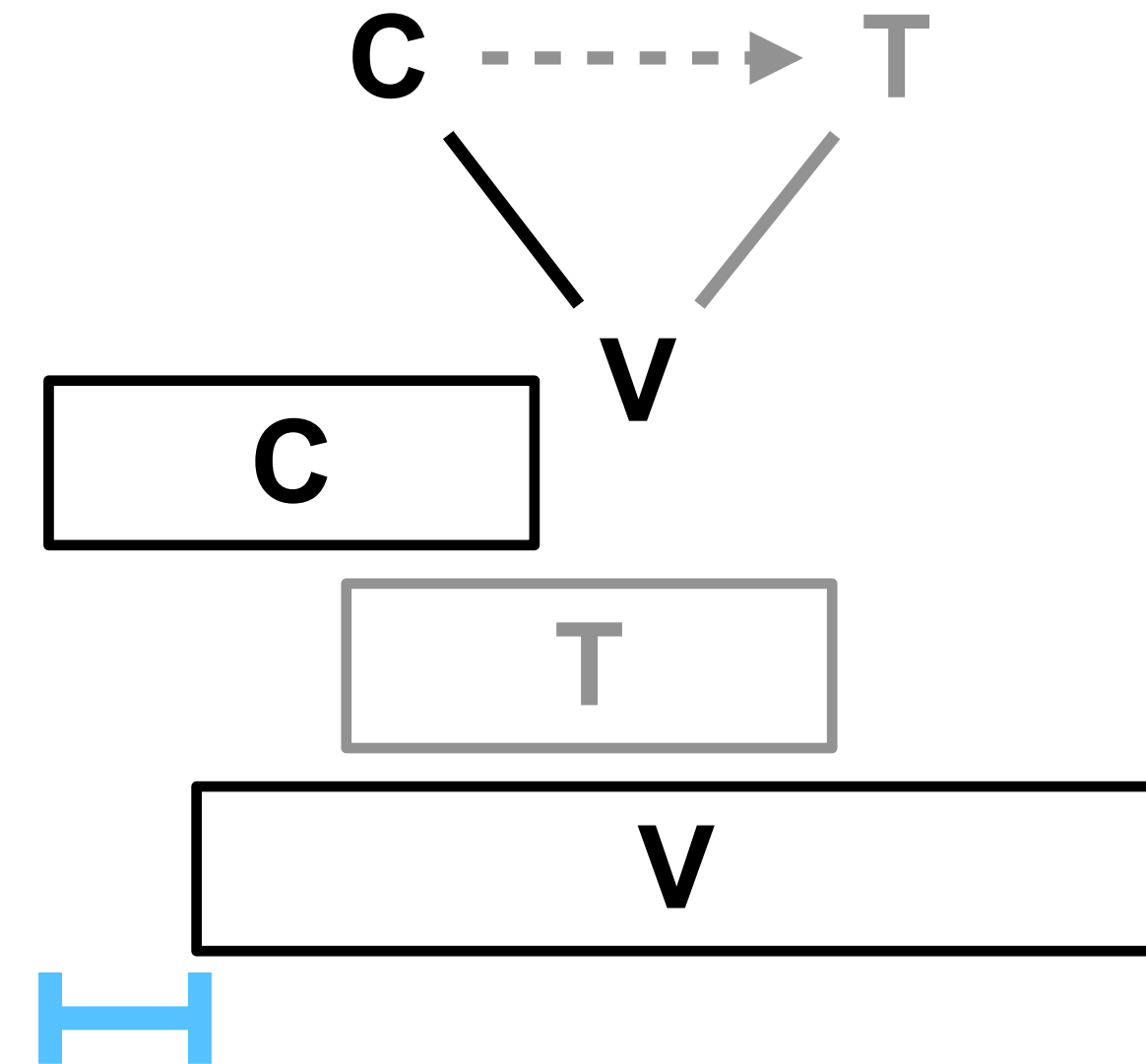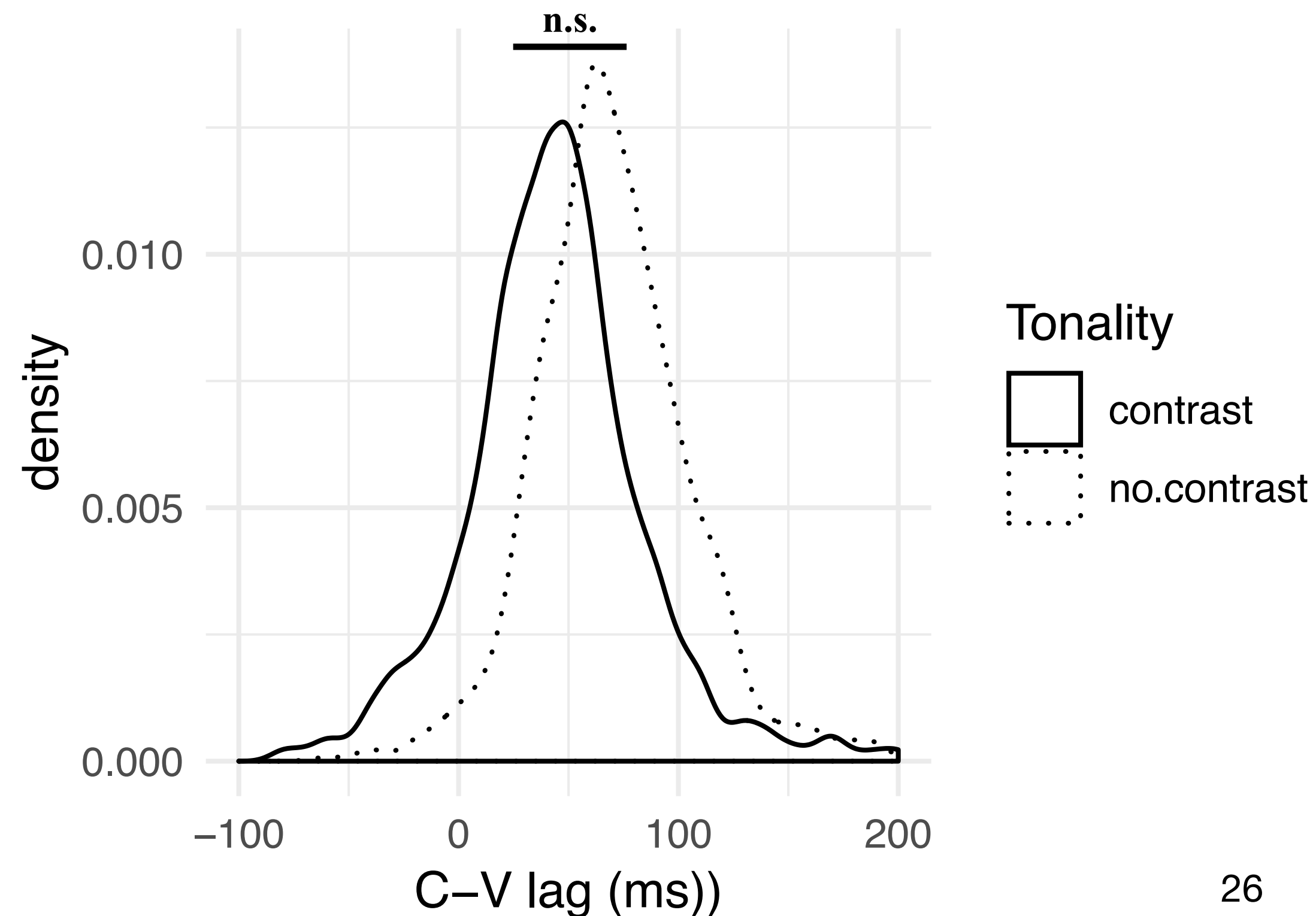


*(Mview software: Tiede 2005)*

# Results: tone contrast

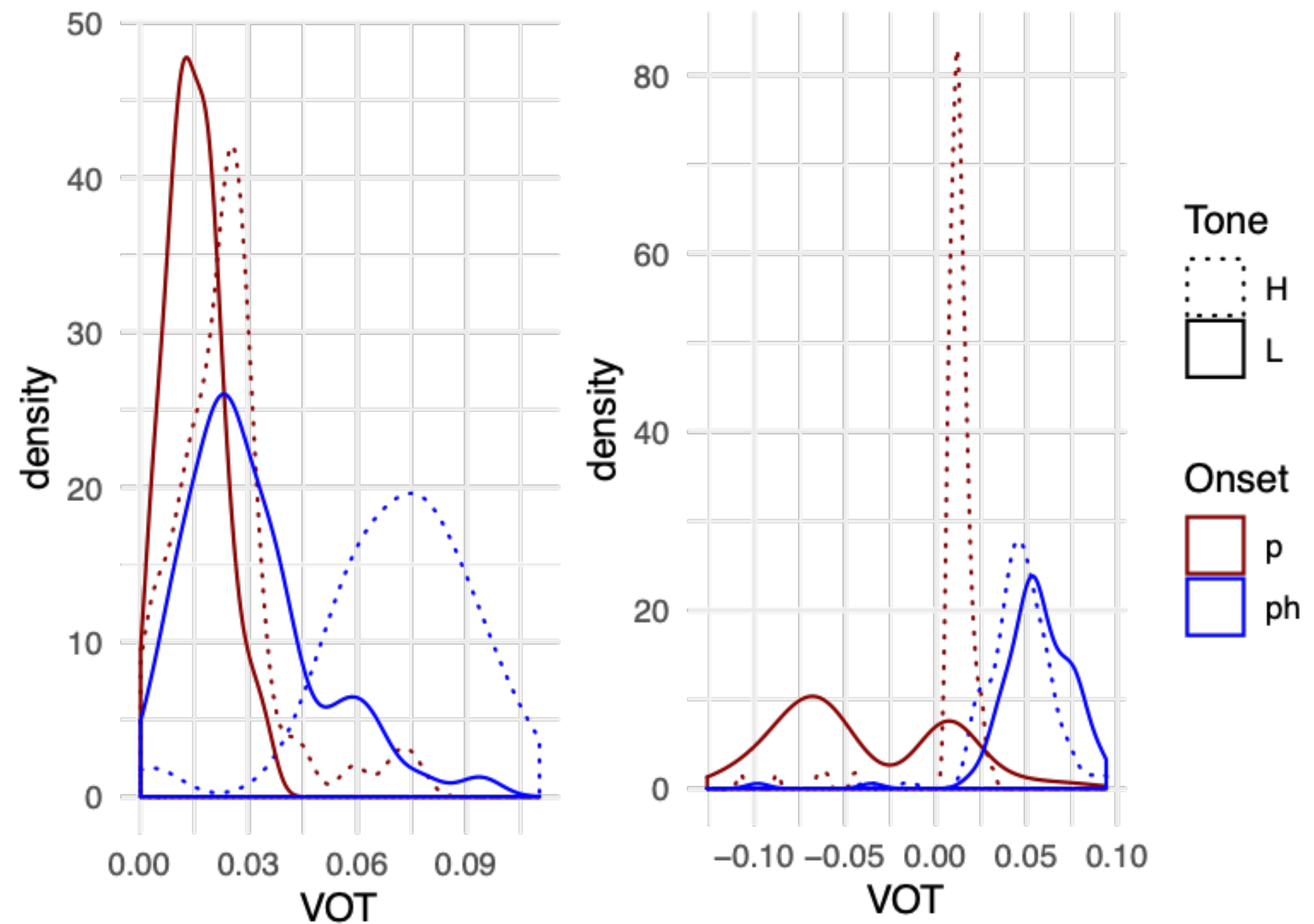- 4 speakers produce a tone contrast, two do not (on /mV/)
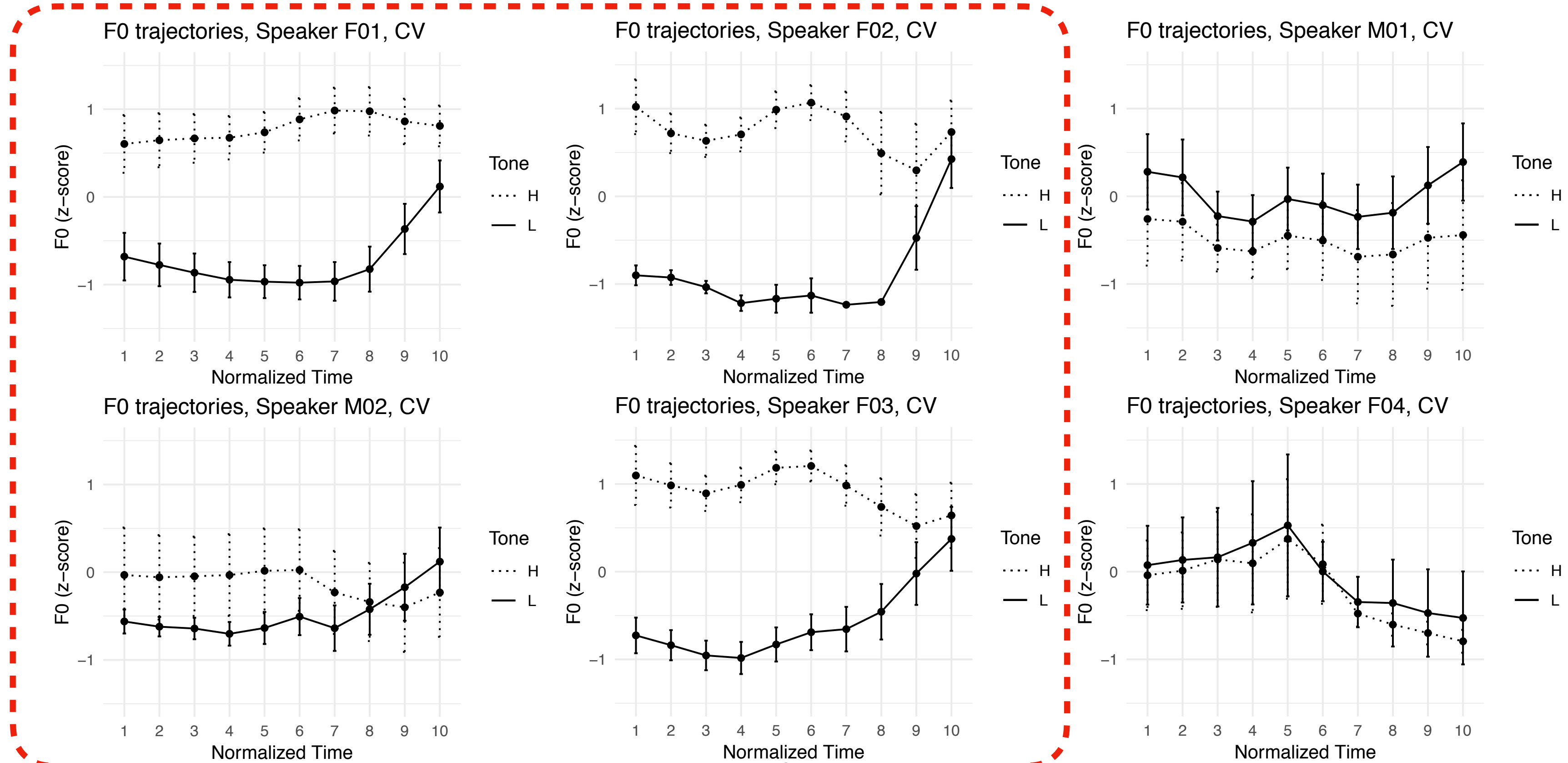
# Results: C-V lag

- 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-$\varnothing$, 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
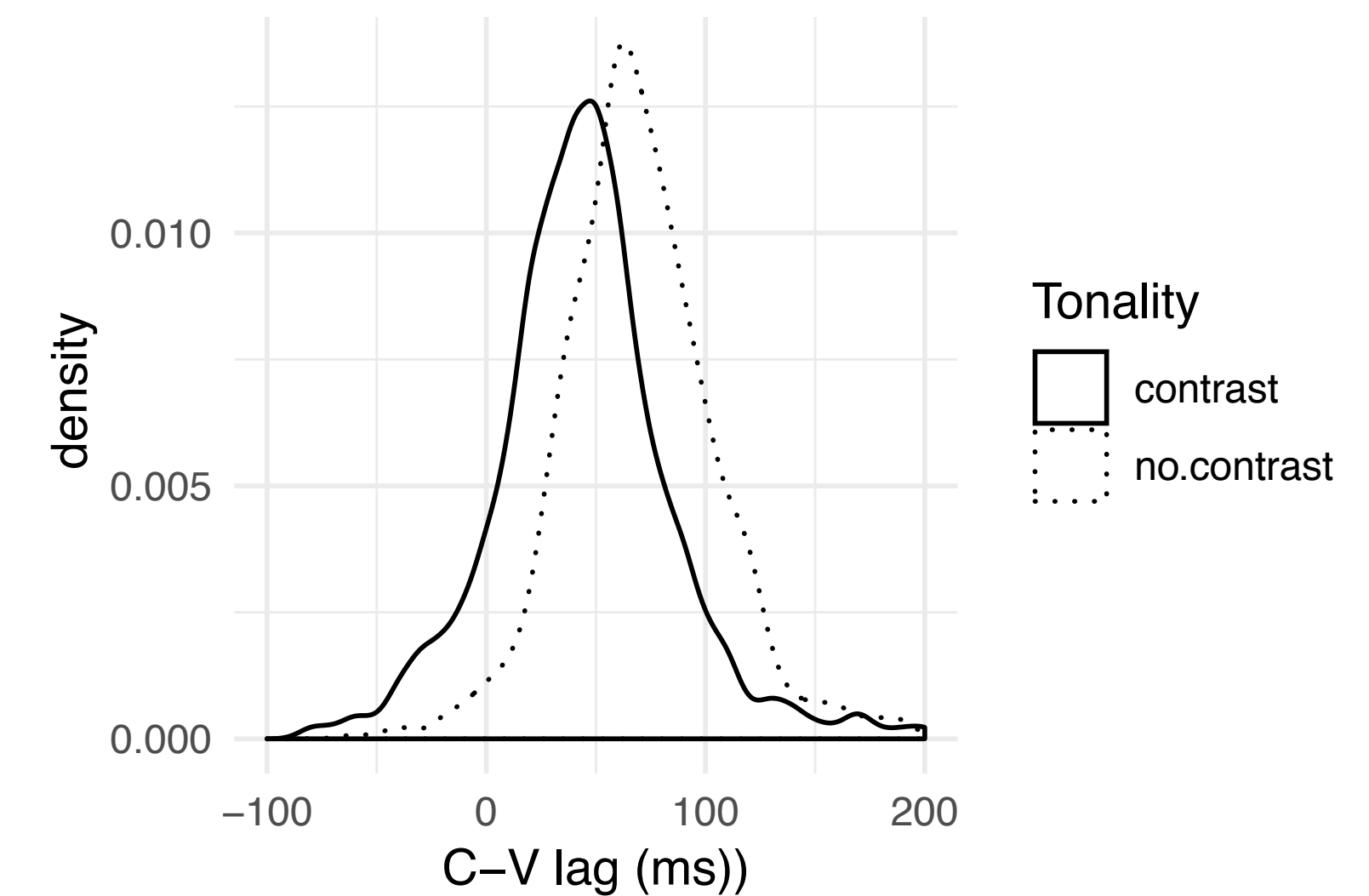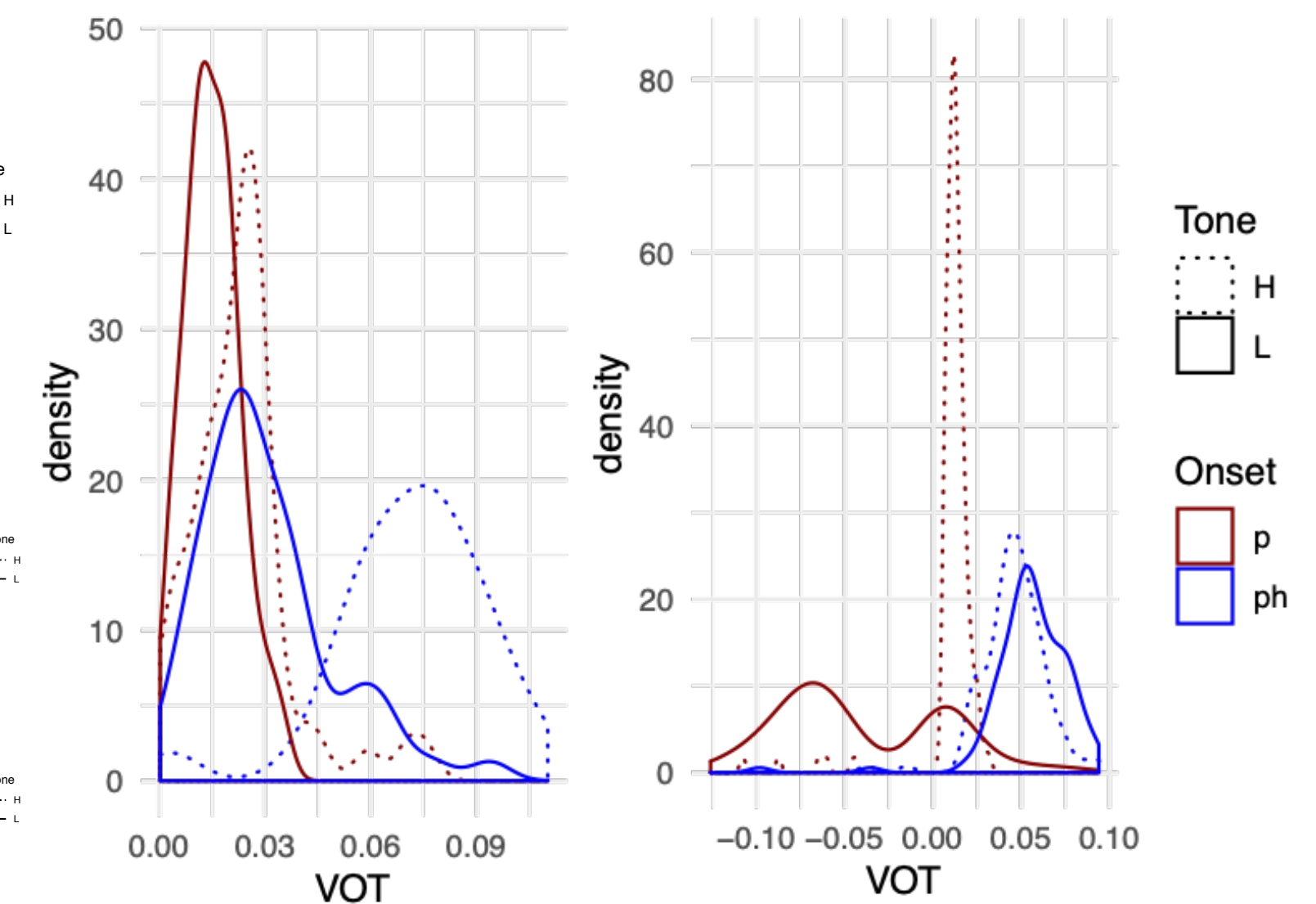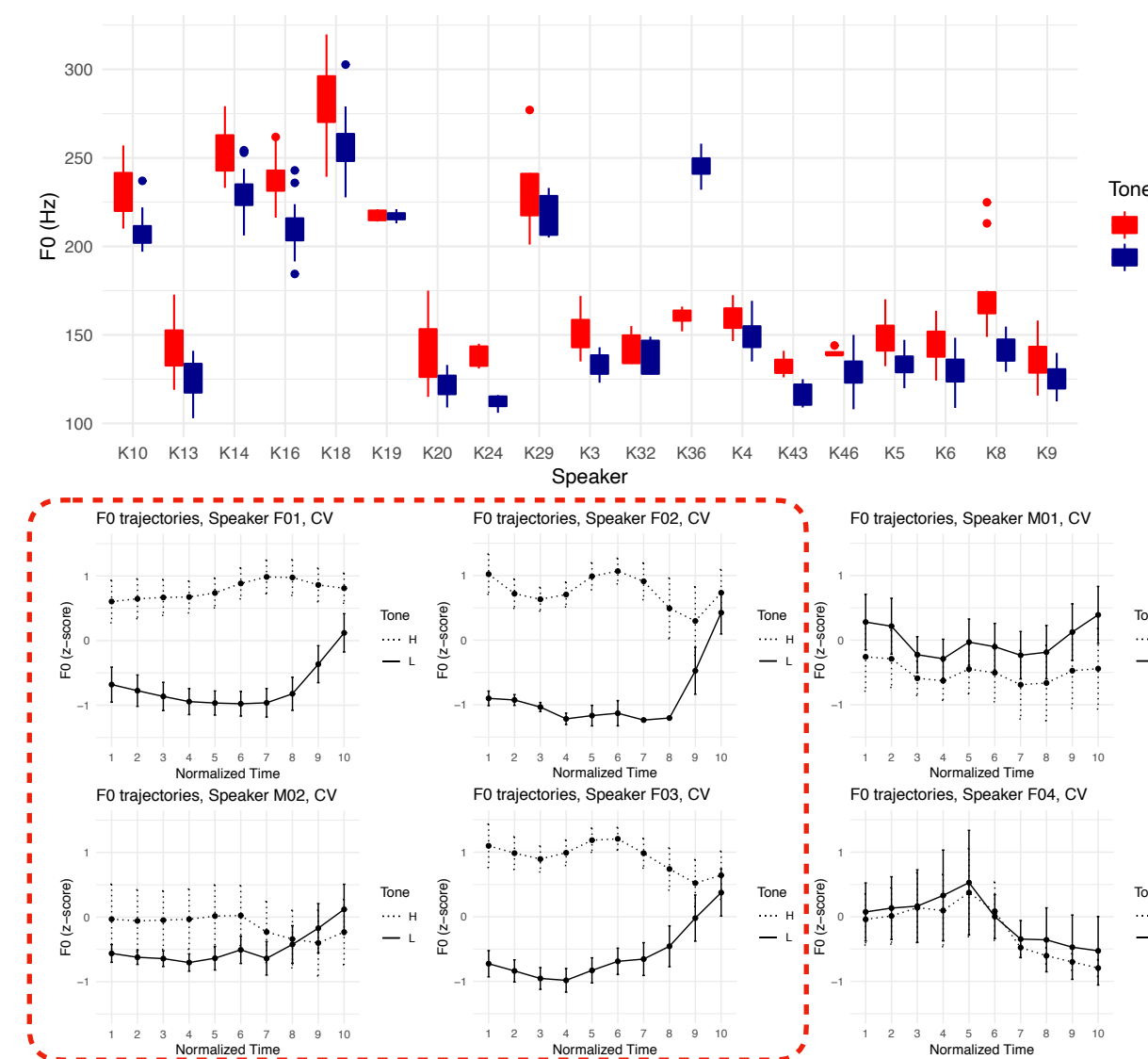
# Implications

- 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
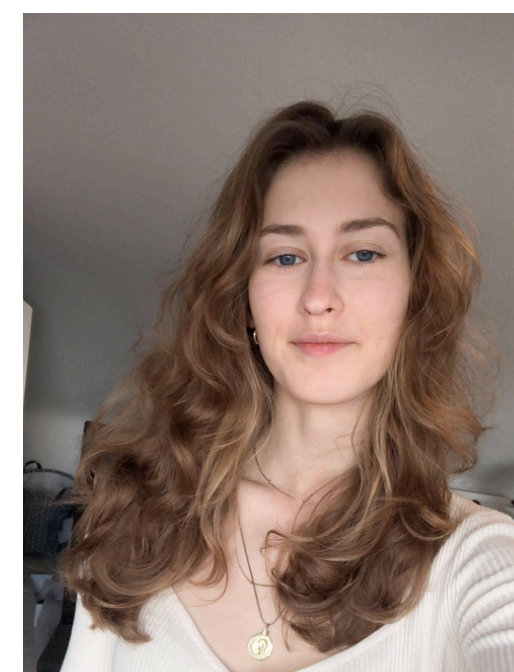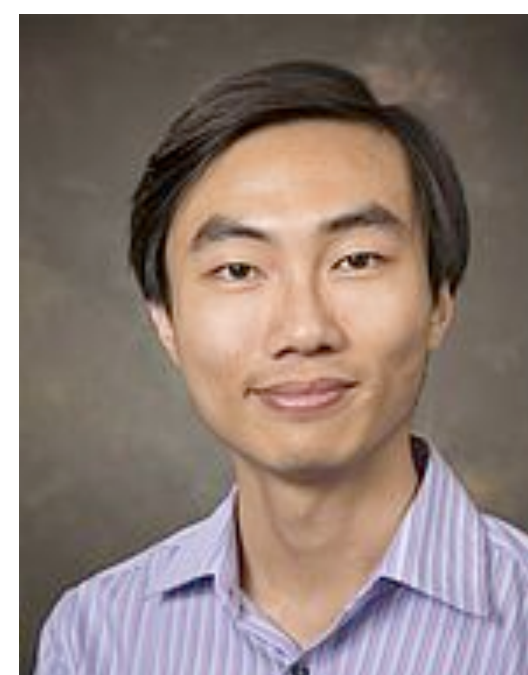


Competitive    Eccentric
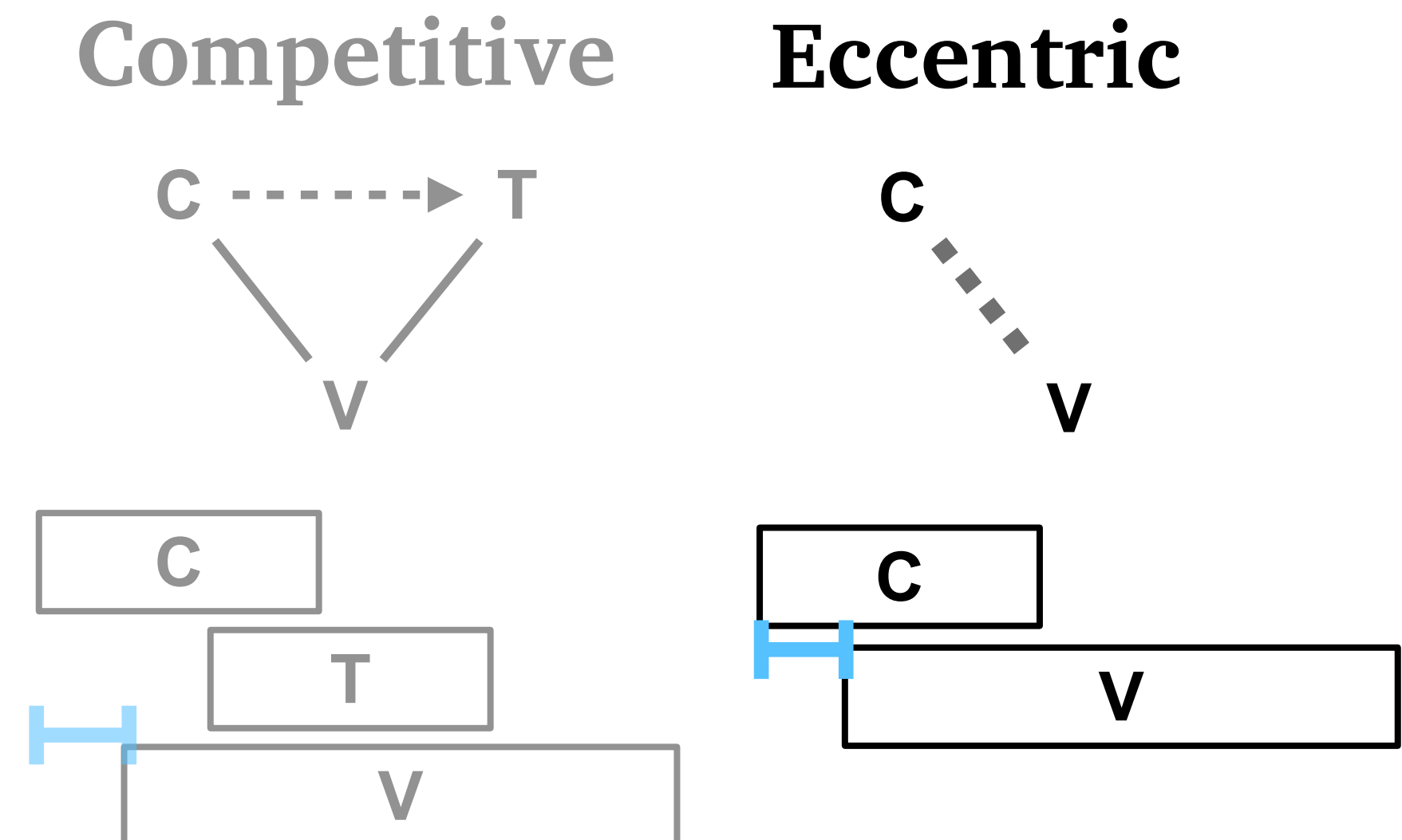
# Ongoing and future work

- 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"?
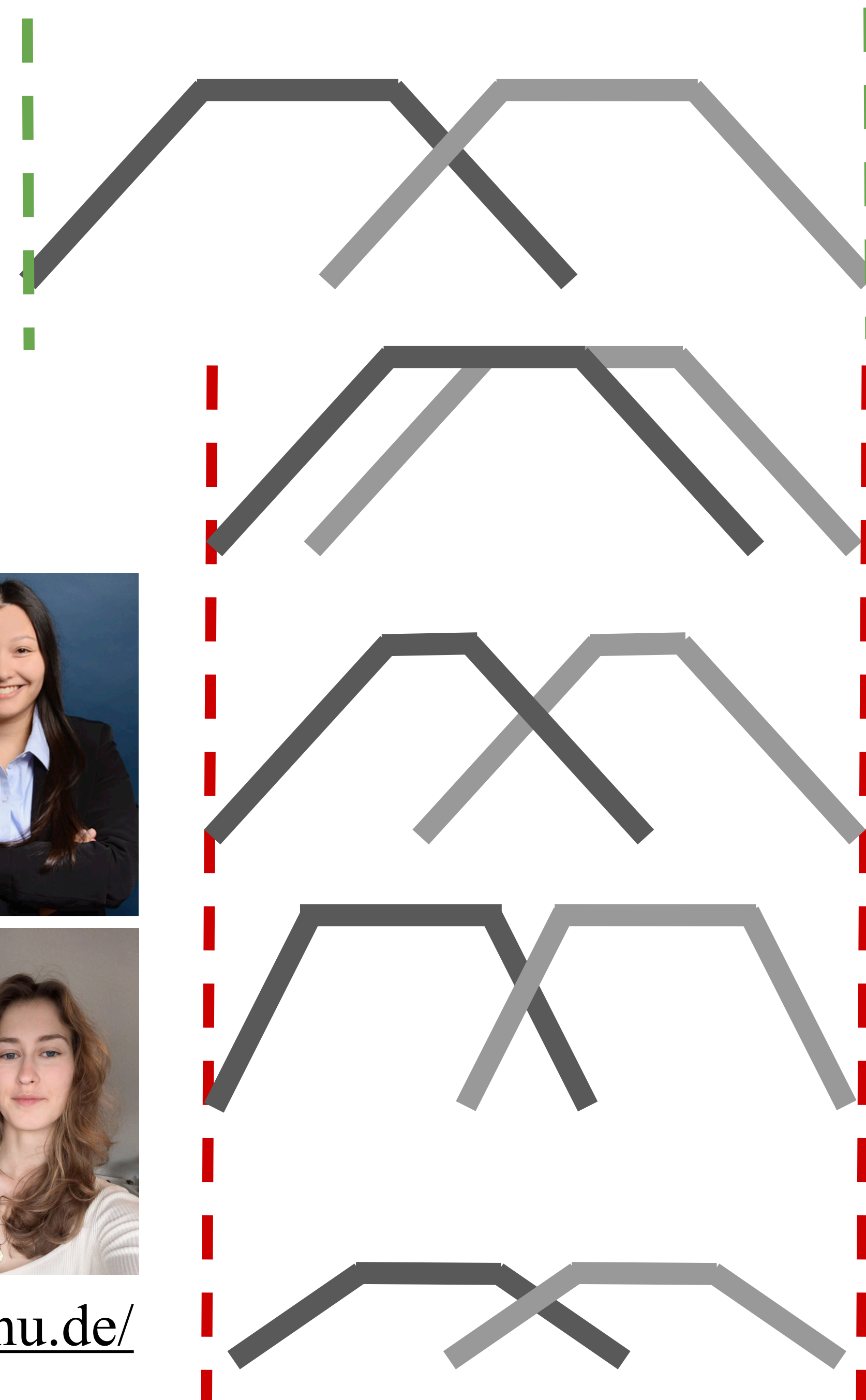
# Upcoming work
## Probabilistic reduction beyond duration

- 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!**