Articulatory Phonology: example studies

Phonology II

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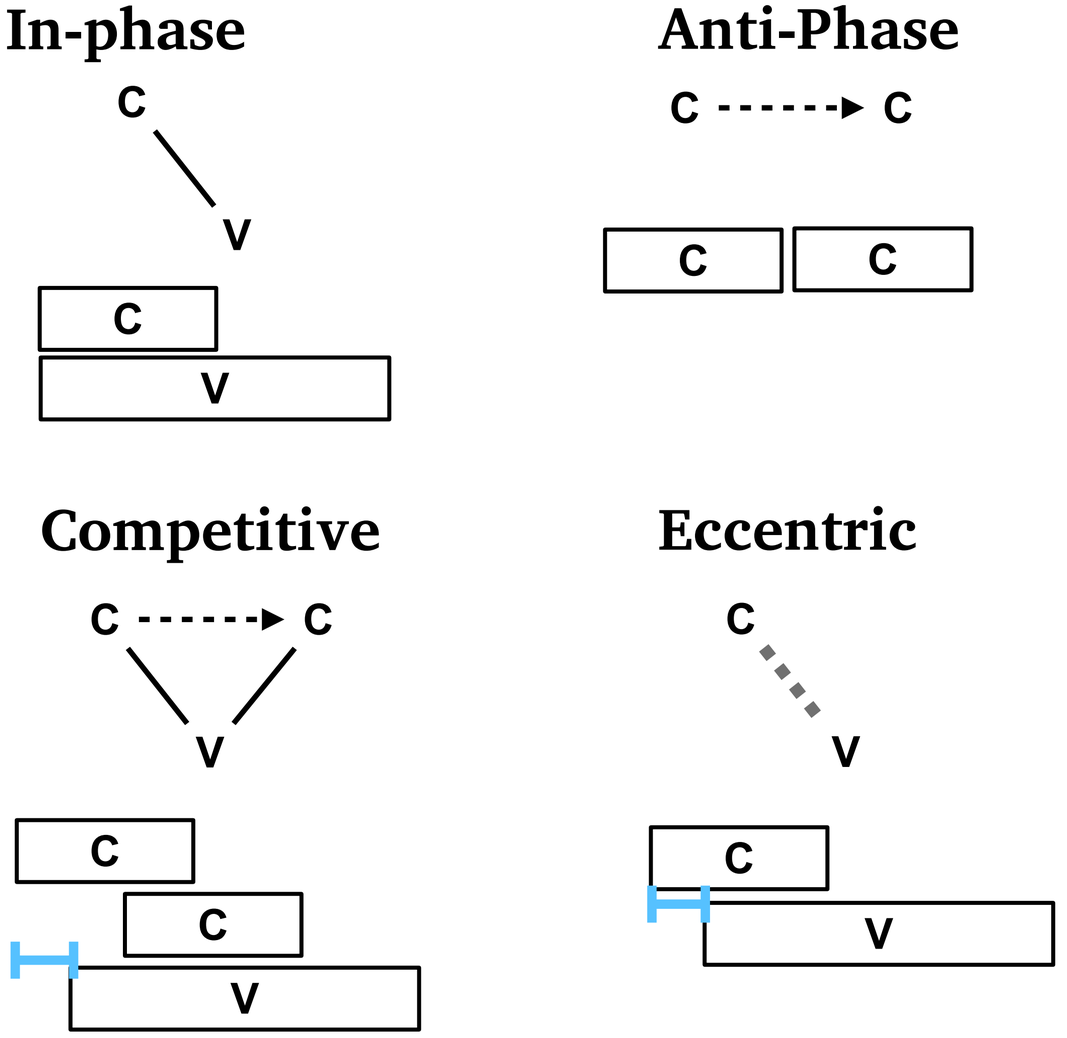
Articulatory Phonology review

Coordinating gestures in time

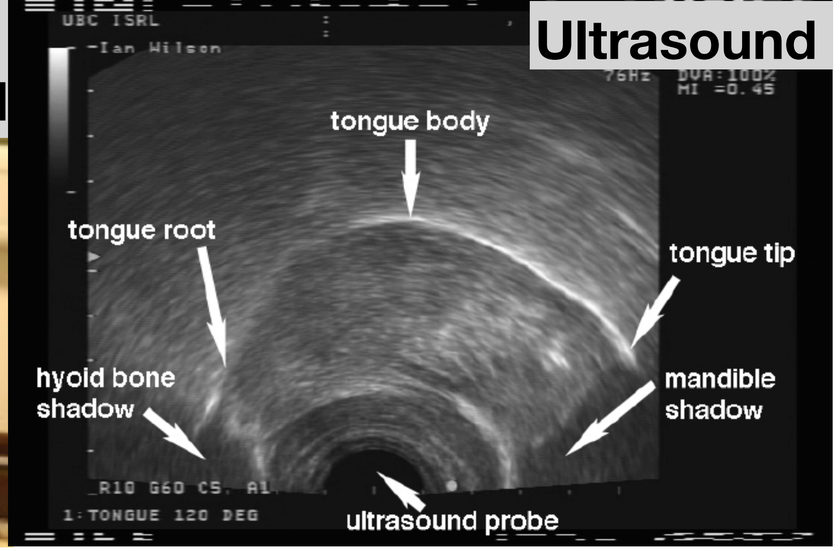
Articulatory Phonology in one slide

- *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)



Optical + Ultrasound

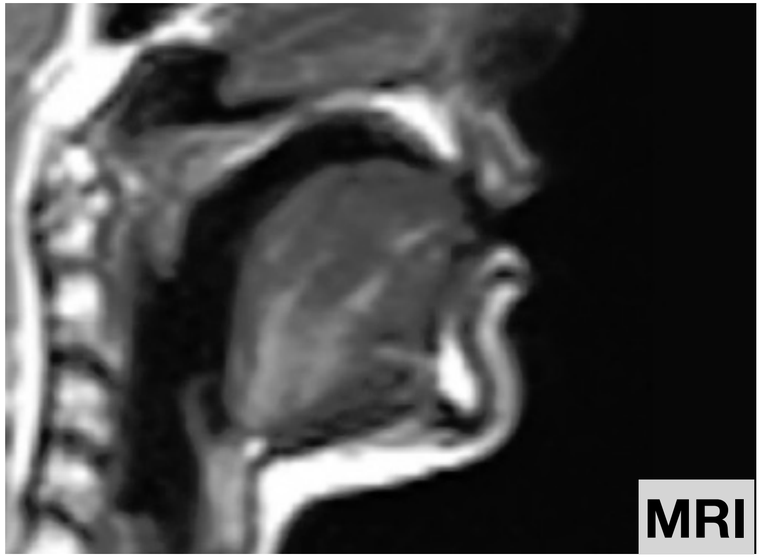


Ultrasound

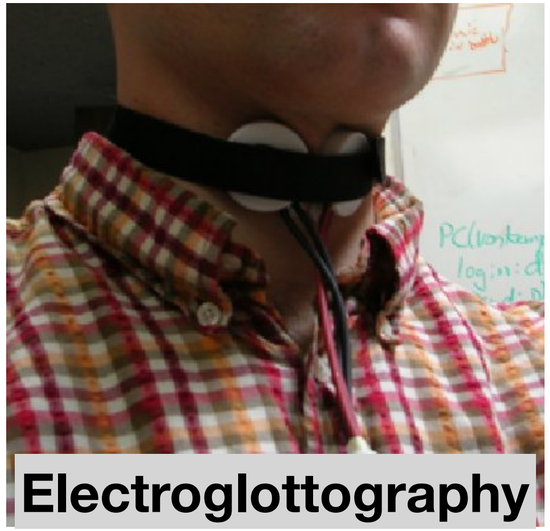
Nasal airflow

- What does it do well?
- What does it *not* do well?
- When might you use it?

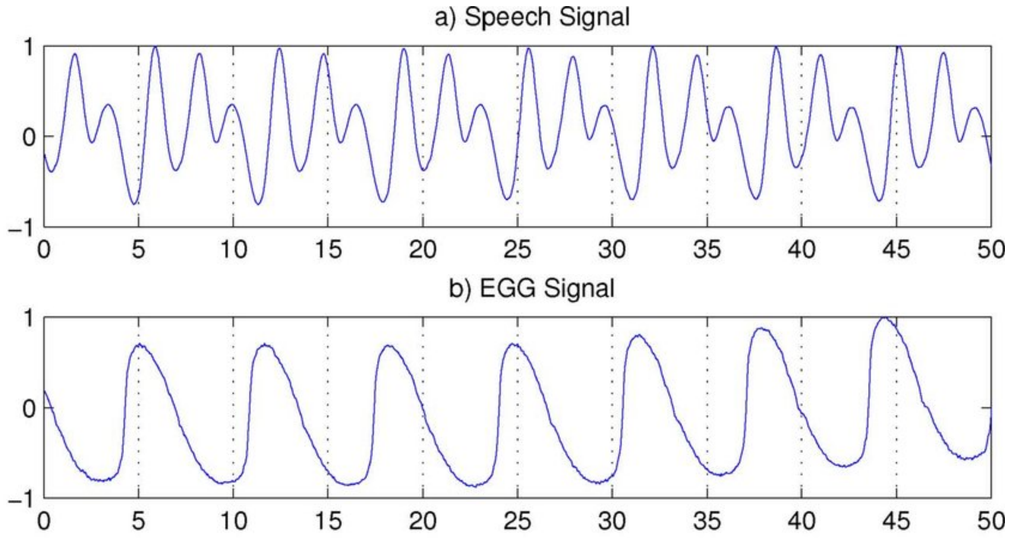
Articulatory Imaging



MRI



Electroglottography



Articulatory Imaging

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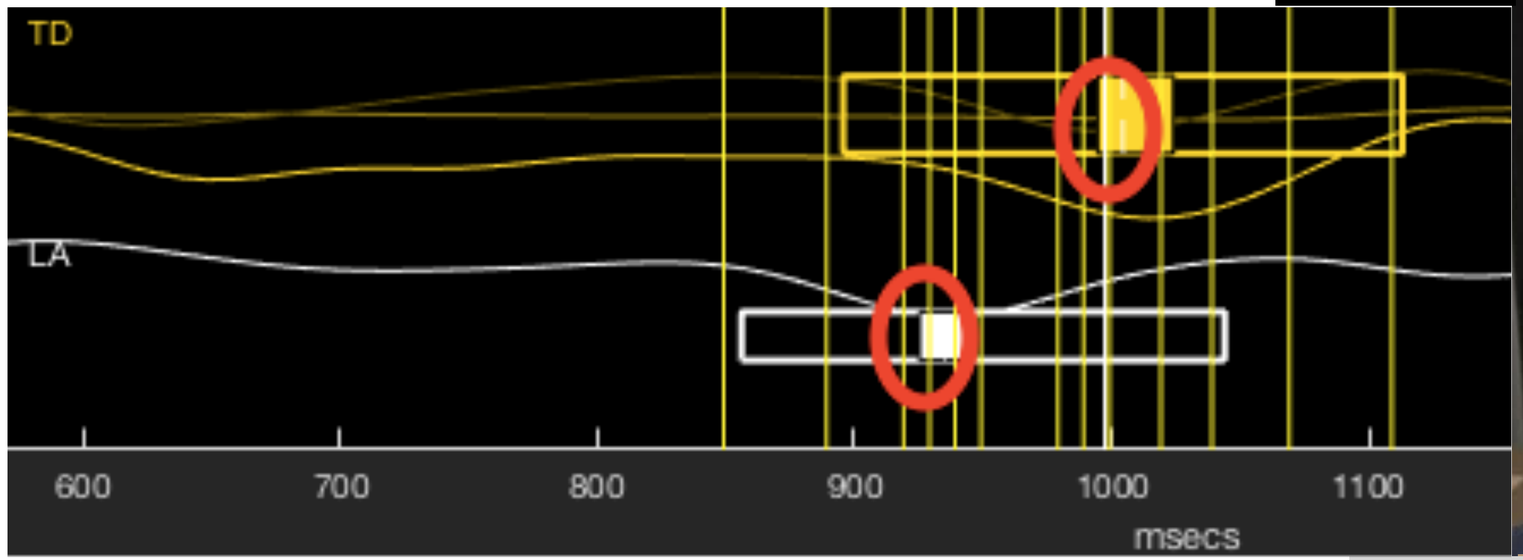
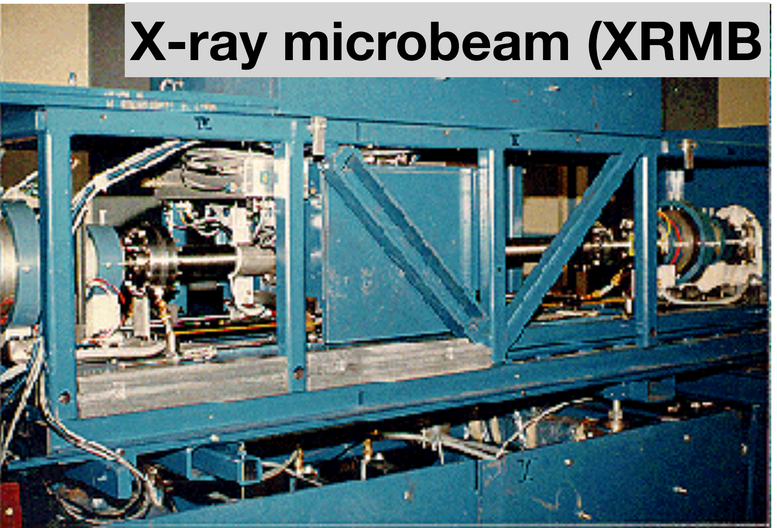


Electromagnetic Articulography (EMA)

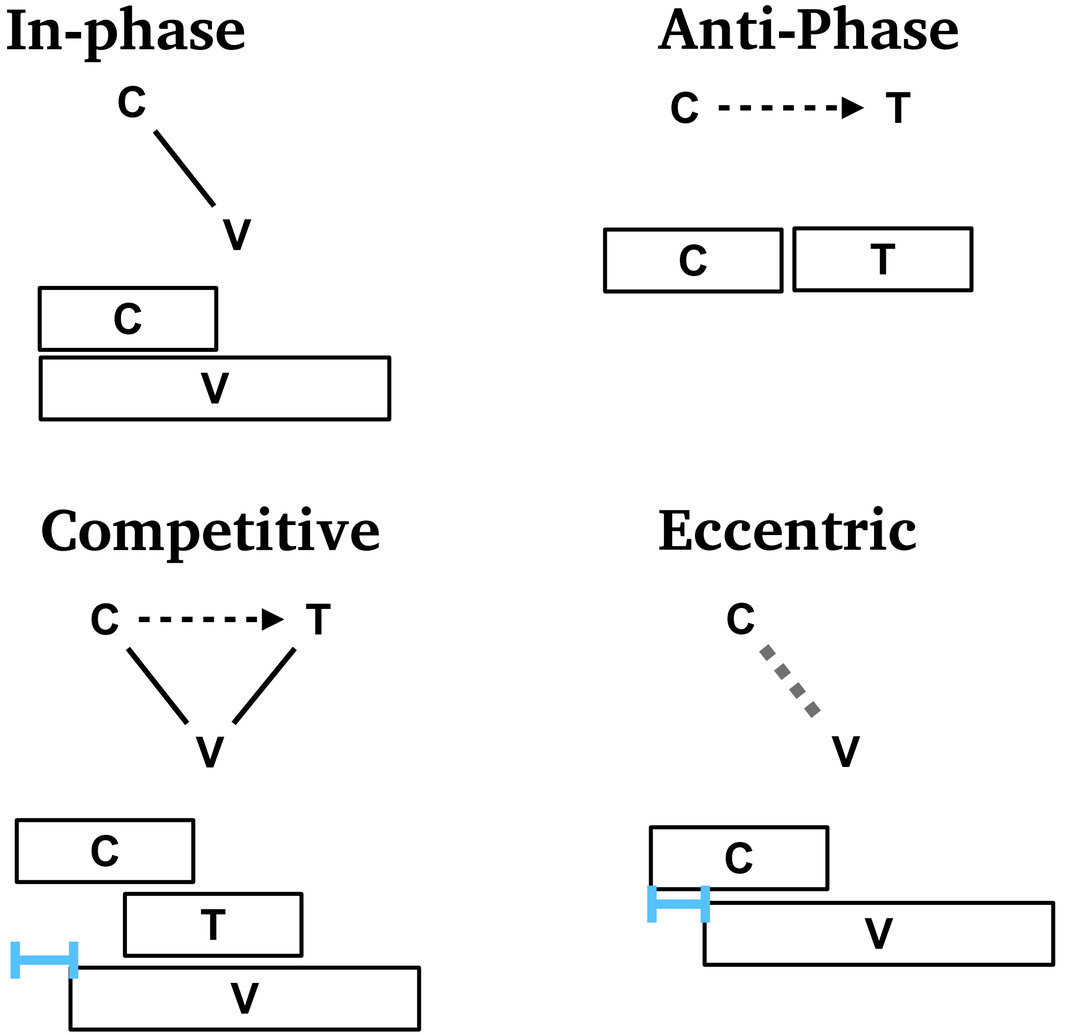
X-ray microbeam (XRMB



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…



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

Tibetan

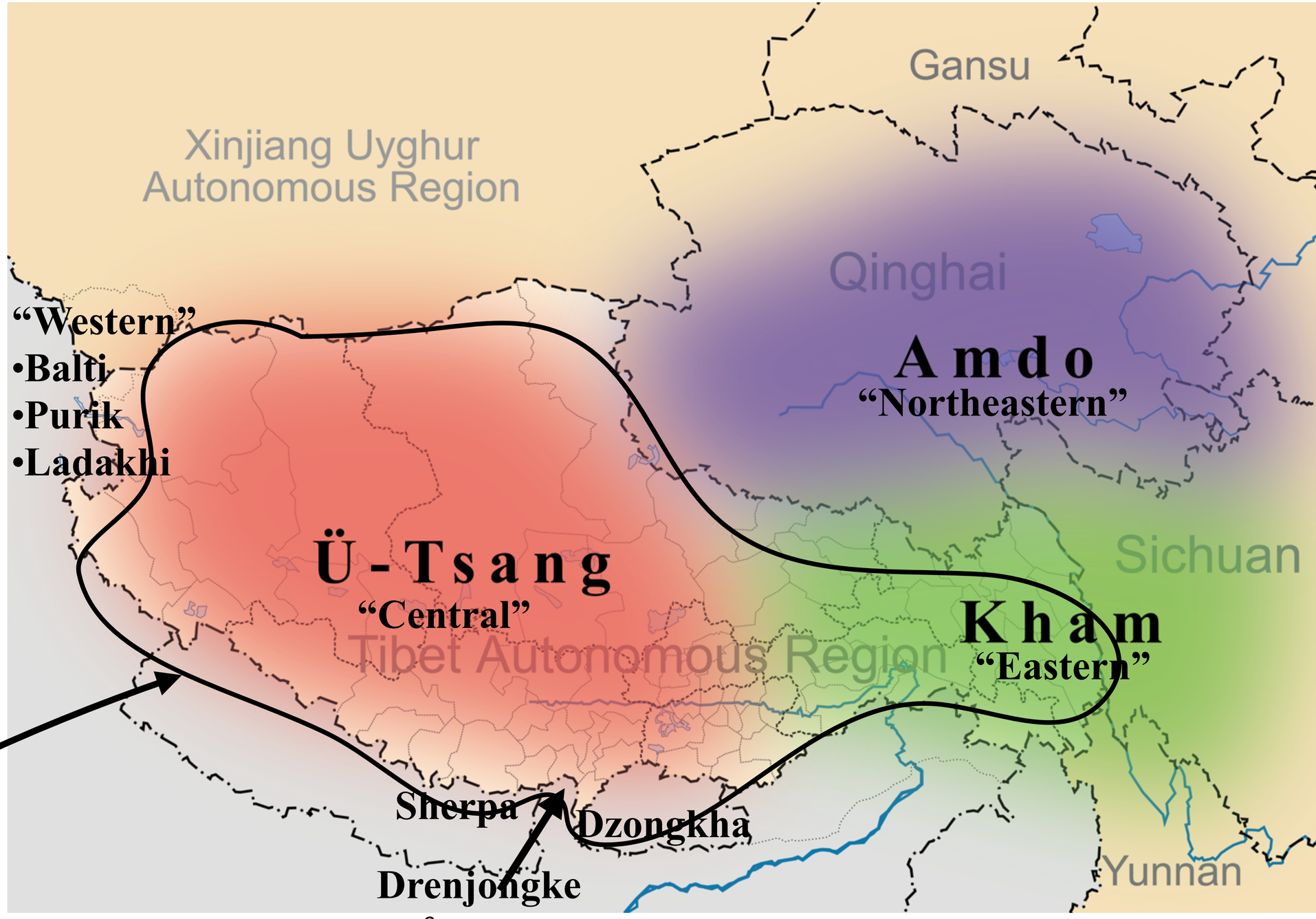
A “Natural Laboratory”

- 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 et al. 2019)
  - across speakers of the same language…

Tibetan

བོད་སྐད་

- “archaic”/“cluster”
- “innovative”/“non-cluster”
- dialect continuum
- post-1959 diaspora



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]	[tʰʌ́k] ([tʰák])	‘blood’
rtswa	[xst͡soa]	[xt͡sa]	[t͡sá]	‘grass’
spyang ki	[spjaŋ.ˈku]	[xt͡ɕaŋ.ˈkʰɤ]	[t͡ʃáŋ.gú]	‘wolf’
bcu bdun	[t͡ɕub.ˈdʊn]	[t͡ɕɤb.ˈdɤn]	[t͡ʃúp.tő] ([t͡ʃúp.tỹ])	‘seventeen’

(Adapted from Caplow 2013)

Tonogenesis
(tonal dialects only)

- Voiceless onsets > high tone
  - *p^{h}ar ‘over there’ > H
    *sa ‘earth’ > H
- Voiced onsets > low tone
  - *bar ‘between’ > L
    *za ‘eat’ > L
    *mar ‘butter’ > L
    - Sonorants with pre-initial > high tone
      - *sman ‘medicine’ > H

Laryngeal contrasts

	Etymological onsets							Innovative features
Orthography	སྤ་	ཕ་	བ་	སྦ་	ས་	ཟ་	བཟ་	
Old Tibetan	sᵊpa	pʰa	ba	sᵊba	sa	za	bᵊza	aspiration allphonic
Northeastern and Western dialects	spa	pʰa	ba ~ wa	ʁba	sa	za	za	cluster simplification aspirated/unaspirated contrast
Eastern dialects	pá	pʰá	pà	bà	sá	zà	zà	tonogenesis cluster simplification
Central dialects (Lhasa)	pá	pʰá	pʰà	pà	sá	sà	sà	voiced clusters > voiceless voiced simplex > aspirated

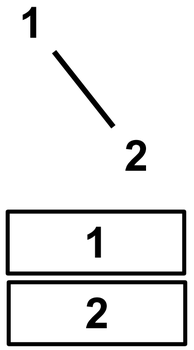
The temporal basis of complex segments

Shaw et al. 2019

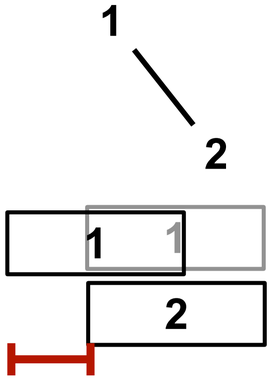
Shaw et al. (2019): predictions

and how to test?

In-phase



In-phase + lag



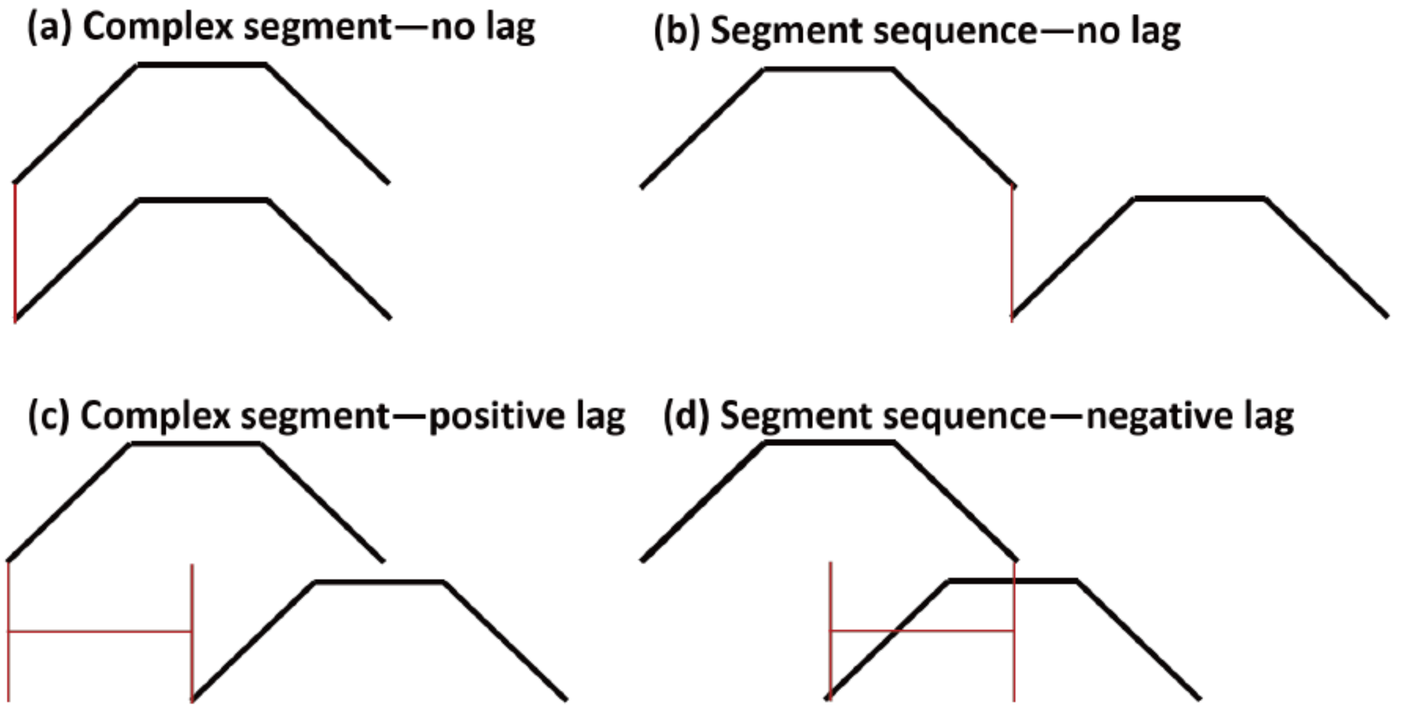
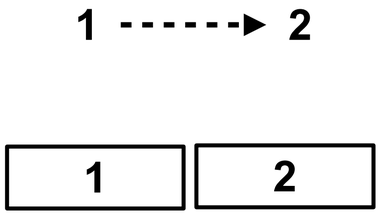
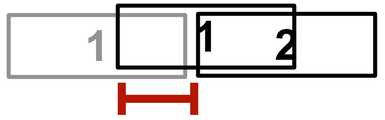


Figure 1: Hypothesized gestural coordination patterns for complex segments (a), (c) and segment sequences (b), (d)

Anti-Phase



Anti-Phase - lag



Shaw et al. (2019): results

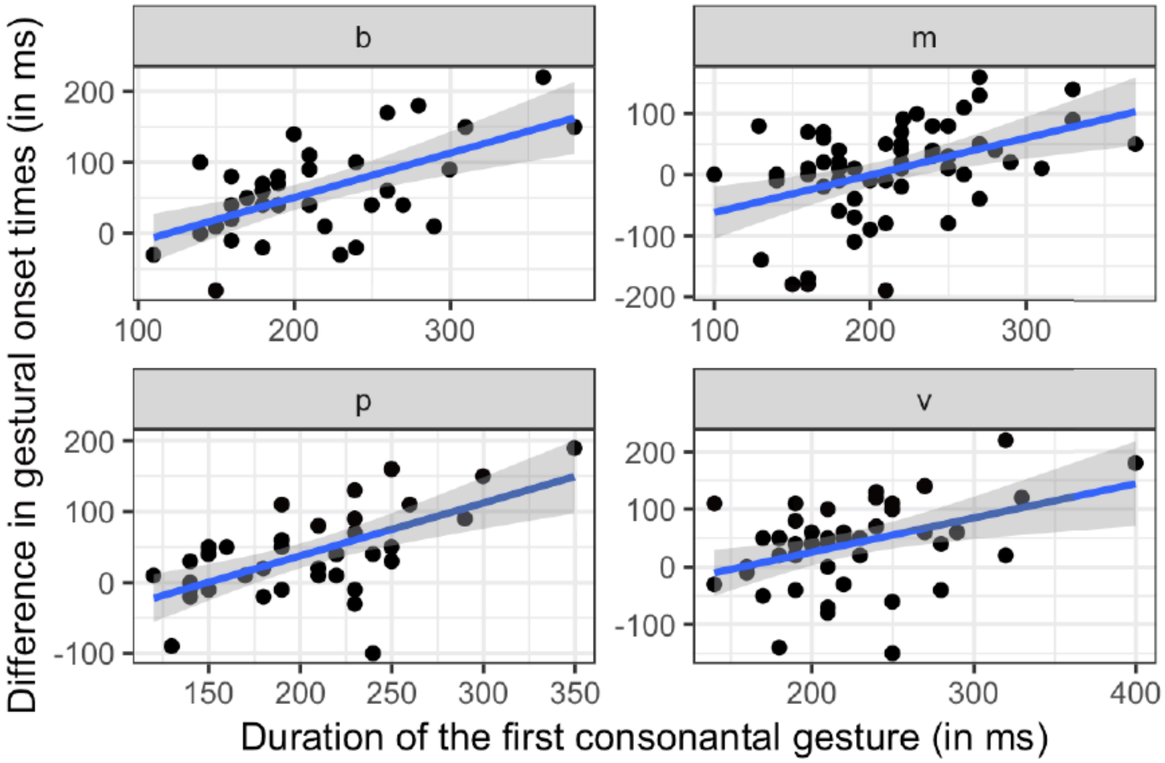


Figure 4: Correlations for the data from the English experiment

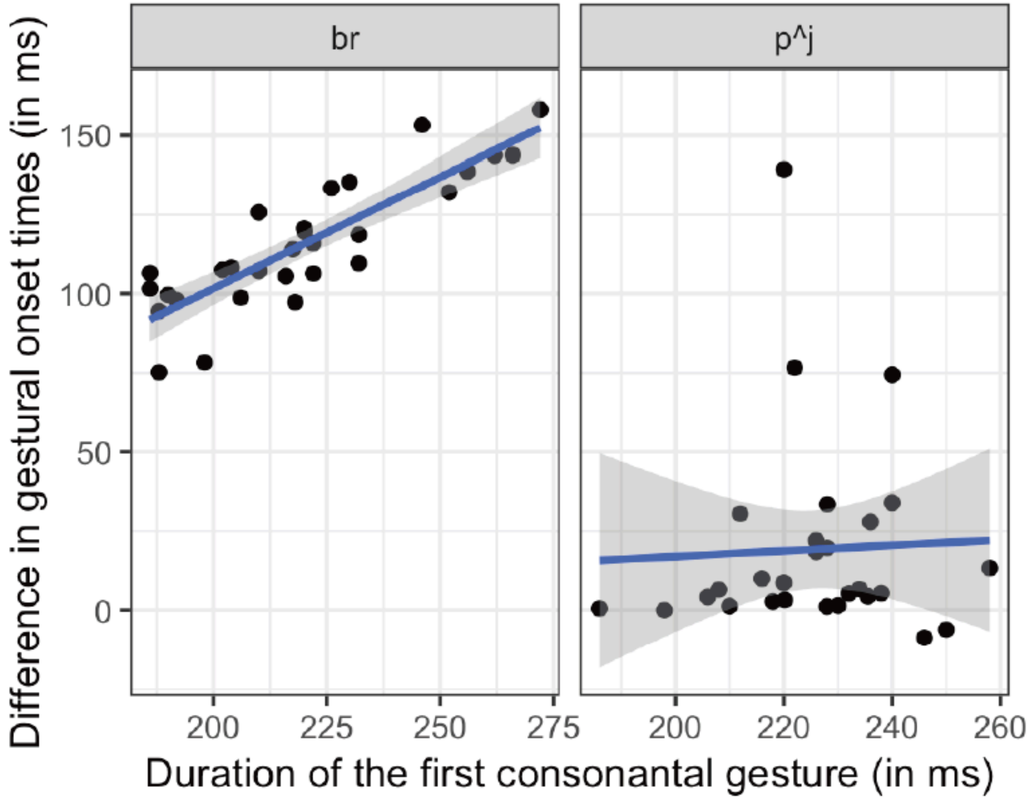


Figure 2: Correlations for the Russian data

Interpreting LMMs

Shaw et al (2019)

- Predicting: lag
- Random effects: speaker, item
- Fixed effects (R): gesture duration, sequence ([**p**^{j}], [br]), interaction
- Fixed effects (E): gesture duration, segment: [**m** b p v]
  - no interaction because effect of duration on lag is uniform across segments

Table 1: Mixed effects model for the Russian TB gestures in palatal(ised) consonants [G.D. = GESTURE DURATION, Seq = SEQUENCE]

Fixed Eff.	Est.	Std. Err.	t-val	p(>|t|))
Inter.	-9.2	33.2	-0.3	0.78
G.D.	0.09	0.2	0.6	0.54
Seq	-72.8	49.3	-1.5	0.15
G.D.:Seq (br)	0.82	0.2	3.6	<0.001

Table 2: Mixed effects model for the English TB gestures in palatal consonants [G.D. = GESTURE DURATION, FirstSeg = FIRST SEGMENT]

Fixed Eff.	Est.	Std. Err.	t-val	p(>|t|))
Inter.	-128.3	20.1	-6.4	<0.001
G.D.	0.64	0.09	7.4	<0.001
FirstSeg (b)	51.5	13.1	3.9	<0.001
FirstSeg (p)	39.6	13.1	3.0	0.003
FirstSeg (v)	25.8	12.4	2.1	0.04

An acoustic and articulatory study of Drenjonke fricatives

Guillemot et al. 2019

Drenjonke (Sikkimese) fricatives & tones

- Acoustic study to confirm
  - F0 → tone? yes
  - spectrogram, EGG → voicing?
    - yes for 1 female speaker
      no voicing for 4 male speakers

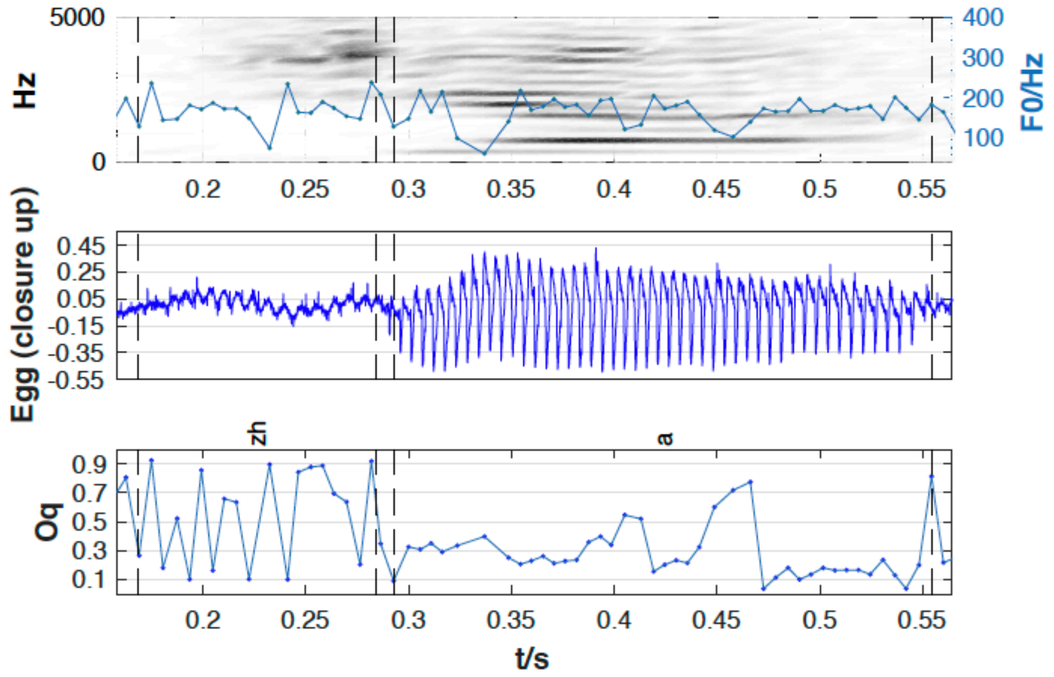
Previous descriptions			
	voiceless	voiced	devoiced
High	sá, ʃá		
Low		zà, ʒà	z̥à, ʒ̥à

Results: female speaker			
	voiceless	voiced	devoiced
High	sá, ʃá		
Low		zà, ʒà	sà, ʃà

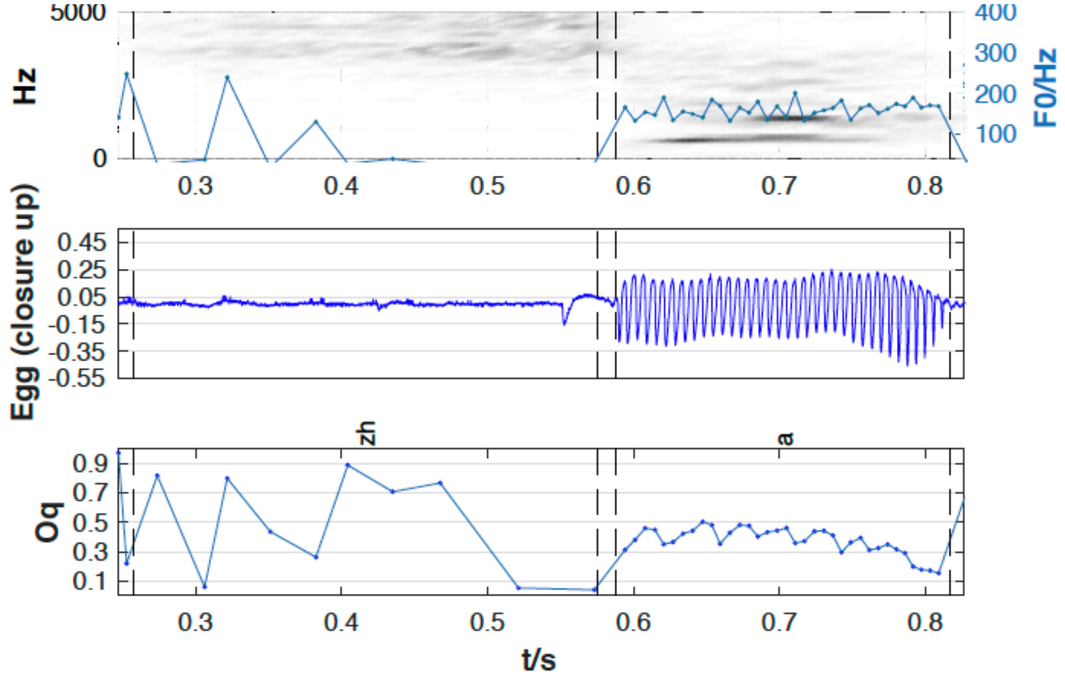
Results: male speakers			
	voiceless	voiced	devoiced
High	sá, ʃá		
Low		sà, ʃà	sà, ʃà

Drenjonke (Sikkimese) fricatives & tones

Results: female speaker			
	voiceless	voiced	devoiced
High	sá, ʃá		
Low		zà, ʒà	sà, ʃà



Results: male speakers			
	voiceless	voiced	devoiced
High	sá, ʃá		
Low		sà, ʃà	sà, ʃà



Corpus study

Geissler (2021)

Goals

- Establish facts about consonantal and tonal contrasts
  - Interspeaker variation?
  - How to tone and laryngeal contrasts co-occur?

- Inform hypotheses for controlled articulatory study

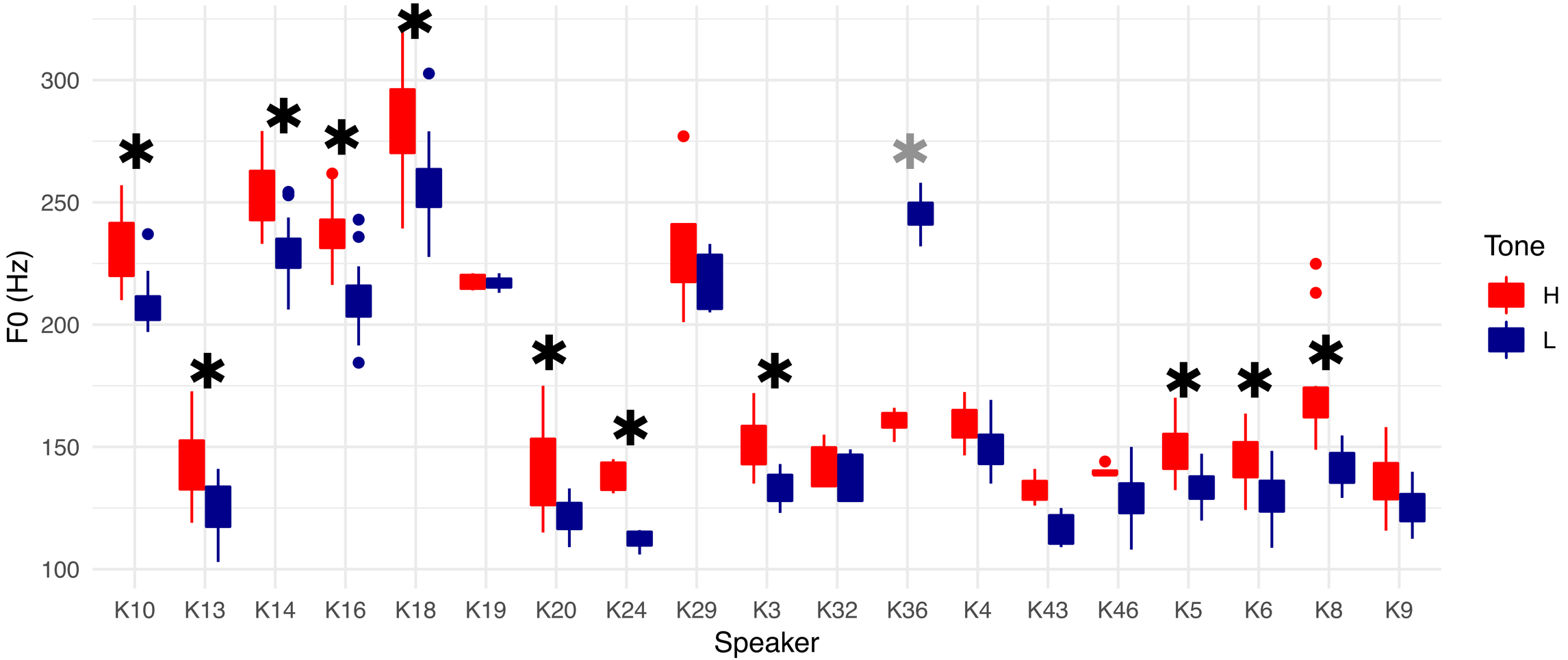
Methods

- 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

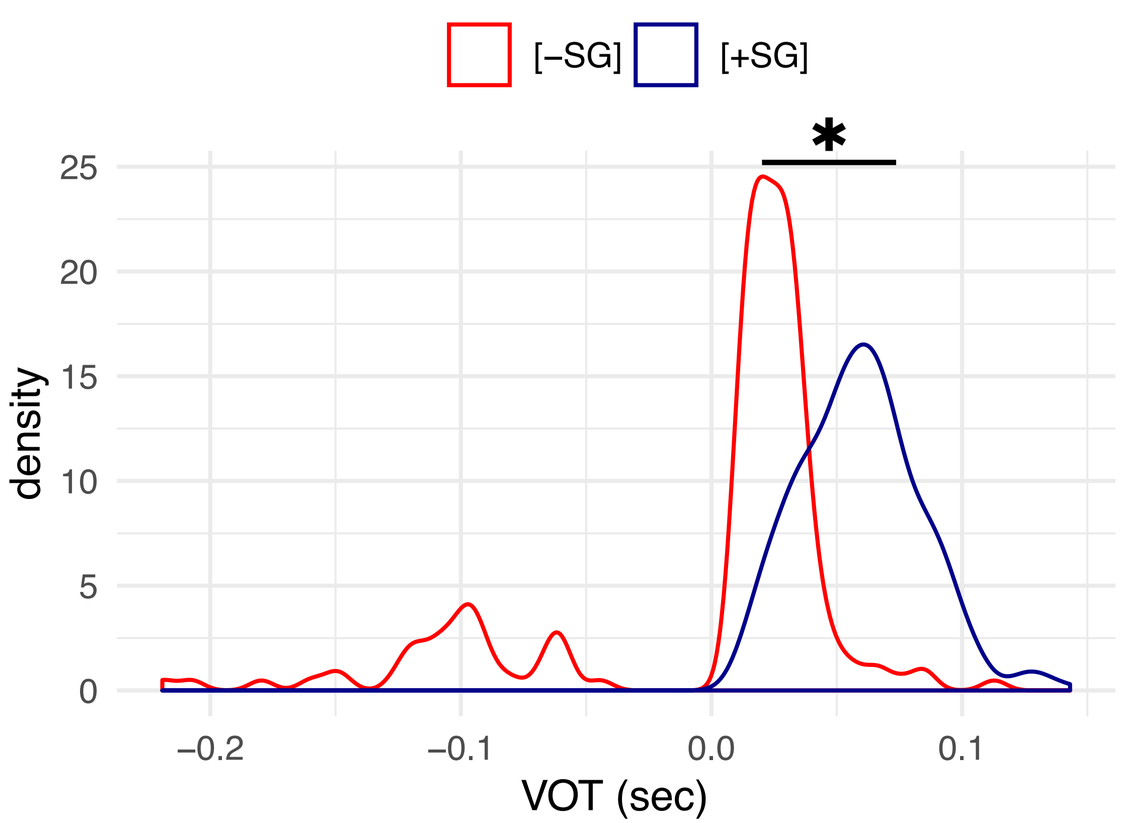
F0-tone

F0 at onset of voicing

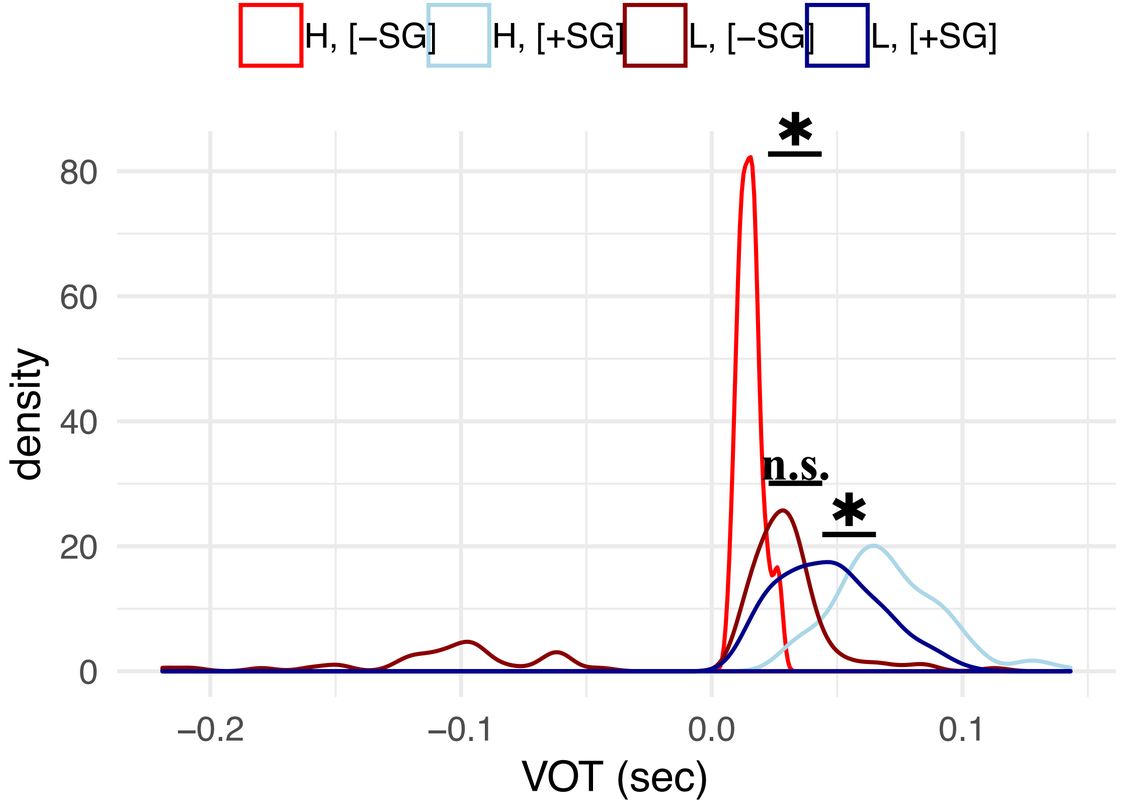
- H > L significant for 11/19 speakers
- no significant difference for 7/19 speakers



VOT and tone categories



- Unaspirated vs. aspirated



- Unaspirated vs. aspirated…
  … plus tone

Summary of corpus study

- Confirmed:
  - no clusters in diaspora speakers
- Novel findings:
  - some speakers lack tone contrast (production)
  - effect of tone on aspiration duration
  - effect of tone on prevoicing

Articulatory study

Geissler (2021)

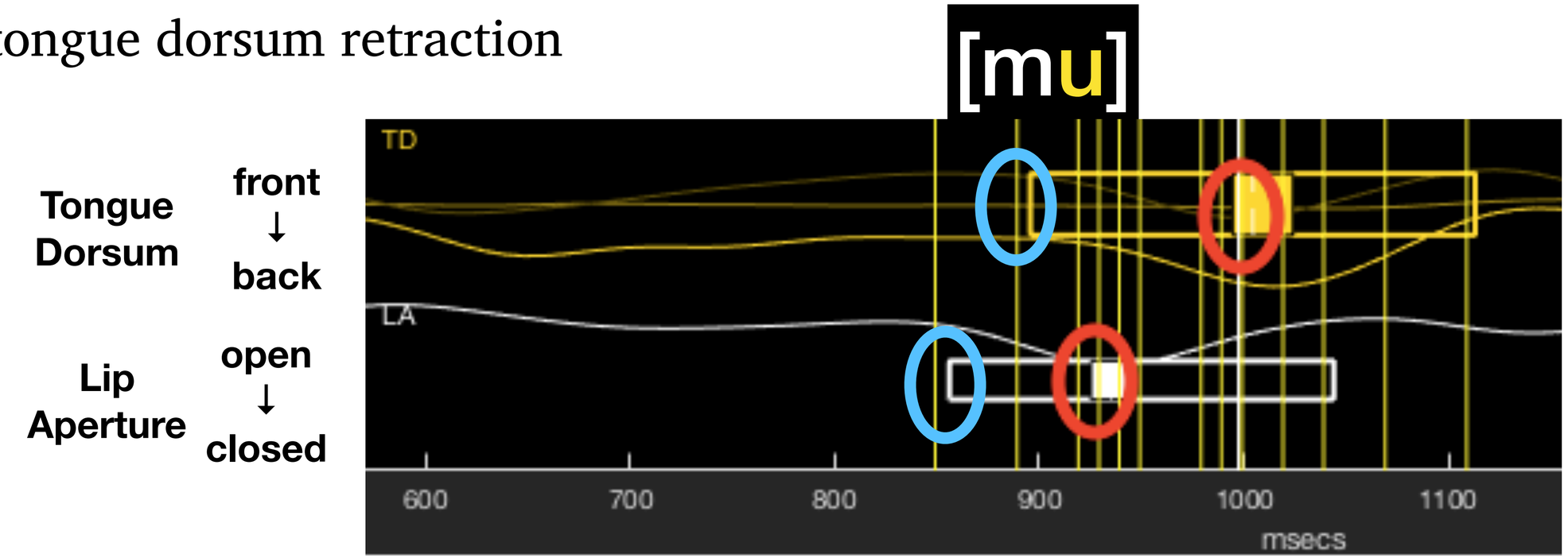
Hypotheses

- 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-∅, then difference will be visible in high vs. low tone words
    - If H-L, then no difference in timing by tone.

EMA data

articulatory trajectories

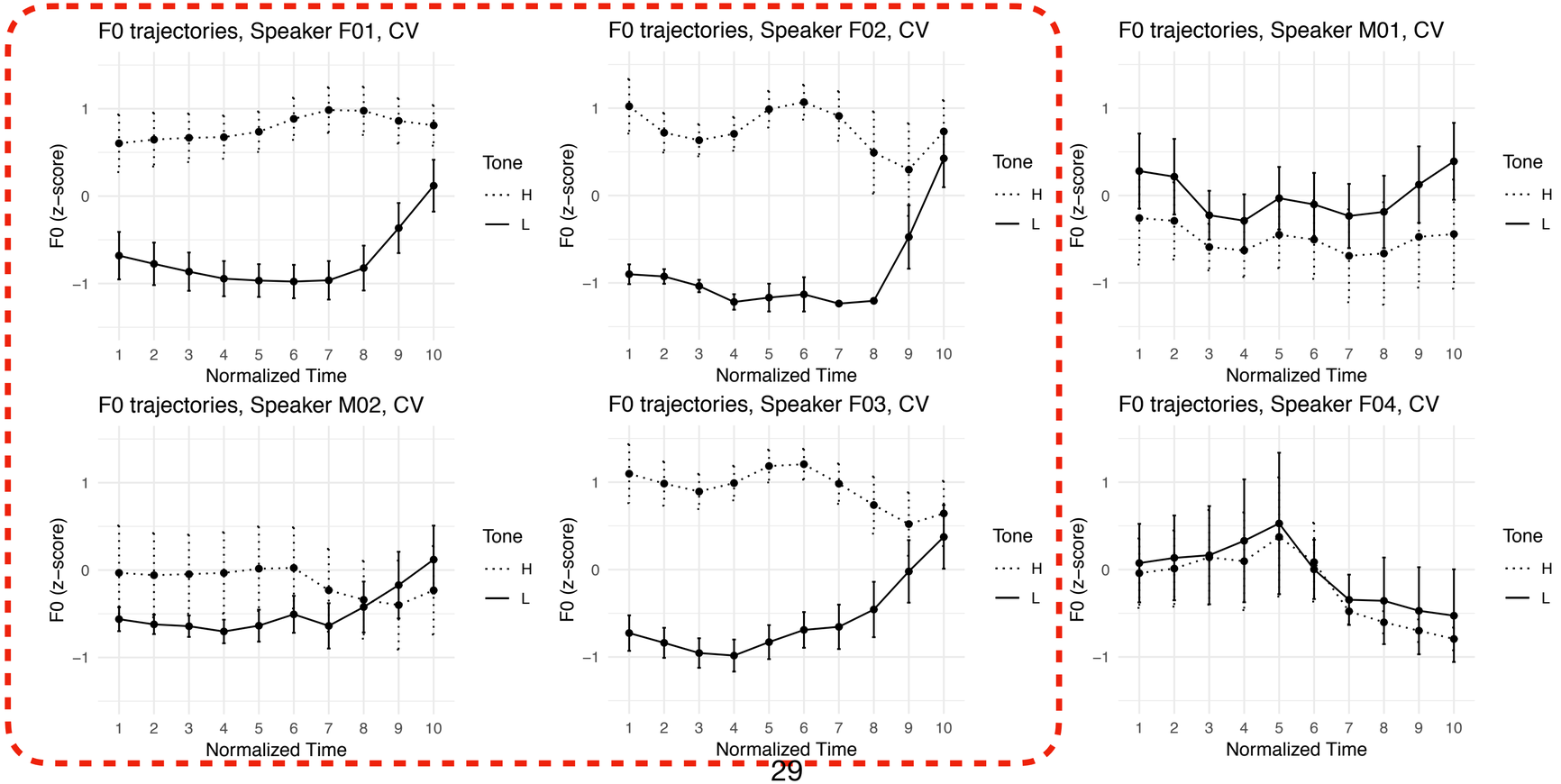
- Tracks movement of sensors over time
- [p p^h m]: distance between lip sensors
- [i]→[u o a]: tongue dorsum retraction



(Mview software: Tiede 2005)

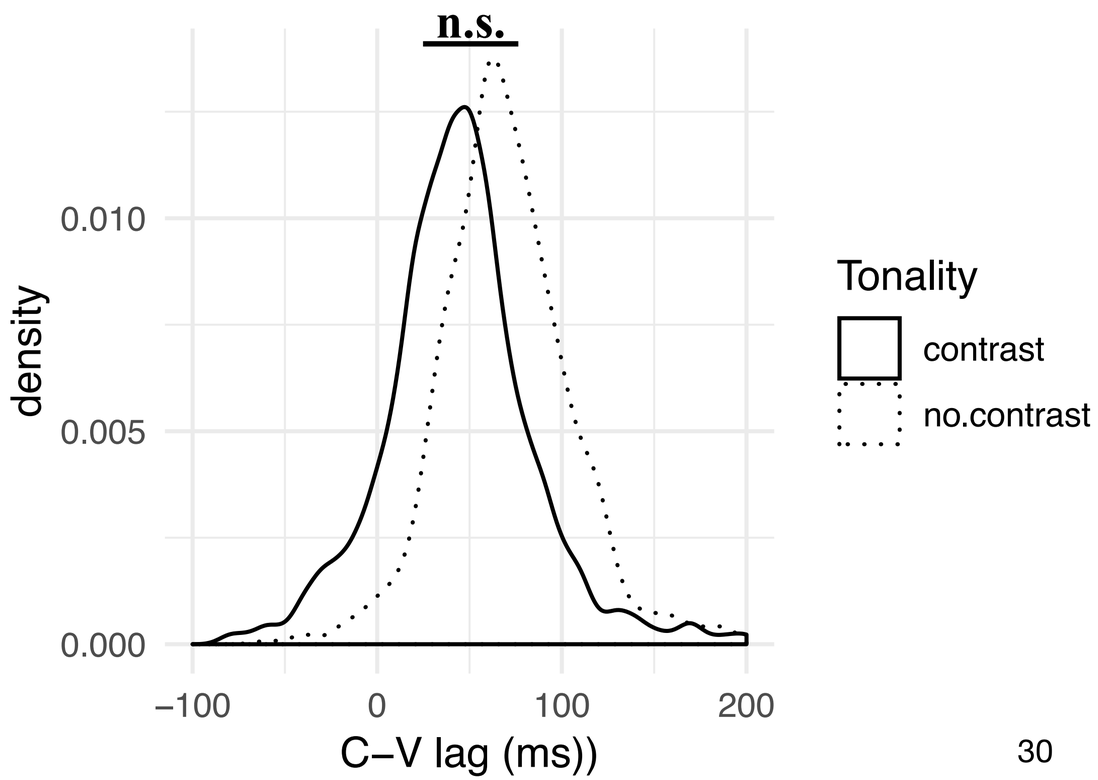
Results: tone contrast

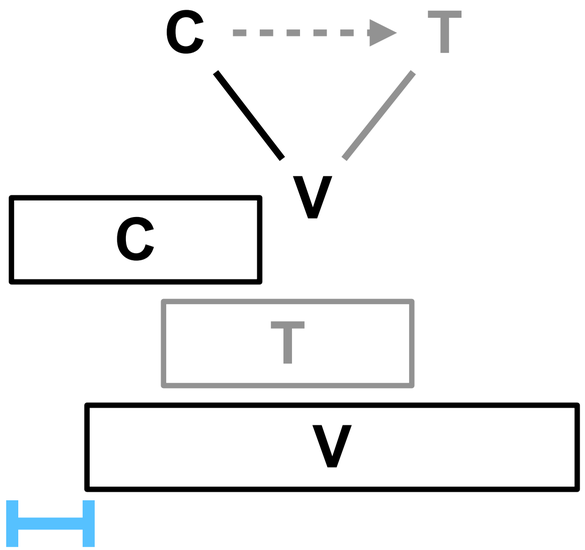
- 4 speakers produce a tone contrast, two do not (on /mV/)



Results: C-V lag

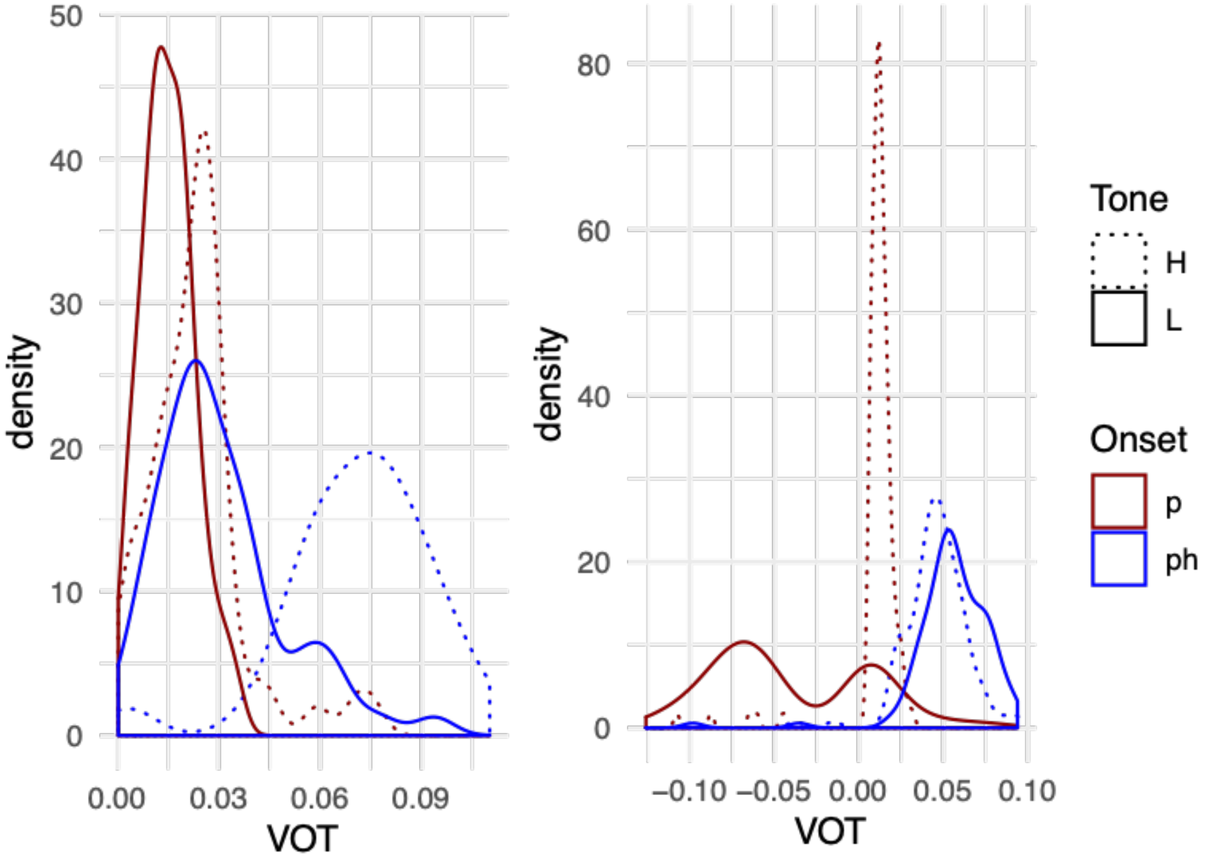
- There is a positive C-V lag… for speakers with and without the tone contrast
- No significant difference between the tones





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

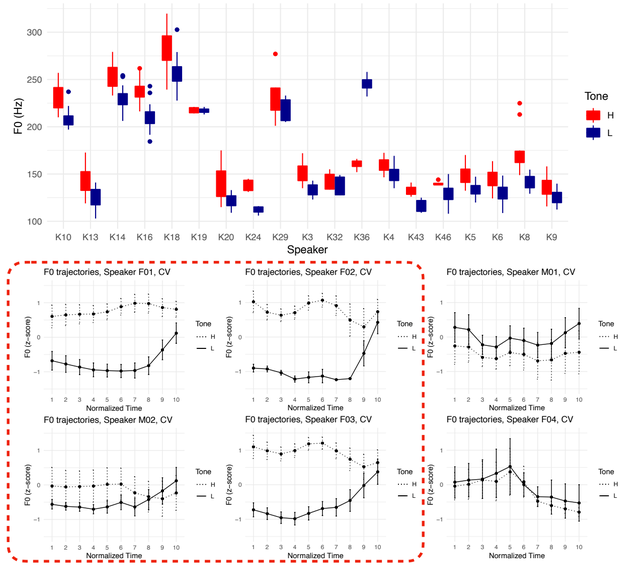


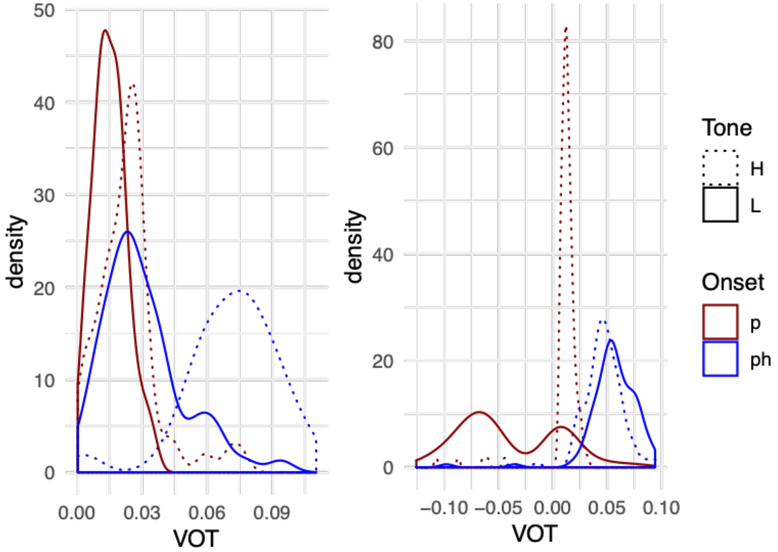
EMA Study conclusions

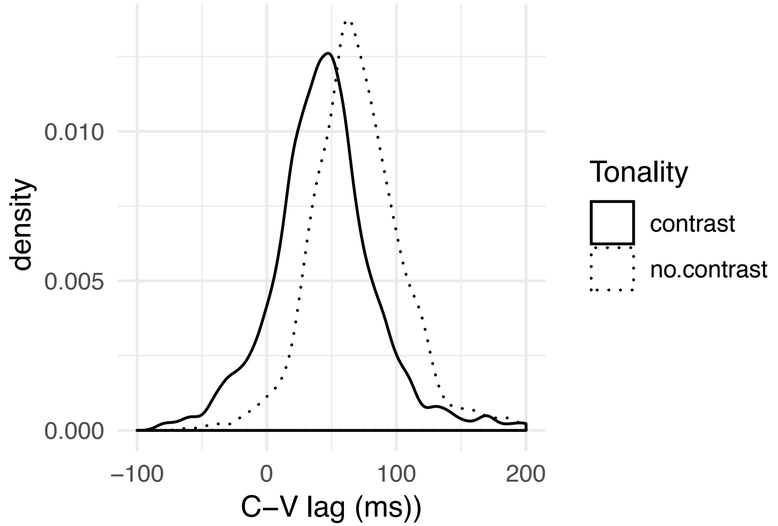
- H1: variation in timing conditioned by presence/absence of lexical tone
  - speakers with tone contrast will have competitive coupling (pos. C-V lag)
  - speakers without tone contrast will have in-phase C-V timing (no C-V lag)
- ✔ **H2: timing convergence:**
  - all speakers have similar coordination 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 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

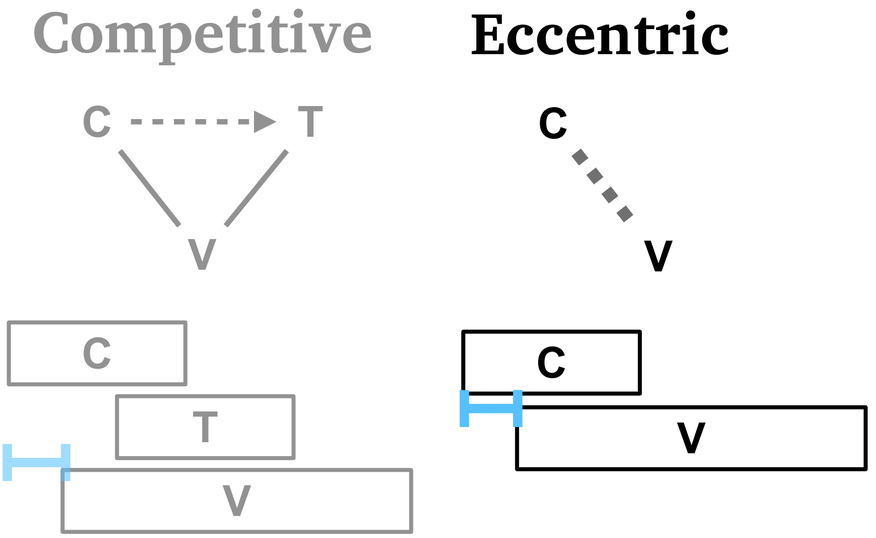






Implications

- 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



General summary

- What is AP useful for?
- What is AP *not* useful for?
- What are some challenges in AP?
- What do you want to learn more about?

ཐུགས་རྗེ་ཆེ།

Thank you!