

The coordination of tone gestures in Thai



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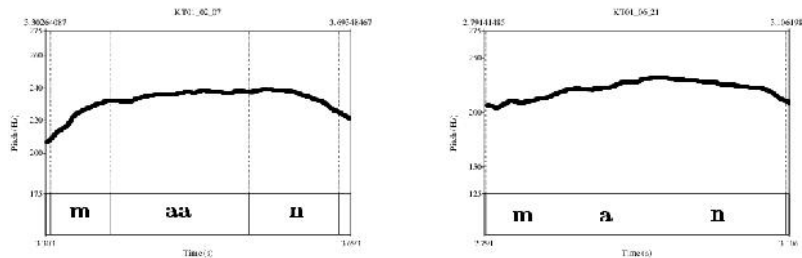
MFM23
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The Thai tone-bearing unit

- ▶ In addition to three level tones (low, mid, and high), Thai also contrasts two contour tones, Falling (HL) and Rising (LH)
- ▶ Standard analysis: Thai tone-bearing unit (TBU) is the mora (Morén and Zsiga, 2006)
 - ▶ Syllables with one mora can only carry simple tones;
 - ▶ Syllables with two (*sonorant) moras can carry contour tones
 - ▶ Specifically, tones associate to the right edge of a mora

Shape	Moras	Low	Mid	High	Fall	Rise
CV	1					
CVO	2*					
CVS	2					
CVV	2					
CVVO	2					
CVVS	2					

The Thai tone-bearing unit



- ▶ Acoustically, the “right edge” breaks down
 - ▶ The turning point changes based on the content of the mora
 - ▶ Acoustic landmarking is not as consistent as articulatory landmarking (Prieto and Torreira, 2007)
- ▶ Standard approach does not emphasize the relationship between representation and production

Articulatory Phonology approach to tone

- ▶ Aims of Articulatory Phonology (AP):
 - ▶ Explicit predictions regarding articulatory timing
 - ▶ Demonstrate implementational reality of abstract representations
- ▶ Recently, tone has fruitfully been treated as a gesture, similar to those involved with consonants and vowels
- ▶ **Proposal:** a TBU is a gesture with which a tone gesture coordinates
 - ▶ In Thai, these gestures correspond with the segments that are traditionally viewed as moraic
 - ▶ The mora corresponds to a bundle of gestures that are selected and activated together: “co-selection set”

Coordination and co-selection sets

Anti-phase coordination

- ▶ Two gestures activated 180° out of phase with each other
- ▶ Still activated at the same time: feedback not necessary to start the temporally second gesture
- ▶ VC syllables: co-selection set with V, C gestures in anti-phase coordination

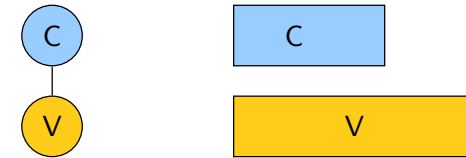


5

Coordination and co-selection sets

In-phase coordination

- ▶ Two gestures activated in the same phase
- ▶ Onsets together, but may not end together
- ▶ CV syllables: co-selection set with C, V gestures in in-phase coordination



6

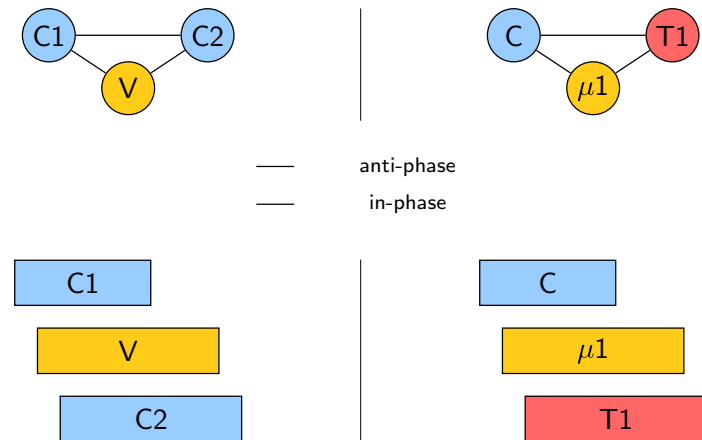
Co-selection sets (Tilsen, 2014)

- ▶ Groups of gestures that are selected together and coordinated
 - ▶ **Segment-like**: Lips closing, velum lowering, vocal folds vibrating ([m])
 - ▶ **Syllable-like**: Coordination of segment-like co-selection sets to make CV, VC, CVC (etc.) syllables
 - ▶ **Mora-like**: Consists of the gesture that constitutes the segment that is considered moraic, plus any non-moraic gestures that may be associated
 - ▶ A V and its onset consonant C;
 - ▶ A V and its non-moraic coda C;
 - ▶ A V and its tone

7

The articulatory TBU: “A vowel and its tone”

- ▶ Recent work has found that lexical tone gestures behave like consonants (Gao, 2008)
- ▶ C-center effect



8

How is T_2 coordinated?

- ▶ Previous studies of tone have focused on Mandarin (Gao, 2008)
 - ▶ Syllable is the TBU
 - ▶ Tone 4 not affected by syllable structure—/ma/ vs. /man/
- ▶ Is T_2 most like a coda?
- ▶ What is the relationship between T_2 and the other members of its mora?

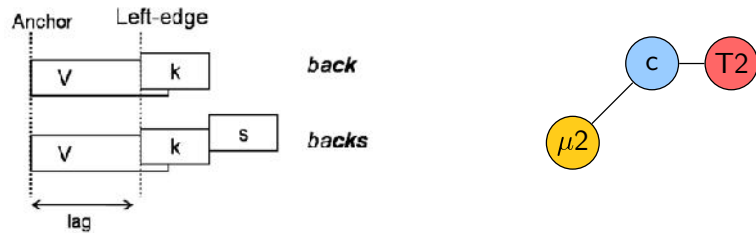
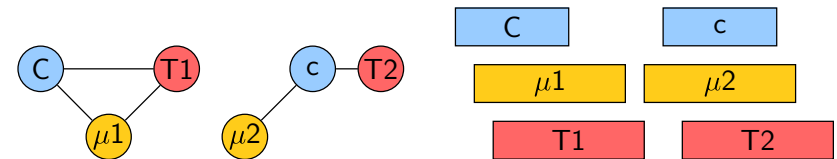


Figure: The schematic of complex codas from Marin and Pouplier 2010 (left) and the associated coupling diagram (right).

9

Current study: hypotheses and predictions

- ▶ Examine the timing of T_2 with respect to:
 - ▶ T_1
 - ▶ Other gestures in the second “moraic co-selection set”
- ▶ **Hypotheses:**
 - ▶ There is an “articulatory TBU”—i.e., there is some gesture that T gestures are robustly coordinated with.
 - ▶ **Possibility 1:** T gestures are coordinated within their moraic CSS, but not with each other
 - ▶ **Possibility 2:** There is an additional level of coordination between T gestures
- ▶ Schematic below illustrates the predictions of Possibility 1:



10

Current study: Methods

- ▶ **Articulatory:** Electromagnetic articulograph (EMA) with sensors on tongue, lips, jaw
- ▶ **Acoustic:** For F0
- ▶ **Target words:** Bimoraic words with falling tones

	Monophthongs		Diphthongs	
No coda	มา	mâa	มัว	mûa
Coda: n	มาน	mân	มวน	mûan
Coda: t	มาต	mâat	มุต	mûat
Moraic coda: n	มัน	mân		

- ▶ Two carrier sentences
- ▶ Three speeds
- ▶ Four participants

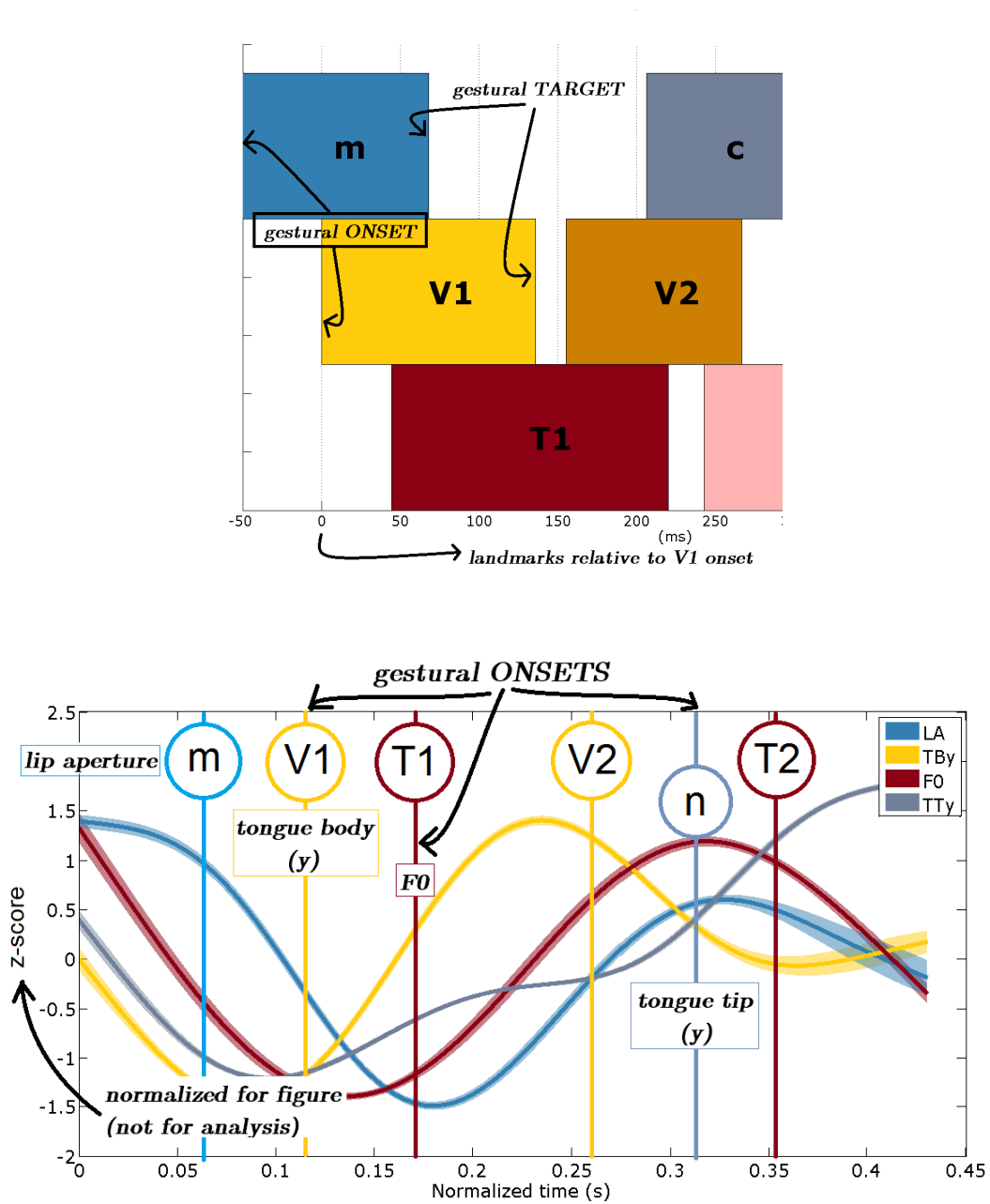
11

The coordination of tone gestures in Thai: Supplemental figures

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Figure guide



Diphthongs

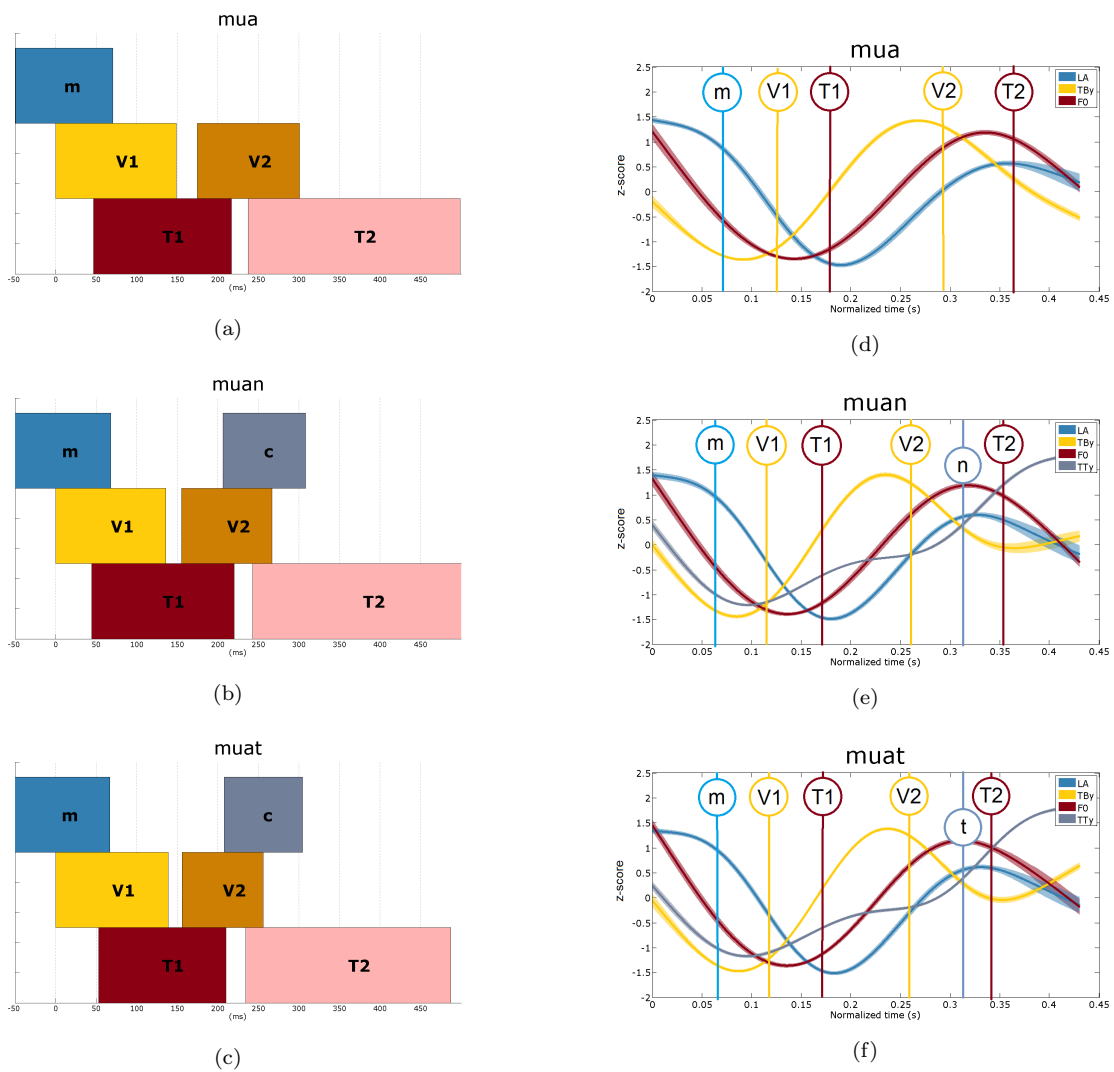
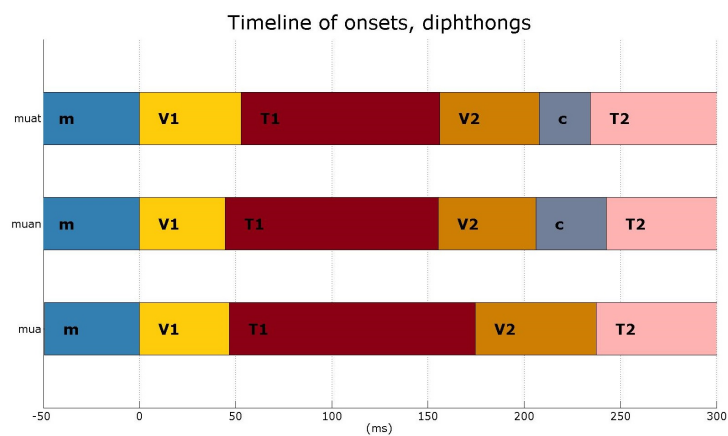


Figure 1: Gestural scores and landmarked trajectories of diphthong target words, collapsed across speed and carrier conditions.



Monophthongs

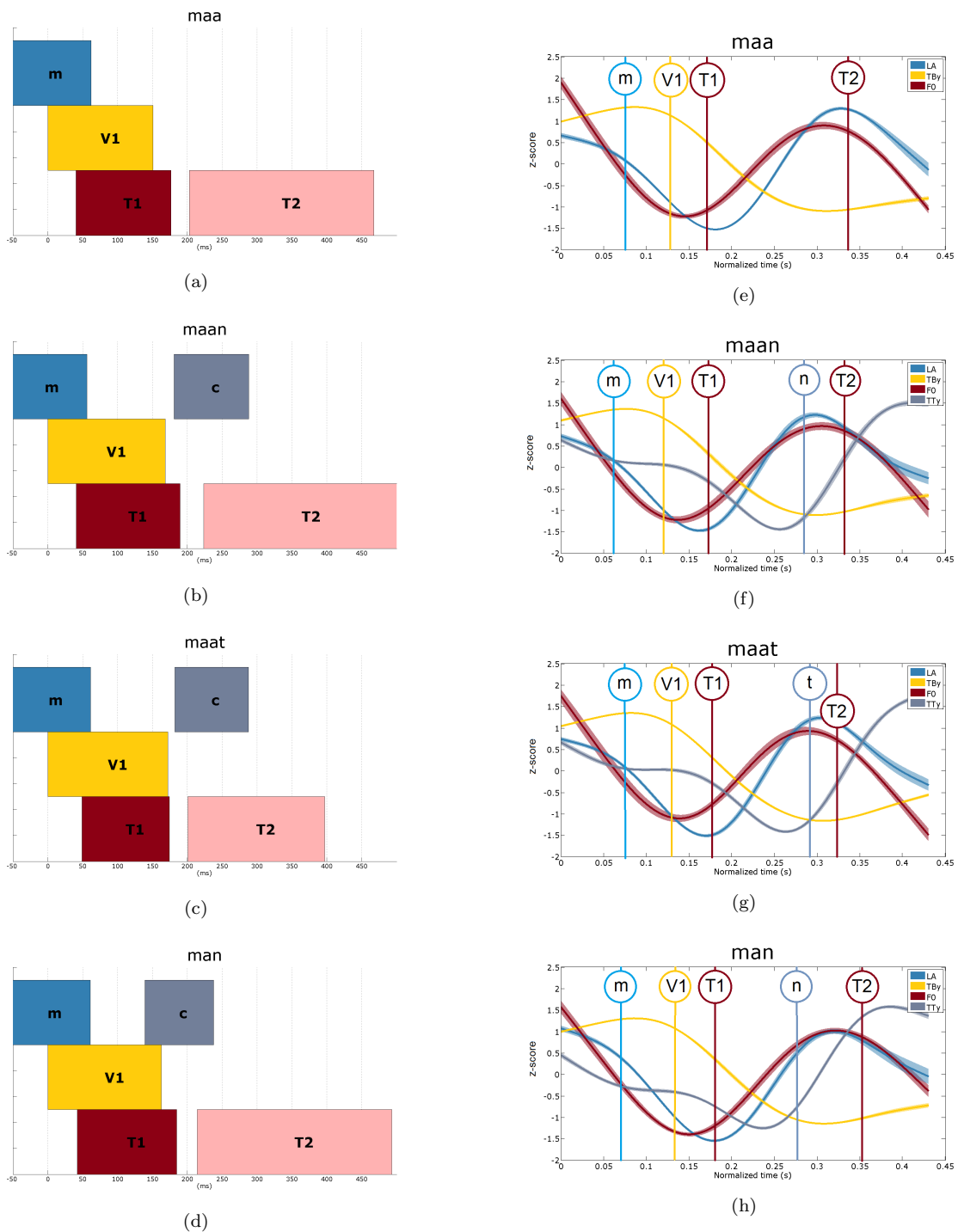
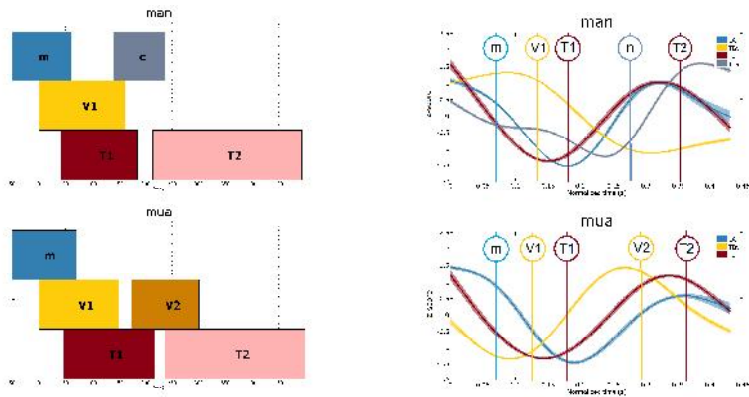


Figure 2: Gestural scores and landmarked trajectories of monophthong target words, collapsed across speed and carrier conditions.

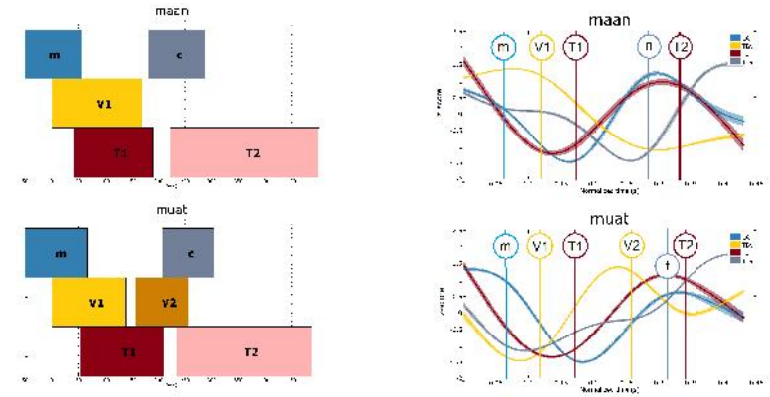
T2: "Bare" second mora (/mân/, /mûa/)



- ▶ Mora 1: $C - \mu 1 - T1$
- ▶ Mora 2: $\mu 2 - T2$
- ▶ *C \hat{V} O?

14

T2: Non-moraic coda (/mân/, /mûat/)



- ▶ Mora 1: $C - \mu 1 - T1$
- ▶ Mora 2: $\mu 2 - c - T2$
- ▶ T2 follows c gestures even when c is voiceless

15

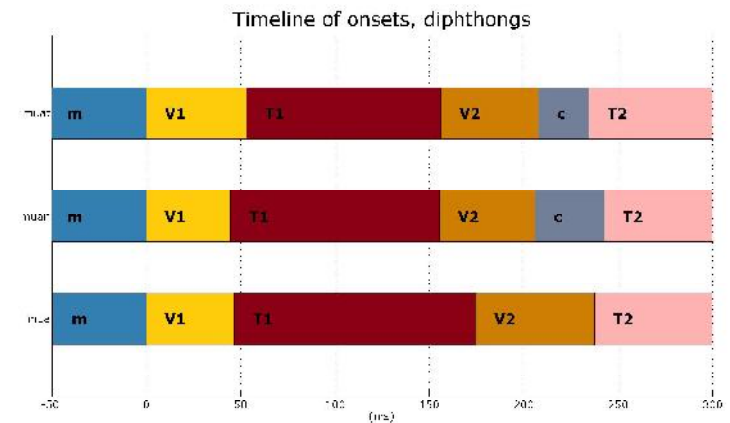
Some evidence for moraic co-selection sets

	mûan		mûa
	St. Dev.		St. Dev.
V1 - m	15.5 ms	T2 - V2	14.3 ms
V2 - n	17.7 ms	V1 - m	15.0 ms
T1 - V1	19.3 ms	T1 - m	22.5 ms
T1 - m	22.9 ms	T1 - V1	23.0 ms
T2 - V1	25.5 ms	T2 - T1	25.9 ms
T2 - V2	27.7 ms	T2 - m	28.6 ms
T2 - m	28.4 ms	V2 - m	30.0 ms
T2 - T1	29.4 ms	T2 - V1	32.0 ms
T2 - n	31.2 ms	V2 - V1	32.4 ms
V2 - V1	31.2 ms		
T1 - V2	33.2 ms		
V2 - m	35.3 ms		
T1 - n	42.1 ms		
n - m	42.6 ms		

- Same μ
- Different μ
- Moraic μ

16

Diphthongs: T1-T2 coordination?



- ▶ Order of onsets is the same for all diphthong target words
- ▶ T1-T2 time lag is the same for all diphthong target words
- ▶ V1-V2 time lag is shorter when there is a non-moraic coda!

17

Diphthongs: $T1$ - $T2$ coordination?

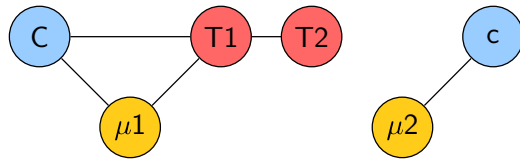


Figure : A schematic of word organization including $T1$ - $T2$ in direct anti-phase coordination, but with no coordination between $T2$ and the other second mora members.

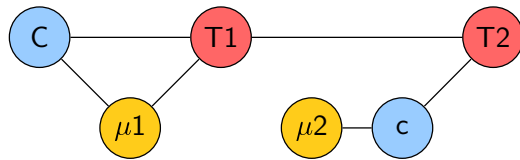


Figure : A schematic of word organization including $T1$ - $T2$ in direct anti-phase coordination, along with each T coordinated within its own mora.

18

Conclusions

- ▶ T gestures show very consistent patterns of coordination with segmental gestures
 - ▶ Across target word;
 - ▶ Across speed conditions;
 - ▶ Across surrounding tone environments
- ▶ Data suggest that there is a co-selection set that resembles a mora

19

Discussion: $T1$ - $T2$ coordination

- ▶ Is it the $T1$ - $T2$ contour that is “driving” the timing of the word?
- ▶ Not enough evidence yet, esp. with inconsistent monophthong data
- ▶ Thoughts from intonation: extended duration of words with extra pitch accents
- ▶ **Future research:** altered feedback of pitch contours (on-line, long-term effects?)

20

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21