Effects of anticipatory dissimilation on the F0 and alignment of Thai contour tones

or

The role of targets and timing in tonal representation

Robin Karlin
Cornell University

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Previous co-articulatory research

- Coarticulatory research in tone is not new
  - DiCanio (2014) for Triqui
  - Xu (1997) for Mandarin
  - Gandour et al. (1992); Potisuk et al. (1997) for Thai
- Focus is mainly on effects on pitch

Figure: From Gandour et al. 1992 (left), Potisuk et al. 1997 (right)
Recent analysis: the mora is the TBU in Thai (Morén and Zsiga, 2006)

- Three level tones: High, Mid, Low
- Two contour tones: Falling (HL), Rising (LH)
- Contour tones are restricted to words with two sonorant moras

<table>
<thead>
<tr>
<th>Shape</th>
<th>Moras</th>
<th>Low</th>
<th>Mid</th>
<th>High</th>
<th>Fall</th>
<th>Rise</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVO</td>
<td>2*</td>
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<td></td>
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<tr>
<td>CVS</td>
<td>2</td>
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<tr>
<td>CVV</td>
<td>2</td>
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<tr>
<td>CVVS</td>
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</tr>
</tbody>
</table>
Timing and the tone-bearing unit in Thai

- Tone is realized at the right edge of the mora
  - $T$(one)$1$ is realized at the end of the first mora
  - $T2$ realized at the end of the second mora

Figure: Thai tones on words with long vowels, from Abramson 1962
Stepping away from the primacy of the segment in timing

- Right edge alignment breaks down (Karlin, 2014)
  - Right-edge alignment is consistently inconsistent
  - Segment-to-tone alignment varies with segmental structure

- **Alternative hypothesis**: tones are represented with a combination of tonal targets and intertonal timing relationships
  1. Tones affect the timing of other tones, but segments do not determine the timing of tones
  2. “Tipping point” between primacy of targets and primacy of timing
Current study: Stimuli

- Four sequences of contour tones:
  - F+F
  - F+R
  - R+F
  - R+R

- Four types of sonorant bimoraic words:
  - CV₁V₂ (/mâa/, /mûa/) (/mǎa/, /mǔa/)
  - CV₁V₂N (/mîan/, /mûan/) (/mǎn/, /mǔan/)
  - CVN (/mân/, /mûn/) (/mǎn/, /mǔn/)
  - CVVN (/mâan/, /mûun/) (/mǎan/, /mǔun/)

<table>
<thead>
<tr>
<th>Kin</th>
<th>Targ. word 1</th>
<th>Targ. word 2</th>
<th>Adv well</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ms.</td>
<td>name</td>
<td>verbs</td>
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<tr>
<td>khun</td>
<td>mân-F</td>
<td>mûa-F</td>
<td>diiidii</td>
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<tr>
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<td>mûun-R</td>
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</tr>
</tbody>
</table>
Results
Brief summary of segmental effects on tone timing

- Do moraic edges control tonal timing?
  - No. (Please feel free to ask me during questions/after the talk!)

- In this talk, focusing on:
  - Effects of the word on the tone contour
  - Effects of the tone contour on the segments
Context “1”: tone identity does not affect word timing

- Elbow timing differs significantly between Falling and Rising tones ($p < 0.0001$)
  - Falling: 54% through the word
  - Rising: 67% through the word

Duration of the whole word is the same, regardless of tone ($p = 0.83$)
In words produced in isolation, tone identity affects the duration of the word:

- Rising is longer than Falling
- Lengthening **only** affects segments after the start of T2

*Figure*: /mûan/ (left) and /mǔan/ (right), in citation form
Word shapes do not have the same duration ($p < 0.0001$)

- /man/ is the shortest
- /mian/ and /maan/ are the longest

Excursion length (ms) depends on word ($p < 0.0001$)

Excursion length (ratio) is more consistent ($p = 0.001$)
Excursion size (Hz) does not differ across words ($p = 0.31$ altogether)
  - Falling: /mian/ has a large excursion ($p = 0.0003$)
  - Rising: /mia/ and /mian/ are almost larger ($p = 0.02$)
Context “1”: Effects of word shape on excursion size

Similar excursion sizes despite duration, Falling tones
Context “1”: Summary of word shape effects

- Excursion duration differs across word shape
- Excursion size does **not** differ across word shape

Excursion duration by excursion size, separated by participant
Context “2”: Effects of context on contour timing

Alignment of elbow in target word 1, all tone sequences
Context “2”: Effects of context on contour timing (Falling)

- In F+R sequences, the elbow of Target 1...
  - Is later ($p < 0.0001$)
  - and is higher, with a greater excursion ($p < 0.0001$)

... than in F+F sequences
Context “2” : Effects of context on contour timing (Rising)

- In R+F sequences, the elbow of Target 1...
  - Is later in terms of ms values only \( p = 0.003 \),
  - and is lower \( p < 0.0001 \),
  - but with an equal excursion \( p = 0.25 \)

... than in R+R sequences
But, the whole first word is longer in R+F than R+R (true for /mia/, /mian/, /maan/)
  ▶ Lengthening is **not** uniform through the whole word
  ▶ Lengthening **only** affects the last segment

Some déjà vu...

**Context “0”: tone identity affects segmental timing**

- In words produced in isolation, tone identity affects the duration of the word
  - Rising is longer than Falling
  - Lengthening **only** affects segments after the start of T2

*Figure*: /mùan/ (left) and /mùan/ (right), in citation form
Discussion
Summary of results

- A longer excursion does **not** necessarily mean that the elbow is more extreme
- If the elbow is more extreme, the excursion is **longer**
- Tones are not bounded by segments... and if they need more time, they will create it
Tonal representation

- Tone representation includes a **tone target**
  - Likely a pitch range
  - Determined by distance from some median
- Tone representation includes timing relationships
  - Second tone references the first?
  - First tone specification in c-center
Conclusions and future directions

- Mora works well for phonological distribution (though with some additional restrictions)
- Evidence that tonal representation includes target and timing relationships
  - Articulatory study (in progress)
  - Beyond just contour tones
  - Altered feedback for pitch
Thank you!
References


Non-Effect of tone identity: Segmental timing

- Right edge of the first mora remains constant regardless of tone
  - Duration of onset + vowel is the same ($p = 0.19$)
  - Duration of vowel alone is the same for diphthongs ($p = 0.36$)

![Alignment of tonal elbows in /manF/ and /manR/](image-url)
(Non-)Effects of non-moraic codas: Tone and segmental effects

- Both $V_1$ and $V_2$ are shorter in $CV_1V_2N$ than in $CV_1V_2$
- Elbows do not move accordingly
  - Do not move at all (Falling)
  - Move in the wrong direction (Rising)

Alignment of tonal elbows in /mia/ and /mian/

![Graph showing alignment of tonal elbows](image-url)
Elbow timing: /mia/

Alignment of tonal elbows in /mia/

![Alignment of tonal elbows in /mia/](image)
Elbow timing: /mian/

Alignment of tonal elbows in /mian/

![Graph showing the alignment of tonal elbows in the word /mian/](image-url)
(Non-)Effect of Mora 2 (and the syllable): Middle elbow timing

- For both F+F and R+R sequences, the tone trajectory continues beyond the edge of the word.

Alignment of end of contour tone relative to word end, F+F and R+R

- Target word 1
- Target word 2
Speech error: continuation of tone contour

[khun_M] [man_R] [mun_R] [diidii_M]

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