The independence of the timing of tones and tone-bearing units: a study on Thai

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The mora as the tone-bearing unit in Thai

- 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)
  - Only syllables with two (*sonorant) moras can carry contour tones
  - Specifically, tones associate to the right edge of a mora

<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>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVO</td>
<td>2*</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVS</td>
<td>2</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>CVV</td>
<td>2</td>
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<tr>
<td>CVVO</td>
<td>2</td>
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<td>CVVS</td>
<td>2</td>
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</tbody>
</table>
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 generate their own timing independently of segments
  1. Tone sequences affect tone timing, but not segment timing;
  2. Segmental structure of words affect segmental timing, but not tone timing

- Acoustic study on Thai tonal articulation
  - Examine effects of surrounding tones on tone timing
  - Examine effects of segmental structure on tone timing
Four sequences of contour tones:

- F+F
- F+R
- R+F
- R+R

Four types of sonorant bimoraic words:

- CV₁V₂: (/m̄a/, /mûa/) (/m̄a/, /mûa/)
- CV₁V₂N: (/m̄an/, /mûan/) (/m̄an/, /mûan/)
- CVN: (/m̄n/, /mûn/) (/m̄n/, /mûn/)
- CVVN: (/m̄an/, /mûun/) (/m̄an/, /mûun/)

<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>
<td></td>
</tr>
<tr>
<td>khun</td>
<td>mân-F</td>
<td>mûa-F</td>
<td>diidii</td>
</tr>
<tr>
<td>naang</td>
<td>mûa-F</td>
<td>mûun-R</td>
<td>diidii</td>
</tr>
<tr>
<td>naang</td>
<td>mûn-R</td>
<td>mûan-R</td>
<td>diidii</td>
</tr>
<tr>
<td>khun</td>
<td>mãn-R</td>
<td>mûn-R</td>
<td>diidii</td>
</tr>
</tbody>
</table>
Results
Effect of tone identity: Elbow 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 ($p = 0.83$)

Alignment of tonal elbows in Falling and Rising tones
(Non-)Effect of tone identity: Segmental timing

- However, 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 ($p = 0.36$)
  - Duration of vowel alone is different for CVN ($p < 0.0001$), but $m$ also longer
(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)
Elbow timing: /mia/

Alignment of tonal elbows in /mia/
Elbow timing: /mian/

Alignment of tonal elbows in /mian/
(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
Effects of tone sequence: Elbow timing (Falling tones)

- In F+F sequences, the elbow of Target 1 is earlier than in F+R sequences ($p < 0.0001$)
- Right edge of mora 1 does not move with the tone ($p = 0.97$)
Effects of tone sequence: Elbow timing (Rising tones)

- $R+R \approx R+F$: $p = 0.16$ (normalized)
- Right edge of mora 1 does not move with the tone ($p = 0.84$)
- But, the whole first word is longer in $R+F$ than $R+R$
Elbow timing: R+F and R+R
Discussion
Relation with previous work

- Unlike previous coarticulation studies, this study focuses on timing
  - Effects of tone identity on elbow location
  - Effects of following tone on elbow location
  - Effects of segments on tone (or tone on segments)
- Corroborates finding from articulatory study on falling tone: tone timing remains constant, while segments change timing
Conclusions

- Mora works well for phonological distribution (though with some additional restrictions)
- In terms of concrete timing, the right edge of a mora does not bound tonal contours
  - Planning: delayed presentation of second word in sequence (tone vs. segments)
  - Some gestural coordination at the beginning of a word
  - Planning within larger, phrasal domain
Thank you!
References


Speech error: continuation of tone contour