# The coordination of tone gestures in Thai

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In addition to three level tones (low, mid, high), Thai also contrasts two contour tones, which are distributionally restricted to bimoraic words. The contour tones are true contours: the so-called "falling" tone (HL) first rises and then falls, while the "rising" tone (LH) falls and then rises. The standard account of this distribution is that the mora is the tone-bearing unit (TBU). In this paper, I propose that a TBU is a gesture with which a tone gesture (H or L) coordinates. In particular, I argue that in Thai, these gestures correspond to the segments that are traditionally regarded as moraic—i.e., vowels and moraic codas.

Morén and Zsiga (2006) account for the restricted distribution and realization of the contour tones by arguing that tone levels in Thai are associated to the right edge of a moraic TBU, based on acoustic evidence that showed that the turning point of the contour tone was approximately at the midpoint of the long vowel in a CVV syllable, or at the border between moras. Under the analysis offered by Morén and Zsiga, we expect that the segmental content of the mora has no effect on the alignment of tones. However, in bimoraic words with the shape CVVS(onorant) or CVVO(bstruent), the turning point of the tone occurs well after the acoustic end of the first mora.

This paper presents the results of an acoustic and articulatory study that examines the production of falling tones on CVV, CVS, CVVS, and CVVO words. The experimental data support the idea that bimoraic Thai words are organized into two sets of gestures that are selected as units ("co-selection sets"; Tilsen (2014)); these units correspond to the first and second moras. The order of gesture onsets in the first moraic co-selection set is *onset-$\mu1$-T(one)1*, with $\mu1$ at the midpoint between *onset* and *T1*. This pattern corresponds with the C-center effect found for complex onsets (Marin and Pouplier, 2010) and Mandarin tone (Gao, 2008), and indicates that *onset* and *T1* are in-phase coordinated with the $\mu1$ gesture, but anti-phase coupled with each other.

In contrast, the order of gesture onsets in the second co-selection set is *$\mu2$(-coda)-T(one)2*, which indicates that $\mu2$ is first anti-phase coordinated to *coda*, if present. That is, *T2* does not have a direct relationship with the onset of $\mu2$ in CVVS words, but is rather anti-phase coordinated to *coda*. This additional coordinative structure results in the acoustic delay of the turning point of the falling tone in CVVS words as compared to CVV words. The figure below depicts the proposed coordinative relationships in CVV/CVS words (Fig. 1a) and in CVVS/CVVO words (Fig. 1b). In the proposed model, each mora is a set of co-selected gestures that includes the moraic gestures and coordinated non-moraic gestures, such as onsets and tones.

(a) /mân/, /mâa/, /mûa/   (b) /mâan/, /mâat/, /mûan/, /mûat/
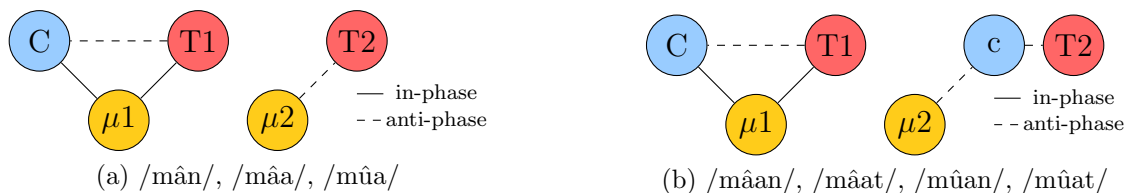
This work builds on recent work in Articulatory Phonology showing that pitch is fruitfully treated as a gesture similar to those involved in consonants and vowels (Prieto et al., 2007; Gao, 2008). By analyzing Thai tone in terms of gestural coordination, we are able to preserve the insights of the traditional moraic analysis, while accounting for the effect of segmental content on the realization of contour tones.