DIRECTIONALITY OF TONE CHANGE

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ABSTRACT

In this paper, I present a theory of tonal change focusing on the directionality of tone change. Drawing on studies on phonetic variation in tones, I propose three main mechanisms that govern the directions in which tones change: 1) segment-tone interaction, 2) contextual variation, and 4) perceptual maximization. The predictions made by a model that includes these mechanisms are borne out by the tonal development of Bangkok Thai.

Keywords: Tone, variation and change, Thai.

1. INTRODUCTION

The essence of the typology of sound change is the asymmetry in the directionality of change, e.g. [ki] > [ci] is more likely than [ci] > [ki]. Although our understanding of different types of sound changes, including the phenomenon of tonogenesis (e.g. [8], and [11]), has advanced tremendously, particularly our understanding of the directionality of change, many questions about how tonal contours change after tonal categories have been established.

Drawing on the advances in the phonetic study of lexical tone (e.g. [2], [6], and [21]), this paper attempts to establish a theory of tone change by positing mechanisms that predict the directions of tonal contours change. Following Ohala [14], I assume that each phonological unit is realized with a great deal of orderly phonetic variation, as shown by fine-grained instrumental analyses. Studying this phonetic variation and speakers' accommodation of ambiguity that it entails can provide a principled way of determining the likelihood of sound changes.

I claim that a change in tonal contour (i.e. change in the overall f0 trajectory) results from a reorganization of the tonal variants that occur in different environments (phonetic, phonological, stylistic, sociolinguistic, etc.).

2. MECHANISMS OF TONE CHANGE

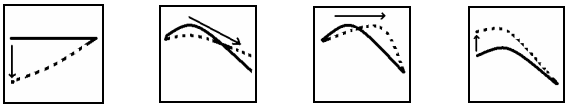
Drawing from synchronic studies of tonal variation, I proposed three major mechanisms of tone change that make predictions about the directionality of tone change: 1) segment-tone interaction, 2) contextual variation, and 3) perceptual maximization.

2.1 Segment-tone interaction

It is well-established that segments may cause variation in the f0 trajectory of tones (e.g. [11] and [12]). I argue that the interaction between tones and segments may cause the tonal onset to shift. Under this view, any change in overall contour shape is an incidental consequence of the onset shift. Furthermore, the mechanism of segment-tone interaction is predicted not to affect the tone offsets.

For example, for a case in which aspiration in the initials induces pitch lowering, a mid level tone would more likely yield a low rising tone than a low level one (see Figure 1a). Similarly, a mid level tone is more likely to become a high falling tone in cases when aspiration causes pitch raising.

Figure 1: Schematization of the mechanisms



(a) (b) (c) (d)

This claim is supported by the fact that the greatest effect is observed at the onset of the vowel. Note that the effects on the f0 values of vowels after initials of different laryngeal configurations may be significantly different long after the onset of the vowel [11].

2.2 Contextual variation

The phonetic realizations of lexical tones have been shown to vary across phonetic and phonological contexts (e.g. [6], and [19]). I claim that the fact that the underlying targets of lexical tones are often not fully reached due to such effects as contour reduction, peak delay, etc. [21] causes "distorted" variants to be generalized and taken as the best approximation of the underlying representation. The intuition is that the frequency

of contextually-affected contours is greater than that of "ideal" contours.

2.2.1 Contour reduction

Dynamic tones are realized with reduced contours when the relevant syllables are in non-final positions. I claim that the mechanism of contour reduction only targets the contour shape and leaves the tonal onset intact. A change due to contour reduction can therefore be viewed as a change from a dynamic tone to a static tone without modification of the tonal onset. For example, a change from high falling tone to high level tone is more likely than a change in the opposite direction (see Figure 1b).

This is supported by the fact that reduced variants show a flatter contour characterized by a smaller amount of f0 excursion, and a less extreme f0 value for the tonal offset. However, in these contours the tonal onset stays in the range expected for the onset of the full contour. Under this view, the less extreme f0 in the tonal offset is a result of the flattening of the contour shape.

2.2.2 Peak sliding

I argue that it is more likely for the peak of a tonal contour to slide rightward than leftward. In such cases of peak sliding, the tonal onset should stay intact but the contour shape should change as a result of the rightward sliding of the peak. For example, a change from a falling tone to a convex tone is more likely than one in the opposite direction (see Figure 1c).

Xu [20] finds that the f0 peak of a Mandarin syllable carrying a high or a rising tones may in fact occur in the following syllable. He argues that because sharp rises take relatively long time to terminate, the f0 turning point may occur somewhat after the syllable boundary in certain environments and in fast speech. As f0 peaks tend to be delayed rather than early, tone peaks have a greater tendency to shift rightward than leftward.

3.3 Perceptual maximization

As avoidance of perceptual confusions between phonologically distinct categories is usually hypothesized to be an important ingredient for successful communication [5], I claim that pitch height and pitch excursion may enhance each others to achieve maximal perceptual contrasts. Specifically, the greater the f0 excursion, the less likely a dynamic tone is to be perceived as static. For example, a change from a mid falling tone to a high falling tone is more likely than one in the opposite direction (see Figure 1d).

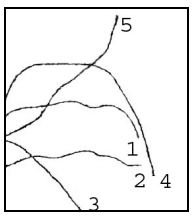
This mechanism is based on Flemming's [5] argument that perceptual difficulties are not derived from properties of particular sounds but from constraints on categorization of speech sounds. In addition, Stevens et al. [15] observe that contrastive sounds are often enhanced by redundant features which help listeners to perceive the distinctions. With respect to tones, Yip [22] argues that the existence of dynamic tones allows a great number of contrasts without placing static tones tightly together in the perceptual space (also see [10]). As argued by t'Hart et al. [16], the size of a pitch change must exceed a certain threshold to play a part in communicative functions.

While contour reduction (2.2.1) tends to convert contour into static tones, perceptual maximization works within dynamic tones to heighten peak-trough contrasts. They need not have contradictory effects. If a dynamic tone has different variants that differ in the value of the onset, this mechanism predicts that the variant that shows the greatest f0 excursion is likely to be generalized.

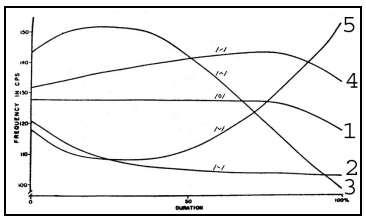
3. CASE STUDY : BANGKOK THAI

Following the first acoustic measurement Thai tones at the beginning of the twentieth century [4], there have continuously been studies on various aspects of the Thai tonal system. The plots in Figure 2 represent four different stages of the Thai tonal system: 1908 [4], 1962 [1], 1979 [3] and 2004 [13].

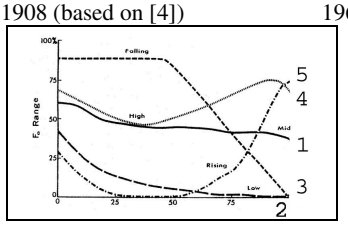
Figure 2: Thai tonal space in 4 stages



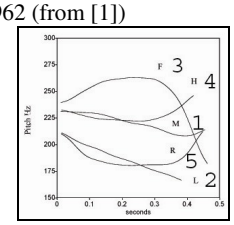
1908 (based on [4])



1962 (from [1])



1979 (from [3])



2004 (from [13])

The measurements in the 1908 graph were obtained with the Rousselot apparatus and the

levels of pitch represented on the vertical axis were calculated according to the algorithm described in [4]. In contrast, the unit of measurement for pitch in the 1962, 1979, and 2006 graphs is Hz. Another difference among the graphs is the number of speakers. The 1908 data are from the author himself, the 1962 data from one male speaker, the 1979 data from 1 male and 3 female speakers, and the 2006 data were from a female speaker claimed to be representative of Bangkok Thai speakers.

A crucial point is that the graphs all demonstrate phonetic characteristics of Bangkok Thai tones in citation form. Therefore, the graphs can be compared, though with caution, to arrive at a picture of how Thai tones have changed in the past 100 years. In an apparent-time study of the five Thai tones, Theranon [18] finds that tones produced by subjects who over 80 years old are different from those produced by younger speakers. She also shows that the contours of the tones produced by the older speakers resemble those recorded in the 1908 graph.

By comparing the four graphs, I argue that changes in the Thai tonal system support the predictions made by the mechanisms with respect to the directionality of tone change.

3.1 Tone 5 (rising tone)

While tone 5 in 1908, 1962, and 1979 rose sharply from a low onset to a high offset, that in 2006 starts in the bottom of the range, stays low, and then ends only with a mid offset. That is, the contour shape has become flattened and the offset less extreme. Such a change is predicted by the mechanism of contour reduction (see 2.2.1). A more detailed account of this change is proposed in [23].

Figure 3: Schematization of tone changes in Thai

3.2 Tone 3 (falling tone)

Tone 3 has experienced two major changes. It was realized as a mid falling tone in 1908 but as a high falling tone in 1962. That is, its onset was raised from mid to high but the overall contour shape stayed roughly the same but with a greater f0 excursion. Such change is predicted by the mechanism of perceptual maximization (see 2.1). Note that this change was possible only after the original tone 4 had lost its characteristic sharp fall, in accordance with the Dispersion Theory [5]. Theranon [18] shows that tone 3 produced by older speakers is higher than that shown in the 1908 graph. One possibility is that tone 3 in the 1908 graph has a lower onset because the subject may not have been a native speaker of Thai.

The second change only became noticeable between 1979 and 2004. While the tone has remained a high falling tone, its peak has shifted from the beginning to the middle of the rime. This rightward shift of the f0 peak is predicted by the mechanism of peak sliding (see 2.2.2).

3.3 Tone 4 (high tones)

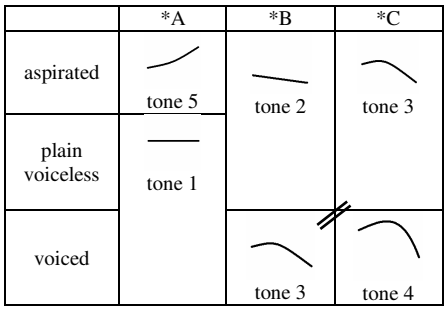
Tone 4 has changed dramatically since 1908, when it was realized as a high falling tone with flat f0 peak in the middle of the rime. This process has been described in [17]. By 1962, the contour was relatively flat and the peak was realized later in the rime, resulting in an overall rising contour shape. This is an instance of contour reduction (2.2.1). As documented by Daniel Jones in 1918, tone 4 was realized as high level when on a short vowel ending in stops in contrast to a full high falling tone [9]. This positional variation seems to have been the source of the change, i.e. the variant found in stop-final syllables has been generalized.

In the graph from 1979, the high tone started in the higher part of the mid region, slowly fell in the first half of the rime, and then rose sharply in the second half. Since the onset and the offset of the tone remained the same as before, it was only the contour shape that was targeted by the change. Therefore, this is a case of perceptual maximization, where the rise of the tone is enhanced by the lowering of the first half of the tone to create a greater f0 excursion. Note that tone 4 has now lowered its onset to the true mid region, losing the valley in the first part of the rime. This minor change probably involves reanalyzing the initial fall as a co-articulatory effect.

3.4 Tone split

The five-tone system of Bangkok Thai developed from an earlier system that only had three tones in non-obstruent-final syllables: *A, *B and *C . By arranging the five tones of Bangkok Thai as recorded in 1908 in the format of Gedney's tone box [7], changes from the original three-tone system to the modern system are revealed.

Figure 4: Thai tones in Gedney's tonebox



We can see from Figure 4 that the tone in the top row in each column can be derived systematically by lowering the onset of the tone in the bottom row. This indicates that tones preceded by voiceless initials had lowered onsets at the time of tone split in Thai (see 2.1.1). The merger of *B after voiced initials and *C after voiceless initials follows automatically from this voiceless-low split. This confirms the proposal that splits conditioned by initials target only the onset of the tones whose shifts result in changes in the contour shapes (see 2.1). Assuming that *A was a mid level tone as preserved in the modern Bangkok Thai tone 1, the rising tone similarly results from lowering the onset of the *A tone after aspirated initials (see 3.1.2).

4. CONCLUSION

Drawing from synchronic studies of tonal variation, I proposed three major mechanisms of tone change that make predictions about the directionality of tone change. An examination of the tonal development in Bangkok Thai seems to confirm the predictions but the result needs to be taken with caution due to the limited nature of the data. Furthermore, a larger catalogue of mechanisms of tone change and cross-linguistic studies on tone change are needed in order to confirm or refute this theory of tone change.

5. REFERENCES

[1] Abramson, A.S. 1962. *The vowels and tones of standard Thai: Acoustical measurements and experiments*, Bloomington, IN: Indiana University Research Center in Anthropology, Folklore, and Linguistics.

[2] Abramson, A.S. 1978. *Static and dynamic acoustic cues in distinctive tones.* Language and Speech. **21**: p. 319-325.

[3] Abramson, A.S. 1979. *The coaticulation of tones: an acoustic study of Thai*, in *Studies in Tai and Mon-Khmer Phonetics and Phonology in Honour of Eugenie J.A. Henderson*, T. L-Thongkum, et al., Editors, Chulalongkorn University Press: Bangkok.

[4] Bradley, C.B. 1916. *On plotting the inflections of the voice*. University of California Publications in American Archeology and Ethnology. Vol. 12, University of California Press: Berkeley. 195-218.

[5] Flemming, E. 2004. *Contrast and perceptual distinctiveness*, in *Phonetically-Based Phonology*, B. Hayes, R. Kirchner, and D. Steriade, Editors, Cambridge University Press: Cambridge ; New York. p. 232-276.

[6] Gandour, J., Potisuk, S., & Dechongkit, S. 1994. *Tonal coarticulation in Thai.* Journal of Phonetics. **22**: p. 477-492.

[7] Gedney, W.J. 1972. *A checklist for determining tones in Tai dialects*, in *Studies in Linguistics in Honor of George L. Trager*, S.M. Estellie, Editor, Mouton: The Hague. p. 423-38.

[8] Haudricourt, A.-G. 1954. *De l'origine des tons en vietnamien.* Journal Asiatique. **242**: p. 69-82.

[9] Eugénie, H. 1976. *Thai phonetics sixty years ago: Gleanings from the unpublished notes of Daniel Jone,* T.W. Gething, J. G. Harris, and P. Kullavanijaya, Editors, Chulalongkorn University Press: Bangkok. p. 162-170.

[10] Hombert, J.-M. 1977. *A model of tonal systems.* UCLA Working Papers in Phonetics. **36**: p. 20-32.

[11] Hombert, J.-M., J.J. Ohala, and W.G. Ewan. 1979. *Phonetic explanations for the development of tones.* Language. **55**(1): p. 37-58.

[12] Maddieson, I. 1984. *The effects of a voicing distinction in sonorants and their implication for a theory of tonogenesis.* Journal of Phonetics. **12**: p. 9-15.

[13] Morén, B. and E. Zsiga. 2006. *The lexical and post-lexical phonology of Thai tones.* Natural Language and Linguistic Theory. **24**(1): p. 113—178.

[14] Ohala, J.J. 2003. *Phonetics and historical phonology*, in *The handbook of historical linguistics*, B.D. Joseph and R.D. Janda, Editors, Blackwell Publishing: Malden, MA. p. 669-686.

[15] Stevens, K.N., S.J. Keyser, and H. Kawasaki. 1986. *Toward a phonetic and phonological theory of redundant features*, in *Invariance and Variability in Speech Processes*, J.S. Perkell and D.H. Klatt, Editors, Lawrence Erlbaum Associates: Hillsdale, NJ. p. 426-449.

[16] t'Hart, J., R. Collier, and A. Cohen. 1990. *A perceptual study of intonation: An experiment-phonetic approach to speech melody*, Cambridge: Cambridge University Press.

[17] Theranon, P. 2002. *Changes in phonetic characteristics of Thai Tone 4.* Warasarn Aksorasat, Silpakorn University. **24**(1-2): p. 188-209.

[18] Theranon, P. 2002. *Thai Tones in the Reigns of King Rama VI and King Rama IX.* Journal of Language and Linguistics. **21**(1): p. 32-46.

[19] Xu, Y. 1997. *Contextual tonal variations in Mandarin.* Journal of Phonetics. **25**: p. 61-83.

[20] Xu, Y. 2001. Fundamental frequency peak delay in Mandarin. *Phonetica* **58**: p. 26-52.

[21] Xu, Y. 2004. *Understanding tone from the perspective of production and perception.* Language and Linguistics. **5**: p. 757-797.

[22] Yip, M. 2001. *Tonal features, tonal inventories and phonetic targets*, in *UCL Working Papers in Linguistics 13*, C. Iten and A. Neeleman, Editors, Department of Phonetics and Linguistics, Univerity College London: London. p. 303-329.

[23] Zsiga, E. 2007. *Modeling Diachronic Change in the Thai Tonal Space*, in *31st Penn Linguistics Colloquium*: University of Pennsylvania, Philadelphia, PA.