TONE SANDHI BETWEEN COMPLEX TONES IN A SEVEN-TONE SOUTHERN THAI DIALECT

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ABSTRACT

This paper examines the behaviour of complex tones in tone sandhi, using data from a seven-tone Southern Thai dialect. Measurements of mean fundamental frequency and duration are presented for unstopped and stopped citation allotones and also for unstopped tones in combination. Tonological implications are drawn.

1. INTRODUCTION

Ron Phibun is a rural area, situated to the south-east of the city of Nakhon Si Thammarat, where it lies toward the southern-most end of Thailand and approximately midway along the Malay Peninsula. In occupying this geographical position, Ron Phibun is located toward the southern end of a 500 km long language continuum, across which, the number of tones found in contrastive distribution increases southward from the five of the Standard Thai of Bangkok in the north to six and farther south still, seven surface contrasts can be found (Diller, 1979;119). The dialect of Ron Phibun, described for the first time in Thompson (1997), has seven contrastive tones and is thus typical of this latter group. The Ron Phibun dialect is also typical of tone languages with a high number of contrasts, in that it exhibits a relative degree of tone pairing, a phenomenon whereby individual tonemes may be grouped together as an upper and lower member of a pair exhibiting similar contours.

The following is a description of the auditory characteristics of the seven contrastive tones of this dialect, occurring on unstopped monosyllables: **Tone 1** has a high convex pitch in the very extremes of the speaker's upper pitch range, with a more salient fall component. Cognates of this tone in other Southern Thai dialects of the area are often referred to as a super-high tone. Rose notes in his work on Pakphanang (Rose, 1997;192) that due to the extreme height of the pitch target, the voice quality on tone 1 is very often falsetto, which would serve as a secondary cue for tonal identification. This voice quality, however, is not present in the Ron Phibun data. **Tone 2** has high level pitch. **Tone 3** has a mid convex pitch with equally salient rise and fall components. The cognate of this tone in the Pakphanang dialect has two variant realisations in free variation, rise-fall and simple rise (Rose, 1997;192). No similar variation was observed in the Ron Phibun data. **Tone 4** has mid level pitch. **Tone 5** has mid level-fall pitch. **Tone 6** has low rising pitch. It rises from low in the speaker's pitch range to the mid region after a low level component. **Tone 7** has a mid linear falling pitch. Thus, the Ron Phibun dialect contrasts two convex tones, two level tones, two falling tones and one rising tone.

Yip (1989) terms tonal contours such as those observed in Ron Phibun's convex tonemes, "complex tones". These "complex tones" are tones with either a LHL or HLH structure and which, it is claimed, are hierarchically structured. At present, little is known with regard to the behaviour of complex tones in tone sandhi. The questions with which this paper concerns itself are: What happens to complex tones in tone sandhi? and; What are the tonological implications of this behaviour?

2. PROCEDURE

The three corpora used in this analysis consist of 14 long open monosyllables, 6 long stopped and 6 short stopped monosyllables and 130 disyllabic utterances whose syllable structure was restricted to either C(C)VV or C(C)V(V)C[1], where C[1] was restricted to a voiced sonorant. Tables 1 and 2 show the unstopped and stopped corpora. Full details of the disyllabic corpus are presented in Thompson (1997;40-56).

Tone	Phon.	Gloss	Phon.	Gloss
1	**kʰaa**	leg	**kʰuu**	threaten
2	**kʰaa**	kill	**pʰuu**	male
3	**kaa**	crow	**kuu**	I
4	**klaa**	rice seedling	**kuu**	borrow money
5	**kʰaa**	thatch grass	**kʰuu**	ditch
6	**kʰaa**	value	**pʰuu**	wasp
7	**kʰaa**	trade	**ruu**	know

Table 1: Corpus of unstopped monosyllables.

Tone	Phon.	Gloss	Phon.	Gloss
1	**kʰat**	rub	**kʰut**	dig
2	**kʰaat**	lack	**kʰuut**	scrape
3	**kat**	bite	**put**	sp. plant
4	**kaat**	announce	**buut**	spoilt
5	**kʰat**	conflict	**kʰut**	bent
6	**kʰaat**	guess	**tʰuut**	ambassador
7	—		—	

Table 2: Corpus of stopped monosyllables. One of the falling tonemes does not occur on stopped syllables.

The informant, an educated male speaker of the Ron Phibun dialect of the approximate age of 26 years, was asked to produce the four sub-minimal series shown in tables 1 and 2. The two series shown for both the unstopped and stopped tones, were chosen with the maximally contrasting vowel values, [-a] and [-u]. Using syllables containing maximally contrasting vocalic nuclei attempts to approximate more closely an underlying tonal contour target by filtering out the intrinsic effect of vowel height upon F_0 and duration. The selection of sub-minimal series was necessitated by two restrictive factors. The first of these was lexical constraint within the language. It was not possible to find seven minimally contrasting morphemes with initial oral stops. The second factor was the fact that Tones 3 and 4 are in complementary distribution with Tones 1 and 2 respectively for obstruent initial syllables. Tones 3 and 4 are realised upon syllables with initial unaspirated obstruents. Tones 1 and 2 are realised upon syllables with initial aspirated obstruents. These four tones, however, can be found in contrastive distribution elsewhere, thus they represent different tonemes.

Both stopped and unstopped citation tones were recorded in a similar manner. Two recordings were made of both the [-a] and the [-u] series. The first of these recordings consisted of Tones 1 through 7, recorded consecutively with pausing in between each token. The [-a] series preceded the [-u] series. The second recording consisted of Tones 1 through 7, each of which was repeated twice consecutively with no pausing in between repeats of two like tonemes but using pausing between each group of different tonemes. The [-a] series again preceded the [-u] series. Thus, there were six tokens in all for each unstopped and stopped tone. The disyllabic words used in the analysis were recorded as a series of 130 words, each having two tokens. No pausing was used between repeated tokens but pausing *was* used in between each set of differing words. The corpus was not controlled for the intrinsic effects of vowel F_0, consonant F_0 nor the effects of syllable structure. A paradigm of this complexity could not have been controlled for such things.

Aligned audio waves and wide-band spectrograms were made for the purposes of segmentation of the data. Samples of F_0 were taken at 10 percent percentage points of a sampling base which was determined as the distance from phonation onset to offset. Duration measurements were also taken. Arithmetical mean and standard deviation values were calculated for the contours occurring on the four syllable types, unstopped citation, stopped citation, first syllable, second syllable.

3. RESULTS

The following tables present arithmetical mean and standard deviation figures for the underlying pitch contours of the seven Ron Phibun tonemes as they occur on the four syllable types used in this analysis. All mean duration measurements and standard deviation figures for duration are given in centiseconds to the nearest millisecond. All mean F_0 measurements are given in Hz to the nearest Hz. All standard deviation figures for F_0 are given in Hz to the nearest 10^{th}. Using tables 3 and 4, we can see that the mean F_0 measurement of unstopped citation Tone 5 at the 60% sample point is 173 Hz with a standard deviation of 5.3. The duration of this contour is 30.4 csecs with a standard deviation of 3.2.

Tone	1	2	3	4	5	6	7
0%	247	212	165	191	192	157	180
10%	258	221	158	189	195	159	175
20%	271	225	161	186	197	155	179
30%	276	224	173	184	195	157	176
40%	279	223	191	183	189	158	173
50%	273	218	206	182	181	161	168
60%	267	215	214	183	173	165	164
70%	245	212	207	183	161	171	160
80%	209	209	189	182	151	184	156
90%	180	208	165	181	141	203	155
100%	159	208	148	181	133	208	153
Dur.	28.5	42.3	31.5	42.6	30.4	38.5	43.4

Table 3: F_0 and duration measurements for the Ron Phibun unstopped citation tones.

Tone	1	2	3	4	5	6	7
0%	32.5	14.8	16.0	10.6	13.2	11.7	10.4
10%	39.9	13.3	23.8	18.5	8.5	9.1	6.0
20%	33.8	15.8	29.7	18.3	10.6	7.8	6.9
30%	31.6	13.2	26.0	19.3	10.5	10.0	8.6
40%	31.3	14.6	32.5	20.2	10.8	12.0	9.6
50%	29.3	13.4	33.3	21.6	6.5	11.9	9.2
60%	30.9	18.4	32.4	24.1	5.3	14.2	8.2
70%	39.6	16.2	29.6	23.1	5.2	16.6	7.5
80%	24.7	17.0	25.2	24.5	6.2	16.3	8.0
90%	21.2	18.5	18.3	22.7	7.2	10.6	6.7
100%	17.9	19.3	16.3	22.4	6.1	12.3	6.4
Dur.	3.4	6.4	3.3	5.4	3.2	3.5	7.4

Table 4: Standard deviation figures for the Ron Phibun unstopped citation tones.

Tone	Vt1	VVt2	Vt3	VVt4	Vt5	VVt6	7
0%	244	219	164	180	190	163	- - -
10%	248	225	167	185	187	161	- - -
20%	252	232	170	189	188	160	- - -
30%	258	237	173	188	188	156	- - -
40%	261	236	179	191	187	154	- - -
50%	266	234	185	191	187	157	- - -
60%	269	233	186	192	185	160	- - -
70%	266	231	191	192	182	172	- - -
80%	269	229	195	193	181	180	- - -
90%	271	225	201	194	183	191	- - -
100%	269	228	206	194	186	190	- - -
Dur.	6.5	22.7	7.2	22.5	6.8	22.4	- -. -

Table 5: F_0 and duration measurements for the Ron Phibun stopped citation tones.

Tone	Vt1	VVt2	Vt3	VVt4	Vt5	VVt6	7
0%	24.4	14.9	9.7	6.2	8.9	10.9	- -. -
10%	25.0	16.2	11.5	8.6	7.7	10.6	- -. -
20%	26.4	17.4	12.9	11.6	7.1	9.8	- -. -
30%	30.3	16.1	17.5	11.0	7.4	12.5	- -. -
40%	28.1	17.1	17.7	10.7	7.9	16.9	- -. -
50%	28.8	15.7	23.4	10.3	8.7	18.5	- -. -
60%	26.9	14.8	24.5	10.7	9.4	16.6	- -. -
70%	21.9	14.3	18.6	10.8	10.1	8.7	- -. -
80%	20.0	14.3	23.6	13.8	10.9	9.9	- -. -
90%	24.8	13.8	28.6	14.6	13.5	11.6	- -. -
100%	28.4	17.6	31.3	16.8	13.6	11.1	- -. -
Dur.	1.9	1.8	1.2	3.4	0.7	2.7	- -. -

Table 6: Standard deviation figures for the Ron Phibun stopped citation tones.

Tone	1	2	3	4	5	6	7
0%	232	207	169	170	- - -	153	163
10%	238	206	166	172	- - -	153	163
20%	241	208	163	173	- - -	152	164
30%	238	207	160	176	- - -	153	164
40%	232	208	156	178	- - -	154	164
50%	218	207	152	182	- - -	157	164
60%	195	207	147	183	- - -	161	164
70%	177	206	143	184	- - -	165	165
80%	160	204	140	185	- - -	171	165
90%	150	202	138	184	- - -	171	164
100%	144	202	137	182	- - -	171	164
Dur.	21.3	21.0	17.0	19.9	- -. -	19.5	17.2

Table 7: F_0 and duration measurements for the Ron Phibun syllable 1 tones.

Tone	1	2	3	4	5	6	7
0%	15.5	13.0	11.7	9.8	--.-	10.4	7.9
10%	16.9	9.4	11.4	11.2	--.-	8.6	9.4
20%	18.4	9.8	11.5	11.6	--.-	9.4	10.2
30%	18.3	10.4	12.2	10.2	--.-	9.9	9.9
40%	20.4	10.0	11.8	11.1	--.-	11.3	10.1
50%	24.3	9.6	12.0	11.8	--.-	11.9	10.2
60%	26.1	9.4	12.8	11.5	--.-	13.5	9.4
70%	23.0	8.3	12.7	12.2	--.-	13.4	9.8
80%	19.7	7.9	13.0	11.1	--.-	14.2	9.4
90%	13.6	8.9	13.1	12.3	--.-	13.2	7.7
100%	12.8	10.6	13.6	12.1	--.-	13.0	10.4
Dur.	4.2	5.1	3.7	3.6	--.-	3.5	4.7

Table 8: Standard deviation figures for the Ron Phibun syllable 1 tones.

Tone	1	2	3	4	5	6	7
0%	226	205	159	174	181	158	174
10%	241	219	159	177	191	157	174
20%	255	225	166	183	198	157	174
30%	268	228	180	186	201	162	172
40%	272	227	195	188	198	167	170
50%	271	225	211	188	192	173	167
60%	262	223	221	188	181	182	163
70%	243	221	220	188	166	193	160
80%	215	220	212	190	152	204	159
90%	191	218	194	190	143	214	157
100%	174	217	176	190	140	215	156
Dur.	23.8	39.3	27.2	41.5	27.2	35.7	34.8

Table 9: F_0 and duration measurements for the Ron Phibun syllable 2 tones.

Tone	1	2	3	4	5	6	7
0%	27.8	24.0	19.4	23.5	20.0	15.9	19.1
10%	25.3	23.6	18.7	23.0	17.7	15.1	15.9
20%	25.3	22.0	20.4	20.7	16.7	13.9	13.9
30%	25.5	23.7	23.1	19.4	16.6	13.8	14.7
40%	25.1	24.2	25.1	18.9	16.5	14.3	14.7
50%	25.7	24.6	24.8	18.1	16.9	16.2	15.6
60%	29.4	24.2	24.4	18.2	17.4	18.2	14.9
70%	32.3	24.6	21.0	19.2	17.8	19.4	13.9
80%	35.4	25.1	18.6	21.0	17.1	20.2	14.4
90%	34.0	23.6	19.6	20.1	18.7	20.1	13.7
100%	32.7	23.6	18.3	19.3	19.6	22.4	13.8
Dur.	3.5	6.6	4.1	4.0	4.5	4.1	7.4

Table 10: Standard deviation figures for the Ron Phibun syllable 2 tones.

It should be noted that one of the falling tonemes does not occur on stopped syllables. The argument for the author's position that this is Tone 7 can be found in Thompson (1997;98-9). It should also be noted that Tones 3 and 5 merge in syllable 1 position (Thompson, 1997;127-8). Figures 1-4 (opposite) show the F_0 of the underlying tonal pitch contours described in the preceding tables graphed as functions of absolute duration.

4. DISCUSSION

Examination of the results shows that there are a number of different types of modifications to the citation contours taking place on the various syllable types. Some modifications are tonological, others are purely tonetic. Some contours closely replicate those of the corresponding citation form over reduced

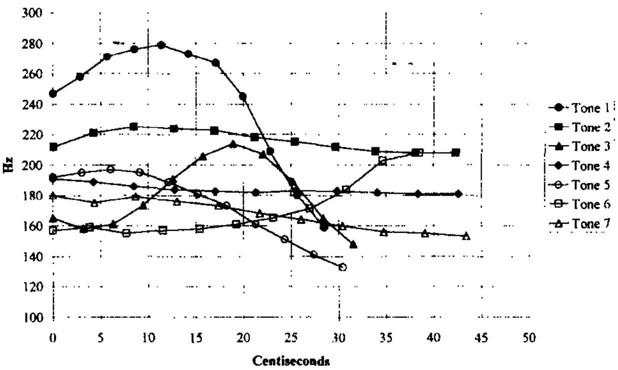

Figure 1: Unstopped citation tones.

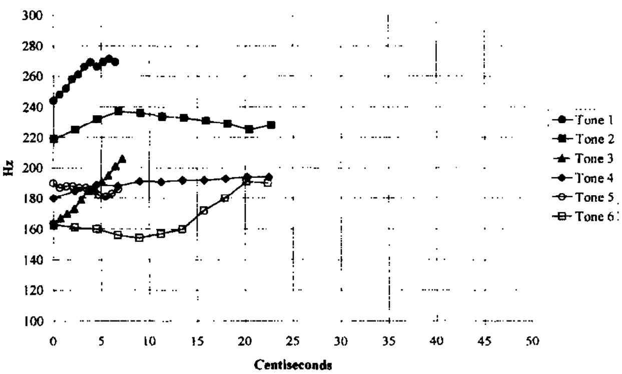

Figure 2: Stopped citation tones.

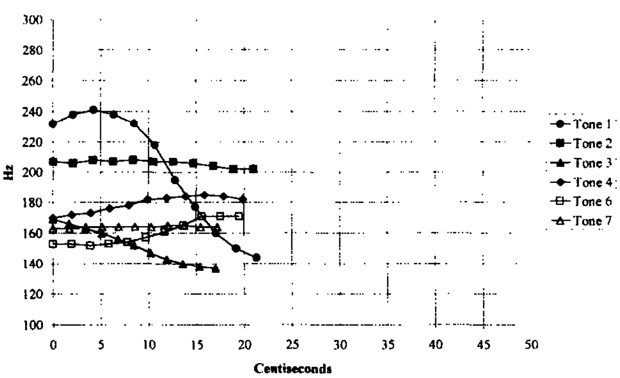

Figure 3: Syllable 1 tones.

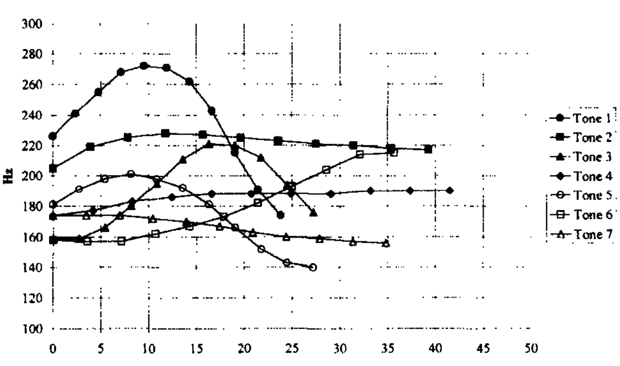

Figure 4: Syllable 2 tones.

rhyme durations, others seem to follow a truncation model or something between these two.

It is clearly observable from the above results that the pitch contours of the syllable 2 allotones (Figure 4) are ostensibly the same as those of the citation forms realised over a reduced rhyme duration. With particular regard to the complex tones 1 and 3, [+/-upper] [LHL], both rise and fall components remain clearly defined with a peak value for Tone 1 at approximately 40%-50% and Tone 3 at approximately 60%-70%. All F_0 modifications on syllable 2 are tonetic.

Figure 2 clearly shows, however, that a number of tonological modifications are present in the realisation of tones on stopped syllables. Notably, the stopped allotones of Tones 1 and 3 lose their fall component to become short rising tones, [+/-upper] [LH] respectively. Tone 5 also loses its fall component to become a short level tone, [-upper] [H].

The major tonological changes to tones on syllable 1 (Figure 3) take place on tones 1, 3, 4 and 7. The behaviour of tones on syllable 1 starkly contrasts that of the stopped allotones. In fact, with regard to truncation, they are seen to behave in precisely the opposite manner. The two complex tones, Tones 1 and 3, are observed to lose their rise component becoming falling tones, [+/-upper] [HL]. As noted above, Tone 3 and Tone 5 merge on syllable 1, leaving only six contrasting tonemes on this syllable. The syllable 1 allotone of Tone 4 has a rising contour, [+upper] [LH]. Tone 7 loses its fall component on syllable 1 and is realised with low level pitch, [-upper] [L].

The results presented here for Ron Phibun's tonal system bring into question some theoretical issues concerning current tonological theory. Yip (1989) argues that contour tones in Asian languages form melodic units as apposed to contours in African tone languages, which can be derived by the concatenation of level tones in sequence. This distinction is clear. However, Yip goes on to argue that this unit structure can be accounted for by means of employing a branching root node structure off which sequences of tones (L and H) hang.

> Such behaviour can be simply understood if tonal features hang off a tonal root node (Archangeli & Pulleyblank forthcoming), and this tonal root node is allowed to branch. A high rising contour tone will have the structure shown in (1), where [upper] is the tonal root node, and [raised] is free to branch. [...]

(1)
```
        [+upper]
           /\
  [-raised][+raised]
```

(Yip, 1989;149)

Further to this, extra-complex tones (tones having convex or concave contours), it is claimed, have a hierarchical structure.

> A last example comes from another Wu dialect Ningpo (data from Chan 1985). I restrict my discussion here to the one complex tone, which is [424] on a citation monosyllable such as *t'i* 424 'body'. On bisyllables the pattern is shown in (19). If the second syllable has a voiced onset, we find 44-44; if it has a voiceless onset we find 42-42:
>
> (19) Second syllable:
>
> | voiced onset | voiceless onset |
> |---|---|
> | kø 44 li 44 'manage' | ka 42 fõ 42 'liberate' |
>
> Assuming that this tone is underlyingly /(HL)H/, where the parentheses enclose a melodic unit, the bisyllabic forms are the result of deleting either the (HL) melodic unit or the H unit, and then spreading the remaining unit over both syllables.

(Yip, 1989;155-6)

The Ron Phibun data presented here contains evidence which would appear strongly to contradict Yip's notion concerning the hierarchical structuring of her proposed melodic units. The data shows clearly that both the rise and fall component of complex tones can be deleted under different conditions and it would therefore be very hard to argue that any of the tones within the melodic unit had any closer affinity with one tone than another.

STOPPED SYLLABLES.

[+upper] [LHL]	→	[+upper][LH]
[-upper] [LHL]	→	[-upper][LH]

SYLLABLE 1.

[+upper][LHL]	→	[+upper][HL]
[-upper][LHL]	→	[-upper][HL]

The whole notion of branching root nodes seems difficult to justify since association with tone bearing units takes place through the root node and this would cause reduplication of the entire tone contour upon reassociation.

5. ACKNOWLEDGEMENTS

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