ON THE REPRESENTATION OF TONE IN SIAMESE[1]

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Introduction

It has recently been suggested for Siamese (or Standard Thai, the national language of Thailand) that phonological tone be represented as a feature on segments (Hiranburana 1971, Leben 1971a, 1971b, 1973a, 1973b) and that phonological contour tones be represented with sequences of level tone features.

Unfortunately, the facts upon which both authors base their arguments are incorrect. Their arguments depend crucially on the simplification of contour tones to level tones in certain positions in fast, casual speech. The results of acoustical measurements of tones in these positions in fast, casual speech (cf. Section 2), however, indicate that the contour tones do not change to level tones, thus making their arguments un-acceptable. Nonetheless, there are other facts in the language that do lend support to their position (cf. Section 3). This paper will argue for treating tones segmentally in Siamese and contour tones as sequences of level tones on the phonological level of representation.

There are 4 main sections in this paper. In Section 1, facts on the phonetic shapes of tones on monosyllabic citation forms are presented. In Section 2, the results of acoustical investigation of tones in certain positions in fast, casual speech are discussed. In Section 3, the other facts are cited that do support a segmental analysis of tone in Siamese, and a sequential analysis of contour tones. In Section 4, a case of tone neutralization is examined in view of different proposed sets of distinctive features of tone.

1. Phonetic shapes of tones in slow, deliberate speech

Siamese has 5 contrastive tones on 'smooth' syllables (i.e., those syllables ending in a nasal, glide, or vowel): (1) mid-level MID ( ), (2) low-level LOW (`), (3) high-rising-falling FALLING (^), (4) high-rising HIGH (´), (5) low-rising RISING (ˇ).

(1)	khaa	'be stuck'
(2)	khàa	'a kind of spice'
(3)	khâa	'to kill'
(4)	kháa	'to engage in trade'
(5)	khǎa	'leg'

The average fundamental frequency contours for these 5 contrastive tones pronounced on monosyllabic citation forms containing double vowels are represented graphically in Figure 1 (adapted from Abramson 1962: 127).
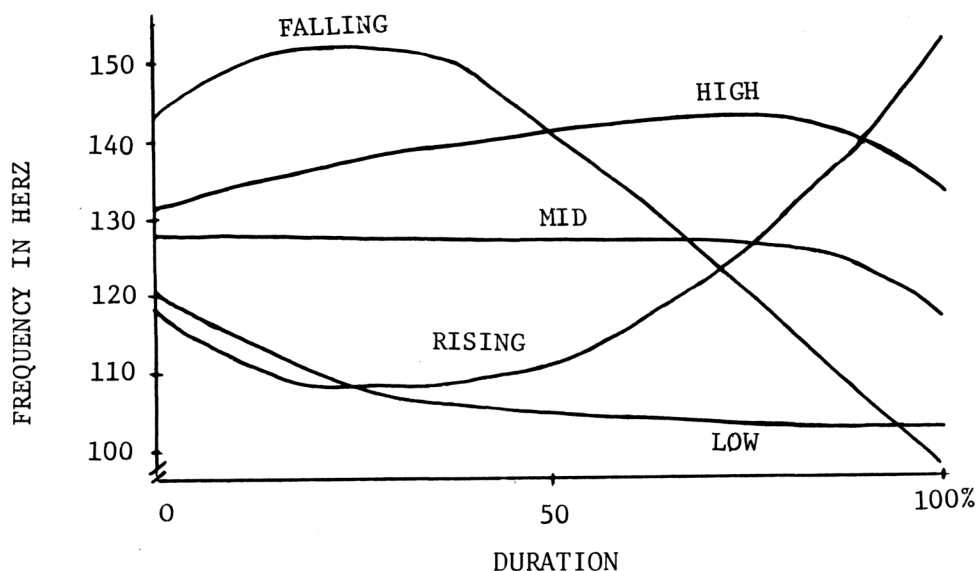

Figure 1
Average Fundamental Frequency Contours for Tones on Double Vowels

For a discussion of consonantal influences on these fundamental frequency contours, see Gandour (1974a).

On 'checked' syllables (i.e., those syllables ending in p t k ʔ) there are only 3 contrastive tones. For 'short' checked syllables (i.e., those checked syllables containing a short vowel) a low-level tone contrasts with a high-level tone; for 'long' checked syllables (i.e., those syllables containing a long vowel or diphthong), a low-level tone contrasts with a high-rising-falling tone. The tones on these checked syllables may be regarded as phonetics variants of the contrastive tones on the smooth syllables--the low-level tone being associated with (2) LOW, the high-level tone being associated with (4) HIGH, the high-rising-falling tone being associated with (3) FALLING.

(2) phìt   'be wrong'

(4) phít   'poison'

(2) yàak   'to want'

(3) yâak   'be difficult'

Interestingly enough, such an analysis based on the principles of phonetic similarity and complementary distribution agrees with the 'traditional' numbering of tones in Siamese (Gedney 1969: 424). However, whether or not one chooses to identify the tones on the checked

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syllables with those that occur on smooth syllables is not relevant to the theoretical questions raised in this paper.

The MID and RISING tones never occur on checked syllables. The FALLING tone occurs on short checked syllables in only a few words, e.g., kʰĺâk 'be crowded'; the HIGH tone occurs on long checked syllables in only onomatopoetic and non-Indic loanwords, e.g. kúuk 'call of a night-bird', káat 'gas'.

2. Phonetic shapes of tones in fast, casual speech

2.1 Conflicting presentations of the facts

The facts concerning the phonetic shapes of tones in fast, casual speech have been disputed by Siamese scholars. The disagreement revolves around the *number* and *type* (level or contour) of contrastive tones possible in certain unstressed positions. No less than four different presentations of the facts have appeared in the literature (Henderson 1949, Noss 1964, Hiranburana 1971, Surintramont 1973, among others).

Table I below gives a summary of the four different presentations. The tones listed in the leftmost column are the lexical tones (i.e. those tones that occur on monosyllabic citation forms); the tones listed in columns (i), (ii), (iii), and (iv) are the sandhi tones (i.e. those tones that are reported to occur in certain positions in connected speech). At the intersection of a given column and row is the sandhi tone corresponding to the lexical tone in the same row.

| LEXICAL TONES | SANDHI | | TONES | |
	(i) Henderson (1949) Leben (1973)	(ii) Gillette (1955) Noss (1964)	(iii) Hiranburana (1971)	(iv) Warotamasik-khadit (1967) Surintramont (1973)
HIGH	HIGH	HIGH	HIGH	HIGH
FALLING	MID	HIGH	HIGH	FALLING
RISING	MID	HIGH	HIGH/LOW	RISING
MID	MID	NONHIGH	MID	MID
LOW	LOW	NONHIGH	LOW	LOW

Table 1
Sandhi tones in fast casual speech: four presentations

LEXICAL TONES	SANDHI TONES			
	(i)	(ii)	(iii)	(iv)
pùu + naa 'Grandfather Naa' 'paternal 'name' grandfather'	LOW	NONHIGH	LOW	LOW
puu + naa 'landcrab' 'crab' 'field'	MID	NONHIGH	MID	MID
mɔ̂ɔ + yaa 'medicine pot' 'pot' 'medicine'	MID	HIGH	HIGH	FALLING
mɔ̌ɔ + yaa 'doctor' 'doctor' 'medicine'	MID	HIGH	HIGH	RISING
khɔ̂ɔ + tɔ̀ɔ 'joint' 'point' 'to connect'	MID	HIGH	HIGH	FALLING
khɔɔ + tɔ̀ɔ 'nape' 'neck' 'to connect'	MID	NONHIGH	MID	MID
nâa + náam 'riverbank' 'front' 'water'	MID	HIGH	HIGH	FALLING
náa + náam 'Aunt/Uncle Nam' 'younger' 'name' aunt or uncle'	HIGH	HIGH	HIGH	HIGH
khɔ̌ɔŋ + hɛ̂ɛŋ 'dry foodstuffs' 'thing' 'to be dry'	MID	HIGH	LOW	RISING
thɔɔŋ + thɛ̂ɛŋ 'gold ingots' 'gold' 'bar'	MID	NONHIGH	MID	MID
mǎa + khɛ̀ŋ 'race dog' 'dog' 'to compete'	MID	HIGH	HIGH	RISING
máa khɛ̀ŋ 'racehorse' 'horse' 'to compete'	HIGH	HIGH	HIGH	HIGH

Table 11
Sandhi tones on the first member of bisyllabic noun
compounds according to (i), (ii), (iii), and (iv).

Analyses of tone sandhi phenomena in Siamese have differed considerably depending on which account of the facts the author accepts. Henderson (1949) and Leben (1971a, 1971b, 1973a, 1973b) base their analysis on (i), Gillette (1955) and Noss (1964) on (ii), Hiranburana (1971) on (iii) and Warotamasikkhadit (1967) and Surintramont (1973) on (iv).

(i), (ii), (iii), and (iv) represent different claims about the number and type of sandhi tones that contrast in fast, casual speech. (i) claims that three level sandhi tones contrast--HIGH, MID, and LOW with the FALLING and RISING contour tones changing to the MID level tone; (ii) claims that only 2 level sandhi tones contrast--HIGH and NONHIGH, with FALLING and RISING contour tones changing to HIGH level tone and LOW and MID merging into NONHIGH; (iii) claims that three level sandhi tones contrast--HIGH, MID, and LOW, with the FALLING contour tone changing to a HIGH level tone, the RISING contour tone changing to a HIGH level tone on syllables that begin with a voiced consonant and a LOW level tone on syllables that begin with a voiceless consonant; (iv) claims that the contrast between all five lexical tones is maintained in fast, casual speech.

All the authors mentioned above who accept (i), (ii), or (iii) agree that the neutralization of contour tones in fast casual speech takes place on the unstressed initial syllable (containing a *long* vowel) of bi-syllabic noun compounds. The list of minimal/near-minimal pairs of noun compounds in Table II illustrates the different claims made by (i), (ii), (iii), and (iv). The tones in the numbered column are the sandhi tones that are supposed to occur on the first member of the noun compound in fast, casual speech according to the different analyses.

2.2 Methods and materials: acoustical investigation of tones in fast, casual speech

In order to test which one of the 4 accounts is correct, pairs of bisyllabic noun compounds distinguished minimally or near-minimally by the lexical tone that occurs on the initial syllable were selected as test material. For each compound, the initial syllable contained a long vowel.

The list included as many pairs of noun compounds that could be found with a minimal contrast in lexical tones on the first member followed by a MID, LOW, FALLING, HIGH, RISING tone on the second member of the compound. 45 such pairs of bisyllabic noun compounds are possible; 29 were found. Only words that actually occur were used in the study. They are given in Table III. Parenthesized numbers indicate that no actually occurring minimal pair of noun compounds could be found with that particular combination of tones.

Each pair of noun compounds was placed in an identical sentence context, for example:

chǎn	chɔ̂ɔp	⎡ khâawthay
'I'	'like'	'Thai rice'
		chaawthay
		'Thai people' ⎤
man	pen	⎡ khɔ̂ɔtɔɔ
'it'	'is'	'joint'
		khɔɔtɔ̂ɔ
		'nape of neck' ⎤

A reading list was prepared containing 164 sentences (3 tokens of each of the *58* members of 29 pairs of noun compounds) and written in the Siamese alphabet.

The reading list was arranged in random order and then read by the speaker, first at a slow speech tempo, and then at a fast speech tempo. For the former, the speaker was told to "speak in a slow, deliberate speech style"; for the latter, the speaker was told to "speak as fast as you can while maintaining a natural speech rhythm".

Recordings were made from the speech of 3 Thai nationals speaking Siamese--2 male (24 and 34 years old) and 1 female (28 years old). The female subject and the younger male subject were born and raised in the capital city of Bangkok. The older of the male subjects came from Nakhon Phanom province in the northeastern part of Thailand.

The tapes were then analyzed by the pitch extraction system at the UCLA Phonetics Laboratory. A Siemens Oscillomink paper recording device registered the fundamental frequency curves continuously and, on a separate channel, a continuous oscillogram of the wave form. A phonetic transcription from the tapes was added to the oscillogram. Segmentation was based on characteristic features of the recorded wave forms and fundamental frequency curves. Frequency values were read off the oscillogram with a pitch scale (0.5 mm = 2.5 hz) prepared from a tape with pure tones of known frequency.

Measurements of duration of the initial syllable in the noun compounds were made from oscillograms as well as narrow-band spectrograms (made from a Kay Sound Spectrograph). Only those fast speech tokens whose durations were less than or equal to half of the average duration of the 3 slow speech tokens were selected for pitch measurements. By this procedure, fast speech was operationally defined as being at least twice as fast as slow speech. Both oscillograms and narrow-band spectrograms were used for comparing the pitch curves of the slow and fast speech tokens of each member of a pair of noun compounds.

1st Member of Noun Compound	M	L	F	H	R
LOW/MID	1	(2)	(3)	4	(5)
HIGH/MID	(6)	7	8	(9)	(10)
FALLING/HIGH	11	(12)	13	14	(15)
FALLING/MID	16	17	18	19	20
FALLING/LOW	21	(22)	(23)	(24)	25
FALLING/RISING	26	27	28	29	30
RISING/HIGH	(31)	32	33	34	(35)
RISING/MID	36	37	38	(39)	40
RISING/LOW	41	42	43	(44)	(45)

(The second header row "2nd Member of Noun Compound" spans M L F H R.)

1. pùunaa 'Grandfather Naa'
   puunaa 'landcrab'
(2)
(3)
4. pòoŋmáay 'hollow log'
   pooŋmáay 'wooden bell'
(5)
(6)
7. máapàa 'wild horse'
   naapàa 'cultivable land'
8. cháaŋbâan 'domesticated elephant'
   thaaŋbâan 'person(s) at home'
(9)
(10)
11. nâataa 'looks'
    náataa 'Aunt/Uncle Taa'
(12)
13. nâabâan 'front of house'
    máabâan 'domesticated horse'
14. nâamáay 'crossbow'
    náamáay 'Aunt/Uncle May'
(15)
16. khâawthay 'Thai rice'
    chaawthay 'Thai people'
17. khɔ̂otɔ̀ɔ 'joint'
    khɔɔtɔ̀ɔ 'nape'
18. nâabâan 'front of house'
    naabâan 'lawn'
19. nâanáam 'riverbank'
    naanáam 'waterfield'
20. khɔ̂ohǎa 'charge'
    khɔɔhǒy 'throat'
21. pâadææŋ 'Aunt Daeng'
    pàadææŋ 'deciduous forest'
(22)
(23)
(24)
25. khâawsǎan 'husked rice'
    khàawsǎan 'news'

26. mɔ̂ɔyaa 'medicine pot'
    mɔ̌ɔyaa 'doctor'
27. mɔ̂ɔkhày 'pot for eggs'
    mɔ̌ɔkhày 'Dr. Khay'
28. mɔ̂ɔkhâaw 'rice pot'
    mɔ̌ɔkhâaw 'Dr. Khaaw'
29. khɔ̂othǎaw 'ankle'
    khɔ̌ɔŋáaw 'a kind of weapon'
30. mɔ̂ɔphǐi 'mystery pot'
    mɔ̌ɔphǐi 'witch doctor'
(31)
32. mǎakhæ̀ŋ 'racedog'
    máakhæ̀ŋ 'racehorse'
33. mǎabâan 'dog'
    máabâan 'domesticated horse'
34. mǎamáay 'a kind of squirrel'
    máanáam 'seahorse'
(35)
36. khɔ̌ɔŋcham 'dry foodstuffs'
    thɔɔŋkham 'gold'
37. mǎapàa 'wolf'
    naapàa 'cultivable land'
38. khɔ̌ɔŋwâan 'snack'
    thɔɔŋyɔ̂ɔn 'title of Thai song'
(39)
40. khɔ̌ɔŋlǔaŋ 'property of royal fam-
    thaaŋlǔaŋ 'public highways' ily'
41. mùudæ æŋ 'a pork dish'
    mǔudæ æŋ 'Sgt. Daeng'
42. khǎaʔɔ̀ɔn 'thigh'
    khàaʔɔ̀ɔn 'a kind of spice'
43. mùubâan 'domesticated pig'
    mǔubâan 'village'
(44)
(45)

Table 111
List of noun compounds used as test material according to
tonal combinations on first and second member of compound.

2.3   Results: acoustical investigation of tones in fast, casual speech

        Acoustical measurements of tones on the first syllable in bi-
syllabic noun compounds show that none of the tone neutralizations
implied in (i), (ii), or (iii) ever occur, i.e. the contrast between
all 5 lexical tones is maintained in fast, casual speech.   In other
words, (iv) is correct.

        In particular, the FALLING and RISING contour tones do not
neutralize to MID level tone.   They simply become progressively shorter
in shorter stretches of time.

        Oscillograms and narrowband spectrograms of representative fast
speech tokens for a few pairs of noun compounds are given in Figure 2
below.   The number accompanying each pair corresponds to the number of
the noun compound pair in the list given in Table III.

2.4   Discussion: acoustical investigation of tones in fast casual
      speech

        Earlier investigations of sandhi tones in fast, casual speech
apparently were not carried out with the use of systematically con-
trolled sentence frames.   Thus, we find enormous discrepancies in the
presentation of the facts from author to author.

        With the aid of reliable instruments, however, we see that the
tonal distinctions are preserved in the fast style of speech, as cor-
rectly observed by native Thai scholars like Warotamasikkhadit (1967)
and Surintramont (1973).   No instruments had been used in the earlier
investigations.

        Some might object that the subjects simply were not speaking
at a rate that would normally be associated with the fast, casual
speech style.   The operational definition of fast speech 'twice as
fast as slow speech'.   However, seems quite reasonable.   In a study
of English diphthongs, Gay (1968) found the same order of magnitude
between the mean diphthong durations for slow speech and fast speech,
i.e. the diphthongs in slow speech are approximately twice as long
(in msec) as in fast speech.

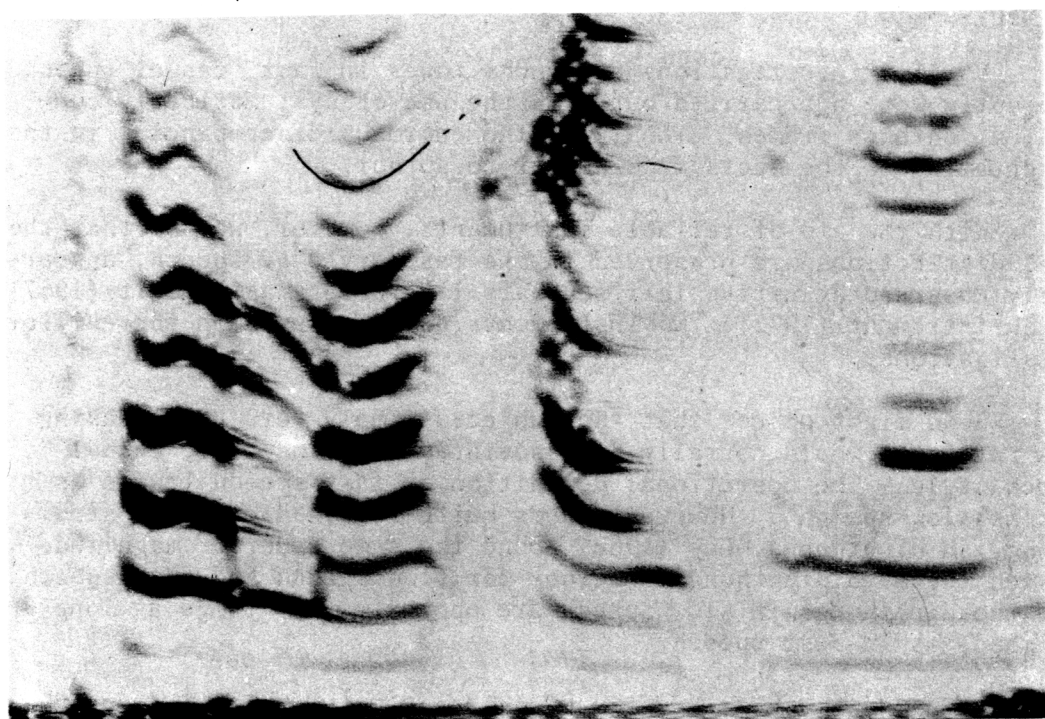3.   Theoretical issues regarding tone in Siamese

        In this section, various theoretical issues currently being
debated on the role of tone in a generative phonology (Woo 1969,
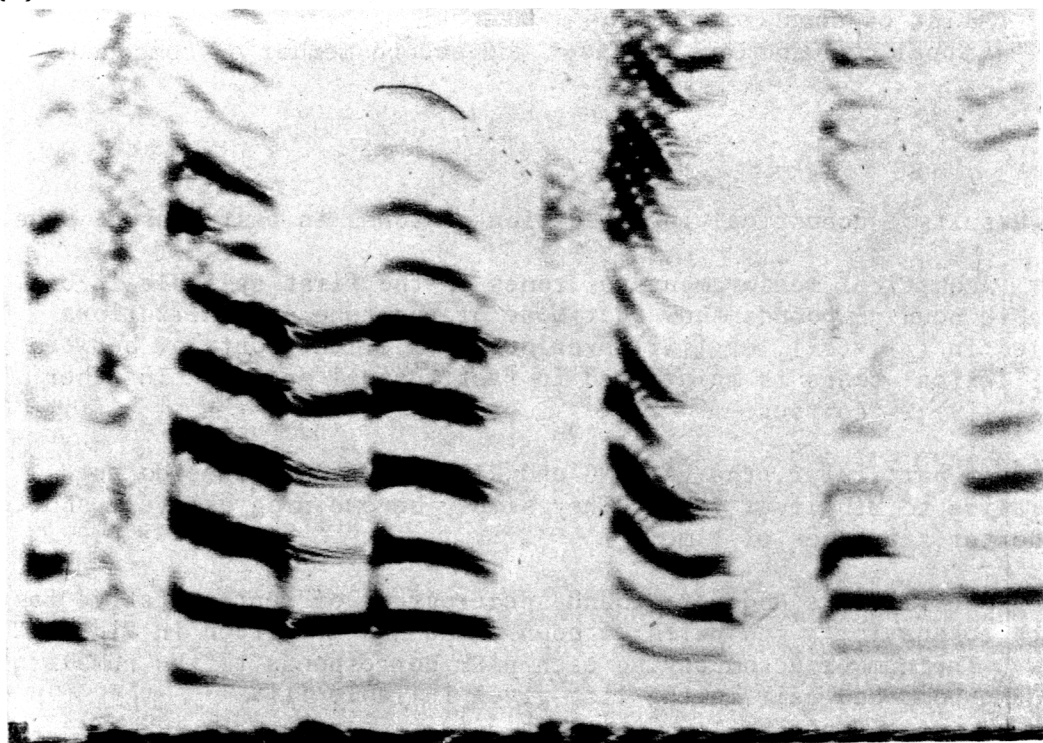
khǎw   chɔ̂ɔp   mɔ̂ɔ   khày   bay   nán

khǎw   chɔ̂ɔp   mɔ̌ɔ   khày   khon   nán

Figure 2

Narrowband spectrograms (a) and oscillograms (b-f) of represen-
tative fast speech tokens of pairs of noun compounds.

(b) 42.

wave form
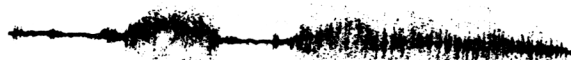
pitch
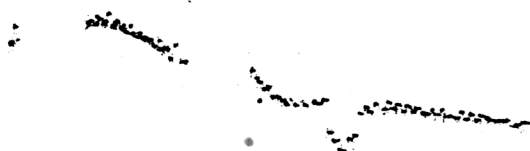
khǎw chɔ̂ɔp khǎa ʔɔ̀ɔn

wave form

pitch

khǎw chɔ̂ɔp khàa ʔɔ̀ɔn

(c) 36.

wave form

pitch

khǎw chɔ̂ɔp thɔɔŋ kham

wave form

pitch

khǎw chɔ̂ɔp khɔ̌ɔŋ cham

(d) 11.

wave form
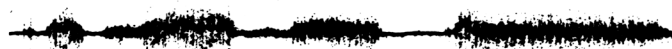
pitch

khǎw   chɔ̂ɔp   nâa   taa

wave form

pitch

khǎw   chɔ̂ɔp   ·nǎa   taa

(e) 20.

wave form

pitch

khǎw   chɔ̂ɔp   khɔ̂ɔ   hǎa

wave form

pitch

khǎw   chɔ̂ɔp   khɔɔ   hǒy.

(f) 30.

wave form

pitch

khǎw   chɔ̂ɔp   mɔ̂ɔ   phǐi

wave form

pitch
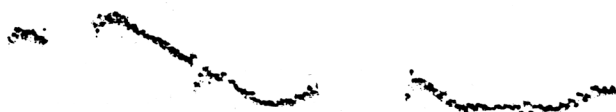
khǎw   chɔ̂ɔp   mɔ̌ɔ   phǐi

Maddieson 1970; Halle and Stevens 1971, Fromkin 1972, Leben 1973, among others) are discussed. In Section 3.1, the arguments advanced by Leben (1971a, 1971b, 1973a, 1973b) and Hiranburana (1971) for a segmental representation of tone in Siamese are shown to be inadequate, since they depend crucially on the simplification of contour tones in fast casual speech (cf. Section 2.3). Nevertheless, other arguments for a segmental representation of tone in Siamese can be made. These arguments are presented as well as arguments for representing contour tones as sequences of level tone features in Section 3.2.

3.1 Previous arguments for segmental tone features in Siamese

Traditionally, tone in Siamese has been considered to be a property of the syllable. More recently, it has been proposed (Leben 1971a, 1971b, 1973a, 1973b, Hiranburana 1971) that tone is a property of an individual voiced segment, not the syllable.

According to Leben (1973b) tone must be analyzed as a feature on segments if and only if at some point in the derivation it is sensitive to phonological rules that either (1) contain information about surrounding segments or (2) collapse two or more segments into one.

Regarding the second type of phonological rule, the collapsed segment is in some sense to be interpreted as a "compromise" (Leben's term) between the original underlying segments, i.e., the collapsed segment is composed of some of the features of each of the original underlying segments. Leben cites nasalized vowels in French as an example of a collapsed segment that results from a compromise between a vowel and a following nasal consonant. A schematic representation of such a vowel nasalization rule is given below:

$$
\text{segments} \qquad V \quad + \quad N \quad \rightarrow \quad \tilde{V}
$$

$$
\text{features} \quad
\begin{bmatrix} +\text{vocalic} \\ -\text{nasal} \\ \cdot \\ \cdot \\ \cdot \end{bmatrix}
\begin{bmatrix} -\text{vocalic} \\ +\text{nasal} \\ \cdot \\ \cdot \\ \cdot \end{bmatrix}
\Longrightarrow
\begin{bmatrix} +\text{vocalic} \\ +\text{nasal} \\ \cdot \\ \cdot \\ \cdot \end{bmatrix}
$$
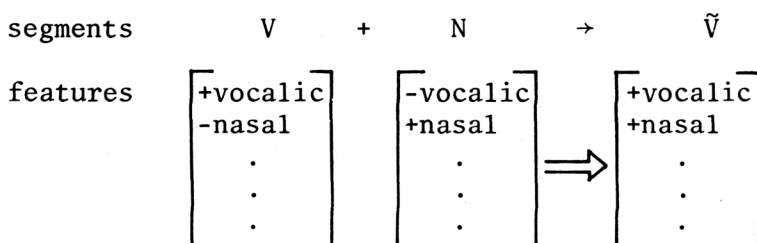
The collapsed segment that results from the application of this rule-- the nasalized vowel--has inherited the +vocalic feature of the V, the +nasal feature of the N, thus is a compromise between the underlying segments V and N.

A more familiar example to which Leben's compromise convention would apply is the contraction of ai to æ in Sanskrit where the collapsed segment keeps the lowness of the first vowel and the backness of the second vowel.

Xhosa is cited as an example of a tone language where tone behaves segmentally according to his first criterion. Leben (1973b, 23) gives the following description of a phonological rule: "a high tone is realized as rising when preceded by a depressor consonant, such as bɦ, mbɦ, mɦ, v, ɦ, but not when preceded by consonants like p, ph, t, ɓ, m, f, h...a falling tone...is realized as rising-falling...when preceded by a number of this same class of depressor consonants".

Siamese is cited as an example of a tone language where tone behaves segmentally according to the second criterion. Before looking at the particular rule Leben proposes, however, let us first consider the data and assumptions on which the rule depends.

Leben's data, taken from Henderson (1949), includes so-called 'compound' forms pronounced in a slow deliberate speech style and a fast casual speech style. They are listed below--the (a) forms occurring in slow speech, the (b) forms occurring in fast speech (examples taken from Leben 1971a).

		(a)				(b)		
1.	(a)	thîi	nǎy	'where?'	(b)	thi	nǎy
		HL	LH				M	LH
2.	(a)	sǐi	khǎaw	'white'	(b)	si	khǎaw
		LH	LH				M	LH
3.	(a)	wâaŋ	wâaŋ	'at your leisure'	(b)	waŋ	wâaŋ
		HL	HL				M	HL
4.	(a)	sǎaw	sǎaw	'young girls'	(b)	saw	sǎaw
		LH	LH				M	LH
5.	(a)	náam	chaa	'tea'	(b)	nám	chaa
		H	M				H	M
but 6.	(a)	tôŋ	kaan	'want'	(b)	tôŋ	kàan
		HL	M				HL	L
7.	(a)	thâw	ray	'how much'	(b)	thâw	rày
		HL	M				HL	L

A few remarks must be made about these data. First, even though Leben (1973b: 20) acknowledges that some length is retained on vowels not followed by a consonant or glide in forms (1b) and (2b) as indicated in the original phonetic transcription (Henderson 1949: 97), he goes on to assume without any justification that the vowel is simply equivalent to a short vowel. Secondly, the indicated change from a M to L tone in forms (6b) and (7b) should probably be attributed to phrase final lowering of MID. A final LOW tone is also lowered. The presence of a falling tone preceding is not required for the lowering to occur. Thirdly, these data are incorrect as shown by the results of acoustical measurements of tones in fast casual speech (cf. Section 2.3).

Nonetheless, it is still instructive to consider the type of argument he presents. Leben's assumptions include:
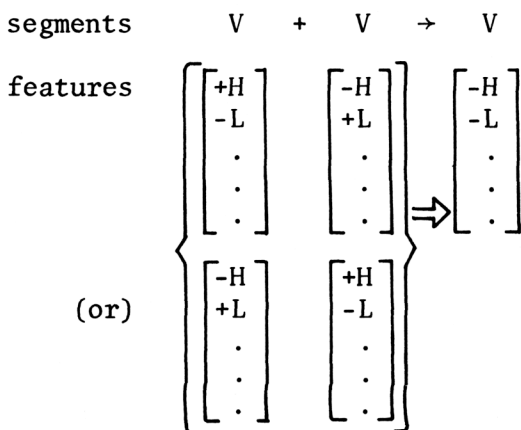
(a) tone features are assigned to individual voiced segments in the syllable,

(b) long vowels are represented as sequences of two identical vowels,

(c) contour tones are represented as a sequence of level tone features,

(d) phonological tones are M L HL H LH for tone numbers 1 2 3
4 5, respectively (cf. Section 1), and

(e) the (a) forms above are underlying, the (b) forms are de-
rived.

With this set of assumptions and the above set of data, Leben formulates
a phonological rule that effects a compromise between a HL or LH sequence
of tones when they occur on short vowels in fast casual speech.

(Vowel shortening)   VV → V

This rule simply reduces a double vowel to a single vowel. Im-
plicit to its operation, however, is a 'compromise convention' that
produces a MID tone as the 'normal' result of a collapsing of a sequence
of HL or LH tones.

segments   V   +   V   →   V

$$
\text{features} \quad
\left\{
\begin{matrix}
\begin{bmatrix} +H \\ -L \\ \cdot \\ \cdot \\ \cdot \end{bmatrix}
\begin{bmatrix} -H \\ +L \\ \cdot \\ \cdot \\ \cdot \end{bmatrix} \\[3em]
\text{(or)} \quad
\begin{bmatrix} -H \\ +L \\ \cdot \\ \cdot \\ \cdot \end{bmatrix}
\begin{bmatrix} +H \\ -L \\ \cdot \\ \cdot \\ \cdot \end{bmatrix}
\end{matrix}
\right\}
\Rightarrow
\begin{bmatrix} -H \\ -L \\ \cdot \\ \cdot \\ \cdot \end{bmatrix}
$$

Consider now how the rule applies to forms (1) through (7). It
simplifies the underlying contour tones to MID in derived forms (1b),
(2b), (3b), and (4b). Because the underlying tone is level, no simpli-
fication occurs in derived form (5b). The underlying contour tones do
not simplify in derived forms (6b) and (7b) because they do not occur
on double vowels. If tones are assigned to segments and if the normal
result of compromise between a sequence of HL or LH is M, then the sim-
plification of contour tones follows automatically from the reduction
of a double vowel to a single vowel. Even assuming the correctness of
Leben's data, his explanation is still unsatisfactory.

First, there is evidence from other tone languages (cf. Maddie-
son 1972) as well as Siamese that the result of a compromise of a LH or
HL sequence of vowels is more often H or L than M. In Siamese, a com-
mon variant pronunciation of the question particle rɨ̀ɨ is rɨ́, not *rɨ̵.
The normally unstressed personal pronouns chǎn 'I', phǒm 'I (male)',
and khǎw '3rd person' are pronounced chán, phóm, and kháw, respectively.
The word for 'city hall,' however, would conform to Leben's compromise
convention for sequences of level tone features. It is written in the
Siamese alphabet with a RISING tone on the first syllable sǎalaaklaaŋ
but normally pronounced with a MID tone on the first syllable [sələklaaŋ].

In this case, it does appear that a LH sequence has been restructured as a MID according to Leben's convention. But what about the word for 'book'? It is written in the Siamese alphabet as nǎŋsɨ̀ɨ, but pronounced as either [náŋsɨ̀ɨ] or [naŋsɨ̀ɨ].

Second, no formal definition of the compromise convention is provided by Leben, a conspicuous omission in view of his emphasis on formalism in grammar (Leben 1973b: 19). What are the constraints on its application? What types of segments and features may be compromised? How many features may be compromised?...

As stated, the compromise convention does not make a unique prediction. For example, in Ogoja Yala, a West African tone language, the compromise between a high tone followed by a low tone separated by a word boundary is a high tone, not a mid tone as Leben's convention would predict (data taken from Maddieson 1972: 958).

H # L (H) → H (H)   e.g., má ɔ̀chí   mɔ́chí   'see tree'

Maddieson (1972) gives numerous examples like the one from Ogaja Yala that strongly suggest that tones are arranged in a hierarchy of dominance. The dominance relationship between tones then determines which tone will appear in the contracted syllable. Until Leben states some such principles to motivate the output of his convention, it is not of any theoretical interest.

As extralinguistic evidence in favor of a segmental analysis, Leben (1973a, 1973b) cites one example taken from Haas (1969) from the Siamese word game khamphǔan 'word-reversal,' in which the syllable finals of adjacent words or syllables are interchanged.

regular form: k →[ôn]   y →[ày]   'big bottom'

game form: k →[ày]   y →[ôn]

In this particular example, note that the tones move along with the segments. This is just what we would expect, according to Leben, if tone is a property of segments in Siamese.

Unfortunately, the one example cited by Leben is not representative of the game rules. Many examples can be found where the tone does *not* move with the shifted syllable-final segments (cf. Gandour, 1974c). For more examples from khamphǔan where the tone does not move along with the shifted syllable-final segments, see Surintramont (1973).

So, the word game data from Siamese is inconclusive. It neither argues for nor against a segmental analysis of tone. The cases where the segments shift independently of the tone demonstrate that tone features may behave differently from other segmental features. But it does not necessarily follow that just because tone features exhibit properties not shared by some of the other segmental features that tone must be established as a suprasegmental phenomenon.

Next let us consider the arguments advanced by Hiranburana (1971) in support of a segmental analysis of tone in Siamese. Based on data obtained from her own instrumental study of the phonetic shapes of tones in non-phrase-final positions (including initial syllables of bisyllabic noun compounds) in fast casual speech, Hiranburana, like Leben, cites putative neutralizations of contour tones as evidence is support of a segmental representation of tone in Siamese. Unlike Leben, however, she claims that the FALLING contour tone simplifies to HIGH level tone and the RISING contour tone simplifies to a HIGH or LOW level tone depending on the syllable-initial consonant.

Unfortunately, the results of her instrumental study are at best inconclusive. Six supposed examples illustrating the simplification of FALLING to HIGH (Hiranburana 1971: 181-84) are given. In 5 out of the 6 examples, the oscillograms do not support her point; the falling contour is clearly evident. The remaining example is the negative morpheme mây that is often realized phonetically as máy in unstressed positions. This is correct, but in no way represents an example of a regular productive phonological rule of the language. Eight supposed examples illustrating the simplification of RISING to either HIGH or LOW level tones (Hiranburana 1971: 185-89) are given. None, however, are instances of a regular rule. Two of her examples are nǎŋsɨɨ 'book' and the 3rd person pronoun kháw (cf. above). Another example nǎaw nǎaw yùu 'I'm cold' is an instance of an emphatic reduplication rule (cf. Abramson 1962: 16), not a regular tone simplification rule. In 3 of the 8 examples, the oscillograms fail to support her point; the rising contour is clearly present.

Her claim that the RISING tone is realized as LOW after voiceless consonants and HIGH after voiced consonants is immediately suspect based on results of instrumental investigations of the effect of preceding consonant types on pitch which indicate that voiceless and voiced consonants tend to raise and lower pitch, respectively (Lehiste and Peterson 1961, Lea 1973, Gandour 1974b). In particular, the first part of the RISING tone becomes higher not lower after voiceless consonants in Siamese (Gandour 1974b). Furthermore, the examples cited occur in totally different syntactic and prosodic contexts.

More examples of deficiencies in her experimental design could be pointed out, but suffice it to say that no conclusions can be drawn from her data.

Next consider her analysis itself. The notion 'optional pitch height' plays a crucial role. Optional pitch heights are "those which do not apply when the lexical item concerned does not contain the maximum number of sonorant segments" (Hiranburana 1971: 149). This is the way she tries to account for the restrictions on the distribution of MID, LOW, FALLING, HIGH, RISING tones (cf. Section 1.1). Her lexical tones for Siamese are shown in Table IV below. The distinctive features for tone are adopted from Woo (1969); the optional pitch heights are enclosed in parentheses.

	MID	LOW	FALLING	HIGH	RISING
HIGH	- - -	- (-) -	(+) + -	(+)(+) +	- - +
LOW	- - -	+ (+) +	(-) - +	(-)(-) -	+ + -
MODIFY	- - -	- (-) -	(-) - -	(-)(-) -	- - -

Table IV
Lexical tones in Siamese (Hiranburana 1971)

The optional pitch heights are supposed to explain why the
FALLING tone occurs on syllables that contain either 2 or 3 sonorant
segments, but not on syllables that contain only 1 sonorant segment
(for example, khâa 'to kill,' khâaw 'rice,' but not *khâp), and simi-
larly why LOW or HIGH tones occur on syllables containing 1, 2, or 3
sonorant segments (for example, phàk 'vegetable', màak 'betel', khàaw
'news', nók 'bird', máa 'horse', and cháaŋ 'elephant'). For the MID
and RISING tones, on the other hand, all 3 pitch heights are obligatory.
This is necessary in order to rule out the possibility of a MID or
RISING tone occurring on a long checked syllable.

Such an analysis has undesirable consequences, however. It
forces one to represent 2-sonorant segment syllables carrying a MID
or RISING tone with an underlying string of 3 sonorant segments since
all 3 pitch heights are obligatory for the MID and RISING tones, re-
sulting in hypothetical lexical entries that never surface phonetically.

/*khaaa/   'a kind of grass'   [kha:]
  MMM

/*khaaa/   'leg'   [khǎ:]
  LLH

/*khaww/   'mountain'   [khǎu]
  LLH

/khaaw/   'white'   [khǎ:u]
  LLH

Implicit in this analysis is a contrast between long and short
glides as well as long and short vowels. This is clearly an unneces-
sary artifact of the segmental analysis.

Neither of the two earlier proposed segmental analyses of tone
in Siamese can be accepted. Both fail to reach even the level of ob-
servational adequacy and both crucially depend on an ad-hoc contrivance
--the "compromise convention" for Leben, the "optional pitch height"
for Hiranburana. Despite their failure to do so, it is still possible
to justify a segmental representation of tone in Siamese (cf. Section
3.2).

3.2 On the segmental nature of tone in Siamese

This section deals primarily with the question of whether tone features in Siamese are to be assigned to the segment or to some larger linguistic unit, such as the syllable, morpheme, word, etc.

Restrictions on the distribution of tones in Siamese indicate that tone is a property of the segment. If the domain of phonological tone is the segment and if the FALLING and RISING contour tones are analyzed as sequences of level tones, then we have a principled reason for excluding contour tones on syllables containing a single vowel followed by a voiceless stop p t k ?. A summary of the distribution of tones on various types of syllable structures in Siamese is presented in Table V. below. An 'X' indicates that the lexical tone at the top of the column may occur on the syllable structure in that same row; a '0' indicates that the tone may not occur. Syllable structures (1) and (2) are the smooth syllables, (3) and (4) the checked syllables (cf. Section 1.1).

SYLLABLE STRUCTURES	LEXICAL TONES				
	MID	LOW	HIGH	FALLING	RISING
(1) CVV	X	X	X	X	X
(2) CV(V)C_f C_f= mnŋwy	X	X	X	X	X
(3) CVVC$_f$ C_f= ptk	0	X	0	X	0
(4) CVC$_f$ C_f= ptk?	0	X	X—	0	0

Table V
Distribution of lexical tones in different types
of syllable structures in Siamese

The absence of a RISING tone on long checked syllables (3) is considered to be a language-specific fact about Siamese. But this is not surprising. Statistically, falling tones outnumber rising tones (Ohala 1973: 3). A higher incidence of falling tones over rising tones is reported for Chinese (Cheng 1973). Furthermore, it has been suggested (Ohala and Ewan 1973) that more physiological effort is required for the production of RISING tones as compared to FALLING tones. They report that for a given pitch interval a subject could execute a falling pitch faster than a rising pitch. Accordingly, the absence of a RISING tone does not argue against a segmental analysis of tone in Siamese. On the other hand, if tones in Siamese are assigned to a larger unit than

the segment (the only plausible candidate is the syllable), then the absence of a FALLING contour tone on short checked syllables (4) appears to be purely accidental.

In the Indic (Pali-Sanskrit) portion (approx. 60%) of the Siamese lexicon, a noninitial syllable (in polysyllabic morphemes) beginning with a sonorant segment and following a short checked syllable carrying LOW tone, carries LOW tone if it ends in a stop, otherwise RISING tone. This generalization has to be stated at the lexical level of representation because HIGH and LOW tones on short checked syllables are neutralized to MID tone in this position in everyday speech (cf. Section 4).

sà?wǎn	'heaven'	sà?mùt	'ocean'
sà?mǎy	'period, age'	sà?lèet	'phlegm'
khà?nǒm	'candy'	khà?nòt	'coils (of a snake)'
thà?nǒn	'road'	cà?rìt	'conduct'
thà?nɔ̌ɔm	'to cherish'	cà?rùat	'rocket'
chà?lɔ̌ɔn	'to celebrate'	sà?nùk	'to be amusing'
chà?lǒəy	'to answer'	sà?rà?	'vowel'

but

sà?taaŋ	'Thai monetary unit'
sà?kun	'family line'
sà?phaa	'assembly, congress'
phá?laŋ	'power'
khá?nɛɛn	'grade, vote'
chá?lǝǝy	'prisoner of war'

These polysyllabic morphemes clearly show that tone in Siamese is sensitive to surrounding segments (Leben's (1) criterion for segmental tone, cf. Section 3.1), thus evidence in support of a segmental representation of tone in Siamese.

There is additional evidence for Leben's (1) criterion for segmental tone in Siamese. No HIGH or RISING tone occurs on syllables that begin with p t c k ?. Thus, syllables like *páa *kǎa *táam *?áaw are not permitted, once again illustrating the close interaction between tones and segments in Siamese. The only exceptions that I know of are non-Indic loanwords, onomatopoeic words, exclamatory expressions, and a few intensifying 'particles', egs. pǔy 'fertilizer (Chinese)', ?óok 'oak (English)', kúuk 'call of a nightbird' báa 'bah!', dampľi 'coal-black'.

As shown above in Table V (cf. Section 3.1), a syllable in Siamese may consist of 1, 2, or 3 tone-bearing segments. If tones are assigned to segments, then it is necessary to state restrictions on the permitted sequences of tones. This can be done easily for syllables containing 1 or 2 sonorant segments, but not for syllables containing 3 sonorant segments.

I know of no crucial evidence that would force us to choose between a solution (a) that required identity between the first and second segments or a solution (b) that required identity between the second and

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third segments in a string of 3 sonorant segments (the underlined tones are considered to be redundant)

(a) M M M   (b) M M M
    L L L   L L L
    H H H   H H H
    H H L   H L L
    L L H   L H H

Perhaps in favor of solution (a) is the fact that the phonetic pitch change on contour tones is concentrated at the end. Whether solution (a) or (b) turns out to be correct, we can see that it would be relatively easy to state permitted tone sequences in a segmental analysis of tone in Siamese without resorting to an ad-hoc contrivance like "optional pitch height" (cf. Section 3.1).

As far as I know, there are no tone sandhi rules in Siamese that require information about surrounding segments. Mohr (1973) uses the absence of such rules as a criterion for establishing tone as a suprasegmental phenomenon in a particular language. But this appears to be a pseudo-issue regarding the segmental or suprasegmental nature of tone. Other things being equal, one could just as easily formulate conventions for application of phonological rules that ignore extraneous intervening material in the domain of the rule.

3.3 On the sequential nature of contour tones in Siamese

This section is concerned with the phonological representation of the FALLING and RISING contour tones. Are they best represented with unit contour tone features or sequences of level tone features?

If the domain of phonological tone is the segment, the absence of FALLING and RISING contour tones in short checked syllables is automatically accounted for if they are represented as sequences of level tones (cf. also Section 3.2). This generalization is missed if they are represented with unit contour tone features. Only if we assign tones to segments do we have a principled reason for excluding contour tones on syllables containing a single vowel. For instance, syllables like *phǎk or *phâk are excluded because RISING (=LH) and FALLING (=HL) tones require a sequence of 2 vowels on the phonological level of representation. If tones are not assigned to segments in Siamese, we are left with no principled explanation for the distributional restrictions on contour tones. Other minor points that might be made in favor of a sequential analysis of contour tones are given below.

Other things being equal, a solution that makes use of fewer features is to be preferred. If the FALLING and RISING contour tones are analyzed as sequences of independently-motivated level tone features HL and LH, respectively, then there is no need to introduce additional unit contour tone features.

I know of no productive phonological *rules* in Siamese that require decomposition of the FALLING and RISING contour tones into sequences of level tone features. In particular, there are no tone copying rules of the kind reported for numerous African tone languages (Leben 1973, Fromkin 1972, Hyman and Schuh 1972) where the sequential nature of the contour tones becomes immediately apparent.

A few shreds of morphological evidence suggest a sequential analysis of contour tones: nîi 'this' / nîi 'this one,' nán 'that' / nân 'that one,' nóon 'that farther away' / nôon 'that one farther away'.

I know of no cases where contour tones cross a morpheme or even a syllable boundary. Some might argue that this testifies to the unitary nature of the contour tones. To the contrary, it is exactly what one might expect in a language that has no derivational morphology and no vowel-initial syllables. Again, *lack* of evidence neither argues for or against a sequential analysis of contour tones in Siamese.

4. A case of tone neutralization in Siamese

The HIGH and LOW tones are neutralized to MID on unstressed short checked syllables (those ending in a glottal stop only)

underlying form		citation form	derived form
thá?hǎan	'soldier'	thá?hǎan	thəhǎan
thà?nǒn	'road'	thà?nǒn	thənǒn

In this section, arguments are presented against Whitaker's (1969) solution. Another solution is proposed based on Fromkin's (1972) set of tone features.

Adopting Wang's (1967) set of tone features--*High Mid Central Falling Rising Convex Contour*--Whitaker (1969: 194-5) argues for (1) as the optimal representation of lexical tones in Siamese on the basis of the formal statements (irrelevant details omitted) of the tone neutralization rules (2) and (3)

(1)

	MID	LOW	FALLING	HIGH	RISING
high	-	-	+	+	-
rise	-	-	+	+	+
fall	-	+	+	-	-

(2) $[+\text{fall}] \rightarrow [-\text{fall}] \Big/ \text{env.}$

(3) $\begin{bmatrix} +\text{high} \\ +\text{rise} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{high} \\ -\text{rise} \end{bmatrix} \Big/$

The two separate rules (2) and (3) fail to reveal what is actually a single phonological generalization. Note what happens when we try to

collapse (2) and (3) into a single rule:

$$(4) \quad \begin{bmatrix} \alpha\text{high} \\ \alpha\text{rise} \\ -\alpha\text{fall} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{high} \\ -\text{rise} \\ \text{fall} \end{bmatrix} \Big/ \quad \text{env.}$$

In the structural change of the rule, [-high] and [-rise] are required just in case the input tone is HIGH, [-fall] just in case the input tone is LOW. A collapsed rule for (2) and (3), then, cannot be written without including *redundant* features in the structural change of the rule.

Implicit also in (1) is the claim that Siamese has 4 underlying contour tones--LOW, FALLING, HIGH, RISING and 1 underlying level tone--MID. Such an analysis gives us no principled reason for permitting LOW and HIGH but not FALLING and RISING tones on short checked syllables.

I propose an alternative solution based on Fromkin's (1972) set of tone features--*High Mid Low*. Using this set of features, the level lexical tones of Siamese could be represented as either.

(5)	HIGH	MID	LOW
high	+	-	-
low	-	-	+

or

(6)	HIGH	MID	LOW
high	+	-	-
mid	-	+	-

Formal statements of the tone neutralization rules (7) and (8), based on (5) and (6), respectively, indicate that (6) is to be preferred.

$$(7) \quad \begin{bmatrix} \alpha\text{high} \\ -\alpha\text{low} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{high} \\ -\text{low} \end{bmatrix} \Big/ \quad \text{env.}$$

$$(8) \quad [-\text{mid}] \rightarrow [+\text{mid}] \Big/ \quad \text{env.}$$

Rule (7) abbreviates the two subrules (9a) and (b) (parenthesized features in structural change of rule are redundant):

$$(9) \quad (a) \quad \begin{bmatrix} +\text{high} \\ -\text{low} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{high} \\ (-\text{low}) \end{bmatrix}$$

$$(b) \quad \begin{bmatrix} -\text{high} \\ +\text{low} \end{bmatrix} \rightarrow \begin{bmatrix} (-\text{high}) \\ -\text{low} \end{bmatrix} \Big/ \quad \text{env.}$$

The fact that one cannot write the tone neutralization rule based on (5), without specifying redundant features in the structural change of the rule, leads us to choose (6).

Note, however, that (6) implies that the MID tone is closer to

LOW than HIGH, MID differs from LOW by 1 feature, from HIGH by 2 features. I do not know of any phonological evidence to support this claim. Note also that (8) requires the application of the sequence structure condition--If [+mid] THEN [-high] - in order to derive the correct surface forms. Nonetheless, this solution is to be preferred because it permits us to state a single phonological generalization in a single rule.

Optimal solutions constructed with other sets of distinctive features for tones--Wang 1967, Woo 1969, Maddieson 1970, Halle and Stevens 1971--would also require that a lexical redundancy reapply to the output of the tone neutralization rule.

5. <u>Summary</u>

An argument that has been advanced in favor of analyzing tone segmentally in Siamese--namely, the neutralization of contour tones in fast, casual speech--is untenable. A systematic acoustic investigation of these putative cases of tone neutralization shows that RISING and FALLING contour tones are not neutralized to level tones in fast, casual speech. Other arguments, however, can be given in favor of assigning tones to segments on the phonological level of representation as well as analyzing contour tones as sequences of level tones. Further, a solution is proposed for a real case of tone neutralization--HIGH and LOW tones neutralize to MID on short checked syllables--and this is shown to be preferred over competing alternative solutions.

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