A GENERATIVE APPROACH TO TONE IN VIENTIANE LAO

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ABSTRACT

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by James R. Chamberlain

Vientiane Lao has seven tones. They have been described briefly by several scholars but not satisfactorily, particularly in the light of recent, though incomplete, insights into the physiological processes of the larnyx. The study begins by discussing what is known about perceptual, physiological, and acoustic aspects of pitch production. Previous approaches to tone in Lao and in Tai linguistics are examined. Next, the Lao tone system is organized according to the principles of generative phonology. Here it is seen how certain underlying features of the segmentals occurring with any given tone enable one to predict the tone on any given syllable. That is, tones in Vientiane Lao do not need to be represented on the lexical level. This type of approach has been overlooked by other theories of tone. Finally, rules are given which formalize these redundancies and in addition offer an explanation of

certain tonal alternations which occur. It is concluded that this analysis adequately handles the tone system of Vientiane Lao and derivations are offered for the reader to observe how the rules apply to the data.

A GENERATIVE APPROACH TO TONE IN VIENTIANE LAO

By

James R. Chamberlain

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ABBREVIATIONS

cns	consonantal
hsp	heightened supglottal pressure
P	pitch
rlng	relative length
seg	segment
snr	sonorant
tns	tense
vd	voiced
voc	vocalic
WB	word boundary
whisp	whisper

Introduction

Although tone is by no means a recent discovery within the wide range of linguistic phenomena, certain aspects of it are only now beginning to come to light. A more specific terminology and clearer schematic representations have advanced our knowledge of the mechanisms of tone production to only a small degree, but even limited progress in the understanding of physiological processes in the larnyx is finally beginning to enlighten us about tone.

Knowledge of Lao tone has progressed but little since its first description in 1798 by Francis Buchanan. In the present study I have attempted to bring together the most recent information on tone production from both articulatory and acoustic sources with whatever information I could glean from previous descriptions of tonal systems in the various Asiatic languages and others. The end result is a description of the tone system of Vientiane Lao (VL) utilizing this information and organized in keeping with the theoretical principles of generative phonology. The analysis is by no means complete and is, in fact, only a beginning. However, it is hoped that some aspects of this particular approach may prove fruitful when applied to other tone languages.

1. Phonetics of tone production

In spite of the existence of a number of studies of tone, our knowledge of the realities of its production and perception remain poor and no natural systematic representation of tone has been devised.

In a discussion of tonal phonetics, four things must be taken into consideration:

1. The primary causes of pitch differences;
2. The effects of surrounding segments on pitch in particular initial and final consonants;
3. The effects of suprasegmental phenomenon such as stress and intonation;
4. What is perceived to be distinctive by the native speaker, e.g., relative pitch as opposed to contour shape.

Ladefoged (1967:5) identifies two causes of linguistically significant pitch production; changes in the air pressure below the vocal cords, and changes in the tension of the vocal cords due to the laryngeal muscles. He goes on to say:

> We do not yet know which factor is most important in making significant pitch changes. The intonation contour in some statements in English has a high correlation with the tension of the vocal cords. . . . But it appears (from hitherto unpublished material) that the high pitch which appears at the end of tag questions such as 'It's true, isn't it?' may also be associated with an increase in the pressure of

> the air below the vocal cords in many speakers. Other recent unpublished studies indicate that in a tone language such as Yoruba there is also an increase in subglottal pressure during high tones.

Initial consonants have played a very important role in the study of tone and tone change. Certain effects of initials on tone are quite clear while others are not. In Yabem, a language of New Guinea, it is reported that the language has two tones, high and low. All syllables beginning with voiceless plosives have the high tone and all those beginning with voiced plosives have the low tone. However, with other initials no tones are predictable (Capell 1949).

Ladefoged (1968) gives the following description of the possible effects of initials on tone:

1. Voiced stops and fricatives lower pitch;
2. Tongue raising in palatal and velar consonants raise pitch;
3. Voiceless stops and fricatives raise pitch.

He concludes that there is a direct correlation between linguistically significant tone and the activity of the laryngeal musculature.

Final consonants also play a large part in tone production. Of particular interest are various types of phonation based on a continuum of glottal constriction

running from voiceless to complete glottal closure with such points as whisper, breathiness, and creakiness in between. Henderson (1965:411) notes breathiness in the hoi tone of Northern Vietnamese. This seems to be accompanied by a rising contour and it may be the case that final breathiness causes a rise in pitch. Ladefoged (1967:6) identifies the origin of "breathy voice" as a glottal state wherein the arytenoid portions of the vocal cords are apart while the ligamental vocal cords are vibrating (see Figure 2).

A second phonation type causing variations in pitch is creakiness. Ladefoged (1964:16) claims that it is the result of the arytenoid and ligamental sections of the vocal cords vibrating separately, out of phase with one another. This means that there is an increase in the number of glottal pulses but since the vocal cords as a whole vibrate more slowly, the pitch is actually lower. This effect can be seen in many Tai languages as well as in Vietnamese and Burmese (Henderson:411-12).

Complete glottal closure also causes the vocal cords to vibrate more slowly, i.e. causes pitch lowering. This accounts for the fact that in VL tones with final stops and final creakiness are both falling.

Whisper is phonetically quite close to voiceless and it seems logical to assume that since voiceless initial consonants cause higher pitch, final whisper causes the pitch to rise (This seems to be the case in VL). Following this line of reasoning, a tone with the combined final features of whisper and creakiness would have raising and lowering forces working against each other thus leveling the tone (see Figure 2).

Along the continuum of glottal constriction, then, there seem to be three points relevant to VL: whisper, creak, and glottal stop, which have the following composition (compared with the more familiar states of voiced and voiceless and where a + indicates independent action):

	Voiced	Voiceless	Creak	Whisper
ligamental vibration	-	+	+	-
arytenoidal constriction	-	-	+	+

Figure 1.--Glottal Constriction

The final complete glottal closure is taken to be the non-continuant form of creak.

Another segmental feature which causes variations in pitch is tongue raising in high vowels or palatalized consonants which stretches the larnyx and increases the rate of vibration. This, however, never seems to be distinctive in languages and, therefore, such pitch variations can always be redundantly supplied.

Figure 2 represents the vocal cords and the parts in question here.

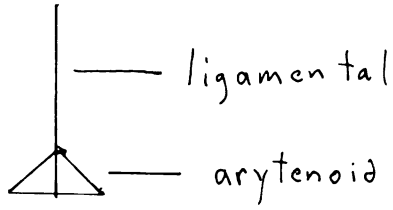


Figure 2.--Parts of the Vocal Cords

Lieberman (1967:101) concludes that tone is definitely segmental but that the tonal features may interact with the intonational features of a language.

> Other intonational features occur in "tone" languages like Chinese. While the scope of these features . . . is clearly segmental, they nevertheless may interact with the breath-group at the acoustic and articulatory level. Phonetic and acoustic analyses were briefly reviewed which indicated that the tones can interact with the overall suprasegmental intonation . . ., but the listener is able to deduce what the appropriate tone is, probably through a process of analysis through synthesis.

Brown (1965) raises a point that has not received much attention in Tai dialectology. He points out that the tones of many languages may be distinguished more by

relative pitch than by contour, while others, such as Standard Thai, go more by the actual shape of the contour than the pitch level. This was shown to be true by Abramson (1962).

Working with a sound spectrograph and a speech synthesizer Abramson was able to successfully synthesize the tones of Standard Thai. After performing a number of perception experiments, he concluded that contour is the dominating factor in the perception of Thai tones. This is not to say that pitch is arbitrary, but rather that it is secondary to the tonal contour. In other words, a general theory of tone must provide for the domination of contour features over features of relative pitch.

2. Phonological treatment of tone

The difficulties encountered in describing tone at the phonetic level have made the treatment of tone awkward at a more abstract level.

2.1 Traditional

The phonemic analysis of tones seems to have faced no major obstacles, probably because there was little variation noted between the phonemic and phonetic levels (cf. Pike 1948). However, many problems have been caused by the phonemicizing of what seemed to be similar allotones, when in reality the reasons for their apparent

similarity were quite unrelated (cf. Haas 1958). A good example occurs in VL where the so-called mid level tone ˧ and the mid level checked tone ˧ have been put into the same toneme. This is very misleading, for the phonological conditioning of these two tones is quite different, as can be seen if, for instance, the effects of the initial consonants and final laryngeal features are considered. Native speakers indicate that they see no similarity whatsoever between these two tones. Traditional tonemics may then be characterized by its concentration on tone contour and relative pitch to the exclusion of other features.

2.2 In generative phonology

Wang (1967) proposed a set of distinctive features with which tones might be abstractly described and which would also make it possible to deal with them using the apparatus of generative phonology. The features suggested, however, are on the one hand too numerous and on the other not inclusive enough to handle tone. Sampson (1969) noted that it would be necessary to include at least three more features in Chinese.

In VL, Wang's features seem to fail because he provides no features for, say, the distinction of the three falling tones in VL (see section 4.14 and rule (11)). We could try to represent them as follows:

	(1) 	(2) 
contour	+	+
high	+	-
central	-	-
mid	-	-
rising	-	-
falling	+	+
convex	-	-

Figure 3.--Lao Falling Tones with Wang's Features

This takes care of the first two but what about the third ()? The only choice remaining is convex which is clearly wrong. One could, however, add another feature, say, short fall which would serve to differentiate (2) from (3). Then all tones would be distinct. But that is only half the problem. Pitch level in VL is of no real importance; that is, the contours, not the pitch levels serve to distinguish the tones. If the pitch features are taken away from tones (1) and (2), they are no longer distinct. Yet if tones are to be represented on the lexical level in VL, only the contours need be specified if redundancy is to be avoided. In fact, however, not even the contours need be specified at the lexical level, since, as will be shown in section 4, they can be predicted on the basis of the features of the segmentals with which they occur. Thus, Wang's features fail in the same way the traditional tonemics of structuralists

do, by failing to eliminate predictable information. They do not, as Wang claims (95), provide an "abstract linguistic basis from which physical phonetic interpretations are made." Wang does mention a few segmental features from which tone may be predicted but he does not incorporate them into his theory. His features are therefore not suitable on either the phonological or the phonetic level, but remain somewhere in between, similar to the level of traditional phonemics.

3. Lao tone

3.1 The Lao language

3.11 Genetic Classification

Lao forms part of the Southwestern group of Tai languages along with Lü, Tai Blanc, Tai Noir, Shan, Siamese (Thai) and many others in the Yunnan province of China (Li 1960).[1] In Laos itself there are between one and two million Lao speakers. They are joined in Thailand by another nine million (Kunstader 1967). Other groups within the Tai family are the Central, Northern, and Kam-Sui branches scattered throughout Southern China and North Vietnam. As a whole they range from the Yangtse to Burma and from Thailand to the Gulf of Tonking (Martini 1956).

Although there has been much dispute, many scholars have accepted Benedict's hypothesis that Tai

bears a closer relationship to Indonesian than it does to Chinese (Benedict 1942, Seidenfaden 1963). Recently, Benedict (1966) has proposed the following classification for the languages of East and Southeast Asia:

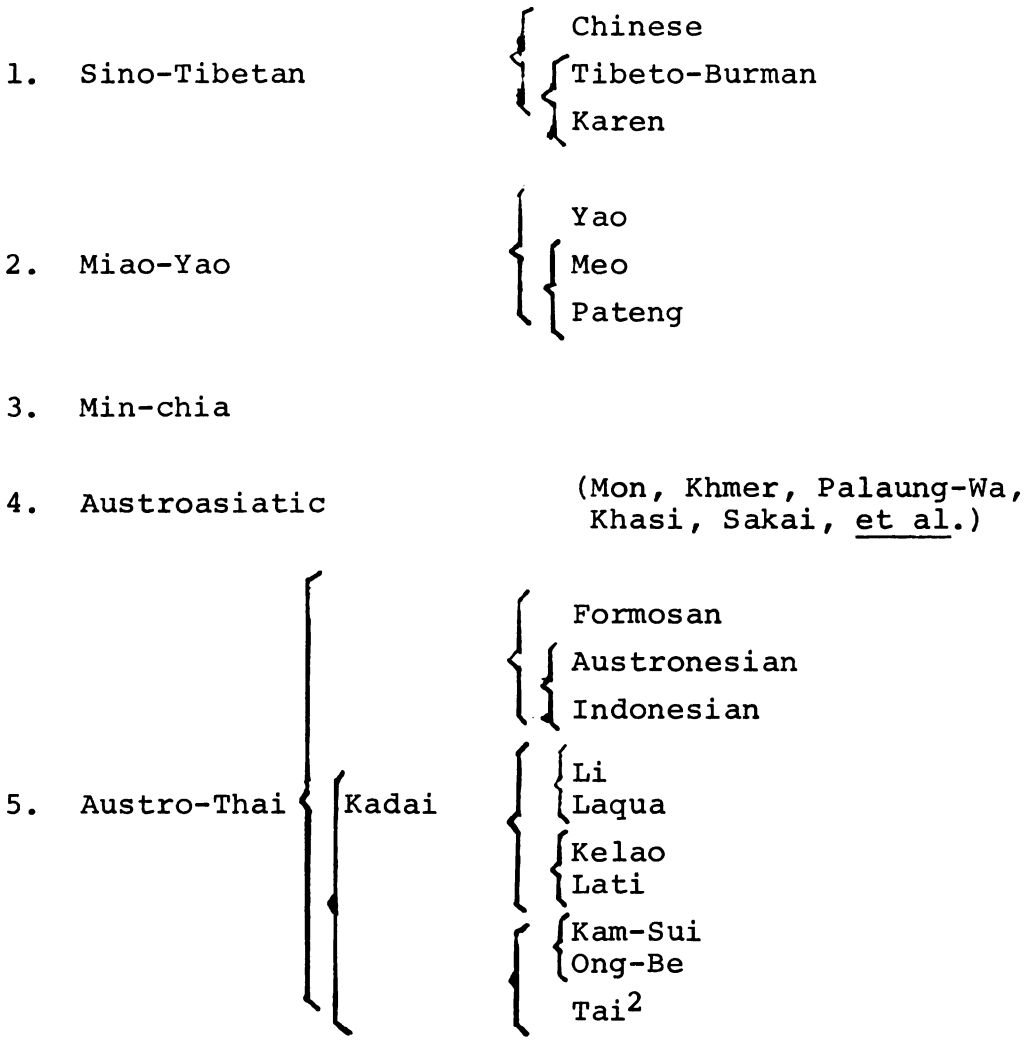


Figure 4.--Classification of Asian Languages

Li gives the following classification of Tai Languages:

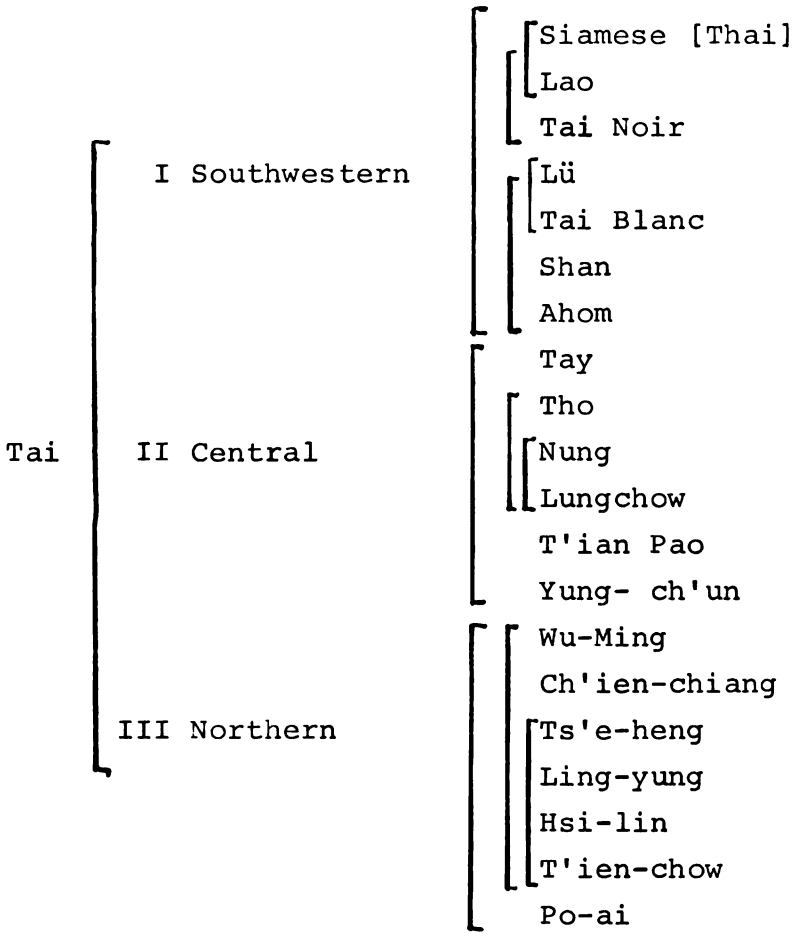


Figure 5.--Classification of Tai Languages

3.12 Phonemes

We assume VL to have the following phonemes within a traditional framework:

Consonants:

p^h	p	$^?b$	f	v	m	
t^h	t	$^?d$	s		n	l
	c	$^?y$			ñ	
k^h	k				ŋ	
	?		h			

Vowels:

i,i:	ɨ,ɨ:	u,u:
e,e:	ë,ë:	o,o:
ɛ,ɛ:	a,a:	ɔ,ɔ:

Tones:

1) low rising
2) mid rising
3) mid level
4) high falling
5) mid falling
6) short mid rising
7) short mid level

(By conventional analysis (6) and (7) are allotones of (2) and (3) respectively--see Hoshino, FSI in Marcus 1968).

Figure 6.--Phonemes of Lao

The only final consonants are p,t,k,?,m,n,ŋ. The vowels e and i, and o and ɔ never seem to contrast before nasals.[3]

Syllables have the form

$$C\begin{Bmatrix} V:(C) \\ VC \end{Bmatrix}.$$

3.13 Orthography

In the Lao writing system initials are broken up into three groups known as High, Middle, and Low class consonants. The phonemes circled on the chart comprise the Middle class consonants. Each remaining consonant, for historical reasons, is represented by two symbols (see section 4.11), one of which is a High class consonant and the other a Low class. Although the segmental distinctions have been lost between the two groups, the tones conditioned by them have not.[4]

3.2 Tone in Tai linguistics

Basic designs for describing Tai tone systems have been put forth by many scholars. Among these the works of Li (1943, 1954, 1962), Haudricourt (1948), Egerod (1961), and Brown (1965) have been very prominent. Their systems contain at least one obvious similarity, the categorizing of Proto-Tai tones into four classes. The same system occurs in Chinese (Wang 1967:p.95 and Li 1945), Miao-Yao (Chang 1953), and even in Proto Lolo-Burmese (Burling 1967). The fourth class in every system encompasses all syllables with final stops. In Ancient Chinese these four tone

classes were known as "level," "rising," "falling," and "abrupt."

> The [abrupt class] is strictly speaking not a tone-class, but a special class of words which end in a final stop consonant. All such words had only one tone, which the old Chinese philologists did not associate with any of the other tones.
> (Li 1945)

Benedict (1966:277) claims that, "Thai features such as monosyllabicism and tonality are explained as the product of an early, profound influence from Chinese upon the Thai languages, at that time (1st millenium B.C. or earlier) spoken in Southern China." Thus, whether by genetic relationship or sheer propinquity, the Proto-Tai tone system came to resemble that of Chinese (see also Li 1945).

3.3 Former treatments of Lao tone

There have been two previous descriptions of VL in the literature. One by Brown (1965:98) and the other by Simmonds (1965:136). These are discussed in detail here.

The first chart represents Brown's description of VL. The symbols H, M, and L represent the initial consonant classes High, Middle and Low respectively. They are translations from the Thai and are assumed to originally have had some relation to the actual tones. However, in most dialects, the resemblance has long since

disappeared. They will be given further explication in section 4.11. The numerals refer to the tone categories. They are taken from the Thai writing system:

0 = not specified in the writing system;

1 = tone on syllables marked with mai ?ek (');

2 = tone on syllables marked with mai tho ( );

3 = syllables with long vowel plus final stop;

4 = syllables with short vowel and final stop.

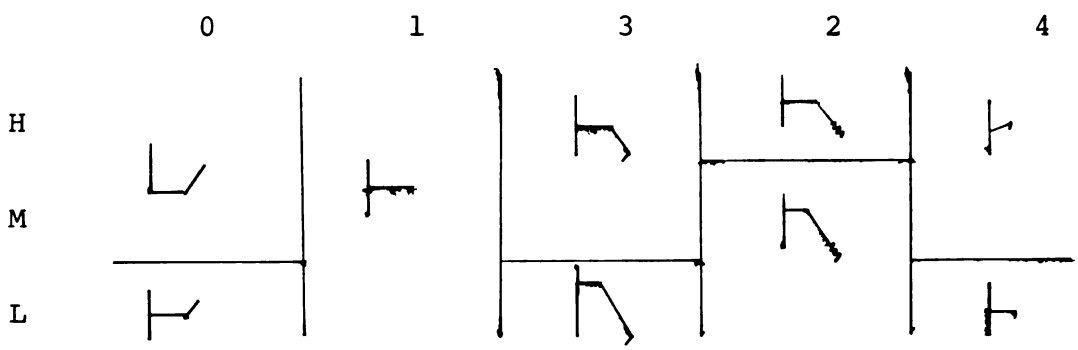


Figure 7.--Tones of VL by Brown[5]

The check at the end of the tones in categories 3 and 4 represent final stops. In category 2 the jagged line represents glottal constriction.

Simmonds uses another format for his description but one much more common in the literature on Tai dialects. The scheme was originated by Li (1945) who equated it with the Ancient Chinese system:

Tai:	Chinese:
A	level
B	raising
C	falling
D	abrupt

In Simmonds' chart below the tone categories A, B, C, DS (short), and DL (long), correspond to Brown's 0, 1, 2, 4, 3 in that order. H and M refer to High and Middle class consonants and 2 is the equivalent of Low class. This system has only two major consonant classes, class 1 being further divided into H and M. This is done because H and M are thought to have merged in many dialects.

	A1H	A1M	A2	B	C1H	C1M	C2	DS1	DS2	DL1	D12
rising	X							X			
mid		X									
high fall			X						X		
low mid				X							
low					X					X	
mid fall						X	X				X

Figure 8.--Tones of VL by Simmonds

There are some disagreements between the two presentations as to what the tones actually are. They are listed here.

1. Brown's MO is  while Simmonds gives 'mid.'
2. Brown's H2 is  while Simmonds has 'low' for ClH.
3. Brown L2 is  where Simmonds C2 is 'mid fall.'
4. Brown has  in H3 and Simmonds has 'low' in DL1.
5. Brown has  in M2, L2 where Simmonds has 'mid fall' for C2 and 'low' for ClM.
6. For AlH and DS1 Simmonds has the tone rising while Brown distinguishes between  for HO, MO and  for H4, M4.
7. Brown's L4 is  , Simmonds has 'high fall' in DS2.
8. Brown notes glottal constriction in 2 where Simmonds does not.
9. Brown LO is  while Simmonds has 'high fall' in A2.

4. Generative treatment of VL tone

4.1 Distinctive features

The first step in providing a generative treatment of the VL tone system is to provide a distinctive feature analysis of VL sounds within which generalizations in the form of phonological rules may be formulated. The features we provide below are conveniently treated under three headings: features of initials, features of finals, and features of (tone bearing) vowels.

4.11 Features of Initials

The importance of Initials in any tone study is, of course, great (see section 4.11). For initials in the Southeast Asian area[6] there seem to be three important phonetic categories: aspiration, voicing, and glottalization (Chang 1953, Li 1966). As was seen in the account of VL consonantism, the overt phonetic categories of VL initials seem to oppose unaspirated stops to the remaining consonants, so that voicing and glottalization are predictable on the basis of the other features. Assuming that the overt distinctive categories faithfully represent underlying categories (that is, effectively differentiate the lexical representation of forms), then the resulting picture of VL phonology is one where initials are more or less randomly related to the tones of the syllables which they begin.

On the other hand, if it is assumed that the underlying features of initials are roughly identical to the features reconstructed for Proto-Tai, a more systematic relationship of tones and initials emerges. In following through on this assumption the initials of VL are divided into three groups: High class consonants are reflexes of Proto-Tai voiceless aspirated stops. Middle class consonants are reflexes of Proto-Tai voiceless unaspirated stops and pre-glottalized consonants (including glottal stop). Low class consonants are reflexes of Proto-Tai voiced consonants.[7]

These three classes are differentiated in modern VL by the tonal effects of their member initials. It is difficult to determine exactly what effect the initials had originally. On the one hand, voiced initials probably tended to lower the pitch while voiceless ones tended to raise it (see section 1). On the other hand the effects of aspirates or preglottalized initials remains unknown. In general, in modern VL, the High class consonants seem to occur with the lower tones while the Low class consonants appear with the higher ones. Middle class consonants merge with either the High or Low class consonants but mostly with the High. The following chart gives the distribution (for exact phonetic shapes see 4.142):

H - 1 3 5 6

M - 1 3 4 5 6

L - 2 3 4 7

Figure 9.--Distribution of Tones

These effects apparently represented the historical effects of the proto-consonants on the proto-tones in the course of development from Proto-Tai to VL. Similarly, the realizations of underlying initials as observed in VL initials reflects the historical process. The middle class initials were unaspirated. The High class and Low

class initials merged: all fricatives became voiceless, all stops became aspirated, and all nasals became voiced. (In other words they all moved to a more "natural" state.) Although the phonemes v and V are classes as fricative, in final position they are phonetically w.

In analyzing the underlying initials in terms of distinctive features only two features are needed to distinguish the three classes: voiced, and heightened subglottal pressure. Pre-glottalization in the Middle class consonants may safely be ignored, since Middle class initials never behave separately from both High and Low class initials in their effect on tone. The following table shows how we classify VL initials on the basis of voiced and heightened subglottal pressure.

p^h	T^h		K^h		p^h	t^h		k^h		p	t	c	k	?
F	S			H	f	s			h	$?_b$	$?_d$	$?_y$		
V					v									
M	N	$\tilde{N}$	Ny		m	n	$\tilde{n}$	ny						
	L					l								
–					+					–				voice
+					–					–				h s p

Figure 10.--Initials[8]

4.12 Features of vowels

VL is one of the several Tai dialects containing two sets of vowels, tense and lax (traditionally they have been labeled long and short). They behave the same tonally in all categories except before final stops. In this position the tones vary according to the tenseness of the vowel.

Features of glottal constriction seem to occur with syllable final vowels. However, following Jones (1965), these constrictions will be considered as final consonants in themselves.[9] In this analysis they may also be considered as co-occuring with syllable final nasals. Jones (1965:195) says that the final consonantal element of glottal constriction usually produces a final allophone with a falling contour and higher pitch.

4.13 Features of finals

Final consonants also play a large role in the determination of tone. The main factor involved seems to be stop, but others such as those discussed in section 1 are important. In some cases (e.g. Miao-Yao, Chang 1953) final consonants have been lost leaving behind a separate tone category. In all extant Tai dialects this type of final has some effect upon the tone. Jones (1965) has pointed out that there is a feature of glottal constriction in many Tai languages, short of a glottal

stop, which also may affect the tone or be distinctive. This feature was also discussed by Henderson _1965). She cateragorized the phenomenon as a different phonation type. She also noted a 'breathy' phonation in the hoi tone in North Vietnamese and a 'creaky' phonation in the ŋ̰a̰ tone, as well as in the high and falling tones of Central Thai, the low level, high level, and falling tones of Shan, the mid and low tones of Bwe Karen, and in the abrupt tone of Burmese. Jones also mentions a distinction in the tones of Egerod's (1961)[10] LG class (Li's DS2, Brown's L4) between the final stops p, t, k, and the glottal stop in Luang Prabang Lao.[11]

Although the author knows of no dialect where final nasals cause tonal alternants, there is a predictable difference in contour between syllables with final nasals and those with final tense vowels.[12]

According to Brown (p.52) the five tone classes of modern Tai languages represent the following final laryngeal components which have been postulated for Ancient Thai:

0 (A) = whisper

1 (B) = voice

2 (C) = creak

3 (DL) = stop

4 (DS) = stop

Figure 11.--Final Components According to Brown

These, coupled with the initial components, aspirate, stop, and voice produce a total of fifteen different tone possibilities. Unfortunately the basis for his assignment is not clear. He goes on to say (p.59):

> In Ancient Thai, there were distinctions in tone endings only. Then register distinctions developed as the initials unloaded distinctions onto the tones. And finally, contour distinctions developed to help bear the load. The order of importance of these three aspects of tones varies considerably. The order of the three main branches seems to be as follows:
>
> Chiang Saen: contour ending register
> Lao: ending register contour
> South: register ending contour

The effects of the various types of glottal constriction were discussed in section 1 and it remains only to demonstrate the feature system.

The finals of VL correspond to the four original tone categories discussed by Li (see section 3.2), that is A, B, C, and D. They are distinguished by two laryngeal features on a continuum of glottal constriction marked at three points: whisper, creak, and stop. The absence of whisper and creak implies stop. Finally, all syllables without final stops are considered to contain the final feature [+ sonorant].

	A	B	C	D
whisper	+	+	-	-
creak	-	+	+	-
sonorant	+	+	+	-

Figure 12.--Final Features of Tone Categories

As mentioned in the preceding section, in syllables with final tense vowels the form of glottal constriction will be considered a final consonant. In syllables with final nasals the constriction features will be added directly to the nasal segment. In the notation system used in this analysis (see derivations) A = ∅, B = I, C = II, D = final stop.

4.14 Features of tone

4.141 Segmentation

Wang (1967:95) says ". . . it is preferable to formalize the tone features differently from the segmental features and regard them as features of individual syllables." Unfortunately he does not say how this is to be done. Therefore in the analysis that follows tonal features will be treated as features of vowels.

From the preceding sections it should be clear that segmentals in all positions in the syllable can affect the tone. Therefore it seems reasonable to assume a tripartite segmentation of each tone at least on the phonetic level, segment one being the result of the initial, segment two the effect of the vowel, and segment three the effect of the final. However, knowledge of tone has not progressed so far that we can with any accuracy predict the effects of the normal segmentals on each tone segment.

Another method of segmentation of tones would be to arbitrarily divide the tone into isochronous segments. This approach seems rather unsatisfactory because the decision as to the number of segments would be entirely arbitrary.

A third, preferable way, is to segment a tone at points of natural perceived changes in direction of its contour. Thus, by means of a very few phonetic tone features for each segment, plus the segmental features put forth in sections 4.11-4.13, it is possible to describe in a fairly systematic way the basic tones of VL, and their alternants.

Segmentation of tone allows for a very limited number of features to describe the contours necessary. Without this segmentation the number of features required to differentiate the tones of many languages would be enormous. For example, Brown (p.82) gives these tones as contrastive in the Tai dialect of Chiang Mai:

Figure 13.--Falling Tones of Chiang Mai[13]

Treatment of these contrasts would either involve a very large number of features or result in a lack of detail at the phonetic level, not to mention the failure to extract the generalization that contour is more important than relative pitch.

In VL and in many Tai dialects recorded by Brown (1965), the segmented tones have, at least perceptually, one thing in common; the first segments are all level. This implies that the segmentation rules always assign a level first segment to the contours thus far generated (see rules (7), (8)). Of course, the two short tones, 6 and 7, do not undergo this segmentation (rule 2).

4.142 Features

The decision as to which features to use for tones is a difficult one. As we have seen (section 1), many varied and not always well understood phenomena enter into the production of pitch. Although tone is predictable on the lexical level in Lao, some means of representing the tonal contour on the phonetic level is necessary. Furthermore, to remain as close as possible to the actual situation, some hierarchy of predictability must be established, as was seen in section 1, in order to represent the fact that the contour shape is most important and the relative pitch predictable from that. The features deemed most relevant for this task are the following:

rise

fall

relative length

Once these features are assigned values by the rules, the relative pitch is assigned in terms of integers.

The tones of VL are given below. The major disagreement with Brown (1965) is that while he has H and M behaving together in category 2, it seems rather that they behave the same in 3, with L and M together in 2. Since this is the only major difference, it may be due to a printing error. A minor difference is found in the description in tone 4, which starts at a higher pitch than in Brown (1965).

The description offered here agrees with Simmonds (1965) to the extent that 1M and 2 merge in category C, and that M and H are identical in DL. However, the actual phonetic shapes of the tones are in no way similar.

	1	2	3	4	5	6	7
							
rise	-+	-+	--	--	--	+	-
fall	--	--	--	-+	-+	-	-
rlng	++	+-	++	-+	++	-	-
P	1	2	2	3	2	2	2

Figure 14.--Tones of VL[14]

In order to compare the author's account with others the following chart is offered in the more traditional form:

	A1H	A1M	A2	B	C1H	C1M	C2	DS1	DS2	DL1	DL2
low rise	X	X									
mid rise			X								
mid level				X							
High fall					X	X				X	
mid fall					X				X		
short rise								X			
short level									X		

Figure 15.--Tones of VL in Traditional Form

4.15 Stress

The stress pattern of VL is extremely elusive because of the barrier to perception created by the tonal system. Therefore, in this analysis only two rules will be used which govern stress in the noun phrase.

1) $V \rightarrow \left\{ \begin{matrix} [+\text{stress}] \\ [-\text{stress}]/[-\text{vd}][^{-\text{tns}}_{\text{a}}][?][\overline{+\text{vd}}] \end{matrix} \right\}^{15}$

2) $[+\text{stress}] \rightarrow [1\text{stress}]/ \left[\begin{matrix} \overline{+\text{voc}} \\ -\text{cns} \end{matrix} \right] \quad ([-\text{voc}]) \;]_{N,NP}$

The rules apply cyclically and follow the convention that after each successive application the innermost brackets are erased (Chomsky-Halle 1968:20) and the stress on every other vowels of the string is weakened by one (Chomsky-Halle 1968:16-17).

4.2 Rules

(1) [+tns] → [-tns]/ ___[+cns] ([$^{-seg}_{+WB}$]) [+cns][lstress]

This rule causes tense vowels to become lax before syllables with primary stress. This rule will have an effect on the tone only when the vowel is followed by a final stop, thereby changing the tone category.[16]

(2) $\begin{bmatrix}+voc\\-cns\\-tns\end{bmatrix}$ → [-rule 7]/ ____[$^{-whisp}_{-creak}$]

Rule (2) is a lexical redundancy rule which prevents the segmentation of lax vowels which are followed by a stop.[17] That is, forms with the short tones 6 and 7 do not undergo rule (7) below.

(3) [-hsp] → [+hsp]/[-vd][$^{-tns}_{a}$][?][$\overline{+vd}$]

This rule aspirates an underlying voiced unaspirated consonant which is preceded by a syllable with the structure [$^{+cns}_{-vd}$] a ? within a single word.[18] VL contains a blank filling rule

(3a) [+hsp] → [-vd]

which states that any aspirated segment is also voiceless. It is assumed that this rule may be applied here

to alter the voicing of the segment which became aspirated by rule (3).[19]

$$(4)\ \begin{bmatrix}+\text{voc}\\-\text{cns}\end{bmatrix} \rightarrow \left\{ \begin{array}{l} [-\text{fall}] \\ [+\text{fall}]/ \left\{ \begin{array}{l} \underline{\quad}\begin{bmatrix}-\text{whisp}\\+\text{creak}\end{bmatrix} \\ \overline{[+\text{tns}]}\begin{bmatrix}-\text{whisp}\\-\text{creak}\end{bmatrix} \end{array} \right\} \end{array} \right\}$$

This rule, as well as several which follow, is a schema which expands to a sequence of rules. Schema (4) expands to:

$$(a)\ \begin{bmatrix}+\text{voc}\\-\text{cns}\end{bmatrix} \rightarrow [-\text{fall}]$$

$$(b)\ \begin{bmatrix}+\text{voc}\\-\text{cns}\end{bmatrix} \rightarrow [+\text{fall}]/\ \underline{\quad}\begin{bmatrix}-\text{whisp}\\+\text{creak}\end{bmatrix}$$

$$(c)\ \begin{bmatrix}+\text{voc}\\-\text{cns}\end{bmatrix} \rightarrow [+\text{fall}]/\overline{[+\text{tns}]}\begin{bmatrix}-\text{whisp}\\-\text{creak}\end{bmatrix}$$

Since the abbreviation utilizes the notational convention of braces, the ordering in the schema (4) is conjunctive (cf. Chompsky-Halle 1968:61-62). Therefore, rule (b) or rule (c) may apply after rule (a), thus changing the specification of the feature [fall] from - to +.[20]

In general rule (4), in assigning the value for [fall], shows the similarity between creaks and stops in VL in that they both cause the tone to fall. Notice that schema (4) can be further abbreviated if we allow conditions on variables, as Chomsky and Halle do, for example, in their fourth tensing rule (1968:242). That is, it is possible to replace (4) by (4'):

$$(4')\ \begin{bmatrix}+\text{voc}\\-\text{cns}\end{bmatrix} \rightarrow \left\{\begin{matrix}[-\text{fall}]\\ [+\text{fall}]/[\overline{\alpha\text{tns}}]\begin{bmatrix}-\text{whisp}\\ \beta\text{creak}\end{bmatrix}\end{matrix}\right\} \quad \begin{matrix}\text{where } \alpha = +\\ \text{if } \beta = -\end{matrix}$$

Since at present there is apparently no principled way of evaluating the simplicity of a schema utilizing a condition on variables as opposed to one in which two additional features are specified but no condition exists, we will utilize rule (4) throughout the remainder of the discussion.

$$(5)\ [-\text{fall}] \rightarrow \left\{\begin{matrix}[+\text{rise}]\\ [-\text{rise}]/\ \left\{\begin{matrix}\text{\_\_}\begin{bmatrix}+\text{whisp}\\ +\text{creak}\end{bmatrix}\\ [+\text{vd}][\overline{-\text{tns}}]\begin{bmatrix}-\text{whisp}\\ -\text{creak}\end{bmatrix}\end{matrix}\right\}\end{matrix}\right\}$$

Here, where the two forces of <u>whisper</u> and <u>creak</u> are working against each other, the result is a leveling of the tonal contour. Where the underlying initial is voiced, the vowel is lax, and the final is a stop, the result is also level.

As in (4) above, rule (5) is a schema which abbreviates the following rules:

(a) $[-\text{fall}] \rightarrow [+\text{rise}]$

(b) $[-\text{fall}] \rightarrow [-\text{rise}]/\ \text{\_\_}\begin{bmatrix}+\text{whisp}\\ +\text{creak}\end{bmatrix}$

(c) $[-\text{fall}] \rightarrow [-\text{rise}]/\ [+\text{vd}][\overline{-\text{tns}}]\begin{bmatrix}-\text{whisp}\\ -\text{creak}\end{bmatrix}$

Due to the conjunctive ordering involved in the brace notation, rule (b) or rule (c) may apply and change the value [+rise] assigned by rule (a).[21]

(6) [+fall] → [-rise]

This is a universal rule, included here for the convenience of the reader when working through the derivations. It states simply that a tone may not be both rising and falling simultaneously.

(7) $[^{+voc}_{-cns}]$

1 ⇒ 1 1

Rule (7) is a copying rule which copies the existing vowel segment.[22] To provide for the phonetic tone contours a sequence of vowels is generated at this point in all cases except those indicated by the diacritic introduced by rule (2) as not undergoing rule (7). Note that at the phonetic level many forms which at this point have a geminate vowel will have only a single vowel. This is discussed below in conjunction with rule (12).

Observe that the rule makes no claim as to which is the copy. In the derivations the copy is placed first since it must be indicated at some point. The placement has no theoretical significance.

(8) $[^{\alpha rise}_{\beta fall}] \rightarrow [^{-rise}_{-fall}] / \left[\begin{array}{c}\overline{+voc} \\ -cns\end{array}\right] \quad [^{+voc}_{-cns}]$

Rule (8) causes the first segment of all segmented tones to become level.

$$(9)\ \begin{bmatrix}+voc\\-cns\end{bmatrix} \rightarrow \left\{\begin{array}{l}[+rlng]\\ [-rlng]/ \left\{\begin{array}{l}[+vd][-cns][\overline{+rise}]\\ [-hsp]\ \_\_\_[+fall][+snr]\\ [+vd]\_\_\_[+fall]\begin{bmatrix}-whisp\\-creak\end{bmatrix}\\ [\overline{-tns}]\begin{bmatrix}-whisp\\-creak\end{bmatrix}\end{array}\right\}\end{array}\right\}$$

This rule assigns the feature of relative length to each tone segment. Schema (9) abbreviates the following rules:[23]

(a) $\begin{bmatrix}+voc\\-cns\end{bmatrix} \rightarrow [+rlng]$

(b) $\begin{bmatrix}+voc\\-cns\end{bmatrix} \rightarrow [-rlng]/\ [+vd][-cns][\overline{+rise}]$

(c) $\begin{bmatrix}+voc\\-cns\end{bmatrix} \rightarrow [-rlng]/\ [-hsp]\ \_\_\_[+fall][+snr]$

(d) $\begin{bmatrix}+voc\\-cns\end{bmatrix} \rightarrow [-rlng]/\ [+vd]\ \_\_\_[+fall]\begin{bmatrix}-whisp\\-creak\end{bmatrix}$

(e) $\begin{bmatrix}+voc\\-cns\end{bmatrix} \rightarrow [-rlng]/\ [\overline{-tns}]\ \begin{bmatrix}-whisp\\-creak\end{bmatrix}$

These sequential rules are conjunctively ordered within the schema; that is, any rule may alter the effect of the preceding one.

At this point all of the contours given in Figure 14 are complete, defined by the features of rise, fall, and relative length.

$$(10)\ [-cns] \rightarrow \left\{\begin{array}{l}[2P]/\ \_\_\_(\begin{bmatrix}+voc\\-cns\end{bmatrix})\\ [1P]/\ \_\_\_\begin{bmatrix}+rise\\+rlng\end{bmatrix}\\ [3P]/\ [\overline{-rlng}]\ [+fall]\end{array}\right\}$$

Rule (10) is a schema representing a sequence of rules:

(a) $[-\text{cns}] \rightarrow [2P] / \_\_\_ \begin{bmatrix} +\text{voc} \\ -\text{cns} \end{bmatrix}$

(b) $[-\text{cns}] \rightarrow [2P$

(c) $[-\text{cns}] \rightarrow [1P] / \_\_\_ \begin{bmatrix} +\text{rise} \\ +\text{rlng} \end{bmatrix}$

(d) $[-\text{cns}] \rightarrow [3P] / [\overline{-\text{rlng}}][+\text{fall}]$

Note that rules (a) and (b) are disjunctively ordered in accord with the notational convention regarding the use of parentheses (cf. Chomsky-Halle 1968:29-30). Therefore, rule (a) will assign 2P to the first vowel in any sequence of two vowels. If rule (a) applies, then rule (b) may not apply, although either (c) or (d) may. If, on the other hand, rule (a) does not apply, as would be the case if there were only a single vowel, then rule (b) applies to assign that vowel 2P. The result, in other words, is that a single vowel has 2P, while in a sequence of two vowels, the second one receives no pitch and the first, at least initially, receives 2P. Examples illustrating rule (10) can be found throughout the appendix.

(11) $[+\text{rise}] \rightarrow \begin{bmatrix} -\text{rise} \\ +\text{fall} \end{bmatrix} / [+\text{vd}][-\text{cns}][\overline{-\text{rlng}}]$

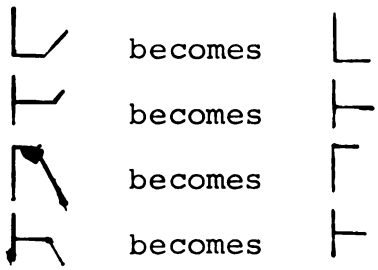
Rule (11) is an optional rule which reflects the s c h oolbook-drill pronunciation of tone 2. In other words ⊢ is sometimes ⊢ .[24]

(12) $[^{+voc}_{-cns}]$ $[^{+voc}_{-cns}]$ [+cns] $([^{-seg}_{+WB}])$ [+cns] [1stress]

1 2 3 4 5 6 ⇒

1 ø 3 4 5 6

In this rule one advantage of the segmentation approach is seen. Merely by dropping the second tone bearing segment the phonetic actualization of tones preceding primary stress is achieved. That is:



(13) [1P] → [2P]/ ____[+cns]$([^{-seg}_{+WB}])$[+cns]$[^{1stress}_{1P}]$

This rule changes the pitch level of tone 1. Tones thus far generated as ˩ become ˧. In other words, (13) is a kind of pitch dissimilation.

4.3 Summary of rules

(1) [+tns] → [-cns]/ ___[+cns]$([^{-seg}_{+WB}])$[+cns][1stress]

(2) $^{+voc}_{-cns}_{-tns}$ → [-rule 7]/ ___$[^{-whisp}_{-creak}]$

(3) [-hsp] → [+hsp]/ [-vd]$[^{-tns}_{a}]$[?]$[\overline{+vd}]$

(3a) [+hsp] → [-vd]

(4) $\begin{bmatrix}+\text{voc}\\-\text{cns}\end{bmatrix} \rightarrow \left\{\begin{array}{l}[-\text{fall}]\\ [+\text{fall}]/\left\{\begin{array}{l}\_\_\_\begin{bmatrix}-\text{whisp}\\+\text{creak}\end{bmatrix}\\ [+\text{tns}]\begin{bmatrix}-\text{whisp}\\-\text{creak}\end{bmatrix}\end{array}\right\}\end{array}\right\}$

(5) $[-\text{fall}] \rightarrow \left\{\begin{array}{l}[+\text{rise}]\\ [-\text{rise}]/\left\{\begin{array}{l}\_\_\_\begin{bmatrix}+\text{whisp}\\+\text{creak}\end{bmatrix}\\ [+\text{vd}]\overline{[-\text{tns}]}\begin{bmatrix}-\text{whisp}\\-\text{creak}\end{bmatrix}\end{array}\right\}\end{array}\right\}$

(6) $\underline{U}$ [+fall] → [-rise]

(7) $\begin{bmatrix}+\text{voc}\\-\text{cns}\end{bmatrix}$

1 ⇒ 1 1

(8) $\begin{bmatrix}\alpha\text{rise}\\ \beta\text{fall}\end{bmatrix} \rightarrow \begin{bmatrix}-\text{rise}\\-\text{fall}\end{bmatrix}/ \left[\begin{array}{l}\overline{+\text{voc}}\\-\text{cns}\end{array}\right] \begin{bmatrix}+\text{voc}\\-\text{cns}\end{bmatrix}$

(9) $\begin{bmatrix}+\text{voc}\\-\text{cns}\end{bmatrix} \rightarrow \left\{\begin{array}{l}[+\text{rlng}]\\ [-\text{rlng}]/\left\{\begin{array}{l}[+\text{vd}][-\text{cns}]\overline{[+\text{rise}]}\\ [-\text{hsp}]\_\_\_[+\text{fall}][+\text{snr}]\\ [+\text{vd}]\_\_\_[+\text{fall}]\begin{bmatrix}-\text{whisp}\\-\text{creak}\end{bmatrix}\\ \overline{[-\text{tns}]}\begin{bmatrix}-\text{whisp}\\-\text{creak}\end{bmatrix}\end{array}\right\}\end{array}\right\}$

(10) $[-\text{cns}] \rightarrow \left\{\begin{array}{l}[2\text{P}]/\ \_\_\_(\begin{bmatrix}+\text{voc}\\-\text{cns}\end{bmatrix})\\ [1\text{P}]/\ \_\_\_\begin{bmatrix}+\text{rise}\\+\text{rlng}\end{bmatrix}\\ [3\text{P}]/\ \overline{[-\text{rlng}]}[+\text{fall}]\end{array}\right\}$

(11) OP [+rise] → $[^{-rise}_{+fall}]$/ [+vd][-cns][$\overline{-rlng}$]

(12) $[^{+voc}_{-cns}][^{+voc}_{-cns}]$[+cns]($[^{-seg}_{+WB}]$)[+cns][lstress]

1 2 3 4 5 6 =⇒

1 ø 3 4 5 6

(13) [1P] → [2P]/ ___[+cns]($[^{-seg}_{+WB}]$) [+cns]$[^{lstress}_{P}]$

4.4 Conclusion

We have seen how the features presented in section 4.1 have been used in rules which generate the seven tones of VL, and further how these tones are altered in various environments. The appendix demonstrates how the rules apply to particular lexical items.[26]

Appendix : Sample Derivations

Data:

$K^hɔ:$	'beg'
ɲu:	'snake'
ɲa:y (I)	'easy'
pa:II	'mother's oldest sister'
Na:II	'face'
$t^ha:t$	'stupa'
pa:k	'mouth'
nak	'expert'
Nak	'heavy'
ta?la:t	'market'
Ma:k $K^ha:m$	'tamarind'
ta: $K^ha:w$	'cowardly'

K^h	ɔ:	ø	(given)
-vd +hsp	+voc -cns +tns	+whisp -creak	
	-fall		(R4a)
	+rise		(R5a)
+voc -cns +tns -fall +rise			(R7)
-rise			(R8)
+rlng+rlng			(R9a)
lP			(R10b)
-fall-fall -rise+rise +rlng+rlng lP			

ŋ	u:	ø	(given)
+vd	+voc	+whisp	
	-cns	-creak	
	+tns		
	-fall		(R4a)
	+rise		(R5a)
+voc			(R7)
-cns			
+tns			
-fall			
+rise			
-rise			(R8)
+rlng+rlng			(R9a)
-rlng			(R9b)
2P			(R10a)
-fall-fall			
-rise+rise			
+rlng-rlng			
2P			
	-rise		(R11)
	+fall		
-fall+fall			
-rise-rise			
+rlng-rlng			
2P			

ŋ	a:	I y	(given)
+vd -hsp	+voc -cns +tns	+whisp +creak	
	-fall		(R4a)
	+rise		(R5a)
	-rise		(R5b)
+voc -cns +tns -fall -rise			(R7)
			(R8) vacuously
+rlng+rlng			(R9a)
2P			(R10a)
-fall-fall -rise-rise +rlng+rlng 2P			

p	a:	II	(given)
-vd -hsp	+voc -cns +tns	-whisp +creak	
	-fall		(R4a)
	+fall		(R4b)
	-rise		(R6) U
+voc -cns +tns +fall -rise			(R7)
-fall			(R8)
+rlng+rlng			(R9a)
-rlng			(R9b)
3P			(R10d)
-fall+fall -rise-rise -rlng+rlng 3P			

N	a:	II	(given)
-vd	+voc	-whisp	
	-cns	+creak	
	+tns		
	-fall		(R4a)
	+fall		(R4b)
	-rise		(R6) U
+voc			(R7)
-cns			
+tns			
+fall			
-rise			
-fall			(R8)
+rlng+rlng			(R9a)
2P			(R10a)
-fall+fall			
-rise-rise			
+rlng+rlng			
2P			

t^h	a:	t	(given)
+vd -hsp	+voc -cns +tns	-whips -creak -snr	
	-fall		(R4a)
	+fall		(R4b)
	-rise		(R6) U
	+voc -cns +tns +fall -rise		(R7)
	-fall		(R8)
	+rlng+rlng		(R9a)
	-rlng		(R9b)
	3P		(R10d)
	-fall+fall -rise-rise -rlng+rlng 3P		

p	a:	k	(given)
-vd	+voc	-whisp	
-hsp	-cns	-creak	
	+tns		
	-fall		(R4a)
	+fall		(R4b)
	-rise		(R6) U
+voc			(R7)
-cns			
+tns			
+fall			
-rise			
-fall			(R8)
+rlng+rlng			(R9a)
2P			(R10a)
-fall+fall			
-rise-rise			
+rlng+rlng			
2P			

n	a	k	(given)
+vd	+voc	-whisp	
-hsp	-cns	-creak	
	-tns		
	-rule 7		(R2)
	-fall		(R4a)
	+rise		(R5a)
	-rise		(R5c)
	+rlng		(R9a)
	-rlng		(R9e)
	2P		(R10b)
	-fall		
	-rise		
	-rlng		
	2P		

N	a	k	(given)
-vd +hap	+voc -cns -tns	-whisp -creak	
	-rule 7		(R2)
	-fall		(R4a)
	+rise		(R5a)
	+rlng -rlng		(R9a) (R9e)
	2P		(R10b)
	-fall +rise -rlng 2P		

t	a	?	l	a:	t	
-vd -hsp	+voc -cns -tns	-whisp -creak	+vd -hsp	+voc -cns +tns	-whisp -creak	
	-rule 7					(R2)
			+hsp -vd			(R3) (R3a)
	-fall			-fall +fall		(R4a) (R4c)
	+rise					(R5a)
				-rise		(R6) U
				+voc -cns +tns		(R7)
				+fall -rise		
				-fall		(R8)
	+rlng -rlng			+rlng+rlng		(R9a) (R9e)
				2P		(R10a)
	2P					(R10b)
	-fall +rise -rlng 2P			-fall+fall -rise-rise +rlng+rlng 2P		

t	a:	ø	K^h	a:	w	
-vd -hsp	+voc -cns +tns	+whisp -creak	-vd -hsp	+voc -cns +tns lstress	+whisp -creak	
	-tns					(1)
	-fall			-fall		(4)
	+rise			+rise		(5)
	+voc -cns -tns -fall +rise			+voc -cns +tns lstress -fall +rise		(7)
	-rise			-rise		(8)
	+rlng+rlng			+rlng+rlng		(9)
	2P			2P		(10a)
	lP			lP		(10c)
	ø					(12)
	2P					(13)
	-fall -rise +rlng 2P			-fall-fall -rise+rise +rlng+rlng lP		

M	a:	k	K^h	a:	m	
-vd +hsp	+voc -cns +tns	-whisp -creak	-vd +hsp	+voc -cns +tns lstress	+whisp -creak	
	-tns					(1)
	-rule 7					(2)
	-fall			-fall		(4)
	+rise			+rise		(5)
				+voc -cns +tns lstress -fall +rise		(7)
				-rise		(8)
	+rlng			+rlng+rlng		(9a)
	-rlng					(9e)
				2P		(10a)
	2P					(10b)
				1P		(10c)
	-fall +rise -rlng 2P			-fall-fall -rise+rise +rlng+rlng 1P		

FOOTNOTES

[1]The spelling Tai refers to the entire group of Tai languages and people. Thai refers specifically to the language or people of Thailand. Unfortunately all scholars do not observe this distinction faithfully.

[2]Benedict uses the spelling Thai but Tai was substituted here for purposes of clarity.

[3]An example may be found in the word len or lin 'to play.'

[4]The Low class s seems to be almost a š for some speakers while the High class s is not.

[5]Brown does not explain why he reverses the order of 2 and 3 in various places throughout the book. It may be due to a last minute printing difficulty. At any rate it leads to much confusion, as the reader never knows what category Brown is considering in the many charts.

[6]Brown (p.62) gives the following explanation of initials and tone change: "They are part of a most interesting areal change that swept over the Orient about 1000 years ago. It seems to have gone like this. Voiced and voiceless initials had different effects upon the tones, and when the tonal differences thus engendered were capable of bearing the distinction, some of the initials fell

together. Non-tonal languages were also affected. In Mon-Khmer languages, which had no tones, the initials had different influences on the vowels and then fell together, doubling the number of vowels. Chinese, Vietnamese, Miao-Yao, Mon-Khmer, and Thai were affected."

[7]This is not true in all dialects, as noted by Li (1966) and others. For example, Lungchow initials are divided into two groups, from Proto-Tai voiced and voiceless consonants; Po-ai and Chiang Mai have three classes, Surd, from Proto-Tai voiceless aspirated and unaspirated, Glottal, from Proto-Tai preglottalized and glottal stop, Voiced from proto-Tai voiced; T'ien Pao has four classes, Surd, from Proto-Tai voiceless unaspirated stops and voiceless nasals, Aspirated from Proto-Tai aspirated or unaspirated stops and h, Glottal, from Proto Tai pre-glottalized and glottal stop, and Voiced from Proto-Tai voiced.

[8]The existence of one or two forms such as tu:t (ᨴᨮ) 'move over' in VL may demonstrate a tendency for the M class consonants to be breaking into two groups of voiced and voiceless. Such is the case in Chiang Mai and a number of other dialects in Northern Thailand.

[9]Chang (1953:375) shows where tones which have lost their final stops still retain the same tone category as tones ending with final stops in Miao-Yao.

[10]Egerod's system divides the Middle class consonants into two groups: M (p,t,k) and G (?b,?d,?y,?). Egerod uses 0 1 2 G :G as the more common A B C DS DL respectively. The division of the Middle class consonants is used only in the Tai dialects of Northern Thailand, Chiang Mai, Yuan, etc.

[11]Donaldson (1963) has pointed out that there are two series of tones in White Tai, those with a final glottal stop and those without. The final glottal stop is considered to be part of the tone.

[12]Brown (p.39) claims that final t is in reality a final ?n and that this is true of all final stops in Tai (i.e. ?m = p, ?ŋ = k). This seems reasonable since glottal closure is certainly present in p,t,k. This closure could be explained by a final ?b becomes p, or ?d becomes t. There is, however, no ?g but ?y is phonetically quite close.

[13]Since the last two tones mentioned here both contain glottal constriction, there would seem to be a good possibility that the glottal constriction plays a large role in the distinction of these tones from one another.

[14]There have been at least two recent papers on Thai tone rules (Whitaker 1968, Warotamasikkhadit 1968)

utilizing Wang's features. Both of these deal only with tonal alternation. The tones are assumed to be the same at both the lexical and phonetic levels. It is the author's opinion that in most Tai languages the lexical representation could be simplified substantially by the use of certain features pertainint to the underlying structure of the initials as has been discussed. The tones of VL have reduced from seven to zero in the lexical representation.

[15]The structure C[$^{-tns}_{a}$] [?] C____ reoccurs again in rule 3. It seems there is something different about forms with this structure. It is suspected that they are loan words of Indic or Mon-Khmer origin.

[16]Rules (1) and (2) are so ordered because (2) applies not only to underlying [-tns] vowels before [$^{-whisp}_{-creak}$] but also to underlying [+tns] vowels made [-tns] by rule (1). (See Ma:k K^{h}a:m in the derivations.)

[17]There is the possibility of some confusion regarding rules like this one. Chomsky and Halle (1968: 175(9) and 238(4)) utilize a similar rule to prevent their vowel laxing rule from applying before formative internal dental consonant clusters. At a later point in their discussion, however, they posit the convention that "all nonphonological features of a given lexical item are distributed to every unit of this item" (1968:374(126)). Either this convention is too strong, a possibility which they mention in a footnote to the convention, or it is

necessary to assume that it applies only to nonphonological features which are specified in the lexicon and not to those features predictable from a phonological environment by means of a lexical redundancy rule. Note that unless the latter assumption is made, the English laxing rule would fail to apply to all of the vowels in a formative which included a single instance of a vowel followed by a dental consonant cluster. The situation is parallel for the VL rule (2), which must prevent application of rule (7) to the first vowel in ta?la:t but allow (7) to apply to the second vowel (see the appendix for the derivation of this form). Therefore, it is assumed here that the Chomsky-Halle convention (126) holds only for those nonphonological features which are included at the level of lexical representation.

[18]Almost identical rules are found in Thai (Haas 1956:49-50) and in Khün (Egerod 1959:30-31), indicating this phenomena may be quite widespread among Tai languages.

[19]It is not clear whether information provided by the blank filling rules must be resupplied by phonological rules like (3) or whether, at least in some cases which at present are not clearly defined, blank filling rules may be reapplied following the application of a phonological rule. The latter assumption is utilized here. The former assumption would be to modify (3) as follows:

(3') $\begin{bmatrix} -hsp \\ +vd \end{bmatrix} \rightarrow \begin{bmatrix} +hsp \\ -vd \end{bmatrix} / [-vd] \begin{bmatrix} -tns \\ a \end{bmatrix} [?]\_\_\_\_$

This solution was rejected because it appears to restate the general VL constraint that aspirated segments are predictably voiceless.

[20]This type of change is illustrated by the application of rule (142b) in the derivation (143) given by Chomsky and Halle (1968:382-383).

[21]Rules (b) and (c) are, of course, conjunctively ordered with respect to one another, but since no formative will satisfy the environment of both (b) and (c), only one of these rules will apply in any given tone.

[22]It is based upon the copying rule given by Rosenbaum (1968) for the generation of prepositions.

[23]It may be mentioned here that a schema involving such dissimilar environments for its rules does not speak well for the feature of relative length. Suffice it to say that knowledge of tonal phenomena is far from complete, and that for the moment, this feature seems to be necessary.

[24]This may account for Simmonds' falling tone in A2.

[25]This helps to explain certain discrepancies in the otherwise consistent Lao orthographic system where such forms as p^hu:II are sometimes rendered as p^hu:I.

[26]Because dipthongs are a problem to the rule writing they have been omitted from the samples. It should be noted, however, that dipthongs act just like regular vowels in the tone system. Naturally they would have to be included in the complete grammar.

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