PROCEEDINGS OF THE EIGHTEENTH ANNUAL MEETING
OF THE
BERKELEY LINGUISTICS SOCIETY

February 14-17, 1992

SPECIAL SESSION
on
THE TYPOLOGY
OF
TONE LANGUAGES

Berkeley Linguistics Society
Berkeley, California, USA

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SPECIAL SESSION on THE TYPOLOGY OF TONE LANGUAGES

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GERARD DIFFLOTH

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TERRENCE KAUFMAN

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GENERAL SESSION

PARASESSION

PAPER REPRINTED FROM BLS 17 PARASESSION

Proceedings of the 18th Meeting
Berkeley Linguistic Society
Special Session on the Typology of Tone Systems

Preface

In accordance with BLS's recently crystallized policy of alternating among Amerindian, African, and Southeast Asian emphases in three-year cycles, the February, 1992 meeting was supposed to have had a Southeast Asian focus. However, two other conferences dealing largely with Southeast Asia were in the offing later in the year in the Western U.S. -- first the 2nd Annual Meeting of the new Southeast Asian Linguistic Society (SEALS) at Arizona State in May; then, closer to home and on a larger scale, Berkeley was to host the 25th International Conference on Sino-Tibetan Languages and Linguistics in October, its "Silver Jubilee". So in the interests of avoiding a 1992 Southeast Asian overkill, it was decided by Larry Hyman and me to come up with something rather different for BLS this time -- a symposium on a topic that cut across our three prime linguistic areas, and that was of broad typological interest. Thus was conceived the *Special Session on the Typology of Tone Systems*, held on Feb. 14, 1992 in the Tilden Room on the 5th Floor of the ASUC Building -- a locale that was considerately kept at a near-freezing temperature so that the participants would remain alert and bouncing in their seats throughout the day.

Papers were presented from 9:00 A.M. to 4:45 P.M., followed after a brief rest by a panel discussion that was just heating up much hotter than the ambient temperature when we were unceremoniously shooed out by the custodial staff precisely at 6:00. The 15 papers (13 of which appear in this volume) covered a wide typological/genetic range, including six on Chinese, four on African languages, and one each on Austronesian and Papuan. Our three invited speakers, Gérard Diffloth, Terrence S. Kaufman, and Martha Ratliff, spoke on Mon-Khmer, Mesoamerican tonal languages, and the typology of tonal systems, respectively.[1] There was a certain diversity of theoretical approaches overall, though the Chinese and African papers were overwhelmingly in the autosegmental framework.

On the Chinese side, the concern with formulating a typology of tone rules within autosegmental theory underlies the contributions of Zhiming Bao ("Toward a typology of tone sandhi"), Mei-chih Laura Chang ("The representation of tone and the parametric variations of tonal systems"), Matthew Y. Chen ("Tone rule typology"), Deborah S. Davison ("Parametric variation in pitch realization of 'neutral tone' syllables in Mandarin"), and Moira Yip ("The spreading of tonal nodes and tonal features in Chinese dialects"). The argumentation in these papers is subtle and abstruse, and occasionally enlivened with some picturesque terminology (e.g. Chen's "tonal Anschluss" and "tonal genocide" rules).

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[1]Diffloth's and Kaufman's papers do not appear in this volume. Hyman kindly yielded his slot to Cassimjee and Kisseberth and although not presenting his paper orally, submitted it to the proceedings.

Of special cross-linguistic interest because of its attempt to unify the autosegmental approach to *contour tones* in Chinese and African languages is San Duanmu's "Re-examining contour tone units in Chinese languages", where he analyzes contour tones in Chinese as sequences of underlying HIGH's and LOW's (even while admitting that this goes against his intuitions as a native speaker). As Jerold A. Edmondson notes at the beginning of his paper ("Tone contours and tone clusters in Iau [Papua New Guinea]"), Kenneth Pike had long ago (1948) established an influential typological dichotomy between *register tone languages* (as found in Africa and the Americas) and *contour tone languages* (characteristic of East Asia). For a variety of valid synchronic and historical reasons, students of E. Asian languages have traditionally been "contour lumpers", regarding moving tones as phonological primitives; while Africanists have been "contour splitters", preferring to break down contours into simple sequences of higher vs. lower pitch ("register" in this sense). (We could almost call this the controversy over the "atomic" vs. the "molecular" nature of contour tones!) As M. Chen puts it, African tone rules are *syntagmatic*, while Asian ones are *paradigmatic*.[2]

I personally believe it is a serious reductionist mistake to try to force all the world's contour tones into a single analytical mould. In fact, some contour systems do not fit neatly into either pole of the atomic/molecular opposition, and there exist many languages with tone systems that are contouristically atypical for their linguistic area. In Edmondson's Iau, which has 2 level and 6 contour tones, tonal "clusters" result from the collapsing of polysyllables (in the African manner), but the units in these clusters may themselves have contours - i.e. the combining units have an internal structure themselves (are these analogous to subatomic particles?). Paul Newman's "The development of falling contours from tone bending in Hausa" traces the multiple morphophonemic sources of an "aberrant" contour phenomenon:[3] besides the more typical cases where the Hausa falling contour results from the loss of a syllable, it also occurs in certain kinship terms (e.g. wâa 'elder brother', yâa 'elder sister' -- from vocative intonation?), in monosyllabic loanwords from English, unpredictably in certain other monosyllables, and by "tone slippage" or "tone bending" in certain grammatical contexts.[4] Conversely, although contours in Asian tone languages almost always function as primitives, there are a few cases where they can be successfully analyzed as underlying sequences of High and Low (as in the demonstrably recent tone system of Lhasa Tibetan).

The term *register* has been used in a confusing variety of ways by tonologists. Besides its Pikean meaning of "higher vs. lower relative pitch" (as

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[2]As Pike contended, Mesoamerican tone systems seem more African than Asian in this respect. Kaufman reconstructs three level tones /*H *M *L/ for proto-OtoManguean, with all possible 2-tone combinations occurring on disyllables, but "probably no moving tones on monosyllables".

[3]Newman's original title was "Unitary contour tones in Hausa: a typological aberration."

[4]This Hausa contour is reminiscent of the "marginal" falling tone of Jingphaw (a Tibeto-Burman language of N. Burma), which is synchronically a toneme, though clearly secondary from a diachronic point of view. Its occurrence is predictable in certain morphophonemic contexts (e.g. a low-tone verb acquires falling tone after the negative prefix /ń-/) and in certain semantic classes of words (e.g. kin vocatives), but is unpredictable in a number of other morphemes (including the numerals 'one' and 'two' and the word for 'house').

opposed to contour), *register* is now used by Asianists synonymously with *phonation type*[5] -- i.e. the various configurations of the larynx that result in clear vs. creaky vs. breathy voice. While phonational distinctions seem quite exotic with respect to Africa or Mesoamerica, they are present at least phonetically in most prosodic systems of East and SE Asia, and are particularly characteristic of the Mon-Khmer family. In his paper "Tone systems and register systems", Gérard Diffloth discusses several types of "registrogenesis" in Mon-Khmer, ranging from the classic development of breathiness from devoicing of initial obstruents (as in Monic) to registrogenesis resulting from the "crowding of vowel space" (as in several Katuic and Bahnaric languages of Vietnam).[6] Many SE Asian languages (e.g. Burmese, Tamang [Nepal]) have complex systems that are ambiguous as to which is the primary prosodic parameter, tone (pitch/contour) or phonation type. Diffloth has discovered MK systems with as many as 4 registers (e.g. Thavung [Vietic], Chong [Pearic]), a number of oppositions comparable to what one finds in a typical tone system *proprement dit*. Diachronically a SE Asian language's prosodic system is as susceptible to outside influence and typological change as any other aspect of its phonology. Thus the originally atonal Austronesian languages of the Chamic group have developed dialects with register contrasts in Vietnam, and a dialect with a fullblown tonal system on the island of Hainan, as described by Graham Thurgood ("From atonal to tonal in Utsat").

Terrence S. Kaufman's "Tone phenomena in Meso-American languages from typological and diachronic perspectives" is a pioneering summation of what is known about tonogenesis in that part of the world. There are only 4 tonal Mayan languages (Yukateko, Mochó, S. Tzotzil, Uspanteko), but all OtoMangean languages are tonal. It appears that manner features of initial consonants (aspiration, fortition, preglottalization) have no tonogenetic effect in OtoMangean (OM), in sharp contrast to what we find in Asia; on the other hand, pOM syllable-final laryngeals (*-h and *-ʔ) disappeared, leading to LOW vs. HIGH tones, respectively (similarly to Asian developments). The modern final laryngeals (*-h and *-ʔ) in OM arose secondarily from the loss of pOM final spirants and stops, respectively. A prosodic dimension foreign to Asian tone languages is the OM rhythmic contrast between "ballistic" or "rapid-fade" syllables (deriving from *-h) and "controlled" or "slow-fade" syllables.

Three of the papers deal with the complex behavior of tone in the verbal morphology of African languages. To an outsider like me, African tone systems seem more straightforwardly susceptible to the autosegmental approach than East Asian ones, though even here it is apparently not always easy to decide among analytical alternatives within the theory. Farida Cassimjee and Charles W. Kisseberth raise a number of theoretical issues in their study of Mijikenda and Nguni ("The tonology of depressor consonants"), e.g. whether the displacement of

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[5]According to Diffloth, this latter use goes all the way back to Henry Sweet, though it has only gained wide currency since E.J.A.H. Henderson's "The main features of Cambodian pronunciation", BSOAS 14,149-74 (1952).

[6]Diffloth's term *registrogenesis* was coined by analogy to my own neologism, *tonogenesis* ("Glottal dissimilation and the Lahu high-rising tone: a tonogenetic case-study", JAOS 90.1.13-44 [1970]); an analogical formation with changed second constituent is Wayne Lea's *tonoexodus* (1973). Thus does terminology proliferate!

HIGH tones in verb paradigms is due to "spreading" or "shifting". Troi Carleton's "The tonology of Asante verbs" neatly demonstrates how an underlying 2-tone system is complicated by specifically African phenomena like downdrift and drop tone, along with assimilatory "spreads" from affixes with inherent tones of their own. Larry Hyman's paper, which concerns a high tone that assimilates rightwards across a low tone nasal prefix, also deals with tonal "spreads" and downsteps.

Martha Ratliff's "Form and function in tone languages" is an ambitious attempt to typologize the world's tone languages in terms of the degree to which they exploit prosodic contrasts for grammatical purposes. In "Type A" languages (with White Hmong taken as exemplar), the primary function of tone is lexical, with some relatively minor attitudinal and grammatical functions on the side. "Type B" languages (e.g. Kanuri of Africa) make major morphological uses of tone (derivation, inflection, demarcation of major form classes).[7] Ratliff concludes that polysyllabicity and the presence of segmental morphology seem to constitute a sufficient condition for the presence of type B tone functions.

Indeed, it is the *mono- vs. polysyllabicity of meaning-bearing units* which seems to be decisive in determining tonological typology -- in terms of the size of the tone-bearing unit, the functional load of prosodic contrasts, and the grammatical use to which tone is put. This Special Session did not include any papers specifically focussing on Tibeto-Burman (TB) tonology, which is too bad, since the great internal typological diversity of TB syllable structure ensures that TB "has it all" in terms of the full spectrum of prosodic systems.[8] The sprawling geographical extent of the TB family puts it in contact with both the Chinese and the Indian linguistic/cultural areas (which I like to call the *Sinosphere* and the *Indosphere*). The Sinospheric branches of TB (Loloish, Karenic, Baic) have monosyllabic morphemes, little morphology, and "omnisyllabic" tone systems of high functional load, where virtually every syllable is under one of a number of distinctive tones (as also in Tai, Hmong-Mien, and Vietnamese). At the other extreme are Indospheric languages with more elaborate morphology, and few monosyllabic words; these may lack prosodic contrasts altogether, or may have at most a rudimentary two-way contrast of low functional load between higher vs. lower pitch[9] or between clear and marked phonation types. All sorts of intermediate types exist as well. Some Himalayish TB languages (Tamang, Kham) have polysyllabic TBU's, so that tonal contrasts, while they have a relatively high functional load, are spread over two or more syllables, and it is hard to figure out the tone of a syllable in isolation. *Sesquisyllabic* ("syllable-and-a-half") TB languages like Jinghpaw (N. Burma) also occupy an intermediate position, with easily distinguished contrastive tones on all

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[7]Ratliff recognizes the intermediate status of the Mpi (S. Loloish) language, which has full lexical tone, but also separate sets of tones for nouns and verbs. This apparent paradox has resulted from the fusion of a vowel-initialled clitic that marked the citation form for verbs, which left a tonal effect as the sole remnant of its former presence.

[8]A recent attempt to formulate a unified diachronic theory of TB prosody is Alfons Weidert's *Tibeto-Burman Tonology* (1986). This brilliant though maddeningly disorganized book fails in its diachronic analysis, but presents the synchronic variety of TB prosodic systems with an impressive wealth of detail. See my forthcoming review in JAOS.

[9]These are similar to "pitch-accent" systems like that of Japanese.

roots, but many unstressed and tonally marginal prefixal syllables. The seeds of cyclical prosodic change are everywere observable in the tonogenetic hothouse of Tibeto-Burman -- some languages are acquiring tones, others are in the process of losing them; there are even cases (Tibetan, Qiang) where one and the same language now has both tonal and non-tonal dialects. In general tones multiply when consonantal contrasts are lost and/or a more analytic syntax is developing; tones decrease in systematic importance when fusions of adjacent syllables create new consonant combinations and a more synthetic syntax.

All the participants in the *Special Session on the Typology of Tone Systems* agree that the meeting was highly worthwhile -- a good start toward transcending our habitual analytical biases, so that we may eventually understand what is universal and what is area-specific in the prosodic systems of the languages of the world.

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Toward a Typology of Tone Sandhi

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Ohio State University

Pike (1948) distinguishes between contour tone languages ('contour system') and level tone languages ('register systems'), and observes that contour is basic in the former, derivative in the latter. Furthermore, each syllable carries only one tone in contour tone languages, but one or more than one tone in level tone languages. Such typological difference will be manifested in the tone sandhi processes found in tone languages. In this paper I develop a formal model of tone sandhi typology that captures Pike's insight.[1]

1 Hierarchical Structure of Tone

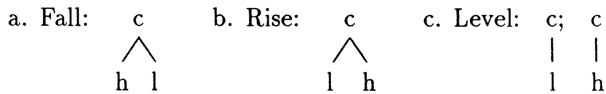
At the core of the model is the structure of tone. I assume that tone consists of register, which specifies the relative pitch range of the tone and interacts with voicing, and contour, which specifies the pitch contour within a given register. It is shown in (1).

(1) t ⟶ r c   t: tonal root node; r: register; c: contour

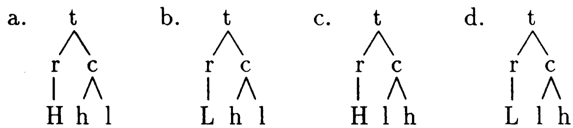
The structure is defended in Bao (1990a), and some of the sandhi processes that lend support to (1) will appear in this paper. Similar tone models have been proposed by a number of researchers, among them Hyman (1986, 1989), Inkelas (1987), Clements (1987), Yip (1989), Duanmu (1990) and Snider (1990). The register and contour will be specified with the features [stiff (vocal cords)] and [slack (vocal cords)] first proposed in Halle and Stevens (1971), as follows:

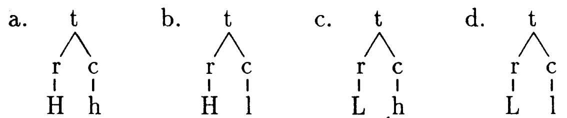
(2) r: H = [+stiff] L = [−stiff] c: h = [−slack] l = [+slack]

Following Yip (1980, 1989), I assume that the c node may branch, binary underlyingly. We thus have the following c node structures:

(3) 

All told, we have four contour tones (5) and four level tones (4):

(4) 

(5) 

[Stiff] and [slack] are functionally equivalent to [upper] and [raised] of Yip (1980,1989) and Pulleyblank (1986); to row 1 and row 2 of Clements (1989) and tonal root node and tonal node of Hyman (1989).

2 The Model

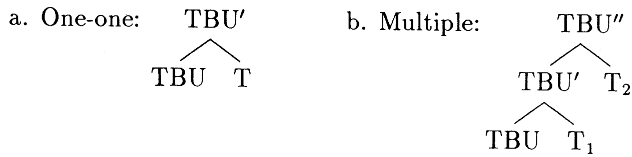
Tone languages may differ by the structure of tone they allow, and by the tone bearing unit (TBU) they choose. The model then consists of two parameters, TBU and Contour, as in (6), and a set of elementary operations, as in (7) (Clements 1989):

(6) a. TBU: prosodic categories such as mora, syllable, etc.
b. Contour: [+contour]: allows (3), i.e. tones in (4) and (5).
[−contour]: allows (3c), i.e. tones in (4).

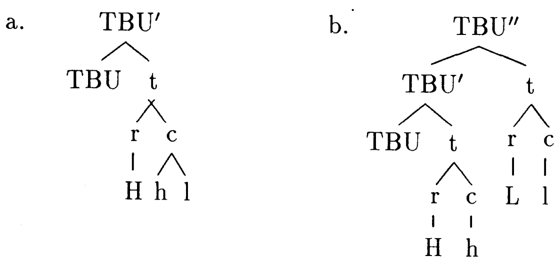
(7) Elementary Operations: spread, delink, permute, insert, etc.

Prosodic categories are the ones proposed in McCarthy and Prince (1986) and Pierrehumbert and Beckman (1989). In [+contour] languages, contour is encoded at c, internal to tone; in [−contour] languages contour is encoded at TBU, external to tone. I assume that the *Association Conventions* adjoin tone to TBU, creating structures shown in (8) (Bao 1990b, 1992); and there is no multiple encoding of contour: it is encoded either at c or TBU, but not both. The structure of High Fall in [+contour] languages is shown in (9a); that in [−contour] languages in (9b).

(8)



(9)



It has been observed that contour tones are distributed freely in contour tone languages, but not in level tone languages (Yip 1989). This follows from the model. If contour is encoded internal to tone, it is available underlyingly, prior to the operation of *Association Conventions*. This is not the case if contour is encoded at TBU, and derived through multiple association. With respect to tone sandhi processes, the model predicts that in [+contour] languages, rules may refer to contour (the c node), or be conditioned by contour; such rules do not exist in [−contour] languages. And in [+contour] languages, the overall pitch may change without change in contour. In what follows we will document the tone sandhi processes predicted by the proposed model.

3 Tone Sandhi Processes

3.1 Processes Affecting Tonal Root Node

The model predicts that in both types of language a tone may spread to a neighboring TBU. This is rather common in [−contour] languages (see, among others, Hyman and Schuh 1974). In Margi, for example, toneless suffixes assume the tone of the stem (Williams 1976, Pulleyblank 1986): *n`ərì* 'to tell a person'; *tsárí* 'to knock at'. Pulleyblank (1986) analyzes the facts in terms of the spreading rule shown in (10).

(10) Tone-spreading:

$$\begin{array}{lcl} V & & \boxed{V} \\ | & & \\ T & & \end{array}$$

The same phenomenon can be observed in [+contour] languages as well. In Changzhi, a Mandarin dialect of Chinese, the suffix *ti* assumes the tone of the adjectival stem to which it is suffixed, as shown by the data in (11) (Hou 1983, Bao 1990a, Yip 1992):[2]

(11)	suaŋ 213 ti 213	'sour'	yaŋ 535 ti 535	'soft'
	xuaŋ 24 ti 24	'yellow'	iŋ 53 ti 53	'hard'

The facts can be derived by Tone-spreading given in (10).

3.2 Processes Affecting Register

Processes affecting the register are more complex in [+contour] languages than in [−contour] languages, due to the complex tonal structure in the former. Consider register dissimilation in Luoyang, a Mandarin dialect. Luoyang has four lexical tones, 33, 31, 53 and 412. In sequences of two 53s, the first 53 lowers to 31: *iaŋ 53 ma 53 > iaŋ 31 ma 53* 'raise horses'; *lɔ 53 mi 53 > lɔ 31 mi 53* 'old rice' (He 1984, Bao 1990a). Such facts can be handled in terms of the register dissimilation rule in (12):

(12) Register Dissimilation: H → L / [__,hl] [H,hl]

Note that the contour is not affected by *Register Dissimilation*; it remains falling as the register switches from H to L.

Wuyi provides data which suggest register assimilation. Wuyi has eight citation tones, as follows (Fu 1984):

(13)		H	[−voiced]	L	[+voiced]	
	a.	24	sa 'raw'	213	za 'tailor'	*ping*
	b.	55	pu 'beach'	13	bu 'part'	*shang*
	c.	53	t'ia 'supreme'	31	dia 'big'	*qu*
	d.	5	foʔ 'duplicate'	<u>212</u>	voʔ 'cloth'	*ru*

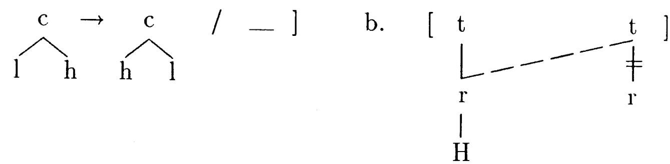
The H and L tones in (13) are derived from the same historical source, and H tones occur with voiceless initials, and L tones occur with voiced initials. In dissyllabic phrases with the tone melodies 24/213–24/213/53/31, we have the sandhi facts shown in (14):

(14)

	I	II	III	IV
	24	213	53	31
24	24–53	$\boxed{24–53}$	24–53	$\boxed{24–53}$
213	213–53	213–31	213–53	213–31

Observe that the rising tones 24/213 become falling when in phrase-final position (columns I and II). We can handle this fact with the rulle *Contour Change*, shown in (15a), which permutes the two branches of the c node. Observe further that low fall 31 in phrase final position is raised to high fall 53 when following high rise 24 (boxed patterns in columns I and IV). In other words, the low fall assimilates to the register of the preceding high rise. We account for this with the rule *Register Assimilation* shown in (15b).

(15) a.



As in Luoyang dissimilation, the contour remains unchanged.

One [−contour] language that displays register change is Mixteco, described and analyzed in Pike (1948), and in Goldsmith (1990) in the framework of autosegmental phonology. My analysis follows Pike's.

Mixteco has three surface tones, Hi, Mi and Lo. There are eight dissyllabic tone patterns in the language, shown in (16).

(16)

	Stable			Unstable	
1.	Hi-Hi	sana 'turkey'	5.	Mi-Mi	beʔe 'house'
2.	Hi-Mi	ñiʔi 'steam bath'	6.	Mi-Lo	kutu 'nose'
3.	Hi-Lo	baʔu 'coyote'	7.	Lo-Hi	suči 'child'
4.	Mi-Hi	kuči 'pig'	8.	Lo-Mi	mini 'puddle'

When preceded by a set of lexically determined, 'perturbing type' words, initial Mi or Lo of the unstable types are raised to Hi. For example, *sùčí* 'child' has the tone pattern Lo-Hi; but surfaces as Hi-Hi when following a perturbing word *kēē*: *kēē súčí* 'the child will eat'. Assuming that the tones have the structures as in (17a), we may derive the unstable types by *Register Raising* formulated in (17b):[3]

(17) a. Hi: [H,h] or [H,l] Mi: [L,h] Lo: [L,l]
b. L → H / W_p __ where W_p is a perturbing type word.

The two H-registered tones [H,h] and [H,l] are phonetically neutralized. The stability of Type 4 is not unexpected if we invoke the OCP. Note that Mi-Hi pattern has the structure [L,h]–[H,h], to which *Register Raising* would apply to derive the ill-formed [H,h]–[H,h]. The rule is blocked by the OCP computing identity on the tonal root node (cf. McCarthy 1986, Yip 1988 and references cited therein). By contrast, the pattern Lo-Hi has the structure [L,l]–[H,h], to which *Register Raising* applies to derive [H,l]–[H,h]. Hence Lo-Hi is unstable; Mi-Hi is stable.

3.3 Processes Affecting Contour

Contour in [+contour] languages may classify tones into natural classes. This can be seen in the sandhi behavior in Luoyang reduplication data, given in (18) (He 1984):

(18) a. gong 33 gong 3 'grandpa' b. kan 412 kan 3 'take a look'
c. yi 31 yi 33 'move' d. nai 53 nai 33 'grandma'

The tone on the first syllable is the base tone. Note that the second tone in (18a,b) are reduced to the so-called 'light tone', denoted by a single digit 3. By contrast, the two falling tones 31/53 become the mid level tone 33, rather than the light tone 3. The falling contour here serves as a natural class.

Perhaps the most interesting sandhi property involving contour is contour dissimilation, whereby a fall becomes rise; and rise becomes fall. Consider Zhenjiang, a Mandarin dialect. This language has four citation tones, 42, 31, 35 and 55. The two falling tones become rise 35 when preceding another falling tone (Zhang 1985). This process can be accounted for by the rule *Contour Change*, which permutes the two branches of a fall into a rise:

(19)
$$\begin{array}{ccccc} \text{c} & \longrightarrow & \text{c} & / \;\_\_ & \text{c} \\ \wedge & & \wedge & & \wedge \\ \text{h l} & & \text{l h} & & \text{h l} \end{array}$$

Contour tones in [+contour] languages may also be derived by rule. Consider Gao'an, another Mandarin dialect (Yan 1981). Gao'an has five citation tones: 55, 33, 11, 24 and 42. In this dialect, 55 becomes 53 when it precedes a 33 or 11: *siu 55 p'i 33* > *siu 53 p'i 33* 'repair', *ka 55 p'ɛi 11* > *ka 53 p'ɛi 11* 'double'. Assuming that the tones have the structures in (20a), the observed sandhi can be derived by the rule in (20b), which creates a fall contour:

(20) a. Tones: 55 [H,h]; 33 [H,l]; 11 [L,l]; 24 [L,lh]; 42 [L,lh]

b. Contour Formation:

```
c         c
h         l
```

Unlike [−contour] languages, contour tones are formed at the c node.

We have seen that contour tones in [+contour] languages may be underlying, or derived. In [−contour] languages, contour tones are derived, and their distribution is restricted (Yip 1989). We can see such phenonmenon in Margi (Williams 1976), Yoruba (Pulleyblank 1986), Keyang (Odden 1988), Kikuyu (Clements 1984), and Digo (Kisseberth 1984). Consider Digo, where contour tones occur on last two syllables of a phrase, derived through *Association Conventions* and Digo-specific rules. The derivation of *ku-fwinǐkâ* in (21) is due to Kisseberth (1984) (low tones are not marked):

```
(21) Underlying                    L   H   L
                                   $ku-fwinik-a$
     High Tone Displacement        L       H L
                                   $ku-fwinik-a$
     Association Conventions       L       H L
                                   $ku-fwinik-a$
     Leftwards High Spread         L       H L
                                   $ku-fwinik-a$
     Surface:                      ku-fwinǐkâ
```

One thing that is striking in [−contour] languages is the lack of sandhi processes which turn a fall to a rise, and vice versa (cf. Hyman and Schuh 1974), which are attested in [+contour] languages. This typological difference needs to be explained. One reason why contour dissimilation does not take place in [−contour] languages is due to the lack of applicable environment. Take Digo, where, as we have seen, *Association Conventions* and Digo-particular rules create a rise-fall sequence on the last two syllables of a phrase; but never a fall-fall (or rise-rise) sequence. Thus, in Digo contour dissimilation can not take place because its structural description is not met.

Perhaps the lack of contour dissimilation in [−contour] languages is due to some formal principle, rather than the accident of the rule system of a particular grammar. The intuitive idea towards an explanation is that the typological difference follows from the different formal mechanisms of encoding contour (see the structures in (9)). Suppose that the operation of permutation is so constrained as to apply to two nodes exhaustively dominated by a common node, then, in [−contour] languages the two tones forming a contour tone are not permutable, since they do not have a common mother node (cf. (9b)). By contrast, the two branches of a contour tone in [+contour] languages are permutable due to the fact that they have a common mother node, namely c (cf. (9a)).[4]

3.4 Prosodic Word as TBU

So far we have seen languages which take the syllable (by assumption) as TBU. Some languages may take a larger prosodic category as TBU. The Wu family of dialects typically have the following property: the entire phrase takes the shape of the first tone. Such languages include Shanghai (Zee and Maddieson 1979, Selkirk and Shen 1990) and Tangsic (Kennedy 1953, Leben 1980), and Grebo, which Newman (1986) shows to have phonemic contour tones, and yet exhibits some of the properties of Shanghai and Tangsic. Consider Tangsic (Kennedy 1953):

(22)	nyin 24 'man'		
	syao 51 'small'	tzong 33 'middle'	dhu 24 'large'
	syao-nyin 5001	tzong-nyin 3003	dhu-nyin 2004

The zeros indicate a graduate shift in pitch. Kennedy observes that the phrases surface with the tonal shape of the first tone. No further sandhi takes place. Suppose that Tangsic chooses the prosodic word ω as the TBU, *Association Conventions* adjoins tone to ω, creating the following structures:

(23)

ω'	ω'	ω'
ω [H,hl]	ω [L,h]	ω [L,lh]
syao nyin	tzong nyin	dhu nyin

The tone is realized over the entire tone bearing unit, which, in the case of Tangsic, is the entire phrase.

4 Conclusion

We have shown that some of the typological differences in sandhi processes are attributable to the parametric settings of tonal structure and tone bearing unit. The properties of tone sandhi in a language are determined in part by the structure of tone and by the prosodic category that the language chooses as TBU. We note that contour dissimilation is attested in [+contour] languages, but not in [−contour] languages, and explain the difference in terms of the formal mechanism of encoding contour. Furthermore, we note that register change may lower or raise a contour tone (such as 53 > 31 in Luoyang, cf. (12)); such process is not attested in [−contour] languages (Hyman and Schuh 1974). Again, this is due to the tonal structure: in [−contour] languages, contour tones are concatenations of level tones. Formally, register change of the start tone is not related to the end tone.

Notes

[1]I will ignore important issues concerning domains in which tone sandhi takes place. For this line of inquiry the reader is referred to Chen (1986, 1987), Selkirk and Shen (1990), and references cited there.

[2]When suffixed to a stem with the level tone 44, the suffix surfaces with its citation tone, 535. I assume that 44 is underlyingly unspecified, so *ti* assumes its citation tone when suffixed to the 44 stem. See Bao (1990a) and Yip (1992) for detailed analysis.

[3]Goldsmith (1990) assumes that perturbing words carry a lexically specified floating H, which spreads to the following Mi or Lo.

[4]Hyman and Tadadjeu (1976) and Pulleyblank (1986) discuss a rule in Dschang which metathesizes a HL sequence to LH, which surfaces as downstepped H (in some languages the metathesized sequence surfaces as a rise (Hyman, personal communication)). In the underlying sequence HL, L is floating. Therefore at the stage when metathesis takes place, there is no contour tone structure. This process is of different nature than contour dissimilation we saw in [+contour] languages.

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THE TONOLOGY OF ASANTE VERBS

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1. INTRODUCTION

The purpose of this paper in to present an autosegmental analysis of the tonal behavior in the Asante disyllabic verbs. Asante is a dialect of Akan, a Kwa language spoken in Ghana. The data I will be presenting comes primarily from Berry (1975), and is supplemented by data taken from Schachter and Fromkin (1968), and Dolphyne (1988) .

Disyllabic verbs in Asante fall into two major classes with respect to tonal behavior. These classes are completely predictable based on segmental information. Class I is marked by a medial sonorant, and Class II is marked by a medial obstruent. My central claim is that tonal alternations *between* the two classes of verbs can be explained entirely by segmental interference on tonal behavior, and that tonal alternations *within* the classes of verbs can be attributed to basic phenomena of tonal assimilation and tonal shift.

1.1 BACKGROUND

Let's begin by looking at some of the basic properties of the Asante tone system. Underlyingly, there are two basic tones in Akan — high and low. These tones contrast in all environments, as is illustrated in (1).

(1)	HH	pápá	"good(ness)"	LL	bɔ̀à'	"to help"
	LH	pàpá	"father"	LH	bɔ̀á	"to tell a lie"
	LL	pàpà	"fan"	L	bɔ̀	"chest"
	HL	pá:pà:	"to slap"	H	bɔ́	"stone"

Contour tones in Asante are not common. In fact, contour tones never surface in the verb system in lexical phonology[1]. They do, however, surface occasionally in other grammatical categories, such as nominals and adverbials (2). These contour tones are derived from the simple high and low tones in the underlying system.

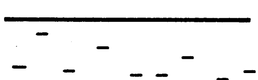
(2) a. me fíě "my house"

b. ɛ̂ "when"

When contour tones are are derived in the verbal system lexically, they always undergo simplification.

The phenomenon of downdrift plays a crucial role in the formulation of this analysis. The basic principle governing downdrift is that a H tone is lowered just in case it is preceded by a HL sequence. Conceivably, a long enough HLH sequence will render a H tone at the end of the sequence which is phonetically as low as a L tone at the beginning of a sequence. Consider the following example (Dolphyne, 1988,p.57).

(3)



pàpá Kɔ̀fí rèfrɛ nè bɛ́.
Papa Kofi is calling his child"

As we can see, the H tone in /papa/ is considerably higher than the H tone in /be/. The H tone in /be/ is actually level with, if not lower than the first L tone in /papa/. This phenomenon is often referred to as "automatic" downdrift since a L tone will automatically and always trigger the lowering of a following H tone.

Keeping this in mind, there is a third tonal contrast in Asante, namely the drop tone. The drop tone is higher than a L tone and lower than a H tone. The drop tone is derived from a H tone and surfaces only after another drop tone or after a H tone. It never surfaces phrase initially or after a low tone. The drop tone is a product of downstep. Downstep is often referred to in the literature as "non-automatic" downdrift. Like downdrift, downstep has the effect of lowering the pitch of a H tone relative to a preceding H tone. Unlike downdrift, however, there are no surface indications as to how this "down step" effect was triggered. This analysis assumes a H tone is lowered just in case it is preceded by a HL tonal sequence. However, the L in this sequence is not a surface L, it is floating.This follows Clements' and Ford's assertions on the drop tone with respect to Kikuyu (1979), namely that drop tones are always and only triggered by floating L tones . Drop tones in Asante are always derived and will be represented in this paper by "!" followed by a high tone. This analysis of the the drop tone is illustrated by the following contrasting pair.

(4)	a. mɛ́!bó	" my chest"
	b. ɔ̀bó	"the chest"

Notice that in both cases the nominal [bó] is H toned. The H of [bó]is dropped after [mɛ́] in (4a.). This correlates with the loss of [ɔ]. [ɔ̀] is a third person singular nominal marker which deletes *segmentally* before a possessive marker (which in this case is the first person singular [mɛ́], leaving the L tone floating). The drop tone in (4a.) is triggered by a floating L tone preceding [bó] "chest". Consider the following derivation.

(5)	/mɛ́ ɔ̀-bó/	
	mɛ́ ` bó	Segmental deletion
	[mɛ́ !bó]	

The floating L tone from the third person singular nominal marker is the trigger needed to instantiate "non-automatic" downdrift resulting in a drop tone . The bulk of this paper will focus on the distribution of drop tones in two classes of disyllabic verbs.

1.2 Disyllabic Verb Classes I and II

The two classes of verbs that this analysis concerns itself with are shown below in (6). What class a verb belongs to is entirely predictable based on segmental information. Class I verbs are characterized by either word medial sonorants, or no medial consonant whatsoever. Class II disyllabic verbs are characterized by a word medial obstruent. The distribution of drop tones in the inflected forms of these verbs is predictable with respect to their medial consonants.

(6)

Class I		Class II	
sane	"to untie or loosen"	pata	"to passify"
sore	"to get up"	kasa	"to speak"
gyae	"to stop"	posa	"to rub hands"
kae	'to remember"	didi	"to eat"

ware	"to marry"	hwete	"to scrape"
hini	"to shut the door"	tasa	"to gather"
dane	"to turn"	bisa	"to ask"

The inflected form of the verbs we will be looking at is characterized by the following template.

(7) Subject Concord Clitic + Aspect Prefix-Verb Root

In this analysis, the verbal word refers to only the aspect affix and the verb root. To most efficiently illustrate tonal behavior in Asante, we will only be considering verbs which are inflected for the 3rd person singular subject — namely, [wɔ́]

2. DATA AND ANALYSIS

In addressing the data, let us consider the tonal melodies of verbs inflected with L toned aspect markers. These forms are cited for you in (8) below.

(8)

L-TONE ASPECT	CLASS I	CLASS II
	/sane/ (to loosen)	/bisa/ (to ask)
a. Present Indicative	wɔ́- <u>sàné</u>	wɔ́-<u>bìsá</u>
b. Progressive	wɔ́- rè - <u>sàné</u>	wɔ́-rè-<u>bìsá</u>
c. Consecutive	wɔ́ - à - <u>sàné</u>	wɔ́-à-<u>bìsá</u>

Directing our attention first to the tonal melody associated with the verb roots in the above forms, notice that all six forms carry the same LH melody when preceded by a low tones aspect marker (the present indicative aspect morpheme is a floating L tone). In fact, it is the case that *any* disyllabic verb root inflected with low toned aspect prefixes will surface with a LH tonal melody. This generalization can be expanded further to include polysyllabic verbs, in general, as is shown in (9) below.

(9)

Verbs inflected for Aspect		Verbs Uninflected for Aspect	
i. wɔ́bìsá	"we ask"	i. bìsá	"ask"
ii. wɔ́bìsábìsà	"we ask (repeatedly)"	ii. bìsábìsà	"ask (repeatedly)"
iii.wɔ́bìsábìsàbìsà	"we ask (repeatedly)"	iii.bìsábìsàbìsà	"ask (repeatedly)"
iv. wɔ́pàtírì(w)	"we slip"	iv. pàtírì(w)	"to slip"

Each form has the LH melody associated with the first two syllables of the verb root. In (ii) and (iii) the verb roots are reduplicative forms, and in (iv) the verb root is trisyllabic. All syllables following the LH melody have L tones associated with them. The predictability of the tonal melody in polysyllabic verbs leads us to the preliminary analysis that these verbs are underspecified for tone in the in the underlying representation. This analysis asserts that a LH verbal morpheme associated to the verb root early on in the derivation, before aspect and subject affixes are introduced (for a more in depth discussion of the motivation behind this assertion, see Carleton, 1991).

The following set of data illustrating verb roots inflected with High toned aspect markers lends additional support to the proposal of a LH verbal melody associating to the verb root.

(10)

HIGH TONED ASPECT MARKER	CLASS I	CLASS II
	/sane/	/bisa/
a. Future I	wɔ́ - bɛ́ - !sáné	wɔ́-bɛ́-bí!sá
b. Perfect	wɔ́ -á- !sáné	wɔ́-á-!bísá
c. Future II	wɔ́ - rèbɛ̀ - sàné	wɔ́-rèbɛ̀-bí!sá

Notice that in every form except [wɔ́ - rèbɛ̀ - sàné] the verb root has a drop tone associated with it. The drop tone, by assumption, is derived from a High tone preceded by a floating L tone. The proposed LH verbal melody is ,hence, present in verbs inflected with H toned aspect markers , as well as those inflected with L toned aspect prefixes. In the case of L toned inflection, the L surfaces. With H toned inflections the L is floating.

Having addressed the background assumptions needed for this analysis, now let us consider the alternations, namely those associated verbs inflected with H toned aspect affixes, that this analysis will account for. In (10a) a drop tone is associated with the first syllable of the verb root in class I, and with the second syllable of the verb root in class II. This means there are different operations involved in the placement of the floating L. In (10b), again we have a drop tone on the first syllable of the verb root in Class I, but instead of a drop tone on the second syllable of the verb root in class II, like we saw in (10a), the drop tone shows up on the first syllable of the verb root. This is peculiar considering that surface environments look identical, namely , a H tone prefix precedes the verb root in both (10a) and (10b). Therefore, whatever operations determined the tonal patterns in (10a.), are not at work in (10b.). Finally, considering (10c) we find a third alternation. There is a simple LH melody associated with the class I verb root, and the prefix preceding is L toned. This may lead us to conclude that Future II belongs up in the L-toned aspect paradigm. However, we must abandon this premature conclusion when we look at the Future II in Class II verbs. Notice in (10c) that there is a drop tone on the second syllable of the Class II verb root , even though the prefix remains L toned. We know that drop tones are always derived in Asante, and we know that we can only derive drop tones in a *non-neutral* environment, namely, when we have high toned prefixes preceding the verb root. Hence, we must conclude that Future II belongs grouped with the H toned prefixes and, therefore, we must come up with a story to account for the surface L on the aspect affix.

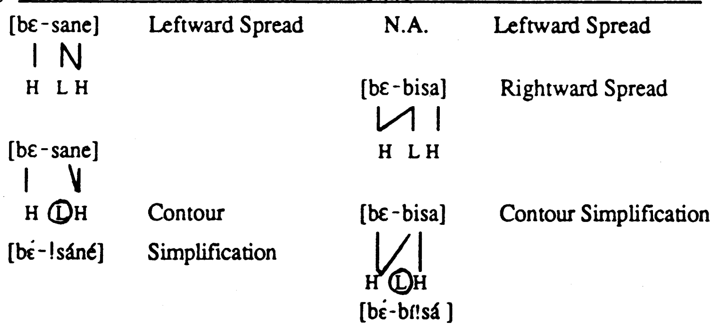
Before accounting for the alternations in the data set above, let's consider some of the generalizations that can be made about this data. 1. HLH melodies never surface in the verbal word. When a H prefix adjoins the LH verb root, the HLH sequence never makes it to the surface representation. 2) Class I verbs only have drop tones on the first syllable of the verb root or not at all. Class II verbs allow drop tones on both the second and first syllable of the verb root. With this in mind, let us first consider the Future I case in (10a) [wɔ́ - bɛ́ - !sáné] vs.[wɔ́-bɛ́-bí!sá] .

When the H aspect marker gloms onto the verb root, which is already assigned a LH melody, we get a HLH melody in the verbal word. We know that HLH never makes it to the surface representation. This, in addition to the fact that we have posited floating L tones in two different locations, depending upon the class of verbs, leads us to further posit two rules of H tone spread, one leftward, and one rightward. In doing so, the H spread will play a crucial role in eliminating the HLH sequence on the surface by creating either a LH or a HL contour tone. Since we already know that contour tones never surface in the verbal system, we posit a mirror image contour simplification rule which will delink the L tone from from any contour tone (e.g., HL or LH). Motivation for delinking the L tone comes from the fact that we previously posited a floating L in all of the forms (save Future II, Class I). We can control the location of the floating L tone with respect to the two different verb Classes by imposing constraints on the spread rules which prohibit leftward spread in class II verbs and condition leftward H tone spread in Class I. Rules 11-13 both eliminate the HLH sequence in the verbal word, as well as distinguish Class I from Class II by putting the floating L tones in the correct positions. These three rules, as well as the rest of the rules in this analysis are morphologically conditioned to apply only with in the verbal system, and more specifically are restricted to lexical phonology.

(11) Leftward Spread (12) Rightward Spread (13) Contour Simplification

Leftward Spread correctly predicts that given a HLH sequence, a H will spread leftward just in case if there is a medial consonant, it is a sonorant. If it is an obstruent, leftward spread will be blocked. In the event that leftward spread is blocked, rightward spread will kick in, spreading the H from the Aspect prefix onto the first syllable of the verb root. A mirror image contour simplification rule will delink the L form the derived contour. Consider the following examples.

(14) Class I / Class II



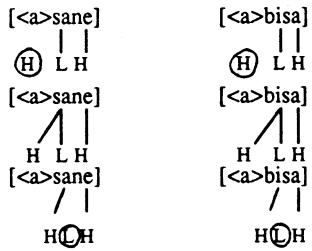
Leftward Spread insures a drop tone on the first syllable of the verb root, and rightward spread insures a drop tone on the second syllable of the verb root. Leftward Spread must be ordered before rightward spread, so that both forms don't get a drop tone on the second syllable of the verb root. Contour Simplification applies whenever the structural description is met so as to bleed rule (12). Therefore, it is a persistent rule with morphological conditions (for discussion of persistent rules, see Myers, 1991).

Turning now to the Perfect forms in (10b) [wɔ̀-á-!sáné] and [wɔ̀-á-!bísá], we must account for the fact that we have a drop tone on the first syllable of the verb root in class II [wɔ̀-á-!bísá]. The Spread rules above prohibit leftward spread across an obstruent, hence, there is a different process altogether which is taking place with these forms. In order to account for the Perfect, we begin by considering the aspect prefix . We posit that the H tone of the Aspect marker is realized on the first syllable of the verb root. If, in fact, it were realized on the aspect marker itself, then leftward spread would not be blocked and we would expect the same drop distribution in the perfect forms that we found in the Future I forms. Therefore, we must insure that the H tone does not associate to the aspect marker itself. In order to do this, we posit the following underlying representation for the perfect aspect affix.

(15) Perfect Aspect Affix

The perfect aspect marker consists of an extraprosodic segmental /a/ and an unassociated H. Extraprosodicity forces the H to associate to the right, in this case, onto the first syllable of the verb root in both classes. This rightward tonal shift has the same effect on the first syllable as a rightward spread. A contour tone is created on the first syllable. Contour simplification delinks the L leaving us with a drop on the second syllable of both verb roots. This is illustrated below.

(16)



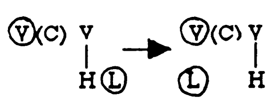
Association Convention

Contour Simplification

According to the surface representation of these forms, the floating L is missing from the stem, and unexpectedly appears on the prefix. By positing a Postcyclic rule of tonal metathesis, we can remove the floating L from between the two H tones, thus eliminating the drop tone on the second syllable, and place it before the verb root, resulting in a drop tone on the first syllable of both classes of verb roots. The rule and operation are cited below in (17) and (18).

(17)

Postcyclic Tonal Metathesis Rule



The rule tells us that if we have an unassociated vowel and a floating low tone separated by a linked H tone, the floating low tone will metathesize to the left. In the postcyclic stage of rule application in Asante, extraprosodicity is "turned off". The extraprosodic segmental portion of the perfect aspect affix is subject to rule application in the postcyclic stage. As we see in (18) (below) the structural description for metathesis is met. Metathesis allows us to address in one operation what would require two operations, namely a floating L tone deletion rule and a floating L tone insertion rule, in strict non-linear terms.

(18) Postcyclic Application

[a-sane]   [a-bisa]
H(L)H   H(L)H

[a-sane]   [a-bisa]   Metathesis Rule
(L) H H   (L) H H

It is assumed that OCP fusion will eliminate any OCP violations at the end of the derivation.

In the postcyclic stage, the perfect aspect is left unassociated for tone. Left as is, the principle of well-formedness will dictate that the floating L tone link to the unassociated vowel in the perfect aspect affix. In order to both prevent this from happening, and assure that vowel surfaces with a H tone, we posit that the affix receives its tone from the subject concord clitic during the postlexical stage of the derivation. A postlexical rule of H spread will insure that the toneless affix gets the H it needs. The rule responsible for this is cited in (19) below.

(19)

Postlexical H Spread Rule

H   H
V (V) → V V

Simply stated, this rule conditions H spread onto an unassociated adjacent vowel. Crucial to the application of this rule is that the unassociated vowel be directly adjacent to the vowel from which the spread will take place. That is to say, the structural description of this rule is not met if there is an intervening consonant. Note the following example.

(20) PostLexical Application

[wo-a-sane]   [wo-a-bisa]
H(L) H H   H(L) H H

[wo-a-sane]   [wo-a-bisa]   H Spread Rule
H(L) H H   H(L) H H
[wɔ́á!sáné]   [wɔ́á!bísá]

As we can see, when the Subject concord clitic adjoins postlexically, the structural description for the H spread is met, so we get H spread onto the aspect affix, rendering the correct surface representation for the forms in both classes of verbs.

Finally, we turn to the Future II in (10c),[wɔ̇-rèbɛ̀-sàné] vs.[wɔ̇-rèbɛ̀-bí!sá]. In order to account for the fact that the aspect marker surfaces L and that Class I verb roots surface with a LH melody, while Class II verb roots surface with a drop tone on the second syllable, we'll begin by directing our attention to the aspect marker and the Class II inflected form [wɔ̇-rèbɛ̀-bí!sá]. Since we have a H on the first syllable of the verb root, and a L on the aspect prefix, we posit that the H tone of the aspect prefix, like the perfect prefix, is realized on the first syllable of the verb root, thus suggesting a rightward tonal shift resulting from extraprosodicity. If the entire aspect melody shifts rightward, then we assert that the tonal melody associated with the disyllabic aspect prefix is LH, and that the first syllable of the prefix is extraprosodic. This explains the L tone associated with the second syllable of the prefix /bɛ/. Keeping all of this in mind, we posit the following as the underlying representation of the Future II aspect prefix.

(21) Future II Aspect Affix <re> bɛ
L H

In doing this, we can attribute the surface representation of the class II verb to the tonal association of the aspect prefix melody by convention. The L will associate to /bɛ/ and the H will associate to the first syllable of the verb root, creating a HL contour tone on the first syllable. Contour simplification will leave us with a L preceding the second syllable. See below.

(22) [<re>bɛ-sanel] [<re>bɛ-bisal] Association Convention
L HLH L HLH

[<re>bɛ-sanel] [<re>bɛ-bisal]
L H L H L H L H Contour Simplification

While the drop tone on the second syllable of the verb root in Class II is expected, it is unacceptable for the class I verbs to surface with a drop tone associated to the second syllable of the verb root. The surface representation suggests that the H tone on the first syllable of the verb root is eliminated altogether, thus eliminating the downstep effect on the second syllable. There are several alternatives as to how to eliminate the first H tone. None of them are terribly satisfactory. The alternative I choose to present here is a fair representative of the choices at hand.

(23)

Postcyclic H Tone Replacement

H → L / ___ L H
+son V

This rule replaces a H tone with a L tone just in case it precedes floating L followed by a H sonorant initial syllable. This is not terribly elegant, and we would hope to find a simpler way of dealing with this in future research. For the time being, it serves its functional purpose. It eliminates the drop tone associated with the second syllable of the verb root in Class I verbs. The example is cited below.

(24) [rebɛ-sanel] [rebɛ-bisal]
Postcyclic L H L H L H L H
[rebɛ-sanel] NA H-Tone Replacement
Rule
L L L H

Notice that the first syllable of the aspect affix is unassociated for tone once the extraprosodicity is turned off in the postcyclic stage of rule application. In the post lexical stage, when the subject concord clitic as adjoined to the verbal word, H tone spread is not applicable, because H tone spread can only occur within a syllable at the post lexical stage. Hence, for purposes of well-formedness, we introduce a L tone default rule, which will assign a L tone to any unassociated tonebearers at the end of a derivation. This rule is cited below in (25)

(25)

Postlexical L-Tone Default

$$V \rightarrow \underset{\substack{| \\ L}}{V} \;/\; V$$

(26) illustrates how this rule is applied.

(26)	[wo-rebɛ-sane]	[wo-rebɛ-bisa]	
PostLexical Application	H L L L H	H L H L H	
	[wo-rebɛ-sane]	[wo-rebɛ-bisa]	L-Tone Default
	H L L L H	H L L H L H	
	[wɔ́rèbɛ̀sàné]	[wɔ́rèbɛ̀bí!sá]	

We have now accounted for all of the stem melody alternations in disyllabic verb classes I and II, as well as the postlexical influence of the Subject Concord morpheme on the verb complex. We have done this by positing that the lexical phonology of Asante verbs needs both cyclic and postcyclic rules. In the cyclic component, we have posited two rules of H tone spread, which needed to be ordered, and one contour simplification rule. We need to posit cycles so that we can take advantage of extraprosodicity. This allows us to explain quite simply the propensity for tone shift. In the postcyclic component we have posited a metathesis rule, and a H tone replacement rule. We have also conditioned extraprosodicity not to hold status at the postcyclic level. In addition, we have shown how postlexical rule of spread can explain the second person subject concord behavior. Finally, remember that the lexical phonology involved in this analysis is morphologically governed and pertains specifically to the verbal system. Of particular interest in this data is the apparent sensitivity the tonal system shows with respect to segmental information. The sonorant/obstruent influence on the tonal behavior in this system merits further investigation.

APPENDIX 1

Future I Full Derivation:

Cyclic Application	[bɛ-sane]	[bɛ-bisa]	
	H L H	H L H	
	[bɛ-sane]	[bɛ-bisa]	Association Convention
	H L H	H L H	

	[bɛ-sane] H LH	NA	Leftward Spread
	NA	[bɛ-bisa] H LH	Rightward Spread
	[bɛ-sane] H L H	[bɛ-bisa] H L H	Contour Simplification
PostLexical Application	[wo-bɛ-sane] H H L H [wɔ̀-bɛ̀-!sáné]	[wo-bɛ-bisa] H H L H [wɔ̀-bɛ̀-bí!sá]	Nothing applies

Perfect Full Derivation:

Cyclic Application	/sane/ [<a>sane] H L H	/bisa/ [<a>bisa] H L H	
	[<a>sane] H LH	[<a>bisa] H LH	Association Convention
	[<a>sane] H L H	[<a>bisa] H L H	Contour Simplification
	NA	NA	Spread Rules
Postcyclic Application	[a-sane] H L H	[a-bisa] H L H	
	[a-sane] L H H	[a-bisa] L H H	Metathesis Rule
PostLexical Application	[wo-a-sane] H L H H	[wo-a-bisa] H L H H	
	[wo-a-sane] H L H H [wɔ̀á!sáné]	[wo-a-bisa] H L H H [wɔ̀á!bísá]	H Spread Rule

Future II Full Derivation:

Cyclic Application	[<re>bɛ-sane] L H L H	[<re>bɛ-bisa] L H L H	
	[<re>bɛ-sane] L H L H	[<re>bɛ-bisa] L H L H	Association Convention
	[<re>bɛ-sane] L H L H	[<re>bɛ-bisa] L H L H	Contour Simplification
	NA	NA	Spread Rules
Postcyclic Application	[rebɛ-sane] L H L H	[rebɛ-bisa] L H L H	
	NA	NA	Metathesis
	[rebɛ-sane] L L L H	NA	H-Tone Replacement Rule
PostLexical Application	[wo-rebɛ-sane] H L L L H	[wo-rebɛ-bisa] H L H L H	Association Convention
	NA	NA	Spread Rule
	[wo-rebɛ-sane] H L L L L H	[wo-rebɛ-bisa] H L L H L H	L-Tone Default Rule
	[wɔ́rɛ̀bɛ̀sàné]	[wɔ́rɛ̀bɛ̀bí!sá]	

ENDNOTES

1. While verbs in Asante do not generally have surface contour tones, verbs may allow contour tones to surface on the final vowel of the verb in certain syntactic and tonal environments postlexically. For example, if the verb is directly followed by an object of the right structural description a contour tone on the verb may surface. It is not within the scope of this paper to discuss this. For the purposes of this paper, it is sufficient to say that contour tones do not surface in the verb system *lexically*.

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The Tonology of Depressor Consonants:
Evidence from Mijikenda and Nguni

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1. Introduction.

Over the past few years we have been exploring the tonal structure of two different Bantu subgroups. Mijikenda constitutes one of these subgroups and Nguni the other.

Mijikenda consists of a group of nine closely related languages (Chichonyi, Chidigo, Chiduruma, Chidzihana, Chikambe, Chikauma, Chirabai, Chirihe, Kigiryama) spoken along the Eastern coast of Africa from around Malindi in Kenya down to Tanga on the northern coast of Tanzania. It is a member of the Sabaki branch of the North East Coastal Bantu family of languages, and as such is closely related to the Swahili language group.

Nguni languages are sometimes classified into two broad categories, namely the "Tekela" dialects and the "Zunda" dialects. The Tekela group includes Swati, Bhaca, Lala, Nhlangwini, Phuthi, and Sumayela Ndebele (=Northern Transvaal Ndebele). The Zunda dialects include such well-known languages as Zulu, Zimbabwean Ndebele, and Xhosa, as well as (perhaps) Ndundza Ndebele (=South Ndebele). Dialectal variation within Xhosa and Zulu is known to exist, but the tonal aspect of this variation has not been thoroughly studied. These languages belong to Zone S in the Guthrie classification, and thus seem to have no especially close link to the Mijikenda.

While our interest in these languages has quite independent origins, it has become clear that the juxtaposition of these two subgroups in our research has been fortunate indeed. For Mijikenda and Nguni both exhibit two phenomena that are of considerable theoretical interest: namely, the long-distance displacement of High tones from their point of origin (whether via a "spreading" or some sort of "shift" operation is an issue that we shall address) and a significant interaction between tone and a class of consonants that are generally referred to in the literature as "depressor" consonants. We shall demonstrate below that there are significant parallelisms between the Mijikenda and the Nguni tonological systems, although this parallelism is not necessarily immediately obvious.

Given the limitations of space, we will not be ably to fully justify many aspects of our analysis of Mijikenda and Nguni. Suffice it to say that the analysis presented here is based on a considerable body of data, and detailed presentations of these data will be forthcoming.

We will proceed as follows. First, we give a brief introduction to the theoretical issues we will be concerned with. Next we give an account of the central long-distance rule in Mijikenda and discuss its interaction with depressor consonants. The implications of this interaction for the theory of phonology are then examined. The same procedure is then followed for Nguni as well.

2. Theoretical issues.

The "displacement" of a High tone from one tone-bearing unit to some other tone-bearing unit has been a central topic in the development of the autosegmental theory of tone. Issues concerning such displacements include: is displacement linked to metrical structure, and if so, in what ways? is displacement accomplished by means of a spreading rule, or is it better viewed as the direct realignment of a High tone from one position in the representation to another? In what follows, we will assume that in both Mijikenda and Nguni, displacement is dependent on metrical structure, but we shall not pursue this in any detail here. Instead, we will focus on whether the displacement involves spreading or shifting.

The tonal behavior of so-called "depressor" consonants has not attracted the same amount of theoretical attention as the displacement of High tones. The term "depressor" consonant arose in connection with the description of Nguni languages, and these languages have provided some of the most striking examples of how consonants can interfere with the tonal pattern of a language. There are two closely related phenomena in Nguni languages that require the recognition of depressor consonants and which suggest some sort of identification of depressor consonants with low tones. We review these two phenomena below, though they are not the principle focus of our discussion of depressor consonants.

In Nguni, a High-toned syllable that has a depressor consonant in onset position is realized phonetically with a "lowering" of the tone in the initial portion of the syllable. This in general produces a surface rising tone (though we shall see below that in certain instances the phonetics may be somewhat different). We can illustrate this phenomenon by citing some examples from Siswati, a Nguni language spoken in Swaziland and in the Eastern Transvaal region of the Republic of South Africa. For instance, in most environments in Siswati, the infinitive prefix /ku/ is preceded by a floating High tone (originally part of a "preprefix" element); when the verb stem is toneless, this High tone docks on the antepenult syllable. In examples such as **ku-phocéle:la** 'to force, compel' and **ku-hlokólo:ta** 'to prod', the antepenult does not have a depressor onset and the syllable is pronounced with a level High tone. In **ku-vímbe:la**, however, the antepenult syllable begins with a depressor consonant and the High on that syllable has a distinctively rising character. (In our transcription of Siswati, we underline syllables that are "depressed"; in Siswati, any syllable beginning with a depressor consonant is depressed, but there are other depressed syllables as well.)

High-toned verb stems in Siswati ordinarily have a High tone associated with the first stem syllable (though in trisyllabic or longer stems, this High realigns to a following syllable -- see the final section of the paper for discussion). In examples such as **kú-sá:la** 'to remain', **kú-bé:ka** 'to put' and **kú-sé:nga** 'to milk', we see that the floating H of the infinitive construction links to the prefix while the stem H is linked to the first stem syllable (which is penult in the word and thus lengthened by a general penult lengthening rule in the language). In these examples, the first stem syllable does not have a depressor onset, and the High tone on this syllable is realized with a High tone that (in the speech of our consultant) has a gradual descent over the long vowel. In the dialect that we have studied, there is no downstepping between these two High tones. In examples such as **kú-v!ú:ka** 'to wake up' and **kú-dl!á:la** 'to play', on the other hand, the High on the first syllable of the stem is pronounced with a mainly level pitch. This level pitch is downstepped to a very considerable degree in comparison with the prefix High tone. Clearly, the depressor onset to this syllable is affecting the phonetic shape (turning a somewhat falling pitch into a level pitch) of the syllable by depressing the initial stages of the tone. The downstepping is also a reflection of the essentially low nature of depressor consonants.

Effects such as these have been taken to suggest a close connection between depressor consonants and Low tone. The details of the formulation of this connection depend ultimately on one's theory of phonological representation. If one's theory permits tonal specifications on non-moraic consonants, then one might propose that (at some point in the derivation) a Low tone is associated with depressor consonants, and this Low tone spreads onto the following High-toned vowel, thus creating a rising tone on that vowel.

```
(1)   L H         L H
      | |         |\|
      C V   ==>   C V
```

If one were to adopt a position that tones **cannot** be linked directly to consonants, then one would have to develop a proposal whereby depressor consonants **induce** the introduction of a Low tone into the tonal tier (and link that tone to the moraic element following the depressor consonant).

In some Nguni languages (including Siswati) there is another phenomenon that is connected to this rising tone. When a High syllable with a depressor onset is followed by a (non-final) syllable that does not have a depressor onset, then the High tone spreads onto that syllable (and delinks from the depressed syllable). If the syllable that the High spreads to is short, then that syllable is simply realized with a High tone. If the syllables is long (i.e. is a lengthened penult syllable), then the syllables is realized with a very distinctive falling tone (quite different from the gradually descending High tone on non-depressed penult syllables discussed above).

Consider the following examples from Siswati: **ku-vimbetê:la** 'to trap' and **ku-vikê:la** 'to doge'. These examples involve toneless verb stems in the infinitive. Ordinarily, the floating H tone of the preprefix associates to the antepenult syllable of the word. But the antepenultimate syllable here has a depressor onset. We do not find a rising tone on this syllable, but instead find that this syllable is low and the following syllable (the lengthened penult syllable) has a falling tone. The onset of the penult syllable here is not a depressor consonant. This example contrasts with **ku-vímbe:la** cited earlier, where the antepenult syllable has a rising tone (not indicated in the transcription) and there is no falling tone on the penultimate syllable. The reason of course is that in **ku-vímbe:la** the penultimate syllable has a depressor in onset position.

The examples in (2) below show more examples of the depressor-induced High tone shift. In the forms in the first column, there are no underlying High tones. In the second column, the subject prefix **ba** has an underlying High tone. This High tone would be expected to appear on the antepenult, but here the antepenult has a depressor onset, and we see the shift to the penult.

(2)	siyabongelana	bayabongelâna	(congratulate e.o.)
	ngiyabingelela	bayabingelêla	(greet)
	ngiyahlelembisisa	bayahlelembisîsa	(organize well)
	ngiyahlanganyela	bayahlanganyêla	(gang up)

The precise account of the process illustrated above again depends on the details of the phonological representation assumed. If skeletal positions are taken to be the tone-bearing units, then given the output structure in (1), we can account for this Depressor-Induced High Tone Spreading phenomenon by postulating a rule such as in (3):

```
(3)   L H
      \X\
       x  x
```

(where "x" stands for tone-bearing unit).

(We ignore here the details of how to explain why the lengthened syllable, when it receives the spreading of the H from the depressed syllable, develops into a falling tone. This matter is tangential to our concerns here.)

When the depressed syllable with a rising tone is followed by another depressed syllable, rule (3) will not be able to apply since its structural description is not met. Specifically, the tone-bearing unit with a LH sequence is not followed by an unassociated tone-bearing unit, but rather by a depressor consonant with a Low tone (or -- under the scenario where depressor consonants do not actually have a Low tone, but only induce a Low tone -- by a mora that has received a Low tone by inducement from the depressor consonant). The above phenomenon supports the connection between depressor consonants and Low tones in that it shows that the Low tone induced by depressors blocks rule (3) from applying.

We have discussed two examples that suggest a relationship between depressor consonants and Low tone. In one of these cases, the depressor consonant seems to prevent a spreading rule from applying. This indicates clearly that there is strong potential for interaction between rules of High tone displacement mentioned at the beginning of this section and depressor consonants. It is this interaction that we will focus on in the present paper, and the implications that this interaction has for (a) the question of whether long-distance displacement is by spreading or shifting and (b) the correctness of the claim that depressor consonants are linked to Low tones or induce Low tones on following morae and therefore necessarily block spreading of a High tone across them.

3. Mijikenda.

We assume that in the underlying structure of Mijikenda, only High tones are specified. Low tones do not occur. At some point, syllables that are not associated to High will receive a default Low tone specification.

In Mijikenda, there is overwhelming evidence that a (pre-penultimate) High tone is attracted to the penultimate syllable of the representation. We believe that this attraction-to-the-penult is actually a case of attraction-to-accent, i.e. we believe that the penultimate syllable is metrically prominent and that a High tone located earlier in the word is attracted to this prominence (rather than to the penultimate syllable as such). There is much about the details of this process that we will not go into here -- specifically, we ignore the complications that arise when more than one High tone appears underlyingly in a representation.

One place where we can clearly see attraction-to-accent in Mijikenda is in the present tense form of the verb. Verb stems are of two tonal types in Mijikenda (as in many other Bantu languages). One type has an underlyingly High tone in its structure. The other type has no tonal specifications. The present tense form of the verb consists of a prefix marking the subject, a tense marker /na/, and the verb stem. The verb stem ends in the final vowel /a/. In the present tense, first and second perfect subject prefixes do not have a High tone, while third person subject prefixes do. The tense marker /na/ does not contribute a High tone to the representation. Verb stems are either High-toned or toneless, and the final vowel contributes no tone to the representation. In (3) below we illustrate toneless verb stems. (The nine Mijikenda languages are abbreviated as follows: Ch=Chichonyi, Di=Chidigo, Du=Chiduruma, Dz=Chidzihana, Gi=Kigiryama, Kam=Chikambe, Kau=Chikauma, Ra=Chirabai, Ri=Chirihe. The acute mark over a vowel indicates a High tone. In Chidigo, a High tone which in other dialects is linked to the penult surfaces as a rising-falling sequence over the last two syllables if the final syllable does not have a depressor onset. This phenomenon represents another case of depressor consonants blocking the local spread of a High tone, but we do not explore this matter here.)

(4) ni-na-rima [Ch,Di,Du,Dz,Gi,Kam,Ra] n-a-rima [Kau,Ri] (cultivate)
yu-na-ríma [Du,Dz,Kam] a-na-ríma [Ch,Gi,Ra] a-na-r`ímâ [Di] w-a-ríma [Kau,Ri]

ni-na-sukuma [Ch,Di,Du,Dz,Gi,Kam,Ra] n-a-sukuma [Kau,Ri] (push)
yu-na-sukúma [Du,Dz,Kam] a-na-sukúma [Ch,Gi,Ra] a-na-suk`úmâ [Di] w-a-sukúma [Kau,Ri]

ni-na-sonjerera [Ch,Dz,Kam] ni-na-sengerera [Di,Du] ni-na-songerera [Gi,Ra]
n-a-songerera [Ri] n-a-sonjerera [Kau] (approach)

yu-na-sonjeréra [Dz,Kam] yu-na-sengeréra [Du] a-na-sonjeréra [Ch] a-na-senger`érâ [Di]
a-na-songeréra [Gi,Ra] w-a-songeréra [Ri] w-a-sonjeréra [Kau]

If we examine these data, there is a very clear pattern. The verb stems in the above data do not have any inherent High tone. The tense/aspect prefix (/na/ or /a/, depending on dialect) also does not have any inherent High tone. There is a contrast in the subject prefixes however: first person subject prefixes have no High, but third person subject prefixes do. The High tone that is contributed by the third person subject prefixes does not however appear on the surface associated to that prefix. Rather, the High tone appears on the penult syllable of the word (in Chidigo, the fact that the penultimate syllable is the target is obscured, since in the examples above the High tone surfaces as a rising-falling pattern over the last two syllables; in our discussion, we will largely ignore this phonetic complication in Chidigo, though it is of relevance to point out that when the penult in Chidigo is followed by an ultimate syllable that has a depressor onset, then the penultimate High shows up as such).

Assuming that it is the metrical prominence of the penultimate syllable that attracts the High tone to that syllable, the most pressing question that we face is the following: does the High tone spread to the metrically prominent syllable, or does it shift (realign) to that syllable?

If Attraction-to-Accent involves the spreading of a High tone to the penult, then we must assume that there is also a rule of Delinking, which would be formulated somewhat as in (5):

(5) H

xx (iterative, left-to-right)

In a shifting analysis, the High tone would never associate to tone-bearing units located between the point of origin of the High tone and the metrically prominent syllable. It would leap to the penult, and in the process disassociate from its point of origin.

Given the data in (4) we have no basis for choosing between a two-step operation of spreading and subsequent delinking and a one-step operation of shifting the H tone. Critical evidence will be developed below.

Attraction-to-Accent crosses the consonants that we are going to argue are depressor consonants in Mijikenda – namely, the set of voiced oral obstruents (note that prenasalized stops in Mijikenda are not depressors, in contrast to the Nguni languages dealt with later).

We find the following data in seven of the nine Mijikenda languages.

(6) ni-na-gula [Ch,Di,Du,Dz,Gi,Kam,Ra] n-a-gula (buy)
yu-na-gúla [Du,Dz,Kam] a-na-gúla [Ch,Gi,Ra] a-na-g`úlâ [Di]

ni-na-jitha [Ch,Di,Du,Dz,Kam,Ra] ni-na-githa [Gi] (cook)
yu-na-jítha [Du,Dz,Kam] a-na-jítha [Ch,Ra] a-na-gítha [Gi] a-na-ʃ`íthâ [Di]

ni-na-galuka [Ch,Di,Du,Dz,Gi,Kam,Ra] (change)
yu-na-galúka [Dz,Du,Kam] a-na-galúka [Ch,Gi,Ra] a-na-gal`úkâ [Di]

ni-na-lagula [Ch,Di,Du,Dz,Gi,Kam,Ra] (treat medically)
yu-na-lagúla [Du,Dz,Kam] a-na-lagúla [Ch,Gi,Ra] a-na-lag`úlâ [Di]

ni-na-rejeza [Du,Dz] ni-na-regeza [Ch,Di,Kam,Ra] ni-na-regezha [Gi] (loosen)
yu-na-rejéza [Du,Dz] yu-na-regéza [Kam] a-na-regéza [Ch,Di,Ra] a-na-regézha [Gi]

We have of course not yet given any evidence that the voiced obstruents are indeed depressor consonants in these seven Mijikenda languages. Assume for now that such evidence can be provided. The issue then confronting us is this: does the ability of a H tone to spread/shift past the depressor consonants in the data above pose any difficulty for the proposition that depressor consonants are associated with a Low tone at some point in the derivation? The answer is of course "not necessarily", since we could assume that spreading/shift takes place before the assignment of Low tones to depressor consonants (but this would require some explicit ordering).

If we follow the shift analysis, the story of the above data is over – that is, we simply assume shift occurs before depressor consonants receive their Low tone, and thus the surface results are guaranteed. If we follow the spreading analysis, we must also consider the relationship of Low-Insertion to Delink. If Delink occurs before Low-Insertion, of course all is well. If Delink occurs after Low-Insertion, then Low-Insertion would be creating a structure where association lines cross and the issue would have to be addressed as to whether rules such as Low-Insertion can yield violations of the No-Crossing of Association Line Principle and if so what is done to "repair" the violations.

In Chikauma and Chirihe we find more interesting data.

(7)	n-a-gula [Kau,Ri]	w-á-g!úla [Kau,Ri]
	n-a-jitha [Kau,Ri]	w-á-j!ítha [Kau,Ri]
	n-a-galuka [Kau,Ri]	w-á-gal!úka [Kau,Ri]
	n-a-lagula [Kau,Ri]	w-a-lág!úla [Kau,Ri]
	n-a-rejeza [Kau,Ri]	w-a-réj!éza [Kau,Ri]

How are we to explain these data? There is a single H tone in the UR. This High tone clearly spreads/shifts to the penult. But there is a High tone located in front of each depressor consonant in the path between the point of origin of the H tone and the metrically prominent syllable (in the examples in (3) there is only one depressor consonant in the path; below we will see cases where two, three or more are possible). How are these "spurious" High tones to be explained?

These spurious High tones appear only in the presence of an underlying High tone and only on the path between the point of origin of the High tone and its final landing site on the penult. The spurious Highs must then in some way derive from the association of the underlying High to the relevant syllables. The explanation for these data clearly then must derive from the spreading of the underlying High tone from its point of origin to the penultimate syllable. The shift analysis must be wrong, because in the shift analysis there is no point at which the underlying High is ever associated with the syllables where the spurious Highs appear.

But if the origin of the spurious High tones derives from the spreading of a (single) High tone, then we must assume that somehow this underlying High tone undergoes (in just these cases) a process of fission whereby it is decomposed into two (or more, see below) High tones. What remains to be explained is the precise nature of this fission. Before developing our account of fission, we need to demonstrate in a little more detail additional evidence concerning fission.

In (7) we saw cases where a depressor consonant in the verb stem induces fission. An object prefix with a depressor consonant will have a similar effect:

(8) nakufugula, naBafugula, nazifugula [Kau] (untie)
wanifúg!úla, wázif!úg!úla [Kau]

nakusonjerera, naBasonjerera, nazisonjerera [Kau] (approach)
wanisonjeréra, wázisonjer!éra [Kau]

nakutsukula, naBatsukula, nazitsukula [Kau]
wanitsukúla, waBatsukúla, wázitsuk!úla [Kau]

In these data we see that a H tone is anchored to each syllable that (a) is in the path from the original site of a H tone to the penultimate syllable and (b) is followed by a syllable with a depressor onset. The examples cited contain in some cases one spurious High tone, in other cases two spurious High tones.

High-toned verb stems in Mijikenda provide additional evidence for the general occurrence of fission in Chikauma and Chirihe (in contrast to the other seven languages). It can be argued that in Mijikenda, as in many Bantu languages, High-toned verb stems have an unassociated High tone in their underlying structure which is mapped onto the first syllable of the stem. However, the High tone that is linked to the first syllable will then undergo Attraction-to-Accent and spread to the penultimate syllable. In (9a) we give examples where there are no depressor consonants in non-final syllables in the stem; in (9b) we give examples where there is a depressor consonant in the onset to the first stem syllable; in (9c) we give examples where there is a depressor consonant between the first and the penultimate syllable. (We have just cited two other dialects, Ch and Dz, in comparison with Kau and Ri. Ch and Dz are representative of the other dialects as well.)

(9)	(a)	ni-na-rísa [Ch,Dz]	n-a-rísa [Kau,Ri]	(feed)
		ni-na-lála [Ch,Dz]	n-a-lála [Kau,Ri]	(sleep)
		ni-na-hiríka [Ch,Dz]	n-a-hiríka [Kau,Ri]	(send)
		ni-na-kalánga [Ch,Dz]	n-a-kalánga [Kau,Ri]	(fry)
		ni-na-kalangíra [Ch,Dz]	n-a-kalangíra [Kau,Ri]	(fry for)
	(b)	ni-na-vúndza [Ch,Dz]	n-a-vúndza [Kau,Ri]	(break)
		ni-na-vyála [Ch,Dz]	n-a-vyála [Kau,Ri]	(give birth)
	(c)	ni-na-hegúla [Ch,Dz]	n-a-hég!úla [Kau,Ri]	(take s.t. off cooking stones)
		ni-na-subútu [Ch,Dz]	n-a-súb!útu [Kau,Ri]	(dare)
		ni-na-galagála [Ch,Dz]	n-a-galág!ála [Kau,Ri]	(toss and turn)

These data show that fission occurs inside the High verb stem in Chikauma and Chirihe, but not in the other seven languages; however, fission occurs only in front of a depressor consonant that is on the path between the first stem syllable and the penult syllable. In other words, the facts concerning fission support the position that the High tone in these verb stems originates on the first stem syllable and spreads to the penult syllable.

Additional evidence for fission can be derived from the phrasal tonology of Mijikenda. The Attraction-to-Accent rule is actually a rule that applies not just at the word level, but also at a phrasal level. In particular, if a word with a H tone in its underlying structure is followed by a toneless word, then the H of the first word will realign to the penultimate syllable of the second word.

In the following examples, the verb has an underlying H verb stem and the following noun is toneless underlyingly.

(10) n -a-rya nyáma [Ri] 'I am eating meat'
n-a-ona chi-faránga [Ri] 'I see a chick'
n-a-ona ngúwo [Ri] 'I see clothes'

These data indicate that Attraction-to-Accent (and Delinking) operate between words.

In (11) we show examples where a depressor consonant is on the path between the point of origin of the High tone in the verb and the penultimate syllable of the following noun.

(11) ni-na-ona mu-gánga [Ch] 'I see a doctor'
ni-na-ona déthe [Ch] 'I see a valley'
vs.
n-a-ona mú-g!ánga [Kau,Ri]
n-a-oná d!éthe [Kau,Ri]

yu-na-gula ngúwo [Ch] '(s)he is buying clothes'
vs.
w-á-gula ng!úwo [Kau,Ri]

yu-na-jitha nyáma [Ch] '(s)he is cooking meat'
vs.
w-á-jitha ny!áma [Kau,Ri]

In general the data in (11) simply reflect the fact that Chikauma and Chirihe have fission under the conditions that we have already spelled out. Specifically, we see that in **n-a-ona mú-g!ánga**, there is a depressor consonant in the noun that stands between the High verb stem and the penult syllable, thus we find a High tone both on mu and the penult of the noun. In **w-á-jitha ny!áma**, we find a depressor consonant in the verb between the High subject prefix and the penult of the noun, thus we find a High tone on **wa** as well as on the penult of the noun. The Ch data illustrate the fact that the other languages do not have fission and thus there is only a High tone on the penult of the noun. [It is interesting to note however that Chidigo also shows a more limited form of fission. It is only at the phrasal level, and the spurious High only shows up in front of a depressor in the ultimate syllable of a word. We do not attempt here to deal with this example.]

Having given considerable motivation for fission, let us look closely at exactly how it ought to be explained. In particular, let us consider more explicitly the relationship between fission and the analysis of depressor consonants as being associated with Low tones. Let us consider two scenarios. Under the first scenario, Low tones have not been assigned to depressor consonants at the point where Attraction-to-Accent applies. In a case such as **w-á-zi-f!úg!úla**, then, the output of Attraction-to-Accent will be:

(12) H
w-a-zi-fugula

Given such a representation, if the next rule to apply is the rule inserting Low tones on depressor consonants (and if this rule places the Low tones on the same tier as the High tone), we immediately face a dilemma. Where do we place the Low tones for /z/ and /g/? in front of the H? after the H? both in front and after? Not only is the placement of the Lows relative to the H indeterminate, but the result (wherever we locate the Low tones) is an ill-formed representation, since association lines will be crossing. [If Delinking were to apply before the insertion of Low tones, of course, we would derive the correct form for the other seven languages, but not for Chikauma and Chirihe.]

Under the second scenario, the rule inserting Low tones on depressor consonants applies before Attraction-to-Accent. This means that Attraction-to-Accent must be permitted to spread a High tone to the penultimate syllable across depressor consonants (i.e. it must create violations of the No Crossing of Association Lines Principle). Under this scenario there is of course no question of where the Low tones in w-á-zi-f!úg!úla are located relative to the underlying High tone (they are to the right of that High tone).

(13)
```
H L   L
w-a-zi-fugula
```

Under either scenario, the result however is that an inadmissible representation has been constructed. If we assume that inadmissible structures may be derived by rules but must be immediately repaired, then we can immediately see that fission is a possible repair strategy. Specifically, suppose that a possible repair strategy is that in (14) below:

(14) *Maintenance of Association Lines Strategy* (=MALS)

> Retain all the linkages (between a given syllable and H tone) specified in the representation but make the minimal modifications to satisfy the No-Crossing Principle.

The minimal way in which syllables can continue to be associated with a High tone but have no crossing of association lines is for the underlying High tone to undergo fission.

(15)
```
HL HLH
w-a-zi-fugula
```

Of course, MALS does not immediately yield the correct surface form. The rule of Delinking will have to apply to the output of Fission to delink all but the rightmost syllable in a High-span (i.e. in a sequence of syllables all linked to the same High tone). The representation in (15) will undergo Delinking, resulting in the representation shown in (16).

(16)
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HL HLH
w-a-zi-fugula
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The correct surface form follows from a general principle whereby a HLH sequence always results in the downstepping of the second H.

Let us summarize. (i) The phenomenon of fission in Chikauma and Chirihe provides evidence that Attraction-to-Accent is a spreading phenomenon. (ii) It is clear that the joint result of Attraction-to-Accent and the assignment of Low tones to depressor consonants is a representation that violates some principle (since fission can only be understood as somehow the result of the incompatibility of these two rules). (iii) If we assume that the Low tones associated with depressor consonants are on the same tier as High tones, then the representational incompatibility is the crossing of association lines. (iv) The surface fission of the underlying High tone can be interpreted as the result of a particular repair strategy: the Maintenance of Association Lines Principle.

Up until this point we have focused our attention on Chikauma and Chirihe, the two Mijikenda languages which very clearly have fission as a repair strategy. Let us now turn our attention briefly to the other Mijikenda languages. All the languages show evidence that the voiced oral obstruents are depressors. We will cite just one set of data to illustrate this point, and space will not permit us to discuss the full range of issues raised by this data set. Consider the following examples of High verb stems in the present tense. In (17), we illustrate the behavior of verb stems that do not have a voiced oral obstruent in the onset to the first syllable.

(17) ninalála, yunalâla [Du] (sleep)
ninalála, yunálâla [Dz]
ninalála, analâla [Di,Gi]
ninalála, analála [Ra]
niṅalála, análâla [Ch]
ninalála, yunálála [Ka]
nalála, wálâla [Kau,Ri]

ninakalánga, yunakàlánga [Du] (fry)
ninakalánga, yunakálânga [Dz]
ninakalánga, yunákalánga [Kam]
ninakal`ángâ, anakálángâ [Di]
ninakalánga, anakálânga [Ch]
ninakalánga, anakálánga [Ra]
ninakalánga, anakál!ánga [Gi]
nakalánga, wakálânga [Kau,Ri]

Notice that in the first person case, there is just the underlying High tone of the verb stem, and this High tone spreads to the penult syllable as described earlier. The third person forms, on the other hand, involve two underlying High tones: one that originates on the third person subject prefix and another that originates in the verb stem. There is considerable variation as to precisely what happens in this situation, and it would take us too far afield to work out the precise rules for each language. It is important to note, however, that in general the prefixal H spreads/shifts to the first stem syllable.

(18) below shows that when the verb stem begins with a voiced oral obstruent a different tone pattern emerges: the prefix H fails to get into the verb stem.

(18) ninavúndza (other languages) navúndza [Kau,Ri] (break)
yunáv!úndza/anáv!úndza (other languages) wáv!úndza [Kau,Ri]

ninagalagála (other languages) nagalág!ála [Kau,Ri] (toss and turn)
yunágalag!ála/anágalag!ála (other languages) wágal!ág!ála [Kau,Ri]

The failure of the H of the prefix to spread/shift into the stem in (18) is clear evidence that voiced oral obstruents in all Mijikenda languages have "depressor"-type effects.

But if all of the Mijikenda languages do assign a Low tone to depressor consonants, then we must also provide an account of those languages where we do not find fission as a result of Attraction-to-Accent. There are of course various possibilities: perhaps Attraction-to-Accent is really a shift operation in these languages and a spread operation in Chikauma and Chirihe; perhaps Attraction-to-

Accent and Delinking are ordered prior to the insertion of Low tones on depressor consonants; perhaps the answer lies in the typology of repair strategies.

We cannot go into a proper exploration of the possible explanations for the lack of fission in the other seven Mijikenda languages, for it would require us to engage in a more extended analysis of the complex body of Mijikenda tonology than there is space for here. But it should be obvious that the Mijikenda system is an especially fertile area for trying to come to grips with the interplay between long-distance tone rules and depressor consonants.

4. Nguni.

Is Mijikenda an isolated case? A close look at Nguni reveals that in fact fission also occurs in Nguni, although the result is somewhat different from the Mijikenda case. We have not yet surveyed all of the Nguni languages, and will confine our discussion here to one of the Nguni languages, Siswati. There are however parallels in other varieties (e.g. our research has found parallels in Xhosa and Rycroft's work on Zimbabwean Ndebele reveals additional affinities).

We will assume an analysis of Siswati whereby only High tones are specified in underlying representations. Low tones will be introduced by default onto all morae that are not linked to a High tone (following the operation of the tonological rules of the language). Verb stems in Siswati are either toneless or have a H tone that links initially to the first stem mora. In certain tenses there is a tonal contrast between first and second person subject markers which are toneless and third person subject markers which have a H tone associated to them.

In Siswati, as in Nguni in general, there is a rule that has the result that a pre-antepenultimate H is attracted to the antepenult syllable in certain verb tenses. We will again assume that this is a case of attraction of a H tone to a metrically prominent syllable, but we do not undertake to develop the details of such an analysis here since it is beyond the immediate concerns of this paper. We call this rule Attraction-to-Accent for ease of reference. We illustrate the process in Siswati by citing the present tense form of toneless verb stems and comparing first person and third person forms.

(19)	ngi-ya-ba:la	ba-yá-ba:la	(write)
	ngi-ya-laye:la	ba-ya-láye:la	(order)
	ngi-ya-tsele:ka	ba-ya-tséle:ka	(pour in)
	ngi-ya-liba:la	ba-ya-líba:la	(forget)
	ngi-ya-tsikame:ta	ba-ya-tsikáme:ta	(disturb)
	si-ya-tselela:na	ba-ya-tseléla:na	(pour for e.o.)
	ngi-ya-gobondze:la	bayagobóndze:la	(bend)
	ngi-ya-gilikidze:la	bayagilikídze:la	(stumble)

From these data, we can see that in the first person forms, the verb is entirely low-toned. This is because none of the morphological elements making up the first person form has a High tone underlyingly. On the other hand, the third person forms show that the High tone contributed by the third person subject prefix realigns itself to the antepenultimate syllable.

One essential question that must be addressed in analyzing the above data is the following: is Attraction-to-Accent a spreading rule or a shifting rule? Examination of the data in (19) does not immediately give any indication of what the appropriate analysis might be.

There is powerful evidence that Attraction-to-Accent is a spread rule in Siswati. Consider the following data from High-toned verb stems.

(20)	ngiyafí:hla	bayáfí:hla	(hide)
	ngiyabó:na	bayábó:na	(see)
	ngiyabuyí:sa	bayábúyí:sa	(return)
	ngiyasebé:nta	bayásébé:nta	(work)
	ngiyabulá:la	bayábúlá:la	(kill)
	ngiyapheléli:sa	bayáphéléli:sa	(complete s.t.)
	ngiyakhuléke:la	bayákhúléke:la	(call out s.o.'s name)
	ngiyafinyéle:la	bayáfínyéle:la	(reach)

Consider the first person data first. Notice that in bisyllabic High verbs, the H tone is associated to the first stem syllable; in trisyllabic stems, the H is associated to the second stem syllable; in longer stems, the H is always on the antepenultimate syllable. We assume that the High tone of these stems is initially linked to the first stem syllable. In the longer cases, it is realigned to the antepenult by Attraction-to-Accent. Without going into the details of the analysis, we believe that even the trisyllabic cases – where the High tone realigns to the penult – are properly subsumed under the same Attraction-to-Accent process.

Now consider the third person forms. Notice that the High tone contributed by the third person subject prefix is not realized on the subject prefix, but on the next syllable to the right (the prefix /ya/ that characterizes the present tense when the present tense form of the verb is phrase-final). In a full treatment of the metrical structure of Siswati, we would claim that this realignment of the subject H to /ya/ is also a reflection of an appropriately expanded Attraction-to-Accent rule. But what is of concern to us is the following observation: all of the syllables starting from the beginning of the verb stem up to the place where the stem High realigns are realized with a High tone. Thus we do not find *bayáfinyéle:la but rather bayáfínyéle:la. How are we to account for the fact that the initial stem syllable is raised? We cannot postulate a rule in Siswati that raises a low syllable between two High tones, since there are very clear counterexamples to such a hypothetical rule.

The answer we suggest is the following. The High tone of the stem initially links to the first stem syllable. Attraction-to-Accent ultimately spreads this High to the right. The result is a multiply-linked High structure that we will refer to as a High-span. A High-span ordinarily undergoes the rule of Delinking, with all but the last element in the High-span being delinked. However, the data in (20) above suggest that Delinking is applicable only if the High-span is preceded by a Low tone or no tone whatsoever. A preceding High tone **protects** a High-span from Delinking. Under this analysis, in a word such as bayáfínyéle:la there are two High-spans. The first High-span is a H linked to the subject prefix that has also spread to the /ya/ prefix. The second High-span is a H linked to the first stem syllable that has also spread to the antepenultimate syllable. The first H-span is unprotected, thus the syllable on the left branch is delinked. The second H-span is protected and no delinking occurs. We thus get the correct surface form.

There is additional evidence that Attraction-to-Accent produces High-spans and that High-spans are protected by a preceding High. Recall our analysis of the third person form of toneless verb stems in the present tense. We claimed that the High of the subject prefix is realigned to the antepenult via Attraction-to-Accent. Let us now consider such verb forms when they are located after the word ngi-tsi-té.... 'I said...' (which has an alternative form ngi-tsi-tée....).

(21) ngi-tsi-té ú-yá-lîba:la 'I said he is being forgetful'
(cf. ngi-tsi-tée u-ya-lîba:la)

ngi-tsi-té bá-yá-tséle:ka 'I said they are arriving in full force'
(cf. ngi-tsi-tée ba-ya-tséle:ka)

ngi-tsi-té bá-yá-tséléla:na 'I said they are pouring for one another'
(cf. ngi-tsi-tée ba-ya-tseléla:na)

ngi-tsi-té bá-yá-tsándze:la 'I said they are winding s.t. around'
(cf. ngi-tsi-tée ba-ya-tsándze:la)

Notice that when the **ngi-tsi-tée...** form is used, then the following verb shows a High only on the syllable to which the prefix H realigns in the isolation form. But when **ngi-tsi-té...** is used, then all of the syllables of the verb beginning from the subject prefix up to the point of realignment are High-toned. This is understandable if the syllables from the subject prefix to the point of realignment are all members of a High-span created by Attraction-to-Accent, and the H at the end of the preceding word is serving to protect that High-span.

Let us now consider depressor consonants. It is clear that the Attraction-to-Accent rule crosses depressor consonoants in Siswati (we have already discussed in section 1 the evidence that there are depressor consonants in Siswati).

(22)	ngiyavaleli:sa	bayavaléli:sa	(bid farewell)
	siyabongela:na	bayabongelâ:na	(congratulate e.o.)
	ngiyabingele:la	bayabingelê:la	(greet)
	ngiyahlelembisi:sa	bayahlelembisî:sa	(organize well)
	ngiyahlanganye:la	bayahlanganyê:la	(gang up)

In these data we see that the H tone that originates in the subject prefix has realigned to the right of a depressor consonant onto the antepenultimate syllable. In the event that the depressor consonant happens to be the onset of the antepenultimate syllable, the additional shift of the High to the following syllable discussed in section 1 occurs.

The High tone that is initially linked to the first stem syllable of a High verb stem is also able to cross a depressor consonant.

(23) ngi-ya-gcugcú:ta 'I am urging'
ngi-ya-phambanî:sa 'I am confusing'

We have so far established that Attraction-to-Accent crosses depressor consonants. Let us now consider cases where the High-span that occurs across a depressor consonant is in a protected environment. We will study two structures. First, we look at third person forms of High verb stems where the verb stem contains a depressor consonant. Consider first bisyllabic stems.

(24)	ngiyazú:la	bayáz!ú:la	wander
	ngiyavú:na	bayáv!ú:na	harvest

Here the verb stem H is singly-linked (i.e. there is no High-span). A depressor consonant occurs between the H-span over the prefixes and the H of the verb stem. Notice that there is a downstep between these two High tones. This is a direct effect of the depressor consonant (cf. forms such as **ba-yá-bó:na** where there is no downstep between the prefix H-span and the H of the verb stem).

(25)	ngiyazintí:la	bayázint!í:la	hit hard
	ngiyavungú:la	bayávung!ú:la	pick the teeth

Notice that here the prefixal H does not protect the High-span in the verb stem. The reason should be clear. The depressor consonant is associated to a Low tone (or induces a Low tone) and thus prevents the protection from occurring (since the High span in the verb will not be immediately adjacent to a H in the prefix).

Consider some additional data:

(26)	ngiyatjengí:sa	bayátjeng!í:sa	show
	ngiyatingé:la	bayáting!é:la	hunt

These data are quite interesting because we see that a H-span that has a depressor consonant in its interior cannot be protected by a preceding H tone. The H-span with an internal depressor consonant apparently constitutes a well-formedness violation. This violation is repaired by a rule we will refer to simply as Repair Delinking.

(27) Repair Delinking:

In a H-span with an internal depressor consonant, delink all but the final syllable in the span.

Repair Delinking is not blocked by the presence of a preceding H tone.

The Siswati story is however more complex. Let us next look at cases where ngi-tsi-té... protects a verb form with an underlying H on the subject prefix and no other High tone in its structure.

(28) ngi-tsi-té bá-yá-gucû:la 'I said they are changing'
(cf. ngitsitée bayagucû:la)

ngi-tsi-té ú-yá-vuméla:na 'I said he is allowing people'
(cf. ngi-tsi-tée u-ya-vuméla:na)

ngi-tsi-té bá-yá-bongelâ:na'I said they are congratulating each other'
(cf. ngitsitée bayabongelâ:na)

ngi-tsi-té bá-yá-phendvulâ:na 'I said they are replying to each other'
(cf. ngitsitée bayaphendvulâ:na)

ngi-tsi-té bá-yá-hlelembisî:sa 'I said they are organizing very well'
(cf. ngitsitée ba-ya-hlelembisî:sa)

We see that when the H-span from the subject prefix up to the point of realignment in the verb stem is in a protected position (preceded by ngi-tsi-té...) fission does occur, yielding two High tones. The first H tone (actually a High-span) is over the prefixes. The second High tone is the one on the target of realignment (antepenultimate syllable).

We saw in our discussion of Mijikenda, a H-span with an "internal" depressor consonant (i.e. a depressor consonant that is onset to a mora located between the two morae that are the endpoints of the H-span) undergoes a fission process that, given x number of internal depressor consonants, yields x+1

High tones. In Siswati, on the other hand, an internal depressor consonant in a H-span is repaired differently. If the H-span is internal to a stem, Repair Delinking applies to remove the violation. If the H-span crosses a prefix-stem structure, then the H bifurcates into two H-spans: the first over the prefixes and the second over the stem. The first H span will not contain a violation of well-formedness (there are no internal depressor consonants) and will not be affected by Repair Delinking. The second H-span in the stem will be subject to Repair Delinking.

But notice: the fission of a H in a H-span crossing prefixes and the stem is only in a protected environment. In an unprotected environment, we get forms without any High tones on the prefixes: **ngitsitée bayabongelâ:na**, not ***ba-yá-bongelâ:na**. What this means is that we adopt a fission repair strategy just in the event that the general Delinking rule does not solve the problem. The complex facts of Siswati thus require all of the principles listed in (29).

(29) Delinking
Fission of an offending H span (if it crosses a prefix-stem juncture)
Repair Delinking

We have demonstrated in this paper that High tones spread across depressor consonants, but that this results in a structure that offends apparently universal well-formedness condition that bars a depressor consonant internal to a High span. Repair Delinking may in some cases serve to eliminate the offending structure. But in other cases, Fission of the High tone seems to represent a possible repair strategy.

We do not wish to be understood as maintaining that the ill-formedness of a depressor consonant internal to a High-span is necessarily expressed in terms of a crossing of association lines. This represents one formalization. We suspect that the more appropriate formalizations may emerge (in terms of the "grounding" relationship between High tone and depressor consonants – see the work of Archangeli and Pulleyblank (in press). What is critical is that rules produce the offending structure in Mijikenda and Nguni, and the offending structures may be repaired by the fission of a feature.

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The Representation of Tone and the Parametric Variations of Tonal Systems*

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0. Introduction

This paper is concerned with two closely related topics: the phonological representation of tone, and the parametric differences across tonal systems. The first two sections are devoted to the representation of tone. Section One deals critically with a number of issues central to a model of tonal representation. Section Two presents an approach to tonal representation in which tone, like other "suprasegmentals", is anchored in the prosodic structure. This "prosodic" model is able to relate tone features to other prosodic features (e.g. features for stress, and intonation), and accounts for different types of tones through parameter-setting. Section Three discusses the representation of tones in a number of different types of tone systems, and the implications of the prosodic approach.

1. Issues of Theoretical Importance for a Model of Tonal Representation

Four issues, namely tonal natural classes, number and types of tones predicted by the geometry of tone features, relation of rhyme structure to tonal complexity, and tone-bearing unit (henceforth TBU) in relation to syllable structure, are taken to be central to a model of tonal representation. These four issues will each be discussed in the sections that follow.

1.1. Natural classes of tones:

Shih (1986) has argued that in a number of languages, tone sandhi are most straightforwardly formalized by natural classes based on the shape of the contour tones (Shih 1986:13-20). For example, in Zhangping, a Min dialect, six citation tones exhibit the following tone sandhi alternations (Shih 1986:18):

(1) a.

$$\left\{\begin{array}{c}[24]\\ [11]\\ [21]\\ [55]\end{array}\right\} \quad \text{--->} \quad \begin{array}{l}[33]/\_\_\_ \left\{\begin{array}{c}[24]\\ [11]\\ [55]\\ [53]\end{array}\right\} \\ \\ [55]/\_\_\_ \left\{\begin{array}{c}[31]\\ [21]\end{array}\right\}\end{array}$$

b. $\begin{array}{c}[31]\\ [53]\end{array}$ ---> [21]/___X (X: any tone)

(2) a.

$$[\text{-fall}] \quad \text{--->} \quad \begin{bmatrix}\alpha\text{mid}\\ \text{+level}\\ \text{-low}\end{bmatrix} / \_\_\_ [-\alpha\text{mid}]$$

b. [+fall] ---> [+low] /___X

The sandhi alternations exhibited in (1) are formulated by Shih into the rules in (2), which adopt the contour feature [fall] from Wang (1967). Tones in each natural class [-fall] and [+fall] then undergo different sandhi alternations accordingly.

The concept of "contour tone unit" (henceforth CTU) proposed by Yip (1989) is in accordance with the idea that contour tones of the Asian type often constitute natural classes based on the shape of the contour; i.e., rising tones (LH) in both upper and lower register ranges form a natural class, as do falling tones (HL). Although great differences exist between Yip's 1989 model and Wang's 1967 feature system in terms of the conceptual frameworks involved in tonal representation, the notion of CTU reflects the insight captured by the features [falling] and [rising] proposed by Wang in 1967. Models following the concept of "contour unit", including Yip (1989), and Bao (1989, 1990), are able to distinguish "contour" tones which are the result of the "clustering" of two tones (e.g. the African type), from those which truly form one unit (e.g. the Asian type) (Yip 1989). In contrast, models which take contour tones to be only the concatenation of two tones generally are incapable of making this distinction and are unable to classify "unitary" contour tones into natural classes.

1.2. Types and number of tones predicted by the geometry of tone features:

Bao's proposal (1989) of a "sister" relation between two tone features, which he called "register" and "contour," is most powerful in predicting the types of tonal assimilation (i.e. spread) which may occur in adjacent syllables. Unfortunately, there has so far been little evidence for the independent spread of contour as a unit. Until evidence comes forward in support of the spread of contour tone without also carrying over the register value, one will have to assume that Bao's model is too powerful.

As to how many tones a model of tonal representation must account for, there is still ongoing debate as to whether redundancy results in an overpowerful and thus less desirable model. Unlike Yip (1980, 1989), and Bao (1989, 1990), Duanmu's model (1990) allows three register heights, within which three-way pitch variations are provided.[1] With this provision, the model allows for 27 tonal contrasts within a tone system.[2] Hyman (1989) also provides for nine pitch contrasts, although it is not clear whether his model may apply to contour tones of the Asian type. It is obvious that both models permit many more pitch/tone contrasts than are found in attested tone systems and this raises doubts about them. Duanmu argues that only a small number of available segmental features is present in any language's phonology; therefore, the large capacity of his model does not result in any theoretical problems. However, unlike most segmental features, features for pitch (i.e. tone) are relative in nature, resembling features for vowel height. When so perceived, excessive contrasts may be a drawback for the model.

1.3. Rhyme structure and tonal complexity:

Duanmu's model differs from most other autosegmental approaches in that it attempts to relate the complexity of contour tones to rhyme structure, a relationship first advanced by Woo (1969), who proposed a moraic analysis of tone. Duanmu has incorporated Woo's insight and refuted a number of claims that contour tones are sometimes borne by short vowels, e.g. in languages such as Mende and Igbo. According to Duanmu, short vowels which allegedly bear contour tones in these languages, upon re-examination, are phonetically of a duration much longer than usual, which is just what the moraic analysis of contour tones predicts.[3] The relation between rhyme structure and tonal complexity explains why the complexity of contour tones in the world's languages is greatly constrained i.e. the most complex contour tone bears a contour shape consisting of no more than three digits by Chao's tone letters, the concave/convex type. Approaches which take the syllable to be the TBU cannot explain this close relation, and must assume that tonal components are simultaneously associated with the nuclear segment in the rhyme. The drawback of these approaches is that no theoretical constraint is available in the model to explain why extremely complex contour tones (e.g. [3141] falling-rising-falling) are unlikely to exist and are so far unattested

1.4. TBU and syllable structure:

There are two issues under discussion in this section, i.e. the nature of the TBU, and the syllable structure within a language. Following Clements' claim (1983) that TBU in many African languages is the mora, Duanmu (1990) takes this claim a step further and treats the mora as the universal TBU. However, in doing so, one factor, i.e. the syllable structure of the language, has to be taken into consideration in order for the tonal representation to work. Duanmu claims that all syllables in Chinese are bimoraic, and thus all potentially bear contour tones. According to him, the "checked" syllables, i.e. those with -p, t, k, or glottal stop endings, though acoustically shorter in duration than other syllables, are also bimoraic in structure, and may underlyingly bear contour tones. Unfortunately Duanmu cites only one example of the sandhi alternations of a "checked" tone in Taiwanese. More evidence is needed to support (or discredit) his claim that all Chinese syllables are underlyingly bimoraic.

To sum up, a satisfactory account of tonal representation must be able to deal with the four issues pointed out in the preceding sections. That is , a model of tonal representation must account for natural classes of tones, provide a sufficient but not overpowerful account in terms of the number and types of tones within a tone system, explain the close relation between rhyme structure and tonal complexity, and explore the relation between the nature of TBU and the syllable structure of the language. In addition, a satisfactory model also needs to specify the tone features involved, and the overall geometrical relationship of tone features to other features. In the sections which follow, I will attempt to put these issues in perspective, and present a new approach to tonal representation.

2. A New Approach

2.1. The paradoxical nature of TBU:

It has been proposed that the universal TBU is the mora (Duanmu 1990). In Duanmu's analysis, moras on the core (i.e. skeletal) tier are directly associated in a one-to-one fashion with the segments which carry tones, and no special provisions are needed to avoid violating the association conventions in autosegmental theory.[4] Moreover, since the relevant tone features are specified under the segments associated directly to moras, there is no need to provide for any processes which transfer the tone features borne by the entire rhyme into the feature arrays of the segment(s) in the rhyme. This point is illustrated by a comparison offered by Duanmu himself (reproduced from Footnote One on p.152):

(3) Comparison of two representations of the Mandarin word *man* [51] "slow" (with Register omitted):

```
a. Bao (1990)  m a n          b. Duanmu (1990)  m a n
                 \/                                 | \
               Rhyme                             Lar Lar
                 |                                |   |
            Vocal-cords                       Pitch Pitch
                 |                                |   |
              Vocalis                          [+H] [+L]
               /   \
           [-sl] [+sl]
```

In Duanmu's analysis, the tones are directly represented under the laryngeal nodes of <u>*a*</u> and <u>*n*</u>. In contrast, TBU in Bao's system is the rhyme as a whole, and the falling tone [51] is considered to be a CTU. It is not immediately clear how the tone may be physically realized on the segments in the rhyme. Bao has suggested a process of "segmentalization" which links the tone features to "the laryngeal node of the head of TBU" (Bao 1990:2). Plausible as it is, such a process is spared by Duanmu's moraic approach to TBU.

However, from a different perspective, it seems that the syllable is indispensable to the representation of tone. From the traditional treatment of tone as a "suprasegmental" property to the treatment of tone in "autosegmental" phonology (such as Goldsmith 1976, Leben 1978, and Yip 1980), there is no disputing that tone differs from segmental phonemes in its domain (i.e. larger-than-segment quality) and its ability to spread to adjacent syllables. The syllable is usually the level to which tonal spread, tonal reduplication, and natural classes of contour tones **must** refer. Even Duanmu, who argues extensively for the moraic TBU, cannot eliminate reference to the syllable.[5] Moreover, even though Duanmu argues that the analysis of whole tone spread (as in Yip 1989, 1991, and Bao 1989, 1990) may be replaced by tonal copying, this process nevertheless involves the reduplication of tone(s) at the **syllable** level. The pivotal status of the syllable in tonal processes is so compelling that attempts to restrict tonal representation exclusively to the domain of the mora are unlikely to have universal appeal unless the system also refers to the level of the syllable.

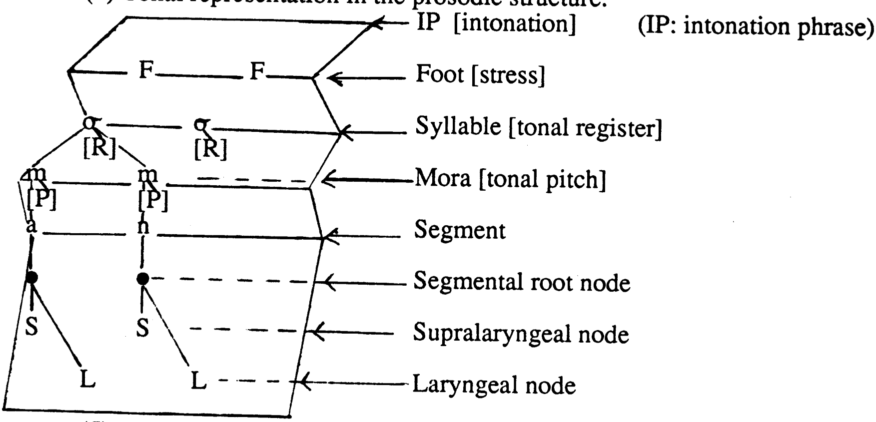
However, as noted already, if the TBU is the syllable (as in Yip's and Bao's models), there is no explanation for the close relation between rhyme structure and tonal complexity. It seems, then, that we are presented with a paradox. The resolution of this paradox, I would like to suggest, lies in a new way of perceiving tonal representation. Tone features, similar to other potential prosodic features for stress and intonation, are borne by relevant entities on the prosodic structure, instead of being directly included in the geometrical array of features linked to the laryngeal node of the tone-bearing segment. The following sections will provide details of this new approach.

2.2. Tone features as properties of the prosodic structure:

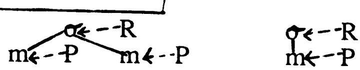
2.2.1. Tone features are prosodic features. We might ask whether tonal representation is simply a matter of the geometrical array of all relevant articulators and features. Although tones **must** be realized through the orchestration of articulators and features, which are in turn part of the feature geometry of the relevant segments, an approach which considers tonal representation to be nothing but a geometrical arrangement of features under the laryngeal nodes of relevant segments, in my opinion, has overlooked an important issue, i.e. the status of tone in the overall picture of phonology. The phonetic property of tone (i.e. "pitch") may be simplistically perceived as the variations of fundamental frequency within a domain (such as a syllable). Although the variations of fundamental frequency are mapped onto the vocalic segments, they are nevertheless not a **property** of the segments.[6] As a distinct property independent of the segments, tone not only often needs to refer to a higher level of the prosodic structure (e.g. the syllable), but it is also conceptually closer to prosodic elements such as stress, which has been analyzed on the basis of the prosodic (or metrical) structure, not in terms of the geometrical array of segmental features.

In this section, I will propose that tone is a property of the prosodic structure. Two prosodic levels, namely the syllable and the mora are pertinent to tone; tone features are borne by the entities on these two prosodic levels. This concept is illustrated in (4) and (5) below:

(4) Tonal representation in the prosodic structure:



(5)



(R: register; P: pitch)

2.2.2. The relation of tone features to other prosodic features. In the prosodic structure, all features relevant to the prosody of the language are present. In addition to features relevant to tone, prosodic features relevant to other traditionally-called "suprasegmentals" such as stress and intonation are also anchored at relevant prosodic levels. Although stress has long been analyzed on the basis of the metrical (i.e. prosodic) structure, the discussion of its **features** is almost nonexistent so far. Despite lingering uncertainty about the nature of the features involved in stress (e.g. loudness, pitch), one must assume the **existence**

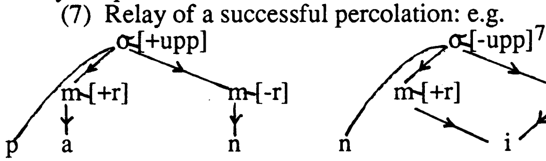
of such features if prosodic contrasts are to be realized in articulation. Furthermore, to some extent, prosodic features for intonation and stress may be similar (or the same in some cases) to those for tone. The difference lies mainly in the level at which the feature is anchored, and the process by which the prosodic units are realized. In this conceptual framework all potential prosodic features originate in their relevant levels within the prosodic structure, and are borne by elements on these levels such as syllable, mora, and foot.

2.2.3. The principle of percolation. In the approach proposed here, tonal representation consists of three inter-related processes. Structurally, tone has its root in the prosodic structure. Tone features, which are referred to as register and pitch features for the purpose of discussion here, are borne by syllables and moras on the relevant prosodic tiers. They then undergo the process of "percolation", which facilitates the coordination of all features into articulatory reality. In the execution of articulation, tone features must be geometrically arranged in the overall array of features. In this section, we propose a principle by which the percolation of prosodic features can be carried out. It is stated in (6) below:

(6) Principle of Percolation:
Prosodic features (e.g. tone features) at a certain level in the prosodic structure must percolate through elements on each subsequent level until they reach the laryngeal node under a segmental root node.

As stated in (6), percolation can be carried out only if a legitimate element is present **at each subsequent level**. I will henceforth refer to this prerequisite as a "relay" in percolation.

(7) Relay of a successful percolation: e.g.



(arrow indicates percolation)

In the example above, the register feature can percolate down to the moraic segments in the syllable but not to the onset, because no element is available at the mora level to carry out the percolation for the onset segment. Note that the requirement of relay in percolation also applies to the percolation of any potential features for stress and/or intonation, in which the percolation process must abide by language-specific rule(s) regarding how stress (or intonation) is assigned.

2.3. Tone features and the realization of tone:

2.3.1. How many tones should tone features provide? The two features Register (i.e. [upper]) and Tone (i.e. [raised]) proposed by Yip (1980) are perhaps the most widely adopted system of tone features to date. Feature systems consisting of two features along the line of Yip's are not only able to capture the register split which occurred historically in many Asian tone languages, but are also able to provide a highly plausible tonal inventory with only four level tones, two rising, and two falling tones. Except for a small number of languages which are reported to have five level tonal contrasts (Maddieson 1978:338), Yip's feature system seems to suffice to account for the great majority of the world's tonal systems.

However, these exceptions must be dealt with, because at least a few are not readily subject to alternative analyses which may reduce the number of contrasts (e.g. Black Miao and Tahua Yao). One candidate capable of accounting for five-level contrasts is the system proposed by Duanmu (1990). However, as mentioned in 1.2., Duanmu's system raises some question as to whether it is too powerful.

Yip (1980) suggested that a third feature such as Woo's [+/- modify] may be used to account for a tone system with five level contrasts. No detail, however, was given as to how the third feature could be added. In pre-autosegmental analyses, Woo's system (1969) accounts for five level tones by means of three features, i.e. [high], [low], and [modify]. By the feature [modify], she assumed that the frequency range of each tone is narrower in a five level tonal system than that in a three level tonal system. However, Maddieson (1978) showed that as the number of level pitch contrasts increases, so does the entire frequency range utilized by the language. Instead of [modify], Maddieson suggested a feature such as [extreme]; thus in Maddieson's view, a system of five pitch contrasts consists of the more common high, mid, and low tones, plus two more, the extremely high, and the extremely low tones.

I agree with Maddieson on the phonetic reality of the feature [+/- extreme]. However, I also accept Yip's feature Register, which nicely recapitulates the historical development of register split in Asian tonal systems. Moreover, Maddieson's feature system does not readily account for tonal systems with four level contrasts. That is, in a rather common system which contrasts four level tones, one of the tones has to be specified with [+extreme]; it is not clear as to how the feature values of these tones are determined.[8]

I believe that Yip's original feature system is basically on the right track, but it must also provide for five-level contrasts with the addition of a feature along the line of Maddieson's [extreme]. A tone feature system, I suggest, may include a feature for the binary distinction of register, a feature fine-tuning the register range, and a highly marked feature which allows for the extremity of either high or low pitch. I will return to discuss the exact nature of these features after examining the articulators involved in the realization of tone.

2.3.2. The physiology of tone. One of the recent concerns in proposals of tonal models is the phonetic reality of tonal representation. In order to develop a model which reflects the articulatory reality of tone features, a better understanding of the physiological aspect of tone is crucial.

Ohala (1973) has attempted to point out a number of physiological factors involved in achieving variation of pitch (i.e. fundamental frequency). In his words, "the F_0 [i.e. the fundamental frequency] of voice is determined basically by two partially independent factors: (a) the state of the vocal cords and (b) the aerodynamic forces driving the vocal cords." He further pinpointed the physiological makeup involved in these two factors. That is, changes of vocal cord tension or glottal configuration are made possible by the muscles attached to the larynx, including the cricothyroid muscles, as well as other muscles of the larynx such as the adductor muscles, and the extrinsic laryngeal muscles (Ohala 1973:4-6). In addition to factors such as the position of the tongue, elevation of the larynx, and voicing, which result in secondary variation of pitch, according to Ohala, most evidence seems to point to "the activity of the laryngeal muscles" to be "the primary force" behind all major linguistic pitch variations (p.5).

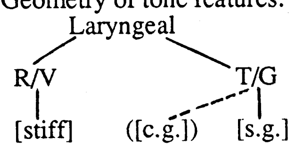
Both Duanmu (1990) and Bao (1990) have developed an articulator-based model. Bao suggests that the articulator for Register is the cricothyroid muscles, and that for Contour it is the vocalis muscle. Duanmu's view, on the other hand, is the opposite: to him, V/R in his system is likely to be related to the vocalis muscle, while Pitch is related to the cricothyroid muscles. In addition, Bao and Duanmu also disagree on the mechanisms involved in tonal variations. Bao considers the vocal cord tension to be the determinant for tonal variations in general. Duanmu considers the articulator V/R to be related to vocal cord tension, but the articulator Pitch to vocal cord thickness. It is not clear to me if their decisions on the articulators were based on precise phonetic evidence, or simply due to a theoretical need to correlate their proposed features to some plausible articulators in the realization of tone.

The physiology of tone appears to be a very complicated matter in reality, a matter perhaps so far not completely understood. It seems quite certain that the variation of pitch (i.e. the production of tone) closely involves the laryngeal muscles. In addition, it could be possible that tonal variations are accomplished through the coordination of a number of muscles intrinsically (and perhaps extrinsically) attached to the larynx such as the vocalis, and the cricothyroid muscles. As our current knowledge stands, the attempts to pinpoint the so-called "articulators" in relation to the tone features proposed for a tonal model are at best no more than speculative in nature. Such attempts serve more of a notational purpose than as a clear explanation of the physiology of tone.

In the discussion which follows, I will therefore consider the articulators in the tonal model as unspecified entities (which, however, are most likely to be related to the larynx. For the purpose of exposition, I will adopt some of the articulatory terms proposed by Duanmu; however, I basically take no position on the exact nature of the articulators involved in the tonal realization and leave this issue open for future investigation.

2.3.3. The geometry of tone features. In 2.3.1., I have pointed out that a tone model should provide for the rare cases of five-level contrasts, and at the same time, account for the register split so commonly seen in Asian tone systems. To facilitate this, I propose the following geometrical relation of tone features at the level of feature geometry:

(8) Geometry of tone features:[9]



R/V: register/voicing
T/G: tone/glottis
s.g.: spread glottis
c.g.: constricted glottis

The laryngeal features adopted here are used somewhat differently from Halle and Stevens' original proposal. For instance, Halle and Stevens used [spread glottis] and [constricted glottis] mainly for representing *h* and ʔ; however, these features are used here for the purpose of representing pitch distinctions. The reason for adopting these features (instead of creating a set of new features) is due to the close relationship between "phonation types" of segments (e.g. creaky voice vs. breathy voice), which are closely related to laryngeal states, and registral/tonal distinctions, as exhibited in many Southeast Asian languages (e.g. Mon-Khmer languages). The articulators in (8) are intended to indicate such a close relationship by correlating tonal register with voicing, and pitch with the glottal state of a segment, both of which are well documented by studies of tonogenesis in some Asian tone languages (e.g. Vietnamese and Chinese)[10].

Under normal circumstances, dominated by R/V and T/G are specifications of features [stiff vocal cords] and [spread glottis] respectively. In rare exceptional cases, a tier usually unspecified under T/G for the feature [constricted glottis] may be specified, provided that the feature [stiff] is also specified with the same value as that of [c.g.]. The close relation between [c.g.] and [stiff] may be captured by the concept of "enhancement" in feature geometry. The feature [stiff] under R/V **enhances** the feature [c.g.]; that is, [c.g.], which, under normal circumstances, is unspecified under the articulator T/G, is restricted by the cooccurrence of the feature [stiff] with the same value specification. Specifications of [c.g.] indicate a highly marked case, with extremely high or extremely low tone. (9) below illustrates how tones are represented by the features in this alternative:

(9)

[+stiff]/[-spread glottis]	Hh
[+stiff]/[+spread glottis]	Hl
[-stiff]/[-spread glottis]	Lh
[-stiff]/[+spread glottis]	Ll
[αstiff]/[αc.g.] [-αs.g.]	Hh↑/Ll↓ (marked)

Until a better physiological understanding of tone is available I will consider (8) an adequate model for tonal representation at the feature level, but underline the continuing uncertainty concerning the nature of articulators and features involved in the model.

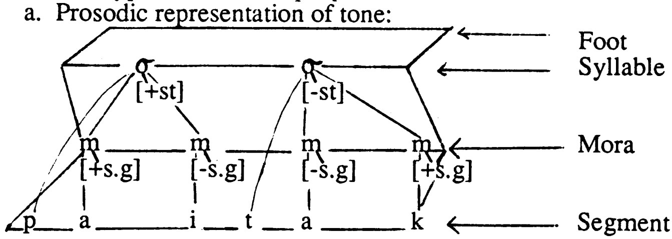
2.4. Summary of the new approach:

I have argued in this paper that tonal representation should be considered a part of the prosodic representation in phonology. In this global model of prosodic representation, all prosodic features originate at the relevant levels of the prosodic plane, and are borne by elements on these levels. Tone features, i.e. [+/- stiff] for register distinctions, and [+/- s.g.] for finer pitch distinctions, are borne by syllables and moras respectively. In the process of speech realization, prosodic features (e.g. tone features) percolate down to the segmental level according to the principle of percolation. The percolation process results in the geometrical arrangement of prosodic features under the laryngeal nodes of relevant segments; the geometrical array of all features then facilitates articulation.

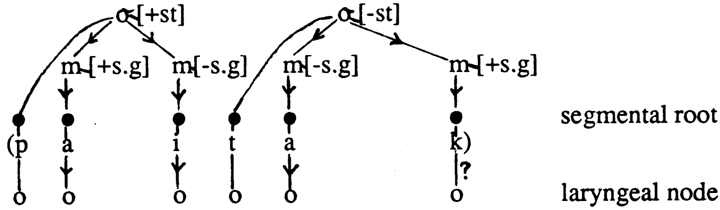
The three major stages regarding tonal representation are illustrated by the following example:

(10) A hypothetical example *pai* ^{35}-*tak* ^{3}:

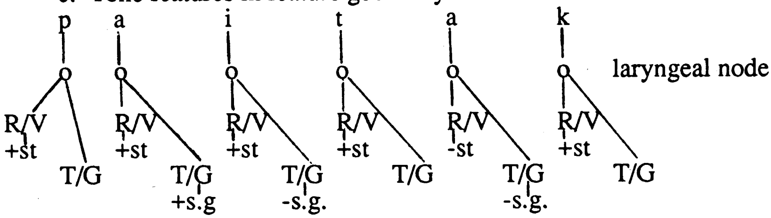
a. Prosodic representation of tone:



b. Percolation of tone features:



c. Tone features in feature geometry:[11]



In (10c) above, tone features are relayed by elements at each subsequent level; therefore, syllable onsets are unaffected by the percolation, since there is no element at the mora level to relay the register feature. In the case of the syllable coda in *tak*, although the percolation can be relayed by *k*, tone cannot be realized since the syllable coda is voiceless and unreleased. When percolation does not apply, the specifications (and unspecifications) of features depend on the voicing and the glottal states exhibited by the consonants.

3. Parametric Differences Across Tone Systems

3.1. Parameters for variation:

In the current approach, TBUs may consist of two levels: at a higher level, the feature for register distinction is borne by the syllables, while at a lower level, moras are the pitch-bearing units. Contour tones in Chinese languages are thus represented by a register specification at the syllable level and two pitch specifications at the mora level. The level(s) at which tonal representation occurs vary parametrically on the basis of the complexity of the tonal system and the syllable structure of the language. In systems where there are only two pitch contrasts, tonal specifications may occur at either the syllable or the mora level, resulting in different surface forms: specifications at the syllable level (i.e. H/L) result in only high/low pitch contrast among the syllables, while specifications at the mora level (i.e. h/l) may give rise to surface "contour" contrasts, depending on the syllable structure of the language. Tone systems which distinguish three-level pitch contrasts are trickier. The representation of the mid tone has two possibilities (i.e. Hl and Lh), and needs to be determined on the basis of the tone's behavior in the language; e.g., in Sicite (or Tagba), a Senufo language of Burkina Faso, although there are three surface level tones, the patterns of alternation of the mid tone suggest that it may be underlyingly represented by both possible configurations, i.e. Hl and Lh (Garber 1988). Tone systems which consist of four level pitch contrasts must be fully specified at both the syllable and the mora levels.

The current approach allows the spread of feature values at both the syllable and mora levels without interference between levels. In other words, register assimilation, pitch assimilation, and both register and pitch assimilations are predicted, but the spread of the entire contour tone (of the Asian type) is not.[12]

3.2. Implications of the Parametric Differences:

This approach provides a "parameterized" account of the differences which exist among tone languages in terms of the level(s) of tonal representation and the types of tonal spread. Moreover, the difference between nontonal and tonal languages is also captured by the proposed model of prosodic representation. That is, the difference between a nontonal language (such as English) and a tonal language (such as Luganda) does not necessarily lie in the absence/presence of tone feature(s), but in the level(s) (or prosodic planes) at which the relevant features are anchored.

To conclude, I have in this paper presented a view of tonal representation quite different in concept from most other previous proposals. The difference mainly lies in the following respect: tonal representation is considered to be part of the bigger scene of prosodic structure, but the realization of tone, nevertheless, must involve the geometrical arrangement of tone features at the segmental level. Future endeavors will have to work out some of the formal aspects of this model.

* I am grateful to Duanmu San and Bao Zhiming for discussing many issues with me. Thanks also go to Moira Yip for useful comments. I am solely responsible for any remaining errors.

1. Duanmu (p. c.) is now inclined to recognize only six level contrasts, which are marked by two register distinctions each with three pitch heights.

2. That is, if contour tones occur only in bimoraic syllables, as he claims. Moreover, this number is based on the assumption that contour tones do not cross register ranges. If there is no such constraint, the number is much larger (viz. 81).

3. The analysis of these vowels as short is due to either (1) a lack of contrastive vowel length in the language, or (2) the occurrence of contour tones pre-pausally.

4. Pulleyblank (1986) has formalized the Association Conventions governing the tone-mapping procedure as follows (1986:11):

"Map a sequence of tones onto a sequence of tone-bearing units,
(a) from left to right
(b) in a one-to-one relation."

5. To constrain his model of tonal representation, Duanmu has proposed two universal constraints as follows (1990:122):

a. Only segments in the rhyme (bearing a mora) can be assigned Pitch.
b. One Register per **syllable** (the emphasis is mine).

6. Except for some rare cases, tones are not determined by the quality of their bearers (i.e. vowels). This sets tone features apart from other features which also exhibit assimilation processes, such as nasal harmony and rounding harmony. In the latter cases, the features have their origins in the relevant segments (e.g.

[+nasal] is a property of a nasal segment); in contrast, tonal assignment in most cases is arbitrary and not related to vocalic qualities.

7. For convenience of discussion, I have adopted Yip's features for register and pitch: [+/-upp(er)] for the binary distinction of register range, and [+/-r(aised)] for the finer distinction of pitch heights within a register range.

8. The same criticism also applies to Woo's use of the three features [high], [low], and [modify].

9. For the phonetic definitions of the features [stiff vocal cords], [slack vocal cords], [spread glottis], and [constricted glottis], see Halle and Stevens (1971:201-2).

10. For a few representative works on tonogenesis, and discussion of "phonation" types in relation to tonogenesis, see Haudricourt (1954a and b), Mei (1970), Matisoff (1973), Thurgood (1980), and Diffloth (1989).

11. Note in (10c) that although the relay is successful in the case of the syllable coda of *tak* (i.e. following Duanmu who considers these "checked" syllables to be also bimoraic), there is some question as to whether tone features should be specified at the feature level, because the unreleased consonant coda is unable to realize the tone.

12. An argument for "whole tone" is presented by Yip on the basis of some data from Changzhi (see Yip's paper in this volume). However, a number of problems remain in the analysis of tone sandhi in Changzhi, and a discussion of these will have to wait for a different forum. More evidence of a less controversial nature is needed before any argument for "whole tone" spread can be established.

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TONE RULE TYPOLOGY

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1. Introduction

One question that has intrigued students of comparative tonology concerns the distribution of various types of tonal processes among different language groups. For instance, downstep, and spread/movement (both local and long distance) are commonplace among African languages, but unattested or highly restricted in Chinese and other SE Asian languages. On the other hand, melodic changes (e.g. rising → falling, or vice versa) and paradigmatic replacement of one tone by another that we see in many Chinese dialects must strike the Africanist as utterly alien. Are these distributional facts mere accidents, or do they reflect some deeper typological differences? For lack of space, I will confine myself to three topics: downstep, the syntagmatic processes of spread/movement, and metathesis or melodic inversion.

2. Downstep

As a purely intonational property, catathesis or declination is presumably universal, and occurs in Chinese, as suggested by instrumental evidence (cf. Shih, p.c.). On the other hand, the analog of the Bantu-type of downdrift and downstep, has thus far not been documented for Chinese or other SE Asian languages. Why?

First of all, downstep is typically the phonetic encoding of a floating L, as suggested by Clements and Ford 1979 among others. Floating tones are exceedingly rare among Chinese dialects. Granted, some have argued for floating H's as a derivational process morpheme in Cantonese and S.Min. But as far as I know, there has been no reliable report of floating L's anywhere in SE Asia. For this reason alone, we do not expect to find downstep among Chinese dialects.

But I have a hunch that there exists a deeper reason why downstep does not, in fact, *cannot* happen in Chinese. There is an ongoing debate whether tone has an internal geometry like (1a), as proposed by Yip 1989, or (1b) as advocated by Bao 1990. In Chen 1991b I argued in favor of (1a).

```
(1)  a.    x                 b.  r                x = TBU
           |                     |                r = register
           T        = r          T --- x          c = contour
          / \                    |                T = tone root
         t   t      = c          c                t = terminal tone
                                / \                   segment
                               t   t
```

Assuming (1a) to be the correct internal structure of tone, what would downstep look like, were it to take place at all in Chinese? The consensus among Africanists points to register spread as the mechanism underlying downstep. That being the case, downstep would be represented as (2). Interpreted in the conventional manner, (2) is identical to tone root spread. This means that the spreading of the L tone root takes whatever terminal nodes are under it "along for the ride". In other words, given the coplanar geometry of (1a), register cannot spread independently of melody. Therefore, to the extent that downstep is construed as register spread, it cannot occur as a process that is distinct in any way from whole-tone copy that has been documented in Changzhi, Danyang etc. To put it differently, tone copy is the functional equivalent of downstep in Chinese.

```
(2)  Downstep as        x   x           = TBU
     register           |  /|
     spread             | / |
                        L   H           = register (= tone root)
                       /\  /\
                      t t  t t          = contour
```

This account of the conspicuous absence of downstep in Chinese naturally raises the collateral question: How, then, is it possible for downstep to occur, as it does, in many Niger-Congo languages? One of the hallmarks of downstep is that it resets the register of all subsequent tones. This global effect is represented in (3). Notice that not only both the second and the third H's are lowered to pitch value 2, but the last L dips to level 4 by the same interval of two steps.

```
(3)  1  3  2   2  4        (1 = highest, 4 = lowest)
     H  L  !H  H  L
```

If we accept (1a) as the universal representation of tone, then how do we encode this global effect? Consistent with (1a), (3) calls for a representation like (4), in the spirit of Hyman (1986, 1989).

```
(4)  Coplanar downstep:  1  3  2  2  4
                         o  o  o  o  o        tone root
                         |  |  |  |  |
                         o  o  o  o  o        register tier
                         |  |
                         H  L  H  H  L        primary tier
```

The global effect of downstep in (4) is achieved by the multiple linkage of the L to the register of all subsequent Hs and L's. The representation of (4) poses a number of technical problems, the most obvious of which is the crossing of association lines. There are several logical alternatives, one of which is to put the register and the primary tiers on two separate planes, as in (5).

```
(5)   Multiplanar downstep:    1   3   2   2   4
                               H   L   H   H   L      primary tier
                               |   |   |   |   |
                               o   o   o   o   o      tone root
                                   +__/___/___/
                                   L                  register tier
```

Since the register tier is on a separate plane, it can spread to any number of tone roots, without creating cross-linkage. This is exactly the tack taken by Inkelas 1987, 1989 in her analysis of Tiv. Therefore, the answer to the collateral question seems to be this: Chinese has a coplanar geometry (1a). Accordingly, downstep equals tone copy. Bantu languages, on the other hand, have a multiplanar structure like (1b), which makes it possible for register to spread independently of the primary tier, creating the global effect characteristic of downstep, as shown in (5).

This kind of geometry-based typological explanation for the presence or absence of downstep I am proposing is not without *bona fide* precedent. Consider two hypothetical types of vowel harmony represented in a nutshell by (6a,b): the former attested in Menomini and Montañes,the latter in Yokuts and Mongolian.

```
(6)   a. bub-V   →   bub-i    (H-harmony independent of R/B)
      b. bub-V   →   bub-u    (H-harmony entails R/B-harmony)

      H,R,B = [high, round, back]
```

How can we make sense of this typological difference? One proposal advanced by Archangeli 1985 turns on precisely the geometrical difference we are contemplating. (6a,b) can be represented as (7a,b) respectively. In (7a), [high] spread does not affect the value of [round, back] of the target vowel; in (7b), on the other hand,[high] cannot spread without taking [round, back] along with it.

```
(7)   a.     H               Multiplanar VH: Menomini, Montañes
             |\
            bub-V            [bub-i]
             |   |
           R/B  R/B

      b.    bub-V            Coplanar VH: Yokuts, Mongolian
             |__/
             H               [bub-u]
             |
            R/B
```

Seen in this light, the dichotomy between (1a,b) looks like a reasonable formal representation of discrete-level tone languages like Chinese, vs. terraced-level tone languages like Bantu.

3. Syntagmatic Processes

Turning to the second topic, it has often been observed in tonological literature that whereas African tones undergo the familiar syntagmatic changes of spread and shift etc.,their Asian counterparts tend to stay put or undergo paradigmatic replacement instead. Schuh 1978 speculates that since tone plays a much greater functional lexical role in Chinese than in African languages, if tones in Chinese were to undergo syntagmatic changes, one tone would have many allotones, in which case, "the lexical role of tone would be jeopardized " (p.251).

I suspect the lexical functional load of tonal contrast has been greatly exaggerated. For instance, Old Chongming has 8 underlying tones. Instead of the expected 64 combinatorial possibilities for disyllabic compounds, we find only 7 (see Chen and Zhang 1990). Shanghai, to take another, better-known example, has a 5-tone system; yet instead of 5^n patterns for n-syllable compounds, we have exactly five 'word melodies', analogous to the Mende case as described in Leben 1978. This drastic neutralization of potential tonal contrasts has not, in all appearances, handicapped either the Chongming or the Shanghai speakers.

More importantly, syntagmatic processes do occur in Chinese, even across long distances. Local spread and shift are exemplified in Zhenhai (8a,b). In (8a) the terminal H of the first syllable spreads to the second syllable; in (8b) the M shifts altogether into the syllable to the right (see Rose 1990, Chen 1991b).

```
            'scissors'             'lake Tai'
(8) a.      jian dao          b.   Tai hu
             M H   L               H M   L
```

More strikingly, long distance spread and shift also occur, for instance, in the related S.Wu dialect of Wenzhou. In (9a) the function words (locatives, prepositions etc.) are inherently toneless (except in citation forms) and assume their pitch values by 'cliticizing' to the preceding tone. Thus the H of *na* and the L of *zhe* spread several syllables to the right. (9b) illustrates a rare case of long distance shift. Wenzhou obliterates all word-initial tones, retaining only the tonal categories of the last two syllables. In most cases, the toneless initial syllables assume some default tonal values. In one particular case, if the lexical sandhi rules produce an intermediate [HM-ML] pattern, [HM-] moves to the word-initial position, across an indefinite number of intervening toneless syllables. The compound-internal syllables assume the default mid level pitch, presumably by virtue of WFC (see Chen 1989).

```
        'that one is taller than this one'
        that Loc DE than this Loc DE tall
(9)  a. na   tou  de bi   zhe  tou de gao
        MH   ML   HM MH   L?   ML  HM  M     Base tone
        MH   o    o  o    L?   o   o   M     Tone deletion
        MH   h    h  h    L?   l   l   M     Tone spread (to the
                                             right)

        'radio receiver'
        wireless telephone receiver
     b.  wu-xian  dian-hua tong
         ML  HM   L    L    ML               Base tone
         o   o    o    L    ML               Tone deletion
         o   o    o    HM   ML               Lexical tone sandhi
         HM  o    o    o    ML               Shift (to the left)
         HM  m    m    m    ML               WFC
```

On the face of it, Chinese tones do not behave all that differently from their Meso-American or African cousins. On closer scrutiny, however, there is one big difference. We can identify six types of syntagmatic changes. As a mnemonic aid, I give each of them a suggestive name. (10a) is a case of peaceful *settlement* of empty space by a neighboring tone. (10b) represents the *encroachment* of one tone on the territory already occupied by an existing tone. I give (10c) a colorful name, *Anschluss*: here one tone annexes a neighboring syllable and throws out the original tone in an expansionist take-over, as it were. One can think of (10d) as the nomadic *migration* of prehistoric tribes across uninhabited land. (10e), on the other hand, is the analog of a far more violent act of *colonization*, i.e. the aggressive movement of one tribe into an already populated area, sometimes wiping out the indigenous population, in which case, *genocide* may be an apt description of what goes on in (10f).

```
(10) a.  x(x)          b. x x          c.   x x
         |/               |/|               |/ǂ
         T                T T               T T
         settlement       encroachment      Anschluss

     d.  x(x)          e. x x          f.   x x
         ǂ/               ǂ/|               ǂ/ǂ
         T                T T               T T
         migration        colonization      genocide

         (x) = toneless
```

It appears as if African tones behave much more aggressively than their Asian cousins: all six types of syntagmatic changes listed in (10) occur with some frequency in African languages. Chinese tones, on the other hand, move in a kinder, gentler world, so to speak: they only migrate or settle into otherwise unoccupied land. The long distance spread and shift of (9a,b) are instances of (10a) and (10d) respectively, namely movements into/across toneless span. As for (8a,b), the L of the second syllables *dao, hu* is the default L, supplied by a late rule. They, too, instantiate spread/shift into tonally empty space. It is noteworthy that '*imperialist*' tone movements, like (10b,c,e,f) either do not occur, or have gone unreported.

One way to characterize the syntagmatic processes we do find in Asian languages is to say that tone movements respect the *Territorial Integrity* of a neighboring tone. This notion is not as far-fetched as it may sound at first blush. Despite the first impression of African tones as aggressive movers and shakers, most of them do respect the etiquette of territorial sovereignity. (11a) is a typical case of long distance tone spread attested in many Bantu languages. Essentially, a H tone spreads as far back as possible until it hits another H. This extremely common process is referred to as '*bridging*' in Kongo (Carter 1980), and as '*plateau mélodique*' in Kinyarwanda(Furere and Rialland 1985). The analog of (11a), or its mirror image, also occurs in Luganda (Hyman 1982), Tonga (Goldsmith 1984, Pulleyblank 1986), Kimatuumbi (Odden 1985), Shona (Odden 1992) and, no doubt, many others. One might attribute the constraint on (11a) to some sort of OCP effect. But I think the explanation lies elsewhere. The correct generalization seems to be: Tone-spread tends to stop short of infringing on a syllable already occupied by another tone. In other words, we can generalize (11a) as (11b).

```
(11)  a.   ...x x.......x...
              |          |
              H          H

      b.   ...x x.......x...          Territorial Integrity
              |          |
              T          H
```

Luganda (Hyman 1982) provides us with some interesting supporting evidence. In Luganda the leftward spread of H's is blocked not only by another H, but also by a L. There are three sources of the surface L's: the phrase-initial boundary L, as in (12a), the buffer L as in (12b), and the L's derived by Meeussen's Rule in (12c). What is important is that H-spread respects the *Territorial Integrity* of a neighboring tone, either H or L, regardless of its origin.

```
(12) a     a-bala # e-bi-kopo           'he counts cups'
           |                |
           L                H

     b.    ba-bala # e-bi-kopo          'they count  cups'
            |  |             |
            H  L             H

     c.    a-ba-ta-li-lab-il-il-a # ba-pakasi
           |  |  |  |                      |
           H  L  L  L                      H

           'they will not look for porters'
```

Turning from tone spread to tone migration, the Proto-Bantu H tone in modern Sukuma moves from the verb-stem-initial position to the right by two syllables within the word and by three syllables across words (Goldsmith 1985) . Informally stated as (13), if the stem-initial H lands on V_1 across the word, it moves further to V_2 on the right.

```
(13) [V...]  #  [V1 V2...]
      |     stem
      |
      H ------>
```

Significantly, rule (13) also obeys the *Territorial Integrity* principle: In (14a) we see that H_2 indeed moves three syllables away and lands on *ta*. Interestingly, H_1 moves only two positions to the right, docking on *ba*. In all likelihood, rule (13) applies iteratively left-to-right. Consequently , the presence of H_2 blocks the rightward movement of H_1. (14b) further illustrates what happens when fidgety tones try to move around in a crowded space. H_1 moves only one position to the right, blocked by H_2. More interestingly, H_2 itself has no place to move, and drops out of sight. H_3 is set afloat and eventually docks on V_1 or V_2 if available.

```
          he saw         chief     big
(14) a.   a-ka-bon-a   # ba-temi # ba-taale   'he saw the big chief'
                H1           H2
                L----> H1    L------> H2


     b.   ba-ku-ba-bon-a # V1 V2...           'they will see them'
          H1     H2   H3
           L> H1  |    L---->...<H3>
                  |
                  v
                  0
```

The correct generalization that emerges from Luganda, Sukuma and other Bantu languages seems to be this: already linked tones tend to block spread or any other kind of syntagmatic movement. Now, turning back to Chinese, it is fair to say that, (a) with a few exceptions (notably, function words, grammatical particles etc.), every morpheme carries a lexically specified tone; (b) for all practical purposes, morpheme and syllable are coextensive; (c) tones are associated with the TBU's early on, as in canonical tone languages; (d) outside of the Wu dialects, tone deletion does not occur in general. Given these facts, the *Territorial Integrity* principle predicts: (i) tones do not spread or move except to inherently toneless morphemes like object pronouns, grammatical particles and other enclitics; (ii) tone spread/movement occurs only in the Wu dialects known to undergo extensive tone deletion. These predictions are borne out by the documented facts.

I submit that the principle of *Territorial Integrity* explains, at least in part, why Chinese tones tend to stay put, firmly anchored in their host syllables. However it cannot explain everything, for the simple fact that African tones *do* move around in crowded space, often aggressively encroaching on occupied territories, sometimes forcing out the original tones from their natural habitat. One of the worst offenders seems to be Aghem (Hyman 1987). In Aghem, both H and L spread rightwards, dislodging the original occupant, and creating a domino effect. This is illustrated by (15a). In particular, (15b) demonstrates a case of *Anschluss*: the L on the prefix of 'dogs' is forced out by the H of the associative marker, eventually surfacing as the downstep operator.

```
(15) a.   o tsOngO kI--bE                    'he has stolen fufu'
          L   H  L  H    H

                rat    AM      dogs
     b.   (kI)-fu + kI + tI-bvU              'rat of dogs'
            H    H    H     L   HL
                                             AM = assoc. marker

     =    [(kI)-fu + kI + tI-bvU]            E,O = open [e,o]
             H    H    H    H  !H            I,U = barred [i,u]
```

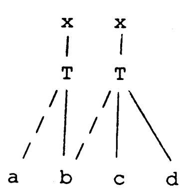
In view of cases like Aghem, we have to ask why Asian languages generally abide by the territoriality protocol, while African languages operate under no such restraint.[1] The answer may lie in another typological difference between African and Asian languages. African tonal systems typically consist exclusively of level tones, with surface contour tones arising only as the by-product of association conventions, spreading, or syllable contraction etc. In contrast, contour tones freely enter into the make-up of Asian languages at the underlying as well as the surface phonetic level.[2] A quick check of 20 dialects in *Hanyu Fangyin Zihui* (second edition, Beijing 1989) attests to the preponderance of contour tones in Chinese. The figures are given in (16).

(16)

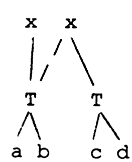
	Free CV(N)	Checked CVC
level	1.5	1.2
contour	3.2	0.8

For *free* syllables (i.e. ending in a sonorant), the ratio between contour and level tones is 1.5 to 3.2. Given the preponderance of complex, branching tones in Asian languages, if spread were to operate freely, the effect would be either (17a), if terminal elements spread, or, worse, (17b), if it is the tone root that spreads.

(17) a



b.



In either case, the resulting tonal configurations would be highly marked, if not outright impossible by virtue of a constraint like (18). The insight behind (18), or some other versions of it (cf. Bao 1990), is that there is a *'Tonal Saturation'* principle that prohibits the 'overcrowding' of the tonal space.

```
(18)        * T                                    Tonal Saturation
             /\
            a b c
```

In light of (17,18), it is not surprising that contour tone systems generally disallow syntagmatic moves, while pitch level systems have no trouble accommodating such changes, which typically create an unremarkable configuration like (19)

```
(19)     x   x
         |  /|
         | / |
         T   T
```

I suggest, therefore, it is *Tonal Saturation* that, in conjunction with *Territorial Integrity*, helps to explain why syntagmatic processes such as spread and move are so restricted in Asian languages. To use a metaphor, whereas African tones are free to roam about across open savannas, Asian tones are largely confined to their pigeonholes in the densely populated Yangzi delta.

What is less clear is why, in order to alleviate 'overcrowding', Asian languages do not make use of a number of repair strategies that are readily available. For instance, some languages impose even stricter limits of tonal saturation, prohibiting contour tones altogether, including (19). In such cases, they resort to strategies such as delinking as in (20a), which in turn either creates the ripple effect of relinking the displaced tone to the next syllable on the right as in (20b), or, under the right circumstances, undergoes tonal absorption as in (20c); or else, the delinked L is set afloat and phonetically interpreted as downstep, as in (20d); finally, the effect of (19) is neutralized by some other contour simplification devices exemplified in (20e).

```
(20)     a.   x   x            b.   x   x   x
              |  /|                 |  /|  /
              | / ≠                 | / ≠ /
              T   T                 T   T

         c.   x   x   x        d.  x   x   x        e.   x   x   x
              |  /|  /|            |  /|   |             | /|   |
              | / ≠ / |            | / ≠   |             |≠ |   |
              H   L   L            H  <L>  H             L  H   L

              <L> = floating L
```

4. Metathesis

We have seen above two types of tonal rules, downstep and 'imperialist' spread/move, that recur in African languages, but do not surface in Chinese. Conversely, there are tonal processes that operate in Chinese but do not appear in African languages. Tonal metathesis is one such example. Metathesis, outside of resyllabification, is rare in general; tonal metathesis, in particular, is virtually unknown, at least in Niger-Congo languages (according to Hyman 1985:66). On the other hand, metathesis has been documented in several Chinese dialects, including Chongming (Chen 1991a) and Pingyao (Bao 1990, Chen 1991b). Pingyao has only two rising tones (LM, MH) and one falling tone (HM). The relevant facts of Pingyao are given in (21).

```
(21) LM-MH  →   ML-MH
     MH-MH      ML-MH
     HM-HM      MH-HM
```

Obviously what is going on is that before a high tone (MH and HM), the adjacent tones must *dissimilate* in terms of their melodic *contour*: rising-rising → falling-rising, and falling-falling → rising-falling. Dissimilation functions as a way to satisfy OCP defined over the entire melodic contour (independent of register). However, since rising and falling tones are decomposed into sequences of relative pitch levels, there is no way to formulate the underlying dissimilatory process except in terms of the permutation of terminal tone segments making up the contour, as in (22).

```
(22)     T          T               H
        /\    →    /\    / ___     /\
       x  y       y  x            x  y

        T = tone root (of either register)
        H = high register
        x,y = [h] or [l] terminal nodes
```

Dissimilation and polarity rules do occur in African languages. Thus, whatever the historical account, synchronically speaking, the definite marker *ma* carries the opposite tone to the noun in Tubu (Saharan) (Wolff & Alidou 1989:71). A similar polar relation holds between the possessor and the possessed NP's in Mende (Conteh et al. 1983), between the affixes and the stem in Margi (Hoffman 1963), etc. In a sense metathesis and polarity rules are both dissimilatory in nature. The fact that functionally equivalent processes are implemented by distinct formal mechanisms (metathesis vs. alpha-switching rules) reflects the dual nature of contour tones in Chinese: on the one hand, there are very good reasons to construe the rising and falling tones as LH and HL respectively, hence LH ←→ HL looks like a permutation rule; on the other hand, LH and HL are opposites in the 'same' way as H and L are to each other, a symmetry that is not captured in the conventional representation of tones.

5. Concluding Remarks

We have shown that at least some of the differences in the distribution of tonal processes stem from other typological properties of the various tonal systems. Thus the multiplanar vs. coplanar tonal geometry may account for the presence and absence of downstep. Likewise, the prevalence of toneless syllables in African languages (many of which distinguish H vs.0 rather than H vs. L) makes ample room for tones to spread and move around, while the one-to-one relation between tone and the TBU (syllable, morpheme) in conjunction with the preponderance of contour tones in SE Asian languages inhibit such syntagmatic changes, consistent with the principles of *Territorial Integrity* and *Tonal Saturation*. Finally, while dissimilatory processes operate in both African and Asian languages, only contour dissimilation calls for a formal statement involving a permutation of elements.

One can no doubt think of other asymmetries in tone rule typology and speculate about their underlying causes. In some cases, the different 'flavors' of the tonology of different language families may have nothing to do with tonology per se. For instance, one striking feature of African languages, from the Sinitic point of view, is the proliferation of tonal morphemes, in particular disembodied, segmentless tones marking certain grammatical functions. Thus, just as Tiv marks the general past vs. the recent past by two melodies, independent of the segmental composition of the verb stem, Kikuria (Odden 1987), signals such inflectional categories like remote past, recent past, subjunctive, and perfective by assigning a H tone on the first, second, third and fourth mora respectively. Such exploitation of pitch is totally foreign to Chinese (outside of such marginal cases as the diminutive suffix in Cantonese). One might hazard the hypothesis that the heavy lexical functional load borne by the tones preempts their playing a significant grammatical role. The truth of the matter is that Chinese doesn't mark any such grammatical functions *tout court*. Therefore, the lack of tonal morphology is not a peculiarity of tones, but a property of Chinese in general.

Notes

* Over the years I have pestered my friends and colleagues with the persistent question I have attempted to address here. My thanks go to them for sharing their thoughts on the subject matter with me, in particular: Larry Hyman, Laura Downing and Chilin Shih.

1 It is worth noting that there does not appear to be any case of long distance spread or shift in violation of *Territorial Integrity*.

2 Note in passing that contour tones are claimed to function as phonological primes in Hausa (Newman, this volume) and some Kru languages such as Grebo (Newman 1986) and Wobe (Bearth & Link 1980). Conversely, Duanmu (1990, and this volume) argues against contour tones in Chinese.

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Parametric Variation in Pitch Realization of 'Neutral Tone' Syllables in Mandarin

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Introduction

Pulleyblank 1986 proposes that languages vary parametrically as to whether tonally underspecified skeletal slots link autosegmentally via spreading from neighboring tones or are filled in by default tone values. In his analysis default tone association applies non-cyclically at the post-lexical level at the earliest in Margi, Tonga, and Tiv and at the phonetic level in Yoruba. He argues that two-tone systems such as Tiv and Margi have a default low [-upper] tone assigned by Universal Grammar in the post-lexical phonology, whereas three-tone systems such as Yoruba and Yala have a default mid [-upper], [+raised] tone assigned by UG in the phonetic component. Pulleyblank, after Liberman 1983, differentiates the phonological and phonetic rules as follows: (i) phonological rules are restricted to binary use of features, phonetic rules are gradient; (ii) the number of phonological entities is bounded, of phonetic entities unbounded; (iii) the consequences of phonetic rules often involve temporal structure and coordination; and (iv) phonetic rules cannot have lexically-conditioned exceptions.

Keating 1990 and others further distinguish phonological assimilation, in which a segment acquires the feature value of a neighboring segment (and by implication also default tone assignment, in which a default tone is assigned late in the derivation,) from phonetic assimilation, in which a segment's value for a particular feature is partial and/or gradient and transitional. In the latter case pitch values derived by phonetic assimilation may result from interpolation through a featurally unspecified span. In Keating's model the output from the phonological component need not be fully featurally specified before being input to the phonetic component. In consideration of the above, four options are conceivable for tonally underspecified morphemes: tone is acquired by phonological spreading, by default tone assignment in the phonological or phonetic component, or by phonetic spreading.

Evidence of phonological assimilation of tones (tone spreading) has been presented for Mexican and African tone languages (cf. Clements and Goldsmith 1984, Goldsmith 1990), as well as Southeast Asian languages (Morse 1988, Delancey 1989, Mazaudon and Michailovsky 1989), and Southern Chinese Min (Chan 1984), Cantonese (Yip 1980), and Southeast Mandarin Danyang and Jin Mandarin Changzhi dialects (Davison 1989). Analyses of default tone association in East Asian languages include Wright 1983 and Davison 1989.

Phonetic assimilation of tones, evidenced by interpolation of pitch values across tonally unspecified syllables, is attested in Tibetan (Mazaudon, pc). Long-distance phonetic interpolation between tonal targets, not phonological spreading, also has been described for pitch assignment to noun phrases in Shanghainese and Wuxi (Zee and Maddieson 1979, Chan and Ren 1986), as well as other Wu Chinese dialects.

In Mandarin Chinese, most syllables are underlyingly fully specified for tone, and thus the contexts available for tone spreading are relatively few. The most obvious exceptions are so-called `neutral tone' morphemes or syllables, stressless syllables of words and phrases which lack a lexically contrastive tone. Pitch realization on these syllables has been the object of intensive research, as reviewed below.

In the present study, pitch contours extracted from spectrographic measurements of controlled data samples of non-phrase-final stressless syllables pronounced by Northern Mandarin (NM) and Taiwanese Mandarin (TM) speakers are compared. The data suggest that Taiwanese Mandarin speakers assign pitch to underlyingly toneless syllables by phonetic interpolation from a mid tone value (cf. Wright 1983's identification of mid tone as the default tone for Amoy and Chaozhou Min Chinese dialects). The Taiwanese Mandarin mid tone generally is timed to occur early in the toneless syllable (at the leftmost edge), after which the pitch either may decline, or, less often, interpolate in the direction of the immediately following tone (this phenomenon also occurs with one of the NM speakers, see (9iiia)). The choice between the latter two options appears to involve syntactic conditioning (compare (9viii) with (9iiia) and (9vii) and see also Davison 1992), suggesting that in Taiwanese Mandarin default tone assignment is postlexical.

For the same set of examples in Northern Mandarin, non-phrase-final, underlyingly stressless syllables between preceding high, following low tones are observed instrumentally to receive pitch assignment by smoothing functions between the pitch values of the surrounding tones, without reference to a tonal target (cf. (9xii) below, where a H-0-L pattern shows the stressless syllable's pitch ending lower than the following syllable's low target in TM, but mid, interpolated between the preceding H and following L, in NM).

In addition, a stressless syllable receives a high pitch by spreading and/or reassociation of the high of a preceding high rising (MH) tone (Mandarin tone two) followed by a low tone (Mandarin tone three) in NM, not in TM (cf. (9xi) below as well as a similar phenomenon reported for Tianjin (Northern) Mandarin in Davison 1991). The latter process may be understood as a phonetically motivated redistribution of the two (mid plus high) tonal targets of the first syllable, resulting in the mid tone being associated to the original tone two syllable and the high tone to the underlyingly toneless syllable. Tone four HL could be analyzed in similar fashion.

Other differences between NM and TM are that the stressless syllable surfaces with a low pitch between two highs in NM, rather than the mid pitch of TM (9a). Also, in two of three NM speakers, in 5/6 examples, a stressless syllable preceding a low tone three is realized as a low-rising + low (LH+L) tone contour (compare (9iv) with (9v) and (9xii)). Only one TM speaker of four, out of a total of seven examples, shows this pattern. The latter phonetic rule closely resembles the (pan-) Mandarin lexical tone sandhi rule dissimilating a sequence of low third tones to a rising plus low tone.

In sum, then, the NM pitch assignment rule appears to be considerably more complex than that for TM. Between high tones and a preceding low tone three a default low tone is apparent; moreover, in the latter case, it is variably subject to low tone dissimilation. Elsewhere there is evidence of phonetic interpolation across the stressless syllable or autosegmental spreading of preceding tones onto it. The differences between the two dialect groups suggest that TM assigns a default mid tone to lexically underspecified syllables post-lexically, whereas in NM tonally underspecified syllables enter the phonetic component as such. Low default tone assignment is then presumably the last of several options available for surface realization of pitch on these syllables, and it itself feeds phonetic low tone dissimilation, suggesting the need for ordering of default low tone insertion before dissimilation in the phonetic component of the grammar.

Compared to Pulleyblank's results in which default mid tone is found in three tone systems, low in two tone systems, we find differences in default tone value, mid vs. low, and conditioning, absolute vs. gradient, across two mutually intelligible varieties of Mandarin dialect, both with four lexical tones. The evidence from these dialects thus suggests default tone assignment in Chinese.

Before proceeding to a review of previous work let us briefly summarize the Mandarin neutral tone facts and exemplify one aspect of the TM/NM difference described above. Recall that the traditional manner of tone contour description assigns 5 to high, 1 to low pitch. Mandarin's four lexical tones thus are describable as T1 55 high level, T2 35 high rising, T3 214 low dipping, and T4 41 falling. Example (1) shows the four lexical tones of Mandarin and pronunciation of following toneless, stressless syllables before pause. Sources vary as to details while agreeing on the overall resulting contours.

(1) Mandarin disyllabic words illustrating lexical tones 1-4 followed by neutral `0' (stressless, toneless) syllables (tone values are according to Chao 1948:27)

(a) Tone 1 (T1) high level + half-low tones: **ta1+de0** `his'
(b) T2 mid-to-high rising + mid tones: **shui2+de0** `whose'
(c) T3 low level + half-high tones: **ni3+de0** `yours'
(d) T4 falling + low tones: **da4+de0** `big ones'

(2a) illustrates the fact that a Taiwanese Mandarin toneless syllable between two high tone words has a high-mid-high pattern, with a noticeable dip in the fundamental frequency over the middle, stressless syllable. The same sequence rendered by a Northern Mandarin speaker has an even more pronounced high-low-high pattern, as in (2b), see (9a). These data serve to support the interpretation that the two Mandarin-speaking groups differ parametrically regarding the assignment of pitch values to toneless syllables.

(2) Pitch realization on stressless syllables between two high tones (H=high tone, M=mid tone, L=low tone)

(a) Taiwanese Mandarin (TM) **dingl+zi0 dil** `[the] nail [is] low'
H M H

(b) Northern Mandarin (NM) **dingl+zi0 dil** `[the] nail [is] low'
H L H

Most Taiwanese Mandarin speakers also speak Taiwanese Min, a Southern Min dialect similar to the mainland dialect of Amoy. Amoy is identified by Wright 1983 as having a default mid tone value. Assuming Taiwanese Min also has a default mid tone value, the results of the present study may be interpreted as showing that Taiwanese Mandarin speakers utilize a single parametric rule assigning default mid tone to stressless syllables for both languages, i.e. for Taiwanese Southern Min and Taiwanese Mandarin.

1. Previous studies of Mandarin neutral tone realization

Mandarin stressless, toneless syllables, also known as `neutral tone syllables', occur as rightmost syllables of disyllabic words or morphemes, either lexically marked as such or morphologically derived by cliticization or reduplication, according to Woo 1969. Realization of pitch contour on lexically marked toneless syllables has been interpreted by some researchers as resulting from default register assignment combined with tonal spreading (Yip 1980) and by others as (in our terms) phonetic interpolation between the tones of neighboring syllables (Shen 1989:40, Woo 1969, Chao 1956:53). Here we have space to review only the work of Yip 1980.

Yip 1980 was concerned to show that evidence in support of autosegmental phonology drawn from African languages also could be found in languages such as Chinese. Yip argued that neutral tone following tones 1 and 2 acquired high tones and neutral tone following tone 4 acquire low tone from the preceding syllable, by means of autosegmental spreading; whereas tone 3 inserted a high tone onto the following neutral tone. This is summarized in (3).

In order to derive the required mid tone value on neutral tones following tones 1 and 2 Yip proposes that the neutral tone syllables, while underspecified for tone, have underlying low register. This approach accomodates the TM but not the NM results summarized above, presented below.

(3) Yip 1980, autosegmental analysis of neutral tone pitch assignment in Mandarin (H=high tone, L=low tone). The surface mid tone value on neutral tone following T1 and T2 results from the interaction of H Tone Spreading with the neutral tone syllable's low register.

(a) T1 55 H	**ma1+de0**	`mother's'	H Tone Spreading
	H		
(b) T2 35 MH	**ma2+de0**	`hemp's'	H Tone Spreading
	MH		
(c) T3 214 L H	**ma3de0**	`horse's'	Floating Tone Assoc.
	L H		
(d) T4 41 HL	**ma4de0**	`angered'	L Tone Spreading
	HL		

In this paper we refer to the models of lexical phonology of Pulleyblank 1986 and of phonetic interpolation in context of phonetic underspecification of Keating 1988 et al. to characterize parametric variation in the realization of TM and NM. Keating suggests that in a phonology allowing surface underspecification, a segment may exit the phonology with no value for a feature, having failed to receive one either lexically or by later rule. The segment, transparent in the phonetics to any rule sensitive to that feature, thus cannot be assigned a quantitative target. When phonetic rules build trajectories between segments, the unspecified segment contributes nothing to its own trajectory, permitting its neighbors to interact with each other, such as by interpolating values for the unspecified feature across the transparent segment, joining immediately preceding and following targets.

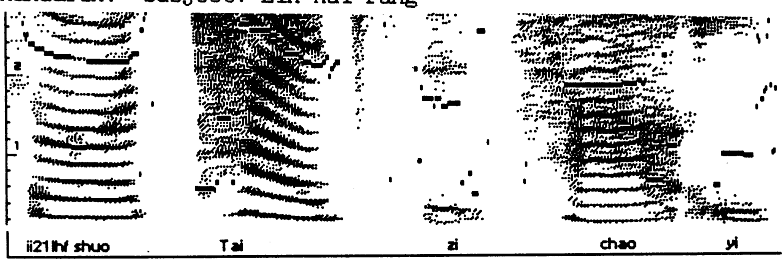
2. Method and analysis of the present study

For this paper a sample of contextually controlled sentences containing the Mandarin stressless, toneless nominalizing suffix **zi** was analyzed spectrographically. The data exemplified in (8) were elicited from five Mandarin speaking natives of Taiwan and three Mandarin speakers from various areas in North China. All are college-educated graduate students or faculty of San Jose State University.[1] Speakers were asked to read a corpus of one hundred sentences as slowly as possible while maintaining natural intonation. The slow speed was to ensure that stressless syllables would be sufficient large in amplitude and duration as to be visible without distortion using the pitch extraction algorithm of the analysis software, the Ariel Sensimetrics Speechstation.

Of the one hundred sentences, fifteen contained the **zi** suffix. These were repeated twice and distributed randomly throughout the corpus. Thus a total of 30 **zi** suffix tokens for each speaker were elicited. All sentences analyzed for this study included a target noun phrase containing the toneless syllable **zi**, embedded in the carrier sentence **Qing ni zai shuo __ yici** `please repeat __ once/twice/thrice again'

Detailed comparisons were made of duration of and pitch variation across the toneless syllable, measured from narrow band spectrograms and a superimposed pitch track traced onto the tenth harmonic. A sample analyzed token appears in (4).

(4) Spectrograms with superimposed pitch tracing of the tenth harmonic. Neutral tone between stressed syllables in Taiwanese Mandarin. Subject: Lin Hui Fang



`...say `Prince's dynasty' one time.' Tones:T1H 4HL 0 2MH 1H 4HL.

Keating's distinction between phonological spreading and phonetic interpolation to underspecified segments may be applied to the question of pitch assignment to neutral tone syllables in Mandarin. Interpolation across a toneless syllable located between two stressed H or L tones or between HL and LH tones might be expected to look like the graphs in (5). The dotted line indicates an interpolated pitch value between target values of preceding and following syllables. Notice that it would be impossible to distinguish between interpolation or spreading applying between like tones: HH or LL. In either case the pitch contour would be flat. The crucial cases would rather be HL and LH. A spreading tone would be expected to show a steep slope over the neutral tone syllable, rather than a gradual one as in (5c-d).

(5) Phonetic interpolation between tonal targets of adjacent stressed syllables (idealization)

(a) High tone - neutral - high (b) Low tone - neutral - low

(c) High tone - neutral - low (d) Low tone - neutral - high

Returning to an analysis of the data in (7), summarized in (6), we see that for TM, a mid to low falling contour typifies stressless syllable realizations between all tone height combinations, with the exception of cases of random individual variation noted above, as well as in certain contexts involving a preceding T3.[2] As Yip and others have argued, Mandarin T3 is well analyzed as an underlying low plus a floating high tone, as in (3c) above. According to these data, in TM, just in case a T3 is followed by a toneless syllable followed by a high tone, T3's floating H may be timed to surface either late in the stressless syllable, giving a L-LM-H or L-LH-H pattern, or throughout the toneless syllable, giving the L-H-H pattern. In contrast, in the L-0-L pattern in (7bv), preceding and following T3s result in the leftmost T3's floating high tone to be realized as mid-falling tone, like TM stressless syllables following all tones other than T3. TM thus could be described as assigning a default mid tone postlexically to stressless syllables, generally timed to occur early in the syllable, after which the pitch typically declines (postlexically, as noted above, because of evidence of the influence that the type of interpolation, either from the left or between left and right targets, depends partially on syntactic bracketing, cf. Davison 1992).

In contrast, NM speakers may be described as leaving stressless syllables underspecified until they exit the phonological component. In the phonetic component autosegmental spreading from a preceding high rising T2 applies optionally and gradiently. Between low and high targets interpolation of the sort predicted by Keating's model is an option. Otherwise, a default low tone is realized, which in turn may be subject to low tone dissimilation, as noted above.

One final point of difference, not previously mentioned, is that NM speakers in this corpus always render T3 low + floating high as L-LH. TM speakers, on the other hand, apparently are not as constrained as to timing of the H in the stressless syllable. This would appear to raise the possibility for NM but not for TM that T3 is underlyingly LLH, as some analysts recently have described it, and that its contour is realized less variably than previously thought. Notice that if NM T3 is understood as a superlong low level plus low rising tone, then its surface manifestations (`allotones') could be analyzed as being the realization of one or the other half of or alternatively all of underlying form: all in the case of prepausal position (214); the second half (14) over stressless syllables and preceding another T3; and the first half elsewhere.

(6) Summary, parametric differences between TM and NM pitch realization on non-phrase-final stressless syllables

	TM	NM
HOH	H-ML-H	H-HL-H~H-ML-H~H-LH-H~H-H-H
HOL	H-ML-L	H-M-L~H-HM-L~H-LH-L

LOH	1st syl. T4:	HL-ML-H~HM-ML-H	HM-ML-H
	1st syl. T3:	L-LM-H~L-LH-H~L-H-H	L-LH-H
LOL		L-ML-L*	L-LH-L*

*excluding example (9iv), see fn 3.

(7) Duration and fundamental frequency at pitch turning points for nominal suffix **zi** and immediately preceding and following syllable, for 10 speakers. TM = Taiwanese Mandarin speakers (subjects LHF, LZC, GMH, PLD, XGC, LZC), NM = Northern Mandarin speakers (subjects TF, JL, GG). R=rising pitch, F=falling pitch, L=level pitch, CC=concave pitch, CV=convex pitch. D=duration in milliseconds. (Speakers varied between **fa3+zi0** and **fa2+zi0** pronunciations for the word `method'. Results relevant to each category for this variably pronounced word are in boldface type.)

(a) high - unstressed - high (Ts 101, 104, 201, 204)[3]

i. **Qing3 ni3 zai4 shuo1 ding1+zi0 san1 ci4.** T101
Please you again say `nail' 3 time.

	ding1	**zi0**	**san1**
TM			
LHF	236-232, F4, D137	197-187, F10, D86	222-220, F2, D144
LZC	123-122, F1, D176	119-100, F19, D109	115, L, D211
GMH	248, L, D174	199-144, F55, D78	220-222, R2, D189
PLD	320, L, D138	197-177, F19, D69	259-265, R6, D87
XGC	189-183, F6, D178	134-115, F19, D94	144-140, F4, D128
LZC	222-224, R2, D178	199-195, F4, D61	232-222, F10, D168
NM			
TF	322-294, F28, D244	218-171, F47, D88	294-275, F19, D138
JL	253-275, R22, D259	148-58, F90, D105	238-210, F28, D64
GG	257-253, F4, D273	218-220, R2, D102	238-246, R8, D211

ii. ...**he2+zi0 san1**... `Please repeat `box' three times.' T201

	he2	**zi0**	**san1**
TM			
LHF	214-212, F2, D93	210-207, F3, D78	222-203, 19, D198
LZC	115-122, R7, D220	113-106, F7, D105	114-115, R1, D271
GMH	201-224, R23, D132	201-185, F16, D74	222-214, F8, D172
PLD	203-242, R39, D148	222-214, F8, D81	251-253, R2, D111
XGC	140-164, R24, D219	148-119, F29, D136	148-152, R4, D141
NM			
TF	207-294, R87, D197	255-164, F91, D150	222-220, F2, D139
JL	201-275, R74, D172	164-140, F24, D125	208-195, F13, D83
GG	201-226, R35, D168	113, L D42	226, L D140

iii. ...**he2+zi0 dan4**... `Please repeat `nuclear bomb'.'

	he2	**zi0**	**dan4**
TM			T204
LZC	119-128, R9, D184	121-113, F8, D54	121-111, F10, D122
GMH	197-220, R23, D115	187-179, F8, D54	212-173, F39, D180

PLD	195-261, R66, D99	177-166, F11, D69	263-195, F68,D131
XGC	134-152, R18, D129	138-119, F19, D86	146-115, F31,D158
LHF	197-232, R35, D112	185-187, R2, D47	232-191, F40,D241
NM			
TF	222-300, R78, D199	199-162, F38, D97	275-179, F96,D172
JL	177-203, R26, D110	189-138, F51, D87	265-154, F111,D259
GG	234-273, R39, D137	109, L, D39	269-189, F80,D212

iiia. ...**fa2+zi0 man4**... `Please repeat `the method is slow'.'

TM	**fa2**	**zi0**	**man4** T204
LZC	133-114, F19, D144	114-125, R11, D100	130-111, F19,D128
GMH	214-191, F23, D138	234-234, CC0, D198	234-197, F37,D66
PLD	**189-238, CC49,D149**	**259-228, CC31,D243**	**259-199, F60,D99**
XGC	142-115, F27, D263	148-164, CC26,D337	166-126, F40,D148
NM			
TF	**214-302, R88, D168**	**283-265, CC18,D288**	**281-167, F114,D163**
JL	85-83, F2, D121	197-269, R72, D113	164-146, F18, D275
GG	**224-250, CC26,D205**	**224-201, F23, D99**	**220-193, CV27,D236**

(b) low - unstressed - low (T4+0+T3, 303)

iv. ...**tai4+zi0 hao3**... `Please repeat `the prince is fine'.'

TM	**tai4**	**zi0**	**hao3** T403
LZC	143-114, F29, D185	114-111, F3, D141	104, L, D185
GMH	265-210, F55, D100	187-208, R21, D130	169-154, F15,D72
PLD	333-255, F78, D135	199-277, R78, D211	177-191, D14,D381
XGC	232-154, F78, D177	126-154, R28, D143	111-99, F12, D108
LHF	263-214, F49, D108	109-113, R4, D37	177-58, F119,D144
NM			
TF	332-212, F120,D148	208-294, R86, D137	166-136, F30,D140
JL	304-189, F115,D187	203-277, R74, D113	162-166, R4, D90
GG	281-207, F74, D186	212-232, R20, D119	103-95, F8, D91

v. ...**fa3+zi0 hao3**... `Please repeat `the method is fine'.'

TM	**fa3**	**zi0**	**hao3** T303
LZC	**112-111, F1, D179**	**123-114, F9, D84**	**114-108, F6, D378**
GMH	**197-173, CC24,D164**	**201-199, F2, D76**	**201-160, F41,D163**
PLD	228-265, R37, D103	232-220, F12, D57	169-175, CC6,D273
XGC	**156-126, F30, D234**	**158-128, F30, D182**	**126-101, F25,D188**
NM			
TF1	224-302, R78, D259	302, L, D54	195-72, F123,D200
TF	228-285, R57, D137	183-177, F6, D75	189-175,CC6, D273
JL1	**152-138, CC14,D119**	**246-261, R15, D84**	**72-80, R8, D108**
JL	**185-140, CC45,D143**	**220-250, R30, D120**	**58-60, R2, D46**
GG1	220-253, CC33,D236	214-250, R36, D167	
GG	197-244, R47, D215	222-240, R18, D160	208-210, R2, D109

(c) low - unstressed - high (Ts 301, 304, 401, 404)

vi. ...**fa3+zi0 man4**... `Please repeat `the method is slow'.'

TM	**fa3**	**zi0**	**man4** T304

LZC	133-114, F19, D144	114-125, R11, D100	130-111, F19,D128
GMH	214-191, F23, D138	234-234, CC0, D198	234-197, F37,D66
PLD	189-238, CC49,D149	259-228, CC31,D243	259-199, F60,D99
XGC	142-115, F27, D263	148-164, CC26,D337	166-126, F40,D148
NM			
TF	214-302, R88, D168	283-265, CC18,D288	281-167, F114,D163
JL	85-83, F2, D121	197-269, R72, D113	164-146, F18, D275
GG	224-250, CC26,D205	224-201, F23, D99	220-193, CV27,D236

vii. ...**tai4+zi0 san1**... `Please repeat `prince' three times.'

TM	**tai4**	**zi0**	**san1** T401
GMH	246-197, F39, D230	148-85, F63, D180	222-220, F2,D134
PLD		302-242,F60, D81	175-207, CC32,D302
XGC	191-128, F63, D205	126-87, F39, D70	150-156, R6,D101
NM			
TF	332-212, F120,D210	173-152, F21, D114	263-250, F13,D189
JL	261-154, F7, D235	115-93, F22, D88	208-210, R2,D209
GG	275-212, F63, D210	197-191, F6, D93	222-220, F2,D180

viii. ..**tai4+zi0 an1**... `Please repeat `the prince is peaceful'.'

TM	**tai4**	**zi0**	**an1** T401
LZC	156-117, F39, D148	121-128, R7, D121	121-126, R5,D205
GMH	250-197, F53, D140	169-152, F17, D70	197-203, R6,D289
PLD	312-234, F78, D135	195-183, F12, D110	366-378, R12,D98
XGC	183-128, F55, D168	115-101, F14, D73	138-154, R16,D207
NM			
TF	320-218, F102,D124	177-152, F23, D96	261-253, F8,D132
JL	271-148, F123,D241	95-91, F4, D69	212-232, R20,D207
GG	292-205, F87, D184	173-113, F60, D96	216-240, R26,D207

ix. ...**tai4+zi0 fan4**...`Please repeat `the prince's food'.'

TM	**tai4**	**zi0**	**fan4** T404
LZC	132-109, F23, D180	111-109, F2, D136	128-111, F17,D128
GMH	244-197, F47, D180	130-87, F43, D89	220-171, F49,D162
PLD	312-242, F70, D149	162-142, F20, D62	265-212, F53,D120
XGC	210-140, F70, D233	125-102, F23, D177	160-111, F49,D174
NM			
TF	310-218, F92, D168	166-154, F12, D79	277-177, F100,D142
JL	322-160, F162,D220	121-107, F14, D105	294-144, F150,D241
GG	302-212, F90, D183	210-193, F17, D115	277-214, F63,D198

(d) high - unstressed - low (Ts 103, 203)

xi. ...**ding1+zi0 liang3**... `Please repeat `nail' two times.'

TM	**ding1**	**zi0**	**liang3** T103
LZC	128-125, F3 D211	117-109, F8, D119	113-115, R2, D248
GMH	250-244, F6. D168	115-164, R49, D128	173-144, F29, D140
PLD	320-324, R4 D230	187-169, F18, D136	185-132, F53, D213
NM			
TF	320-300, F20, D198	189, L, D150	185-154, CC31,D205
JL	267-285, R18, D229	167-183, R16,D103	175-154, F21, D106

GG	277-275, F2, D244	255-207, F48,D142	195-189, F6, D56

xii. ..**he2+zi0 man3**... `Please repeat `the box is full'.'

TM	**he2**	**zi0**	**man3** T203
LZC	115-134, R19, D219	121-109, F12, D143	109-111, R2, D234
GMH	199-222, R23, D144	214-189, F20, D101	175-158, F17, D76
PLD	201-267, R66, D186	224-183, F41, D128	179-228, CC49,D304
XGC	142-136, F6, D90	144-111, F33, D197	111-107, F4, D111
NM			
TF	222-294, R72, D139	292-312-261,CV31,D79	179-146,CC33,D235
JL	154-246, R92, D149	230-232, R2, D183	142-97, F45, D73
GG	220-263, R43, D191	275-232, F43, D244	203-160, F43, D167

xiia. ...**fa2+zi0 hao3**... `Please repeat `the method is fine'.'

TM	**fa2**	**zi0**	**hao3** T203
LZC	112-111, F1, D179	123-114, F9, D84	114-108, F6, D378
GMH	197-173, CC24,D164	201-199, F2, D76	201-160, F41,D163
PLD	**228-265, R37, D103**	**232-220, F12, D57**	**169-175, CC6,D273**
XGC	156-126, F30, D234	158-128, F30, D182	126-101, F25,D188
NM			
TF1	**224-302, R78, D259**	**302, L, D54**	**195-72, F123,D200**
TF	**228-285, R57, D137**	**183-177, F6, D75**	**189-175, CC6,D273**
JL1	152-138, CC14,D119	246-261, R15, D84	72-80, R8, D108
JL	185-140, CC45,D143	220-250, R30, D120	58-60, R2, D46
GG1	**220-253, CC33,D236**	**214-250, R36, D167**	
GG	**197-244, R47, D215**	**222-240, R18, D160**	**208-210, R2, D109**

Syllable duration measurements of the data suggest that both speaker groups share the range of syllable weights proposed to typify all Chinese languages, e.g. by Duanmu 1990, who argues that all stressed non-final syllables are bimoraic, all final syllables are potentially trimoraic, and completely unstressed `toneless' syllables are monomoraic. Duanmu's typology and his "no contour principle" predict that toneless syllables can support a single tone. Some of the NM evidence, such as T2 also T4 reassociation of the second toneme to the following stressless syllable, supports his view. However, in general a considerably enriched range of possible realizations of pitch on stressless syllables is attested, including contours (some of which are, to be sure, phonetically longer than average.)

Evidence from 40 Chinese languages and dialects presented in Davison 1989 shows that distribution of the two parametric values of phonetic default tone realization + interpolation and/or spreading vs. phonological default tone assignment is areal, not genetic, inasmuch as Chinese languages found north of the Yangtze generally follow the Northern Mandarin pattern, those south of the Yangtze the Taiwanese/Taiwanese Mandarin one. The widely dispersed group of genetically related Mandarin dialects thus is split in two. Borderline Jin Mandarin dialects show both values (Huojia) or spread tones to toneless syllables phonologically (Changzhi), see Davison 1989 & 1990.

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2. Additionally, one systematic exception may be noted. In (9iv) 4/5 TM speakers (as well as 3/3 NM speakers) produced a rising tone across the stressless syllable, the syllable itself being of unusually long duration, in the range of 113-294 milliseconds, with 6/8 tokens over 200 ms in length. The standard analysis of this example is that the word **tai+zi** \`prince′ has two fully-toned syllables, T4 + T3, and that in the sequence tai+zi hao \`the prince is fine′ the T3 T3 sequence undergoes the Mandarin third tone sandhi rule. Elsewhere the **zi** of **taizi** resembles a stressless syllable, being short of duration and acquiring pitch as for stressless syllables, cf(9vi-viii).

3. Due to space considerations the table does not include values for the difference in Hz between the endpoint of the tone on the first syllable and the beginning point of the point on the second syllable; and the endpoint of the tone on the second syllable and the beginning point of the tone on the third syllable. These numbers, easily calculated, are twice as large for NM as TM speakers, hence the interpretation of NM as H-L-H vs. TM as H-M-H.

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RE-EXAMINING CONTOUR TONE UNITS IN CHINESE LANGUAGES[1]

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0. Introduction

An often assumed typological distinction between African and Asian tones is that in the former, contour tones are analyzable as sequences of level tones (e.g. rise=LH, fall=HL, etc.), while in the latter contour tones may behave as a unit. Main arguments for 'contour tone units' (CTU) are nicely summarized in Yip (1989), and repeated below

(1) a. Free occurrence of contour tones on nonfinal syllables
  b. Dissimilation between contour tones due to the OCP
  c. Contour tones as a unit in initial association
  d. Contour tone spreading

The bulk of evidence is drawn from Chinese. (1a) is true in most Chinese dialects.[2] (1b) is found in Tianjin, among other dialects. (1c) is found in Wuxi. (1d) is found in Danyang.

In this paper I argue against CTU. For reasons of space, I will focus on Yip (1989), and ignore other proposals for CTU. First, I argue that (1a) is true only in those Chinese languages in which regular rimes are heavy, but not in those where regular rimes are light. Second, I show that 'dissimilation' between contour tones is sporadic and so cannot be attributed to general principles like the OCP (Obligatory Contour Principle). Third, I show that (1c) is analyzable without assuming CTU, as is evident in dialects neighboring to Wuxi. Finally, I argue that the notorious Danyang pattern [42 42...][3] does not result from spreading [42] from the first syllable, but largely from a rule [24 24]-->[42 24], which applies to underlying [24 24 ...]. I will also show that occurrences of [42 42...] decrease rapidly as the domain becomes longer, contrary to the spreading analysis.

I conclude that there is no CTU in Chinese. Two implications follow. First, the difference between Asian and African tones is smaller than previously thought. Second, arguments for 'contour segments' in general are weakened.

1. Arguments for CTU (Yip 1989)

The first argument for CTU comes from the observation that, while in African languages contour tones occur mostly in domain final positions, in Chinese languages contour tones may occur anywhere. Consider a Mandarin example

(1)	LH	LH	
	he	lan	'Holland'

Yip assumes that the tone bearing unit (TBU) in Chinese is the syllable, rather than the moraic segment. The Mandarin word for 'Holland' is a single morpheme. It has two syllables, each carrying a rising tone. According to the customary Association Conventions (e.g. Pulleyblank 1986), which link tones to TBUs one to one, from left to right, we expect the following

```
(2)   LH    LH   -->   *L    H(LH)
                        |     |
      he    lan         he    lan
```

where the first syllable gets L and the second syllable H (ignoring the excess tones). But this is incorrect. (1) is the only correct pattern. To reconcile (1) with the Association Conventions, Yip suggests that LH in Mandarin is a CTU (which we write with underline). A CTU counts as a single unit during the association process. The derivation of (1) is thus as follows

(3) $\underline{\text{LH}}$ $\underline{\text{LH}}$ --> $\underline{\text{LH}}$ $\underline{\text{LH}}$

```
(3)   LH    LH   -->   LH    LH
                        |     |
      he    lan         he    lan
```

It is worth noting that Yip stipulates that the composition of a CTU is restricted to two elements, either $\underline{\text{HL}}$ or $\underline{\text{LH}}$. We will return to this point.

The second argument for CTU comes from the observation that successive contour tones often dissimilate. In Tianjin (Li & Liu 1985), for example, we find[4]

```
(4)   HL    HL   -->   L     HL
      jian  zhu        jian  zhu        'building'
```

where a fall becomes L before another fall. Similarly, Tianjin has [L L]-->[LH L] and [LH LH]-->[H LH]. Yip attributes such sandhi rules to the Obligatory Contour Principle (OCP, McCarthy 1986)

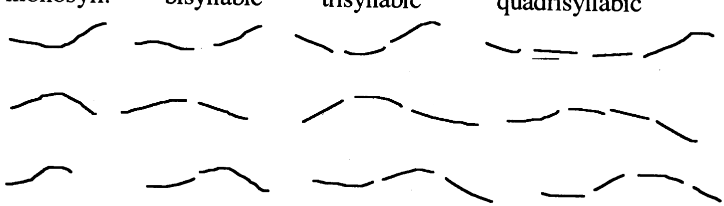
(5) The OCP: *[X X], where X is any feature.
E.g. *[L L], *[$\underline{\text{LH}}$ $\underline{\text{LH}}$], *[$\underline{\text{HL}}$ $\underline{\text{HL}}$], ...

As Yip points out, in order to apply the OCP to Tianjin, it is crucial that the falling tone in (4) is a CTU $\underline{\text{HL}}$, and not a cluster HL.

The third argument for CTU comes from Wuxi, where, according to Yip, a contour tone may behave as a unit in initial association. Relevant phonetic data is given in (6) (adapted from Chan & Ren 1986), with Yip's analysis in (7)

(6) monosyll. bisyllabic trisyllabic quadrisyllabic

a.
b.
c.



```
(7)  monosyll.     bisyllabic     trisyllabic     quadrisyllabic
a.     L LH          L LH          L   LH          L       LH
        \/           |  |          |    |          |        |
        $            $  $          $  $  $         $  $  $  $
```
(In (7), each LH is underlined.)

```
b.   LH L      LH L      LH   L      LH      L
      \/       |  |      |    |      |       |
      $        $  $      $  $  $     $  $  $  $

c.   L HL      L HL      L   HL      L       HL
      \/       |  |      |    |      |       |
      $        $  $      $  $  $     $  $  $  $
```

Two assumptions are made. First, tone-to-syllable association in Wuxi is 'edge-in' (Yip 1988). Second, the pitch of the toneless syllables depends on the interpolation between the tones at the two edges, e.g. low in (7a), gradually falling in (7b), and gradually rising in (7c). As Yip suggests, in order for the first syllables in (7b) to have a rise, <u>LH</u> must be a CTU. Similarly, Yip postulates a CTU <u>LH</u> in (7a) and <u>HL</u> in (7c). It will be noted that Yip's (7c) does not quite agree with the contours in (6c). We will return to this later.

The final argument for CTU comes from Danyang (Lü 1980), which, in several people's view, presents a strong case for the highly rare phenomenon of contour tone spreading (e.g. Chen 1986, Chan 1988, Bao 1990). Relevant patterns are given below

(8)

	Bisyllabic	Trisyllabic	Quadrisyllabic
a.	11 11	11 11 11	11 11 11 11
b.	42 11	42 11 11	42 11 11 11
c.	42 24	42 42 24	42 42 42 24
d.	33 33	33 33 33	33 33 33 33
e.	24 55	24 55 55	24 55 55 55
f.	55 55	55 55 55	55 55 55 55

Danyang is a Wu dialect of Chinese. Usually, in a Wu dialect, the tones of a multisyllabic domain are determined by the underlying tones of the initial syllable, while the underlying tones of noninitial syllables are deleted.[5] The patterns in (8) seem to show tone spreading from the initial syllable to noninitial ones. (8a,b) show L spreading, (8d) M spreading, and (8e,f) H spreading. Of special interest is (8c), which seems to spread a contour tone [42], or HL, from the initial syllable. Yip's analysis of (8c) is as follows

```
(9)a. HL LH        b. HL  LH        c. HL LH        d.  HL LH
         |            |    |            |\  |            /|\  |
         $            $    $            $ $ $            $ $ $ $
```

The initial syllable has two underlying CTUs, which are associated to the syllables 'edge-in'. Finally, <u>HL</u> spreads rightward to the toneless syllables.[6]

Having reviewed Yip's arguments for CTU, I now present arguments against CTU.

2. Arguments against CTU

2.1. Let us look at the issue of free occurrence of contour tones first. It is true that contour tones indeed occur freely on almost any syllable in most Chinese languages, yet in the Wu family of Chinese, contour tones do not occur freely. In

New Shanghai, for example, we find the following (Xu et al 1988, Selkirk & Shen 1990, among others)[7]

```
(10) Monosyllabic   Bisyllabic   Trisyllabic   Quadrisyllabic
a.     HL           H L          H L           H L
       V            | |          | |           | |
       $            $ $          $ $ $         $ $ $ $

b.     LH           L H          L H           L H
       V            | |          | |           | |
       $            $ $          $ $ $         $ $ $ $
```

The tone of a multisyllabic domain depends entirely on the initial syllable. If the initial syllable has underlying HL, then the first syllable is H and the second L. If the initial syllable has underlying LH, then the first syllable is L and the second H. Toneless syllables will either remain toneless or get L as default, which we will ignore. Clearly, New Shanghai exhibits characteristic properties of an African tone language. Facts like (10) present a typological puzzle: Why is it that the Wu family of Chinese and African languages behave one way, while other Chinese languages behave another way? In Yip's analysis, there is no answer.

In Duanmu (1990), I suggested that the key to the typological puzzle lies in syllabic structure. Specifically, I argued that in non-Wu languages, all regular rimes are bimoraic (either the vowel is long or there is a coda), hence they may carry two tones (where the second tone may fall on an obstruent coda). In contrast, in Wu languages, all rimes are simple, i.e. there are no diphthongs nor minimal coda contrasts. Thus, in non-Wu languages, every regular syllable is inherently stressed (cf. the Weight-to-Stress Principle of Prince 1990) and so their tones survive, but in Wu languages, only the domain initial syllable has stress, assigned by rule, and hence only the tones from the initial syllable survive. In addition, I argued that an association domain is a stress domain, starting from a stressed syllable till right before the next stressed syllable; it follows that in non-Wu languages, tones seem to be syllable bound, while in Wu languages, an association domain can be much larger. The full arguments are too long to be reviewed here. The interested reader is referred to Duanmu (1990, 1992).

One final point before we leave this issue. As we mentioned earlier, Yip stipulates that a CTU may consist of just two elements, LH or HL, but not more. This stipulation is based on the fact that complex contour tones, such as LHL or HLH, rarely occur in nonfinal positions. In my analysis, the rarity of complex contour tones follows from the fact that regular rimes in non-Wu languages are bimoraic, so they can carry just two tones. In phrase final positions, a rime may be lengthened to trimoraic, where a complex contour tone may occur.

2.2. Next we consider dissimilation between contour tones. To attribute such an effect to the OCP, one is making an assumption that the OCP holds for all tones in a specific language, or perhaps for all languages. But neither part of the assumption is correct. Consider Tianjin again (Li & Liu 1985)

(11)	Tones on isolated syllables:		21	45	213	53
	Sandhi rules:	a.	21 21 --> 213 21			
		b.	213 213 --> 45 213			
		c.	53 53 --> 21 53			
		d.	53 21 --> 45 21			
		e.	45 45 (no change)			
		f.	21 53 (no change)			

If the OCP applies in (11a-c), why does it not apply in (11e)? And if (11d) is due to the OCP on two falling tones, why is there no change in (11f), where we have the same two tones as in (11d), only in a different order? Similarly, consider Beijing Mandarin below

(12)	Tones on isolated syllables:	55	35	214	51	
	Bisyllabic expressions:	a.	55 55 (no change)			
		b.	35 35 (no change)			
		c.	214 214-->35 214			
		d.	51 51 (no change)			

Of the four Beijing Mandarin tones, only 214 dissimilates before another 214. Other tones do not change. It is thus hard to attribute (12c) to the OCP. What is more, Tianjin and Beijing Mandarin are sister dialects. 53 in (11) and 51 in (12) are historically related, and their apparent phonetic difference is perhaps only due to transcribers' idiosyncrasies. Now if 53 is a CTU in Tianjin, 51 must also be a CTU in Beijing. Why then, does the OCP apply in (11c) but not in (12d)?

Clearly, dissimilation between contour tones is a sporadic phenomenon. It is not attributable to any general principle, but must be due to language particular idiosyncrasies. Therefore, occasional dissimilations between contour tones is no strong evidence for CTU.

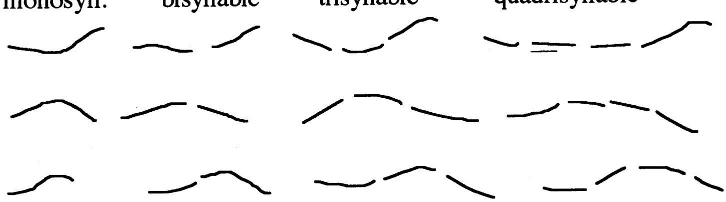
2.3. Next we examine CTUs as initial association units. The phonetic data of Wuxi is repeated in (13). Clearly, (13) is open to different interpretations

(13) monosyll. bisyllabic trisyllabic quadrisyllabic

a.

b.

c.



First, (13c) need not be L<u>HL</u>, but simply LH, which in a multisyllabic domain is linked to the first two syllables. This is shown below

```
(14)   LH        L H(L)      L H          L H
       \/        | |         | |          | |
       $         $ $         $ $ $        $ $ $ $
```

In the bisyllabic domain (or in all multisyllabic domains), the final syllable gets an additional L, due to domain final effect perhaps, which we will ignore. Like Yip, (14) also assumes that the pitch contours of toneless syllables are determined by interpolation. It can be seen that (14) agrees with the phonetic data better than Yip's (7c).

Next consider (13a). We need to explain why the last syllable carries a contour tone LH. I suggest the following analysis

(15)

LH	LH	L H	L H
\$	\$ \$	\$ \$ \$	\$ \$ \$ \$

There are two level tones, L and H, which are linked to the first and last syllables by edge-in association. Then L spreads rightward to all syllables. One may wonder if it is possible for a language to have two ways of association, left-to-right in (14), and edge-in in (15). The answer is yes. Independent evidence is seen in New Shanghai, a neighboring Wu dialect. We have seen in (10) that New Shanghai has left-to-right association. In a third pattern, association may be either left-to-right, or edge-in, as shown below (Xu et al 1988)

(16) a.

```
L              H
ba?  ço  gõ  tsz
11   22  22  13
```

b.

```
L    H
ba?  ço  gõ  tsz
11   55  33  31
```

'Snow White'

Like (10b), the initial syllable in (16) has underlying LH. But unlike (10b), which has just one pattern, (16) has two optional patterns. In (16a) the association is edge-in, parallel to (13a) in Wuxi. In (16b) the association is left-to-right. Why is it that (10b) and (16) have different ways of association, even though their initial syllables are both underlyingly LH? The answer seems to be segmental. Patterns like (16) occur only when the initial syllable has a glottal vowel, and patterns like (10b) occur when the initial syllable has a non-glottal vowel. How exactly vowel features affect the way of association is beyond the scope of this paper. But there is little doubt that a language can have more than one way of association.

Finally, we look at (13b). The question here is why the initial syllable takes two tones, i.e. rise=LH. Again, a comparison with neighboring dialects gives us insight. Consider the corresponding patterns in Old Shanghai (spoken by elderly people) and New Shanghai (spoken by younger people)

(17) Old Shanghai (Shen 1981, 1982)

a.

```
L    H
lo   kʷõ ŋe
13   55  31
```

or b.

```
L    H
lo   kʷõ ŋe
11   55  31
```

'old man's sight (presbyopia)'

(18) New Shanghai (Xu et al 1988)

```
L  H
lo kʷã ŋe
11 55  31
```

'old man's sight (presbyopia)'

The initial syllables in (13b), (17) and (18) have the same tone type[8] which is called Yang Shang.[9] In Old Shanghai (17), there are two optional patterns. In (17a) the initial syllable is linked to both tones; in (17b) it is linked to just one. In New Shanghai (18), the initial syllable is linked to just one tone. On an isolated syllable, Yang Shang is 13 in New Shanghai, 13 or 131 in Old Shanghai, and 131 in Wuxi. In (17) and (18), Yang Shang clearly is not a CTU. It is unlikely, then, that Yang Shang is a CTU in Wuxi just because the initial syllable carries a rise. Instead, I suggest the following analysis for (13b)

```
(19)  LH(L)      LH(L)      LH (L)      LH   (L)
      \|/        \/ |       \/   |      \/     |
       $         $  $       $ $ $       $ $ $ $
```

I assume that, as in Old Shanghai and New Shanghai, Yang Shang is LH in Wuxi. In addition, both LH are linked to the initial syllable in (19), as they are in Old Shanghai (17a) (we return to this immediately). Finally, a L is added to the last syllable. The H may spread to the toneless syllables, which I leave open.

An immediate question arises. How come the initial syllable takes just one tone in New Shanghai (17), one or two in Old Shanghai (18), and two in Wuxi (19)? What happened to the Association Conventions? The answer, I suggest, is both historical and metrical. As I argued in Duanmu (1990), in non-Wu languages all regular rimes are bimoraic, while in Wu-languages all rimes are simple (i.e. no diphthongs, not minimal coda contrasts). This leads to the following scenario of historical development (for details, cf. Duanmu 1992)

(20) a. All regular rimes are heavy, hence inherently stressed, hence association domains are largely syllable bound (non-Wu languages).
b. All rimes become simple, hence there is no inherent stress. Left-headed stress is assigned by rule. Association domains become multisyllabic. Stressed rimes remain bimoraic. Unstressed rimes reduce to monomoraic (Wu languages such as Danyang, and partly Wuxi, Old Shanghai, etc.).
c. After stage b, even stressed, domain initial rimes become monomoraic (New Shanghai, partly Old Shanghai, Wuxi, etc.).

Stages (20a,b) follow directly from the Weight-to-Stress Principle (Prince 1990), which is stated as follows

(21) *Weight-to-Stress Principle*: If heavy, then stressed.

The transition from (20b) to (20c) also has a metrical explanation. As is well known in metrical phonology, a trochaic (left-headed) foot with a light initial rime is preferred to one with a heavy initial rime. Since in Wu languages stress is left-headed, it is natural that the initial rime tends to become light (to improve metrical 'harmony' perhaps, cf. Prince 1990). Moreover, the reduction of the initial rime apparently happens to some syllable/tone types earlier than to others. For example, in New Shanghai, all initial syllables have become light. In Old Shanghai, initial Yin Qu (voiceless onset and LH) remains bimoraic, Yang Shang (voiced onset and LH) optionally bimoraic, and all others monomoraic. In Wuxi, initial Yang Shang (13c) (voiced onset and LH) remains bimoraic, but Yin Shang (13a) (voiceless onset and LH) and Yang Ru (13c) (voiced onset, glottal vowel, and LH) have become monomoraic, and so on. A complete picture of the intricate interactions among segments, tonal associations, and metrical principles cannot be pursued here. Nevertheless, from a historical and metrical perspective, the following outline seems evident to me: The TBU in Chinese is not the syllable, but the mora.[10] The initial syllables in Wu languages are becoming monomoraic, guided by metrical principles, with New Shanghai at the final stage of this process.

2.4. Finally, let us examine contour tone spreading in Danyang. We will focus on the pattern [42 42...24]. Consider bisyllabic combinations first (all data are from Lü, the only original author)

(22) Source of [42 24]: Mostly from [24 24] or [55 24] origins

	Ap,m 33	Dp 33	Bp,y 55	Cp 24	Ab,y 24	Bm,b 24	Cm,b 11/24	Dm,b,y 24
Ap,m 33								
Ab,y 24								
Bp,y 55								
Bm 24			42	24		42	24	
Cp 24			33	33		(33	33)	
Dp 33/24								
Dm 24								
Db,y 24								
Bb 24			11	11				
Cm,b 11/24			(42	24)				

The right hand column shows the tone of the first syllable. The top row shows the tone of the second syllable. Capital A, B, C and D represents the four tone types. Small letters p, b, m, and y represent voiceless obstruent onset, voiced obstruent onset, sonorant onset, and glide onset respectively. When a syllable has two tones, such as Dp, one is used in literary speech and one in colloquial speech. For the bisyllabic outputs, only those combinations in which [42 24] occurs are shown. In the double-lined box, both [42 24] and [33 33] are equally frequent. In the other two boxes, the pattern in parentheses is less frequent. Two points of interest are noted. First, a bisyllabic output depends not only on the first syllable but also the second. Second, [42 24] occurs only when the input combination is [55 55], [55 24], or [24 24]. These patterns can be derived as follows

```
(23)a. H H --> H L H        b. H LH --> H LH     c. LH LH-->(L)H LH
       | |     |/\|            | \/      |/ \|      \/  \/      |/ \|
       $ $     $  $            $  $      $  $       $   $       $  $
```

Admittedly, these rules are not of a very general nature, but they are conceivable. Besides, since tonal dissimilation is often idiosyncratic, we do not expect them to be derived by general rules.

(23) differs from Yip's (9) in that (23) does not assume CTU. The two analyses make different predictions with respect to longer domains. For (23), [42 42..24] comes from a combination of underlying 55s and 24s. Since it is less likely that a longer domain will purely consist of underlying 55s and 24s, [42 42..24] will

be less frequent. In contrast, in Yip's analysis, [42 42...24] depends on the initial syllable alone, so [42 42..24] should be just as common. Now consider trisyllabic domains

(24) [42 42 24] in trisyllabic domains after each initial tone

a.	55	37%
b.	24	21%
c.	11	13%
d.	33	4%

(24) shows the percentage of [42 42 24] after the four underlying initial tones. (24c,d) are obvious exceptions, which we will ignore. Of interest to us is (24b), where the percentage after 24 is very low. This is against Yip's prediction, and in agreement with ours. Note also that the percentage after 55 is quite high. This is again unexplained in Yip's analysis. On the other hand, an examination of the 37% tokens in (24a) shows that the last two syllables are mostly 55 or 24, and this is what our analysis expects.

Turning now to quadrisyllabic domains, our analysis predicts an even lower percentage of [42 42 42 24], while Yip's analysis predicts a considerably higher percentage. Now consider

(25) Quadrisyllabic idioms (number of tokens in parentheses):

a.	11 11 11 11	26%(23)
b.	55 55 55 55	18%(16)
c.	24 55 55 55	17%(15)
d.	42 11 11 11	17%(15)
e.	33 33 33 33	14%(13)
f.	42 42 42 24	9%(8)

(26)

24 24 24 24	24 24 24 24	55 24 55 24	24 55 24 24
24 24 24 24	24 24 55 24	55 24 24 24	55 55 24 24

Most quadrisyllabic domains are found in idiomatic expressions. Of all the tokens, eight are [42 42 42 24], which make up merely 9%. In addition, these eight tokens are all made of underlying 55 or 24, as shown in (26). In our analysis, (25) and (26) are again expected. But if [42 42 42 24] is determined by the initial syllable alone, and given the large number of syllables with underlying 24 tones (which is [<u>HL</u> <u>LH</u>] in Yip's analysis), it is totally unexplained why the percentage of (25f) is so low.

Metrical evidence also suggests that [42 42...24] does not come from CTU spreading. As Lü points out, whether an expression forms one domain or more depends, in part, on the morphological bracketing.[11] For example

(27) a. One domain: [\$][\$], [\$][[\$][\$]], [\$][[\$[[\$][\$]]]
b. Two domains: [[\$][\$]][\$], [\$][[[\$][\$]][\$]], [[\$][\$]][[\$][\$]]

In Duanmu (1991) I proposed that such domains can be derived by left-headed, cyclic stress assignment. The derivations of (27a) are given below (in the notations of Halle & Vergnaud 1987)

```
(28)                                                    x                      x
                      x            x                    (x   x         )       x
 x       x            (x   x  )    x                    x  (x    x     )       x
(x  x)   x             x  (x  x)   x                    x   x  (x  x)          x
[$][$]->[$][$]        [$][[$][$]]->[$][[$][$]]          [$][[$][[$][$]]]->[$][[$][[$][$]]]
```

In the bisyllabic structure, the stress (marked x) on the second syllable will be deleted by Clash Resolution. In the trisyllabic structure, the stress on the third syllable will be deleted on the first cycle, and those on the second syllable deleted on the second cycle, again by Clash Resolution. In the quadrisyllabic structure, the stresses on the last three syllables will all be deleted in the same way. Thus, all the structures in (28) form one tonal domain, since only the initial syllable has stress. Now consider a structure from (27b)

```
                                                 x                  x
(29)                          x                  (x   x       )     x
             x                (x      x)         x  (x      x)      x           x
           (x x)              (x   ) x           x  (x   ) x        x           x
       [$][[[$][$]][$]]-->[$][[[$][$]][$]]-->[$][[[$][$]][$]]-->[$][[[$][$]][$]]
```

On the first cycle the stress on the third syllable will be deleted. On the second cycle, the stress on the fourth syllable will survive, since it does not clash with another stress. On the third cycle, the stress on the second syllable will be deleted. So (29) forms two tonal domains ($)($$$). It can be shown that the other two structures in (27b) also form two tonal domains.

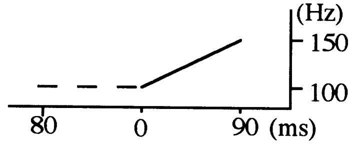
Now consider (28) again. In this analysis, the longer the domain, the greater stress the initial syllable has, and the more likely the tonal pattern will be determined by the initial syllable. This prediction agrees with the fact that the longer the domain, the fewer [42 42...24] we see. In fact, for the quadrisyllabic structure in (27a), we do not find any token of [42 42 42 24]. This again supports our analysis that [42 42 42 24] does not come from CTU spreading.

3. Final remarks

I have shown that Yip's arguments for CTU are all questionable. There have been other arguments for CTU, but they seem to me less strong, and so will not be discussed here. Now suppose my position is correct, then two implications follow. First, the typological distinction between African and Asian tone languages is greatly reduced. Second, postulations of contour features in general (e.g. Sagey 1986), which often take contour tones for their support, are weakened (cf. Steriade 1989 against contour [continuant], Herbert 1979, 1986 and Duanmu 1990 against contour [nasal]) .

Before ending our discussion, I would like to mention a highly interesting experiment reported by Greenberg & Zee (1977). What they did was synthesizing various pitch contours and asking subjects to rank how steeply they rise, from flat 1, to the steepest 6. What they found was that when a contour tone was too short, it could not be heard as a contour tone. An example is (30)

(30)



When the solid line in (30) was played, it was ranked below 2, i.e. almost a flat tone, even though the F0 has increased 50Hz. However, when a horizontal contour was added, shown by the dotted line, the combined contour was ranked over 4, i.e. a clear rise. Now since in normal speech a short vowel is generally less than 90ms long, there is a serious question of whether a short vowel can possibly carry a contour tone at all. Claims of short vowels with contour tones have often been made, particularly in autosegmental phonology (e.g. Leben 1973 for Mende, Green & Igwe 1963 for Igbo, Pulleyblank 1986 for Tiv), but such vowels often turn out to be lengthened (e.g. Innes 1969 for Mende, Ihionu p.c. 1989 for Igbo, Abraham 1940 and Arnott 1968 for Tiv).[12] Now if indeed we cannot perceive contour features on a short segment, we may have found a significant constraint in phonology: within a timing unit, each feature can occur just once.

NOTES

1 I thank the participants at the Special Session on Tonal Typology for discussions, although many did not agree with me. I also thank M.Halle, M.Kenstowicz, and Z.M.Bao for previously discussing some of the points presented here. Finally, I would like to thank M.Yip. Although I have come to a different conclusion w.r.t. contour tones, I have learned greatly from her in the past few years.

2 In this paper I use 'dialect' and 'languages' interchangeably.

3 As is customary in Chinese phonology, the digit 5 means the highest pitch and 1 the lowest. Cf. Chao (1930).

4 I follow Yip in translating Tianjin tones as follows: 45=H, 21=L, 213=LH, and 53=HL. Other translations are possible but immaterial to the present discussion.

5 Not all Wu dialects behave this way. For exposition, we will ignore those Wu dialects that behave like non-Wu dialects.

6 There are other analyses of (8c) (Chen 1986, Chan 1988, Bao 1990), all of which assume CTU spreading. Their differences are irrelevant to our discussion here.

7 Wu languages have kept voiced onsets, which go with the lower register. LH is generally 13 on the lower register and 24 or 35 on the upper register. We do not discuss register in this paper, however.

8 These patterns may occur with other tone types, which do not concern us here.

9 There are four tone types in Chinese, Ping, Shang, Qu, and Ru. A tone type is called Yin when the onset is voiceless and Yang when the onset is voiced.

10 I do not make the distinction between a mora and an X slot in the rime here.

11 In Chinese most morphemes are monosyllabic.

12 Hyman (1987) reports that in Kukuya, a contour tone on a short vowel contrasts with a contour tone on a long vowel. G.Diffloth (p.c.1992) also informed me that short vowels may carry two registers in southeast Asian languages. I leave it open how their reports are to be reconciled with the Greenberg & Zee experiment.

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Tone contours and tone clusters in Iau

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1. Contour splitters and contour lumpers. Pike (1948) established the most popular typology of tonality in tone languages when he distinguished between *register tone languages* (R-languages), as are found in Africa and the Americas, and *contour tone languages* (C-languages), as are found in East Asia. For decades these two types were regarded as so fundamentally unlike that the appellations *register tone* and *contour tone* became like linguistic blood types; there was little reward in seeking common features in these two. In R-type languages, Highs (H) and Lows (L) were taken as primitives, while contours were regarded as secondary phonological features, and these were often very changeable in larger contexts. Indeed, in general, contouring in R-languages was thought to arise by phonological rules of spreading or buildup of multiple H's and L's on domain-final syllables in polysyllabic domains (XP).[2] In C-languages, traditional and modern phonologists alike generally insisted that contours be taken as primitive, because a lexical contour can occur on potentially any syllable whether domain-final or not and, also, virtually every syllable possesses a lexical tone. In short, the spreading of pitch persuaded Africanists to regard pitch trajectories as *split* into sequences of H's and L's, whereas Asianists were more impressed with the stability of pitch trajectories attached to each syllable and choose to regard the *lumps* as phonological primitives. There are, of course, other differences between the two types—downdrift and floating tones, in R-languages, and tone splitting, tone sandhi, register phenomena and voice quality differences, in C-languages,—but in this paper, we will concentrate on the nature of contours in tone languages and not speak of other important tonal properties.

Recent work by Yip (1989), Bao (1990), Duanmu (1990, 1991, 1992), Hyman (1989) and others has extended the successes of an autosegmental analysis of R-languages to contours in C-languages. Following Sagey (1986), Yip proposes that Asian contour features can be treated like the continuancy feature in affricates—a concatenation of H's and L's with a left and right edge occupying a single organizational slot unified by a tone root tier, where the tonal root tier functions as a register feature.[3] African contours, by contrast, are directly attached to the syllable node. But both types can be analyzed as concatenations of H's and L's

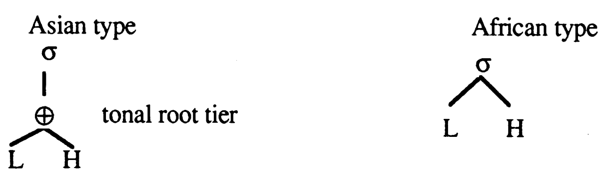

Figure 1: Asian tones and African tones

But once contours are regarded as sequences of features, the question must arise, how many tones can be associated with a single syllable/mora. At present, some theoreticians feel that there should be a one-to-one relation between the number of moras and tone bearing capacity. For instance, Duanmu (1990:101) concludes that "...in Chinese languages, there is indeed a direct relation between the tone bearing ability of a syllable and its rime length. I will argue that in at least two African languages, Igbo and Tiv, the same relation holds,...I am not aware of clear evidence that a monomoraic syllable indeed carries two or more tones without lengthening."

Against this background, we wish to introduce data from Iau, a Non-Austronesian language of Irian Jaya, Indonesia, in which the tone bearing capacity of a syllable exceeds two tones and which, indeed, demonstrate other rather remarkable tonal properties that show Iau to be neither an R-type language nor a C-type language, but a new type having properties in some respects like a combination of R-types and C-types. Because of the still limited nature of our data we will not propose a formal analysis of the tones of this language at this time.

2. Iau, a Non-Austronesian tone language of Irian Jaya. Iau is one of three varieties of Turu, an SOV Non-Austronesian language of the Lakes Plains District of Irian Jaya, Indonesia spoken by about 400 people living in the villages of Faui and Bakusi along the Van Daalan River. According to a classification by Voorhoeve (1975), Iau belongs to the Tor-Lakes Plains Stock and is an isolate with no immediate relatives. Nevertheless, there are a number of distantly related languages spoken in this same district which also have pitch contrasts. Irian Jaya and Papua New Guinea are not generally regarded as being geographic area with large numbers of tonal languages. However, Iau and some other Lakes Plains languages of this area—Kaure, Obokuitai, Sikaritai, and Doutai—all make use of pitch contrasts in their phonological system, cf. preliminary descriptions in Dommel (1991), Jenison (1991), Martin (1991), and McAllister (1991).[4] Of all these languages, however, Iau is the one with the most developed tonality.

2.1. Iau segmental phonology. Although Iau possesses a complex system of contrastive tones, it has a very parsimonious inventory of segmental sounds and is mostly monosyllabic. Of three thousand words in common use there are only about 100 bisyllabic nouns, Bateman (1991b:38). Iau possesses six consonantal segments //t k b d f s// and eight vowel segments //i ɨ ɪ e a o u ʊ//. Vowel length is not distinctive. The voiced stop segments //b d// are described by Bateman (1991b:29) as being implosive and can also be realized as nasals [m n]. There are no obvious examples of voice quality contrasts in Iau. The following exemplify the consonantal sounds: *te*^{8} 'mosquito', *ko*^{3} 'breadfruit', *bi*^{6} 'grandchild'; *du*^{9} 'wild pig'; *si*^{6} 'woman'; and *be*^{7}*fe*^{7} 'snake'.[5] All consonants occur syllable-initially and word-medially in two syllable words. //f// is realized in a variety of ways depending upon environment and geographic location such as [ɸ h x]. //f// also is found word-finally in a limited number of cases, i.e. *of*^{4} 'arm'. Examples of the vowels are: *bɨ*^{8} 'rain'; *bi*^{8} 'message' *bɪ*^{8} 'door'; *be*^{8} 'fire'; *a*^{5} 'land'; *u*^{8} 'tree'; *ʊ*^{4} 'heart'; and *o*^{7} 'sand'. The most remarkable feature of thevowelsis the fricativization of //ɨ//. The presence of a fricative high vowel appears to be typical characteristic of languages of this area as several nearby languages also have this vowel. There are also diphthongs and triphthongs in Iau, specifically //aɨ ei ai ui oi aɪ ʊɪ ae oe au aʊ aui aʊɪ//. There are copious illustrations of the segments of Iau found in Bateman (1991b:29-35).

2.2. Tone contrasts on monosyllabic nouns. Tones in Iau are used to establish lexical contrasts as well as to mark grammatical contrasts of aspect and perform other grammatical functions. As far as lexical contrasts on monosyllables are concerned, Iau possesses eight distinct pitch trajectories, two level trajectories and six with rising or falling contours, cf. Bateman (1991b).[6]

<u>Tone category</u>	<u>Tone value</u>
Tone 9	44
Tone 8	33
Tone 7	45
Tone 6	23
Tone 5	42
Tone 4	43
Tone 3	32
Tone 2	423

In Figures 2 and 3 below we have provided pitch plots of each of the lexical contrasts on nouns in verification of the auditory impressions of these tones. Tape recordings of the lexical items representative of each of the tone categories were first analyzed. Those examples are as follows: e^{9} 'grandparent'; soe^{8} 'uncle'; ty^{7} 'person'; a^{6} 'cross cousin'; vy^{5} 'initiated cross cousin'; a^{4} 'father'; y^{3} 'younger brother'; and dau^{2} 'crocodile'.[7] These items were elicited in the frames ___ si^{4} 'old ___' and $ba^{7}bu^{9}$ ___ by^{5} 'This is a ___.' Each item was repeated twice in each frame. The cassette tape recordings were played back on a Sony TCM5000 professional quality tape recorder into a CECIL speech analysis box (Jaars International, Inc.), which digitizes, amplifies and filters the signal. The CECIL box was interfaced to a MS-DOS 286 computer, which was running the CECIL speech analysis software, which extracts fundamental frequency (FØ) and intensity information. The fundamental frequency for each token of each tonal contrast was then saved as a separate file, eight tones times four repetitions of each for a total of 32 files. Using some locally developed software, we then performed a compositing operation on the data for each of the tonal categories. This compositing operation time-adjusts (for duration) and register-adjusts (for pitch height) each token to correct for uncharacteristic long, short, high, or low utterances before computing mean values over the four token utterances of each tone contrast. In this fashion the common features of the four repetitions are preserved, while features idiosyncratic to a particular token are discarded. The results of the compositing procedure were then transferred to a Macintosh (Apple Computer, Inc.) and plotted using Microsoft Excel and are shown in the figures below. Grid lines were added to make determination of tone values easier.

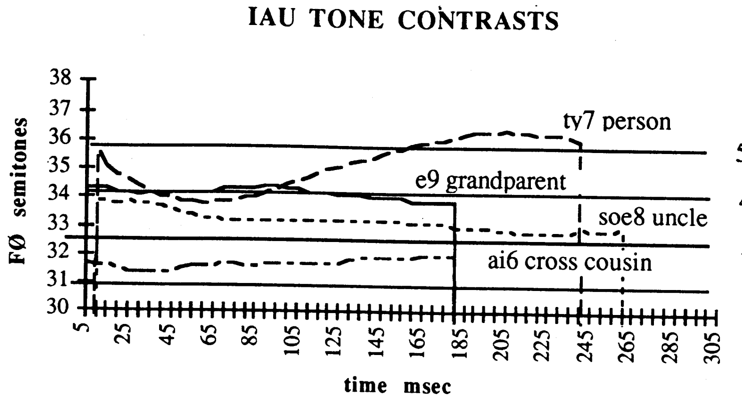

Figure 2: Plot of tone values for tone categories 6-9

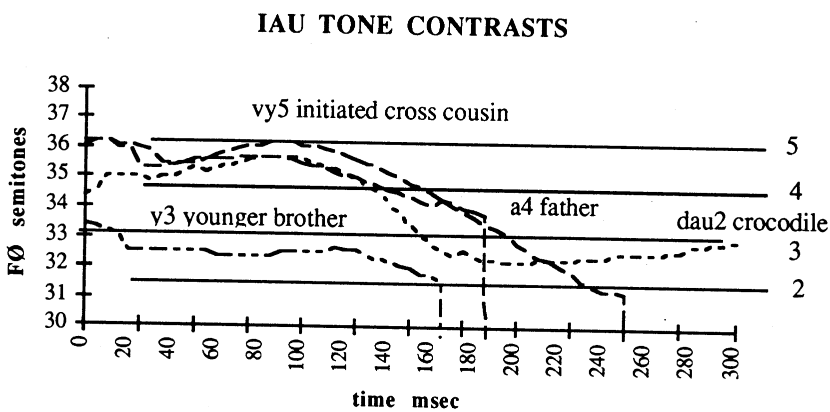

Figure 3: Plot of tone values for tone categories 2-5

Tone 9 in Figure 2 has a level trajectory at the 44 level. We found tone 8 to have a FØ basically at the 33 level with a slight tendency to fall. Tone 7 showed a mid-high to high rising trajectory achieving a level even higher than a 5. Nevertheless, we deemed a 45 to be a reasonable characterization of it. Tone 6 began at the 2 level with an unmistakable rise, although it didn't quite achieve the 3 level. Tone 4 and 5 were falling tones, both beginning somewhat higher than the 4 level. Tone 5 fell to a lower level than tone 4. Pending analysis of larger bodies of data, we will maintain the current transcription of these two tones, 42 for Tone 5 and 43 for Tone 4. Tone 3 demonstrated a level 3 trajectory for the first two-thirds of its course followed by a fall to the 2 level. Therefore, we transcribe as 332 or more simply 32. Tone 2 has the only tone trajectory with a change of direction. Like Tone 5 and Tone 4 it begins slightly higher than level 4 and drops to 2 before rising. The results of this instrumental analysis confirm strongly the tone values assigned by Bateman (1991b) to the eight tone categories in Iau. The only systematic discrepancy seems to be that the falling tones begin slightly higher than described in Bateman (1991b). Tone 2, whose trajectory changes direction, was also the longest.[8]

2.3. Tone contours versus tone clusters. In addition to the eight lexically determined tones that can occur on noun forms, there are also some nouns that possess tone clusters or combinations of some of the eight basic tone trajectories. Consider, for example, the following contrasting sentences: *da⁷doe⁹* 'see a dog'; *da⁸doe⁹* 'see the sky'; *da⁸⁻⁴doe⁹* 'see a mountain'. 'Dog' in Iau is *da⁷*, 'sky' is *da⁸*; but 'mountain' *da⁸⁻⁴* has the same segmental form as these with a pitch trajectory consisting of a tone 8 followed by a tone 4, each lasting about a demisyllable. Instrumental confirmation of this auditory impression is found in Figure 4 in which one token of the three two-syllable sequences are compared in fundamental frequency trajectories.

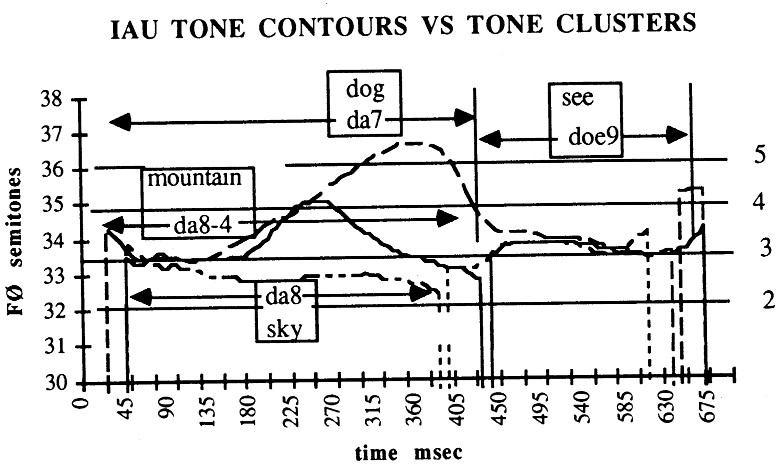

Figure 4. Tone contours vs. tone clusters.

Note first that it is easy to identify the syllable *doe⁹* 'see', which begins for all three sentences at a point about 400-450 msec into the syllable with pitch height 44, lexical tone 9. By contrast, the direct object NP 'dog', 'sky', and 'mountain' are segmentally identical but distinct in pitch trajectory. The item 'dog' *da⁷* is indicated by a rising tone starting below level 4 and ascending above level 5 (i.e., 45), whereas the item 'sky' *da⁸* shows a level pitch at the 3 level (i.e. 33). However, the noun 'mountain' in Iau has a pitch trajectory that is unlike any of the eight contours described in Figure 2 or Figure 3 above. As one can see, 'mountain' is composed of two stretches, a concatenation of two of the eight elementary tone contours in the length of a single syllable. The first half of the syllable (0-175 msec) has a 33 level pitch, whereas the second half—after a transition period—possesses a 43 falling pitch (225-400 msec). This one syllable thus is composed of a concatenation of two tones from the list of lexical tones, tone 8 followed by tone 4.

Another example of tone clustering on a monosyllabic noun is found in the example *sae*[6-4] 'machete' in the frame *sae*[6-4]*doe*[9] 'see the machete', which should be contrasted with *sae*[7]*doe*[9] 'see the brother-in-law' and *sae*[6]*doe*[9] 'see the spirit'. The two syllable sequences are plotted in Figure 5.

IAU TONE CLUSTERS

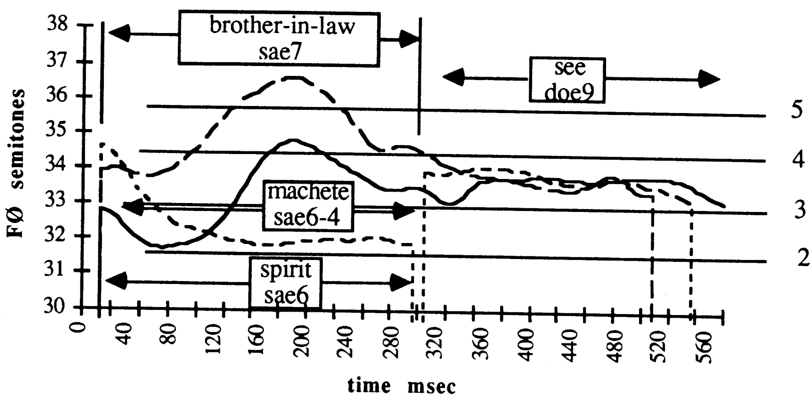

Figure 5: Tone clusters in Iau.

As before, the boundaries of the first syllable are easily recognized. 'Brother-in-law' has a 45 rising course (tone 7); whereas 'spirit, ghost' rises from 2 to 3 (tone 6). However, 'machete', possesses not one of the lexical tones, but rather a concatenation of 6 followed by 4, that is to say a 23 followed by a 43 drop.

2.4. Tone contours to mark verbal aspects. Iau verbs in a context have aspect marking and that aspect marking is signaled by a tone. Bateman (1986:3-6) describes the aspect system of Iau as:

	Punctual	Durative	Incompletive
Totality of Action	Tone 9 (44)	Tone 3 (32)	Tone 7 (45)
Resultative	Tone 6 (23)	Tone 8 (33)	---
Telic	Tone 5 (42)	Tone 2 (423)	Tone 4 (43)

Tone category and tone value in parentheses.[9] As the table makes clear, there is a tone used to signal each of eight verbal aspects.

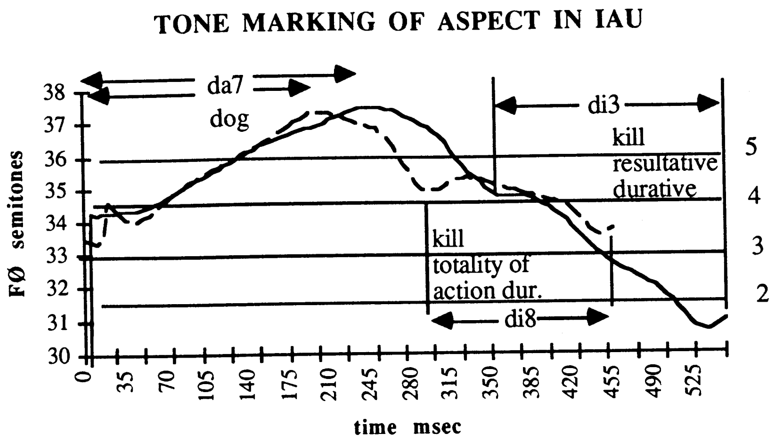

Figure 6: Aspect marking with tones in Iau

In Figure 6 we have indicated those portions of the pitch tracks that correspond to 'dog' da^7. The latter half of the tow tracks correspond to di^8 'kill-resultative durative' and di^3 'kill-totality of action durative' respectively. As is evident, the resultative-durative aspect corresponds to a 32 falling pitch, whereas the totality of action durative corresponds to a 33 level with some fall toward the end.

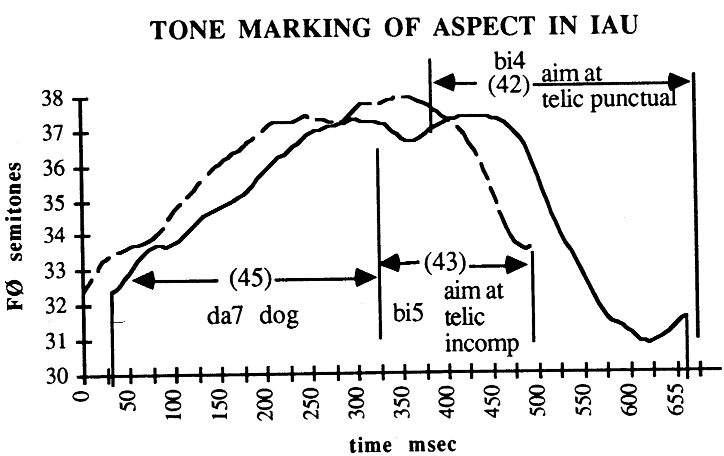

Figure 7: Aspect marking in Iau

2.5. Tone clusters to mark verbal aspects. Not only is pitch used to mark the system of verbal aspects in Iau, more than one verbal aspect may be combined on a single verb. In Section 2.2 we have noted that there can be *lexical tone clusters* associated with some monosyllabic nouns such as *da*$^{8-4}$ 'mountain'. Iau also possesses *grammatical tone clusters*, i.e. two aspects can be composed on one monosyllabic verb stem, cf. Bateman (1986:37-42). There are at present eleven possible combinations of aspect marking tones: 9-3, 9-8, 6-3, 6-8, 6-4, 7-3, 7-8, 7-4, 8-5, 8-4 and 4-7. Consider, for example, the aspect tone 8-4 as it contrasts to the aspect tones 3 and 8 in the sentences:

1. a. O^7 fai^9 ta^9 be^7 baui^3. 'We came to the end of the sandbar.'
sandbar end come to (Process)
b. O^7 fai^9 ta^9 be^7 baui^8. 'We had come to the end of the sandbar.'
sandbar end come to (Res-Dur)
c. O^7 fai^9 ta^9 be^7 baui$^{8-4}$. 'We finally reached the end of the sandbar.'
sandbar end come to (Inter-goal)'

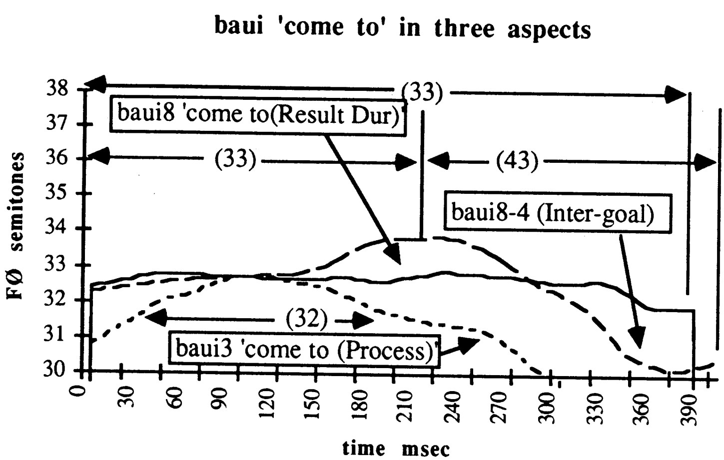

Figure 8: Compound aspects in Iau.

The evidence to date indicates that words evidencing tone clusters in Iau are monosyllabic. Phonetically at least, syllables with clustered tones are not appreciably longer than syllables with simple contours. In fact, the initial or final part of a tone contour in a clustered tone seems to last about one-half as long as a syllable as simple syllables. This timing suggests that only one syllable is involved. Historically, it is not unlikely that some words with clustered tones may have originally come from disyllabic forms. For example, one etymology of the word *da*$^{8-4}$ 'mountain' may be *da*^{8}*a*^{4} 'sky-father' with the subsequent collapse of the second syllable under maintenance of that syllable's tone contour.

3. Typological implications. The tonal system of Iau represents a new type unlike either the African register system or the Asian contour system It is like

the Asian system in that contours can occur on syllables in isolation, which is one of the hallmarks of a contour tone language, Yip (1989). It is unlike Asian systems in that there is no obvious division into an upper and lower subset of categories.[10] It is African-like, in that there exist complexes that can be assigned to a given syllable. Moreover, some kinds of words, perhaps verbs, may have no lexical tone attached to them. It is just that the combining units appear themselves to be contours with possibly an internal structure. Note, however, that the combinations or tone clusters cannot have the internal organization as exhibited by either R-languages or C-languages, cf. Figure 1. The combinations are not just of atomic H's and L's—though this kind of combination also exists—but that contours are combined.

The capacity of Iau syllables to bear tones is extraordinarily large. It has been suggested that languages such as Iau must possess polymoraic syllables to support such massively laden syllables. It is notable, as Duanmu San (p.c.) has pointed out to us, that syllables in Iau can be as much as 400 msec long. It is also significant that Iau demonstrates two triphthongal syllable rimes //aui auɪ//, which would also indicate a complex rime structure.

As far as we know, Iau is the only language that shows clustering of contours, i.e. syllables whose pitch trajectories are composed of two tone contour categories in a single syllable. If there are more such examples, then perhaps we expand our typology to include Register-languages, Contour-languages and Clustering-languages.

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[1]This study of the tonality of the Iau language is a collaborative effort. The first author was made aware of the complexities of Iau by Helen Miehle in 1988. At that time, we decided to undertake an instrumental examination of Iau data. In late 1991 she elicited the help of Janet Bateman and the study began. Tape recordings for the instrumental part of this paper were supplied by Janet Bateman and Helen Miehle. Draft versions of the paper were then circulated among authors via fax. Most of the information about Iau—both raw data and assignment to linguistic categories—comes from Janet Bateman, who has been working on the Iau language for about 10 years. As of 1990, she has been spent about 48 month of village time in Faui working intensively on the Iau language under the auspices of a project conducted by the Universitas Cenderawasih, Irian Jaya, Indonesia and the Summer Institute of Linguistics. Helen Miehle provided original impetus for this paper, some very significant ideas to its central point and crucial bibliographic references. We also wish to thank our native speaker helpers, Das and Sakadia of Furu.

[2]Duanmu (1991b:1) cites the famous case of Margi discussed by Williams (1971/6), which shows the spreading of tones from a verb stem to the toneless causative form.

[3]C-type languages often divide tone categories into upper and lower sets, e.g. mid-to-high rising (35) and low-to-mid rising (13); some may be associated with voice quality differences.

[4]Eunice Pike of SIL (p.c.) has informed us about several additional tonal languages of Irian Jaya. These include: Abun found in the northern Bird's Head, current field work underway by Keith Berry; Irarutu located in the Arguni Bay area, currently being investigated by Takashi Matsumura; Tause of the Western Lakes

Plains, study by Peter Munnings; and Mairasi east and north of Kaimana, Kabupaten Fak Fak, being studied by L. Peckham. Edopi, which seems to be the language most closely related to Iau, is also tonal. LaLani Wood of SIL, Indonesia (p.c.) has also stated that a majority of the 250 languages of Irian Jaya possess some aspects of tonality in their sound systems.

[5]Tone categories are indicated with raised numbers from 2 through 9.

[6]Janet Bateman has used the system of transcribing the phonetic value of tonal heights and contours, whereby 1 is the highest level and 5 is the lowest, cf. Pike (1948:45). Contours are described by means of a two number sequence separated by a dash, e.g. be4-3 'belt', in which 4-3 represents a midlow to mid rising tone. In this paper we have used the more familiar Five-Level System of transcribing tones developed first by Y. R. Chao (1930), in which 55 is a high level tone, 11 a low level tone, and 45 a midhigh to high rising tone. Following Bateman's work we use the digits 2 through 9 to signify phonological tone categories.

[7]We use the orthography used by Bateman, which is identical to that employed by the Dani, a Non-Austronesian language of the area with a large population.

[8]There are also some changes of tone values in context. For example, there is a general tendency toward downdrift toward the ends of domains. Also in a sequence of two syllable with tone 7, the second is somewhat higher, i.e. updrift.

[9]The semantic interpretations of these aspects is the subject of Bateman (1986a). She uses the system developed by Comrie (1976:3), who defines aspect as 'different ways of viewing the internal temporal constituency of a situation.'

[10]We hope to be able to discuss this issue in historical and comparative detail soon. We are currently awaiting more detailed information about neighboring languages. In general, these languages should be very interesting for historical linguists, as these languages must once have had complex morphology that has turned into tonal contrasts.

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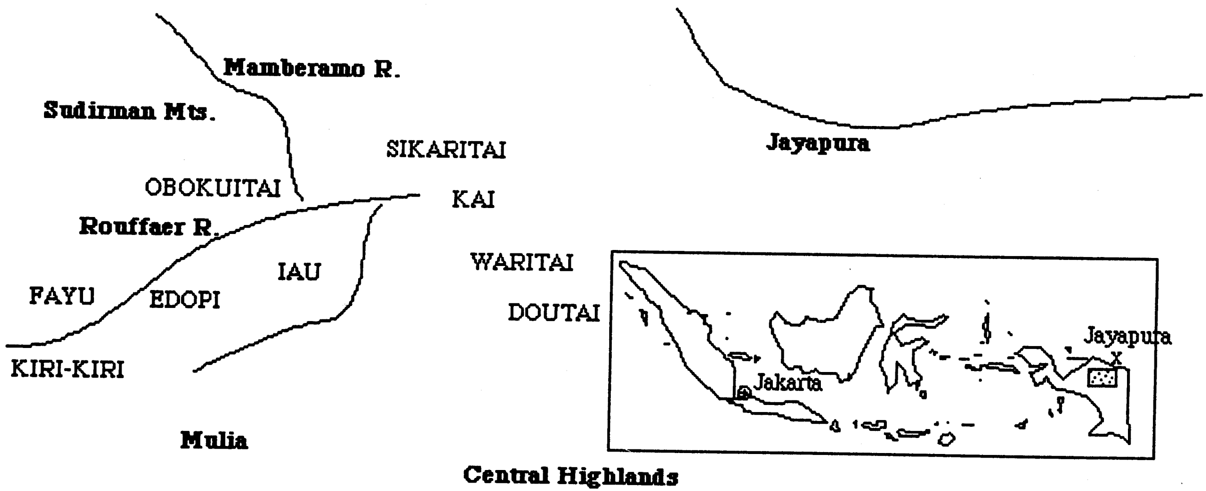

Map: The Lakes Plains District with Geographic features and Government centers in bold; language names in capitals.

Transparent Low Tone in Tuki

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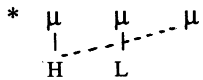
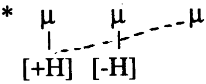
1. Introduction

Since the earliest work in autosegmental tonology, it has been assumed that tonal association lines may not cross. As one consequence of this prohibition, a rule would be impossible such as (1a), where a H tone spreads rightwards across a L tone and onto the following non-adjacent tone-bearing unit (henceforth, mora):

(1) a. *

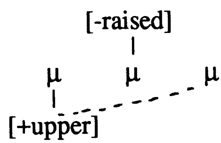


b. *



However, (1) is ruled out by the line-crossing constraint only if H and L represent two values of the same feature on the same tier (say [±H]), as in (1b). The problem is that most researchers on tone do not assume that H and L tones are distinguished by the two values of a single binary feature as in (1b). Instead, two different tone features are generally assumed. Following Pulleyblank's (1986) use of features originally proposed by Yip (1980), the same process can be expressed as in (2).

(2)



As now generally assumed for almost all features, [upper] and [raised] are on separate tiers, as shown.[1] As a result, H (=[+upper]) can spread to the third mora in (2) without creating a violation of the line-crossing constraint.

Assuming still that the process in (2) is an impossible one, it is necessary to look elsewhere for an explanation. The typical response has been to develop adjacency constraints such that certain elements cannot be skipped over (i.e. they cannot be "transparent") to the relevant processes (see especially Archangeli and Pulleyblank 1986). Logically, there are two possibilities in this case: (a) structural: a tone may not skip over a mora, i.e. the trigger and target moras must be adjacent; or (b) featural: a H may not skip over a L—even though no line-crossing results in the formulation in (2). The structural account is inadequate, at best. There are numerous Bantu languages in which a tone is drawn to a designated mora (generally identified as carrying an accent). This may result in a H spreading to the penult over several intervening moras. Thus, if moraic adjacency is ruling out (2), it must be because there is no "accent" on the third mora to attract the H. On the other hand, it would be sufficient to derive (2) if one were to stipulate that any mora following a H-L sequence is accented—followed by a rule spreading a H to the accented mora. Could such a rule "go through" a L tone mora?

If not, then there must be some other reason why a L can block a H from spreading—if in fact this is the case. The problem is that relevant examples of this sort appear to be quite limited.[2] In this paper we shall argue that the L tone feature CANNOT by itself block spreading of H tone to the right. The example we shall discuss comes from the Kombe dialect of Tuki, a Bantu language spoken in Cameroon (and classified as A.64 by Guthrie 1967-1971).[3] We shall show that in a very specific environment in Tuki, a H may spread to the right even though it crosses the L tone of the first person singular nasal prefix N-. The paper is organized as follows. In §2 we present the basic tone system of Tuki, particularly as manifested in verbs. In §3 we present the problem of the first person singular prefix N-. In §4 we provide a fuller presentation of the morphophonemics surrounding N-, and in §5 we discuss alternative solutions to the non-transparency of L tone. We conclude in §6 by discussing the relevance of these findings to autosegmental theory as well as to the study of Bantu tone.

2. Tuki tonology

In this section we present the basic properties of tone in the Kombe dialect of Tuki. [4] Most of our discussion centers around the verbal tonology, which in many respects resembles that of the Tiv system, as described by Pulleyblank (1985).

On the surface, Tuki has H, L and (downstepped) ꜝH tone. While HL falling tones do occur, LH rising tones are much rarer and appear never to occur on a single mora. As we shall discuss below, only vowels (henceforth "moras") can carry tone in Tuki. Since there is a vowel length contrast in Tuki, CVV syllables count as two moras, while CV syllables count as one. There are no consonant clusters in Tuki other than the NC sequence we will be treating below.

We begin by establishing that there are two tonal classes of infinitives in Tuki:

(3)	a.	ò-mwà	'to shave'	b.	ò-nyá	'to eat'
		ò-byà	'to bring'		ò-fá	'to give'
		ò-dìngà	'to love'		ò-túmâ	'to send'
		ò-gùrà	'to crush'		ò-dángâ	'to lose'
		ò-ryàmànà	'to dream'		ò-bángénà	'to break'
		ò-fùnùnà	'to wake up (tr.)'		ò-báráfyà	'to forget'

The forms in (3) begin with an infinitive prefix o- and contain one, two or three stem syllables. They all end in an inflectional final vowel morpheme -a which we shall not separate from the base by a hyphen. All tones are L in (3a). By contrast, there are up to two H tones in the forms in (3b). To account for this opposition, we recognize an underlying L vs. H opposition on verb roots, as in (4).[5]

(4)	a.	-mw-	-by-	-ding-	-gur-	-ryaman-	-funun-
		L	L	L	L	L	L
	b.	-ny-	-f-	-tum-	-dang-	-bangen-	-barafy-
		H	H	H	H	H	H

In the case of the L tone roots in (4a), the L links to the first vowel of the verb stem. Both the infinitive prefix o- and any subsequent stem vowels receive L by default. In the case of the H tone roots in (4b), the stem tones are derived as in (5).

(5)	a.	-nya	-tuma	-bangena	
		H	H	H	UNDERLYING
	b.	-nya	-tuma	-bangena	
		|	|	|	
		H	H	H	TONE LINKING

c. -tuma H -bangena H H TONE SPREADING

d. -bangena H L DEFAULT L TONE

e. -tuma H L BOUNDARY L% TONE

As seen in (5a), these verb stems begin with an unlinked H tone attributable to their verb root. The unlinked H links to the first vowel of each verb stem in (5b), followed by the application in (5c) of the H tone spreading (HTS) rule in (6).

(6) μ μ
H (L)

A H spreads onto a following mora.[6] In (5d) default L tone is assigned in the one case where a mora remains toneless. Finally, in (5e), a L boundary tone (L%) links to a prepausal mora whose H tone is also linked to the penultimate mora, as in (7).[7]

(7) μ μ
H L%

In all other cases the prepausal L% is assumed to be present, but unable to link.

In Tuki, different verb forms may have either no tone other than on their root, as in the infinitive, or they may in addition have a H suffixal tone. A tense which falls into the latter category is the distant past (P3), exemplified in (8).

(8) a.	à-mà-mwǎ	'he shaved'	b.	à-mà-nyá	'he ate'
	à-mà-byǎ	'he brought'		à-mà-fá	'he gave'
	à-mà-dìngá	'he loved'		à-mà-túmá	'he sent'
	à-mà-gùrá	'he crushed'		à-mà-dángá	'he lost'
	à-mà-ryàmánâ	'he dreamed'		à-mà-bángénâ	'he broke'
	à-mà-fùnúnâ	'he woke up (tr.)'		à-mà-báráfyâ	'he forgot'

In (8a) we see that the L tone verb stems acquire a H on their second mora (M2). In the case of monosyllabic verb stems, the assignment of an M2 H tone creates a rising tone. If the underlying stems are /mu-a/ and /bi-a/, the M2 assignment simply precedes vowel coalescence. If, on the other hand, vowel coalescence applies first (with shortening), the M2 H is assigned to the one L tone mora that remains. The remaining forms in (8a) straightforwardly receive an M2 H tone which by HTS will spread to the following mora, if there is one. In the forms in (8b), there is already a H on the first mora of the verb root. A second H is assigned to the M2, which HTS will spread to the following mora, if there is one. Again, the monosyllabic forms are unclear: either the suffixal H has been assigned to the M2 prior to vowel coalescence; or, if vowel coalescence applies first (along with vowel shortening), the suffixal H is simply assigned to the one mora that remains. Sample derivations are given in (9).

(9)	a.	dinga	ryamana	tuma	bangena	
		L	L	H	H	UNDERLYING
	b.	dinga	ryamana	tuma	bangena	
		L	L	H	H	TONE LINKING
	c.	dinga	ryamana	tuma	bangena	
		L H	L H	H H	H H	H ASSIGNMENT
	d	dinga	ryamana	tuma	bangena	
		L H	L H	H H	H H	M2 TONE LINKING
	e.		ryamana		bangena	
			L H		H H	HTS
	f.		ryamana		bangena	
			L H L		H H L	L% TONE

We have thus far established the rule of HTS which applies pervasively in Tuki. One additional feature of the Tuki tone system which frequently interacts with HTS is the downstepping of H tones. To illustrate downstep, we turn to the present tense, exemplified with the L tone subject prefix à- '3rd person sg. human' in (10).

(10)	a.	à-mwà-ḿ	's/he shaves'	b.	à-nyá-ḿ	's/he eats'
		à-byà-ḿ	's/he brings'		à-fá-ḿ	's/he gives'
		à-dìngà-ḿ	's/he loves'		à-túmá-ḿ	's/he sends'
		à-gùrà-ḿ	's/he crushes'		à-dángá-ḿ	's/he loses'
		à-ryàmànà-ḿ	's/he dreams'		à-bángénà-ḿ	's/he breaks'
		à-fùnùnà-ḿ	's/he wakes up (tr.)'		à-báráfyà-ḿ	's/he forgets'

This tense is marked by a suffix -ḿ, which is the only case of a tone prelinked to a consonant in the language. In (10a) all of the verb tones are L except for the H tone of -ḿ. In (10b), the H of the verb root spreads to the right as we have already seen in the infinitive and past tense forms in (3) and (8), respectively. This is followed by the assignment of default L tone.[8] Sample derivations are given in (11).

(11)	a.	dinga	ryamana	tuma	bangena	
		L	L	H	H	UNDERLYING
	b.	dinga	ryamana	tuma	bangena	
		L	L	H	H	TONE LINKING
	c.			tuma	bangena	
				H	H	HTS

```
d.   dinga        ryamana                      bangena
     | |          | \/                         \/  |         DEFAULT
     L L          L  L                         H   L            L

e.   dinga-m      ryamana-m      tuma-m        bangena-m     STRATUM
     |/   |       \//    |       \/  |         \/  | |       2 SUFFIX-
     L    H        L     H       H   H          H  L H       ATION
```

As seen, default L is assigned to all forms except for bimoraic -tuma-, where HTS has filled the only underspecified mora.

Now consider the corresponding present tense forms with the H tone subject prefix vá- 'they':

(12) a.	vá-mwá-!ḿ	'they shave'	b.	vá-nyá-ḿ	'they eat'
	vá-byá-!ḿ	'they bring'		vá-fá-ḿ	'they give'
	vá-díngà-ḿ	'they love'		vá-túmá-ḿ	'they send'
	vá-gúrà-ḿ	'they crush'		vá-dángá-ḿ	'they lose'
	vá-ryámànà-ḿ	'they dream'		vá-bángénà-ḿ	'they break'
	vá-fúnùnà-ḿ	'they wake up (tr.)'		vá-báráfyà-ḿ	'they forget'

The H verb stems in (12b) have exactly the same tone as those seen in (11b). In (12a), however, the H of the subject prefix vá- spreads onto the initial L mora of the L tone verb stems. In all forms the L is delinked. It thus should be clear that HTS can apply in one of the two ways indicated in (6): (i) within the stem, the H spreads onto a following toneless mora; (ii) outside the stem, the H spreads onto a following L mora, delinking that L. When the delinked L is immediately followed by a L, it has no effect. Where, however, the delinked L is immediately followed by a H, deriving the configuration in (13), the result is a H-!H sequence, i.e. a H followed by a downstepped H, as attested in many African languages.

```
(13)     μ     μ
         |     |
         H  L  H
```

Before moving on to discuss the problem of L tone transparency in Tuki, it is worth defending our view that the HTS is accompanied by the delinking of L. The alternative, that a HL contour automatically decontours when followed by another tone is falsified by data such as those from the near future (F1) tense in (14).

(14) a.	à-nú-mwà-ḿ	'he will shave'	b.	à-nû-nyá-ḿ	'he will eat'
	à-nú-byà-ḿ	'he will bring'		à-nû-fá-ḿ	'he will give'
	à-nú-dìngà-ḿ	'he will love'		à-nû-túmá-ḿ	'he will send'
	à-nú-gùrà-ḿ	'he will crush'		à-nû-dángá-ḿ	'he will lose'
	à-nú-ryàmànà-ḿ	'he will dream'		à-nû-bángénà-ḿ	'he will break'
	à-nú-fùnùnà-ḿ	'he will wake up'		à-nû-báráfyà-ḿ	'he will forget'

This tense is marked by the prefix -nû-, which is underlyingly linked to a HL sequence. As seen in (14a), the L is "absorbed" into the following L by the contour simplification process in (15).

(15)

```
 μ    μ
/ǂ    |
H L   L
```

On the other hand, contour simplification does not take place in (14b), where -nû- is followed by a H tone. We thus assume that contour simplification is not automatic in Tuki, but rather should be built into the HTS rule, as we have done.

This completes the presentation of the basic properties of the Tuki tone system. We are now ready to examine the central problem of this study.

3. The Problem

In this section we present some totally unexpected facts concerning the tonology of the first person singular object prefix N-. To begin, all six object prefixes are illustrated in the infinitive forms in (16).[9]

(16) a.	ò-n-dìngà	'to love me'	b.	ò-n-dángâ	'to lose me'
	ò-ò-dìngà	'to love you sg.'		ò-ò-dángâ	'to lose you sg.'
	ò-mù-dìngà	'to love him'		ò-mù-dángâ	'to lose him/her'
	ò-sú-díngà	'to love us'		ò-sú-dángâ	'to lose us'
	ò-nú-díngà	'to love you pl.'		ò-nú-dángâ	'to lose you pl.'
	ò-wú-díngà	'to love them'		ò-wú-dángâ	'to lose them'

From the above examples it would appear that the singular object prefixes have a L tone, while the plural object prefixes have a H, which spreads onto the following L verb root in (16a). The homorganic nasal prefix N- 'me' is non-syllabic, although, as we shall see, clearly associated with the same L tone as -ò- 'you (sg.)' and -mù- 'him/her'. But first, as seen in the present tense forms in (17) and (18), more is needed than a H on the plural object prefixes:

(17) a.	à-n-dìngà-ḿ	'he loves me'	b. à-n-dángá-ḿ	'he loses me'
	ò-ò-dìngà-ḿ	'he loves you sg.'	ò-ò-dángá-ḿ	'he loses you sg.
	à-mù-dìngà-ḿ	'he loves him'	à-mù-dángá-ḿ	'he loses him'
	à-sú-díngà-ḿ	'he loves us'	à-sú-dángá-ḿ	'he loses us'
	à-nú-díngà-ḿ	'he loves you pl.'	à-nú-dángá-ḿ	'he loses you pl.'
	à-wú-díngà-ḿ	'he loves them'	à-wú-dángá-ḿ	'he loses them'
(18) a.	vá-n$^{!}$-díngà-ḿ	'they love me'	b. vá-n$^{!}$-dángá-ḿ	'they lose me'
	vó-ò-dìngà-ḿ	'they love you sg.'	vó-ò-dángá-ḿ	'they lose you sg.'
	vá-mú-dìngà-ḿ	'they love him'	vá-mú-$^{!}$dángá-ḿ	'they lose him'
	vá-$^{!}$sú-díngà-ḿ	'they love us'	vá-$^{!}$sú-dángá-ḿ	'they lose us'
	vá-$^{!}$nú-díngà-ḿ	'they love you pl.'	vá-$^{!}$nú-dángá-ḿ	'they lose you pl.'
	vá-$^{!}$wú-díngà-ḿ	'they love them'	vá-$^{!}$wú-dángá-ḿ	'they lose them'

There are no surprises in (17), although we note there that the sequence /à-ò-/ 'he + you sg.' is realized [ò-ò-]. In (18), however, a number of issues arise. To take the easiest one first, the H of the subject prefix vá- 'they' has clearly spread onto the object prefix -mù- 'him'. As expected, when followed by a L tone root in (18a), the delinked L has no effect. When followed by a H tone verb root in (18b), the delinked L produces a downstep.

Totally unexpected in (18) is the downstep that occurs between the subject prefix vá- and all three H tone plural object prefixes. There must therefore be an unlinked L tone between vá- and -sú-, -nú- and -wú-. But where does it come from? Since we have seen that the H of vá- can spread onto the L of -mù-, we conclude that vá- is underlyingly H. If it were underlyingly HL, we would expect the L to block HTS and thus to obtain forms such as *vá-mù-dìngà-ḿ and *vá-mù-dángá-ḿ. The unlinked L must therefore be a property of the H tone object prefixes. We therefore propose the following underlying representations in (19).

(19) a. -N- (L) -o- (L) -mu- (L)   b. -su- (L H) -nu- (L H) -wu- (L H)

The L that precedes each of the object prefixes in (19b) is thus responsible for the downstep that is regularly observed in the verbal paradigm whenever they are preceded by a H tone morpheme (whether a subject prefix or a prefix marking tense, aspect or polarity.

The first of two remaining complications from (18) concerns the second person singular object prefix -ò-. As seen, the H of vá- does not spread onto it, i.e. we do not obtain forms such as *vó-ó-dìngà-ḿ or *vó-ó-$^{!}$dángá-ḿ. We offer two possible explanations. First, assuming that the sequence vó-ò- constitutes a single syllable at the relevant stage of the derivation, we could require that the HTS rule in (6) must involve two separate syllables. On the other hand, it should be noted that in most cases where two vowels come together in Tuki, the first DELETES, leaving a short vowel, e.g. /vá-ùba-ḿ/ → [vúbàḿ] 'they fail'. This raises the possibility that the second person singular object prefix is underlyingly -òò-, i.e. with a long L tone vowel. In this case it would be possible for HTS to apply, deriving vá-óò-, which then could coalesce as [vóò-].

This leaves one remaining problem in (18): the first person singular object prefix -N-. As seen in (19a), we consider that it has the same underlying L tone as the other two singular object prefixes. This L is straightforwardly responsible for the downstep in (20b).

(20) a. va-N-dinga-m (H L L H) → vá-n$^{!}$-díngà-ḿ (H L H L H) 'they love me'

b. va-N-danga-m (H L H H) → vá-n$^{!}$-dángá-ḿ (H L H H) 'they lose me'

As we saw in several of the above derivations, the H of the verb stem -dánga spreads to the second mora by the HTS rule in (6). The unlinked L of -N- is then directly responsible for the downstep on the verb stem. The L either could have started as linked—or, just as likely, it could have failed to link because the nasal is non-syllabic, i.e. not a TBU. This doesn't explain the downstep in (20a), however. If we assume that the -N- prefix provides an unlinked L tone as in (20b), then one of two outcomes would have been expected: (i) In the vast majority of African tone languages a rightward HTS rule would have been BLOCKED by the unlinked L tone. This would have produced the output *vá-n-dìngà-ḿ. (ii) Assuming the much more rare situation where an unlinked L does not block HTS (as found, for example, in Dagbani (Hyman, in press)), the output should have been *vá-n-díngà-ḿ, i.e. WITHOUT a downstep.[10] In other words, the observed tones of vá-n-!díngà-ḿ pose two problems which require an explanation:

(21) a. How do we get a H to spread across the L tone nasal prefix?
b. How do we get the L to cause downstep?

What is singularly odd about the output in (20a) is that HTS appears to have applied across a L tone which subsequently conditions downstep on the following mora to which the H tone has spread! This is somewhat obscured in the autosegmentalized representation, since we have provided a separate H tone both before and after the unlinked L. As should be clear from the preceding discussion, there is but one H tone: that of the subject prefix vá-. In order to visualize the derivation, we present a multitiered representation with H's and L's on separate planes in (22).

```
(22)      L  L                   L   L
          |  /\                  |    \
      va-N-dinga-m    →    va-N-dinga-m     →    vá-n!-díngà-ḿ
      |          |         |___/       |         |    |  |  |  |
      H          H         H           H         H    L  H  L  H
```

We start in (22) by making the assumption that the L of the object prefix is underlyingly linked to -N-. As shown, HTS applies, spreading the H of the subject prefix vá- onto the initial L mora of the verb stem -dìnga, which delinks. To derive the output, we "conflate" the tiers à la McCarthy (1986), and assign a default L to the second mora of the verb stem. As a result of this "tier conflation", the L that failed to block HTS, now causes fission of the doubly linked H tone feature, as McCarthy (1986) independently argued, based on segmental processes in various Afro-Asiatic languages. As a final step, the L delinks from the nasal which, recall, is non-syllabic (and not a TBU). In fact, we shall ultimately argue that it is its non-TBU status that allows the L to be transparent to the HTS rule in (6).

It is clear that a multitiered representation can allow HTS to apply across a L tone. By placing the H's and L's on separate tiers, there is no violation of the line-crossing constraint. The question we would like now to raise is what sanctions the tier segregation of H and L tones that makes this derivation possible? In the introduction we pointed out that many tonologists consider H and L to be two separate features, e.g. [+upper] and [-raised]. If correct, this could in itself provide the basis for H/L tonal segregation. Or, given the "morphemic tier hypothesis", it could be that the tones are segregated because they belong to different morphemes, in which case each of the tones in (22) is on a separate tier. In either case we seek an analysis that would not open the floodgates for rampant non-local tone rules, i.e. processes whereby one tone can skip over one or more other tones with impunity.

We know of only two cases where tonal "planes" have been invoked to capture non-local tonal processes. The first is Pulleyblank's (1988) analysis of Tiv, in which a prefixal L skips over a stem H to link to a subsequent mora of a verb stem. The second is Bickmore and Broadwell's (1992) account of Sierra Juarez Zapotec, in which tones skip over other tones to link to underspecified positions to their left. Since tonal infixing and other forms of internal modification are virtually unheard of in tone systems, we would hope that these cases will not hold up.[11] In the Tiv case, for instance, the price for rejecting Pulleyblank's analysis would be a stipulated rule of downstep (or unlinked L) deletion, which is sensitive to the number of syllables. (We have not attempted to reanalyze Bickmore and Broadwell's case.) Let us then consider—but reject—two alternative accounts of (22).

The first alternative would be to deny that HTS occurs across a L tone nasal. Instead, as seen in (23), a special rule could convert L to H when preceded by a L tone nasal that in turn is preceded by a H:

(23)
$$\begin{array}{ccccccc} & & & & \mu & \text{-N-} & \mu \\ & & & & | & | & | \\ \mathrm{L} & \rightarrow & \mathrm{H} & / & \mathrm{H} & \mathrm{L} & \_\_ \end{array}$$

This analysis would avoid both of the two problems: (i) the H gets to the other side of the L tone nasal prefix by direct assignment; and (ii) the L causes downstep only of the H tone mora that follows it. Besides the ad hoc nature of this rule, it poses a technical problem: In this language where H tone spreads to the right, why doesn't the H that results from this rule spread? Ordering (23) after HTS at best does not follow from any principle. At worst, it fails to capture the complementarity (or 'elsewhere' relation) between the specific rule (23) and the general HTS rule (6). The consequences are thus quite undesirable.

The second alternative, based on a suggestion made to us by Charles Kisseberth, reanalyzes all applications of HTS as the COPYING of a H feature onto a following toneless or L tone mora. As seen in (24), this copying rule would apply whether a L tone nasal intervenes or not:

(24)
$$\begin{array}{ccccccc} & & & & \mu & \text{(-N-)} & \mu \\ & & & & | & | & | \\ \mathrm{(L)} & \rightarrow & \mathrm{H} & / & \mathrm{H} & \mathrm{(L)} & \_\_ \end{array}$$

In (24) the parenthesized (L) in the input indicates that the mora that receives the copied H tone may or may not already have a L tone of its own. The first problem in (21), the transparency of the 1ps prefix -N-, is directly incorporated into the formulation of the rule: if present, it is skipped over. The second problem in (21) is also directly handled, since the L can cause downstep only on the copied H tone that follows it. In (24) there is only the question as to why the L tone nasal is transparent to the normal H assimilation rule, which has been stated as one of feature copying. The major theoretical disadvantage is that the "assimilation as spreading" generalization is violated: It has long been seen as an advantage of the autosegmental approach that assimilation "extends" the domain of a feature by spreading—and crucially, that spreading is automatically subject to certain constraints, especially the prohibition against line-crossing. As we have just seen, copying is not subject to such an constraint. In the copying approach it is not clear which other "interveners" may occur between trigger and target. Could the parenthetical nasal in (24) instead have been itself a mora (i.e. a L tone vowel)? As in Archangeli and Pulleyblank (1986), it may be necessary to refer directly to constraints on adjacency, i.e. the inability of a tone rule to skip over an arbitrarily specified number of TBU's. If line-crossing does not play a role here, what then is the empirical consequence of insisting that assimilation be expressed as spreading?

In §5 we address a third alternative, namely that the L of the 1ps nasal prefix is not present in underlying representations at all. But first we consider in §4 the segmental phonology of the N- prefix.

4. Segmental Properties of the 1ps Nasal Prefix

In this section we first establish that the few forms cited thus far with a 1ps nasal prefix are not isolated, but rather characterize the entire verbal paradigm in Tuki. We then consider the segmental alternations conditioned by the nasal prefix.

In order to establish the generality of the special L tone properties of the 1ps nasal summarized in (21), we cite verb forms in the major affirmative and negative tenses involving this prefix followed by the L tone verb -dìnga 'love':

(25)	a.	à-n-dìngà-ḿ	'he loves me'	Pr [present]
		à-mú-n-ꜜdíngà	'he loved me'	P1 [recent past]
		à-má-n-ꜜdíngá	'he loved me'	P2 [general past]
		à-mà-n-dìngá	'he loved me'	P3 [remote past]
		à-nû-n-dìngà-ḿ	'he will love me'	F1 [near future]
		à-mú-n-ꜜdíngà-ḿ	'he will love me'	F2 [general future]
	b.	à-tà-n-dìngá	'he doesn't love me'	Pr
		à-tòó-n-ꜜdíngà	'he didn't love me'	P1
		à-tàá-n-ꜜdíngá	'he didn't love me'	P2
		à-tà-má-n-ꜜdíngà	'he didn't love me'	P3
		à-tà-nû-n-dìngà	'he won't love me'	F1
		à-tà-mû-n-dìngà	'he won't love me'	F2

In all of the tenses where the morpheme that precedes the 1ps nasal prefix ends in a H tone, HTS applies—and in all of these tenses a downstep is conditioned by the nasal's L tone. This includes the affirmative P1, P2 and F2, as well as the negative P1, P2, and P3. In addition, when the affirmative Pr has a H subject prefix, the same downstep is also observed: vá-n-ꜜdíngà-ḿ 'they love me'.[12] Finally, note the HL contour on the tense marker in the affirmative and negative F1, as well as in the negative F2. If -nû- and -mû- were directly followed by a L tone mora, the contour simplification in (15) would have applied, incorrectly deriving *à-nú-n-dìngà-ḿ, *à-tà-nú-n-dìngà, and *à-tà-mú-n-dìngà. We attribute the non-application of (15) to the L tone of the nasal prefix which, in this case, breaks the adjacency between the HL contour and the following L tone mora.

The L tone effect of the 1ps nasal is thus widely attested in the verbal paradigm. It remains for us to see how it is realized when the following verb begins with different initials. The full set of initial consonants and vowels that we have attested from a corpus of 125 common verbs is given in (26).

(26)	a.	p	[3]	t	[15]	ts	[4]	č	[2]	k	[3]	kp	[1]
		b	[22]	d	[2]	dz	[4]			g	[3]	gb	[1]
		f	[13]	s	[6]								
		v	[1]	r	[7]			y	[2]			w	[6]
		m	[5]	n	[6]								
				nd	[1]							ŋgb	[1]
	b.	i	[2]	u	[5]	e	[2]	o	[4]	a	[3]		

As seen, we have also indicated how many examples are found of each initial consonant or vowel in our corpus.

Let us consider how the 1ps nasal prefix is realized before each row of consonants in (26a), then before the vowels in (26b). Since all of the examples cited thus far with a 1ps nasal prefix involve the verbs dìnga 'love' or dánga 'lose', we begin by citing voiced stop initials in (27).

(27)	a.	vá-byóǹò-ḿ	vá-m$^{!}$-byóǹò-ḿ	'they follow (me)'
		vá-díngà-ḿ	vá-n$^{!}$-díngà-ḿ	'they love (me)'
		vá-dzódzènà-ḿ	vá-n$^{!}$-dzódzènà-ḿ	'they play for (me)'
		vá-gúrà-ḿ	vá-ŋ$^{!}$-gúrà-ḿ	'they crush (me)'
	b.	vá-byáráfyà-ḿ	vá-m$^{!}$-byáráfyà-ḿ	'they forget (me)'
		vá-dángá-ḿ	vá-n$^{!}$-dángá-ḿ	'they lose (me)'
		vá-dzúnà-ḿ	vá-n$^{!}$-dzúnà-ḿ	'they subtract (me)'
		vá-gírá-ḿ	vá-ŋ$^{!}$-gírá-ḿ	'they wait for (me)'
		í-gbóménà-ḿ	í-ŋ$^{!}$-gbóménà-ḿ	'they bark at (me)'

As we saw above, the H tone of the subject prefix vá 'they' (or í- for class 10, e.g. animals) spreads onto the L of the verb stem in (27a)). As also seen, HTS is not blocked by the 1ps nasal prefix which, in turn, conditions downstep. In (27b) the verb stem is already H. The L of the 1ps prefix again conditions downstep, this time between the H of the subject prefix and the H of the verb.

Going down to the next row in (26), we see that the nasal of the 1ps object prefix does not surface when the verb begins with a voiceless fricative:

(28)	a.	vá-fúnùnà-ḿ	vá-$^{!}$-púnùnà-ḿ	'they wake (me) up'
		vá-fórènà-ḿ	vá-$^{!}$-pórènà-ḿ	'they untie (me)'
		vá-séyà-ḿ	vá-$^{!}$-tséyà-ḿ	'they abuse (me)'
		vá-súwà-ḿ	vá-$^{!}$-tsúwà-ḿ	'they wash (me)'
	b.	vá-fá-ḿ	vá-$^{!}$-pá-ḿ	'they give (me)'
		vá-fwá-ḿ	vá-$^{!}$-pwá-ḿ	'they extinguish (me)'
		vá-súmbá-ḿ	vá-$^{!}$-tsúmbá-ḿ	'they cut (me)'
		vá-síyá-ḿ	vá-$^{!}$-tsíyá-ḿ	'they rub (me)'

Instead, the corresponding non-continuant is found: /f/ becomes [p], while /s/ becomes [ts]. Although not present on the surface, the nasal prefix continues to condition downstep in all cases.

Continuing to the next row of (26), voiced continuants are also subject to "hardening" when preceded by the 1ps nasal prefix. As seen in (29), /r/ and /y/ harden to [d] and [j], respectively, although the nasal does not drop out:[13]

(29)	a.	vá-rátènà-ḿ	vá-n$^{!}$-dátènà-ḿ	'they sew for (me)'
		vá-rámà-ḿ	vá-n$^{!}$-dámà-ḿ	'they pull (me)'

b.	vá-ráméyà-ḿ	vá-n[!]-dáméyà-ḿ	'they lick (me)'
	vá-rábénà-ḿ	vá-n[!]-dábénà-ḿ	'they insist (on me)'
	vá-yáánà-ḿ	vá-n[!]-jáánà-ḿ	'they pay (me)'
	vá-yéérè-ḿ	vá-n[!]-jéérè-ḿ	'they teach (me)'

When the initial continuant is /v/ or /w/, however, it mutates to [k] (in one case [kw]), and the nasal drops out:[14]

(30)	a.	vá-vángénà-ḿ	vá-[!]-kángénà-ḿ	'they fry for (me)'
	b.	vá-wúbá-ḿ	vá-[!]-kúbá-ḿ	'they hit (me)'
		vá-wútá-ḿ	vá-[!]-kútá-ḿ	'they tie (me) up'
		vá-wóró-ḿ	vá-[!]-kóró-ḿ	'they take (me)'
		vá-wáá-ḿ	vá-[!]-kwáá-ḿ	'they put (me)'

The loss of the nasal in this case is clearly due to the voicelessness of the [k]. As seen now in (31), the 1ps nasal prefix regularly drops out when the verb stem begins with a voiceless stop:

(31)	a.	vá-púmìyà-ḿ	vá-[!]-púmìyà-ḿ	'they whiten (me)'
		vá-tírìnà-ḿ	vá-[!]-tírìnà-ḿ	'they write to (me)'
		vá-tsórà-ḿ	vá-[!]-tsórà-ḿ	'they pull (me)'
		vá-kósènà-ḿ	vá-[!]-kósènà-ḿ	'they buy for (me)'
	b.	vá-pímbínà-ḿ	vá-[!]-pímbínà-ḿ	'they sweep for (me)'
		vá-tóménà-ḿ	vá-[!]-tóménà-ḿ	'they send to (me)'
		vá-tsómá-ḿ	vá-[!]-tsómá-ḿ	'they stick (me)'
		vá-céndé-ḿ	vá-[!]-céndé-ḿ	'they alter (me)'
		vá-kásínì-ḿ	vá-[!]-kásínì-ḿ	'they begin for (me)'
		vá-kpétá-ḿ	vá-[!]-kpétá-ḿ	'they shoot at (me)'

In (30), we have thus only to get /v/ or /w/ to harden to [k], and the nasal will drop out by a general rule.

Finally, the data in (32) show that the nasal also drops out when the verb begins with a nasal—either simple, or itself a NC sequence:

(32)	a.	vá-mwá[!]-ḿ	vá-[!]-mwá[!]-ḿ	'they shave (me)'
		vá-ndéndènà-ḿ	vá-[!]-ndéndènà-ḿ	'they walk for (me)'
		vá-ŋgbáàtì-ḿ	vá-[!]-ŋgbáàtì-ḿ	'they disdain (me)'
	b.	vá-númá-ḿ	vá-[!]-númá-ḿ	'they bite (me)'
		vá-nyéná-ḿ	vá-[!]-nyéná-ḿ	'they eat for (me)'

The data in (27) through (32) reflect the fact that the only NC "clusters" permitted on the surface in Tuki are [mb], [nd], [ndz], [ɲɟ], [ŋg] and [ŋgb], i.e. a preconsonantal nasal is found when the following consonant is an oral voiced non-continuant. We place the term "clusters" in quotation marks, since it would be entirely possible to view these are prenasalized consonants. All preconsonantal nasals are non-syllabic in Tuki. The 1ps nasal prefix consists at least of a separate [+nasal] feature, if not a full consonant. Whether the nasality surfaces or not, the data in (27)-(32) reveal a L tone that causes downstep whenever the 1ps prefix is preceded by a H tone. In cases where it is preceded by a L tone, e.g. the subject prefix à- 'he' or ì- 'it' (class 9), there is no tonal effect:

(33)	a.	à-byònò-ḿ	à-m-byònò-ḿ	'he follows (me)'
		à-dìngà-ḿ	à-n-dìngà-ḿ	'he loves (me)'
		à-dzòdzènà-ḿ	à-n-dzòdzènà-ḿ	'he plays for (me)'
		à-gùrà-ḿ	à-ŋ-gùrà-ḿ	'he crushes (me)'
	b.	à-byáráfyà-ḿ	à-m-byáráfyà-ḿ	'he forgets (me)'
		à-dángá-ḿ	à-n-dángá-ḿ	'he loses (me)'
		à-dzúnà-ḿ	à-n-dzúnà-ḿ	'he subtracts (me)'
		à-gírá-ḿ	à-ŋ-gírá-ḿ	'he waits for (me)'
		ì-gbóménà-ḿ	ì-ŋ-gbóménà-ḿ	'it barks at (me)'
(34)	a.	à-fùnùnà-ḿ	à--pùnùnà-ḿ	'he wakes (me) up'
		à-fòrènà-ḿ	à--pòrènà-ḿ	'he unties (me)'
		à-sèyà-ḿ	à--tsèyà-ḿ	'he abuses (me)'
		à-sùwà-ḿ	à--tsùwà-ḿ	'he washes (me)'
	b.	à-fá-ḿ	à--pá-ḿ	'he gives (me)'
		à-fwá-ḿ	à--pwá-ḿ	'he extinguishes (me)'
		à-súmbá-ḿ	à--tsúmbá-ḿ	'he cuts (me)'
		à-síyá-ḿ	à--tsíyá-ḿ	'he rubs (me)'
(35)	a.	à-ràtènà-ḿ	à-n-dàtènà-ḿ	'he sews for (me)'
		à-ràmà-ḿ	à-n-dàmà-ḿ	'he pulls (me)'
	b.	à-ráméyà-ḿ	à-n-dáméyà-ḿ	'he licks (me)'
		à-rábénà-ḿ	à-n-dábénà-ḿ	'he insists (on me)'
		à-yáánà-ḿ	à-n-jáánà-ḿ	'he pays (me)'
		à-yéérè-ḿ	à-n-jéérè-ḿ	'he teaches (me)'
(36)	a.	à-vángénà-ḿ	à--kángénà-ḿ	'he fries for (me)'
	b.	à-wúbá-ḿ	à--kúbá-ḿ	'he hits (me)'
		à-wútá-ḿ	à--kútá-ḿ	'he ties (me) up'
		à-wóró-ḿ	à--kóró-ḿ	'he takes (me)'
		à-wá-ḿ	à--kwá-ḿ	'he puts (me)'
(37)	a.	à-pùmìyà-ḿ	à--pùmìyà-ḿ	'he whitens (me)'
		à-tìrìnà-ḿ	à--tìrìnà-ḿ	'he writes to (me)'
		à-tsòrà-ḿ	à--tsòrà-ḿ	'he pulls (me)'
		à-kòsènà-ḿ	à--kòsènà-ḿ	'he buys for (me)'

b.	à-pímbínà-ḿ	à--pímbínà-ḿ	'he sweeps for (me)'
	à-tóménà-ḿ	à--tóménà-ḿ	'he sends to (me)'
	à-tsómá-ḿ	à--tsómá-ḿ	'he sticks (me)'
	à-céndé-ḿ	à--céndé-ḿ	'he alters (me)'
	à-kásínì-ḿ	à--kásínì-ḿ	'he begins for (me)'
	à-kpétá-ḿ	à--kpétá-ḿ	'he shoots at (me)'
(38) a.	à-mwà-ḿ	à--mwà-ḿ	'he shaves (me)'
	à-ndèndènà-ḿ	à--ndèndènà-ḿ	'he walks for (me)'
	à-ŋgbààtì-ḿ	à--ŋgbààtì-ḿ	'he disdains (me)'
b.	à-númá-ḿ	à--númá-ḿ	'he bites (me)'
	à-nyéná-ḿ	à--nyéná-ḿ	'he eats for (me)'

In most cases the 1ps object prefix continues to manifest itself in terms of nasality and/or consonant hardening. In (37) and (38), however, we see that the 1ps prefix has no surface realization at all. In (37), a nasal + voiceless stop sequence is not permitted, nor may a voiceless stop harden. In (38), a geminate NN sequence is also ruled out. Since the L tone does not surface either, there is no way to explicitly indicate that a 1ps object prefix is present. The double hyphen (--) shows the deletion of the nasal morpheme.

One final set of data needs to be considered. We have not yet shown what happens when the 1ps prefix precedes a vowel-initial verb stem. The relevant data are provided in (39).

(39) a.	v-éndènà-ḿ	vá-ŋ!g-éndènà-ḿ	'they go for (me)'
	v-ónò-ḿ	vá-ŋ!g-ónò-ḿ	'they laugh (at me)'
	v-ófà-ḿ	vá-ŋ!g-ófà-ḿ	'they throw (me)'
	v-ákà-ḿ	vá-ŋ!g-ákà-ḿ	'they help (me)'
b.	v-ídzímà-ḿ	vá-ŋ!g-ízímà-ḿ	'they know (me)'
	v-íbínà-ḿ	vá-ŋ!g-íbínà-ḿ	'they steal for (me)'
	v-éná-ḿ	vá-ŋ!g-éná-ḿ	'they see (me)'
	v-úná-ḿ	vá-ŋ!g-úná-ḿ	'they kill (me)'
	v-úbá-ḿ	vá-ŋ!g-úbá-ḿ	'they hear (me)'
	v-ótéènà-ḿ	vá-ŋ!g-ótéènà-ḿ	'they agree with (me)'
	v-áténà-ḿ	vá-ŋ!g-áténà-ḿ	'they break for (me)'

As seen, vowel-initial verbs acquire a [g] when preceded by the 1ps nasal prefix.[15] The major question is to determine which morpheme this [g] belongs to. There are three logical possibilities. First, this [g] may be part of the verb stem. Since there are three verbs in our corpus whose initial [g] is present in all cases (e.g. ò-gùrà 'to crush'), one could not simply say that the verbs in (39) have an underlying /g/ which deletes whenever not preceded by the 1ps nasal. One would therefore either have to say that the featural representation of this /g/ is different from the /g/ in -gùra 'crush' (etc.) or that some verbs have two different allomorphs: g-initial when preceded by the 1ps nasal prefix, Ø-initial otherwise. A second option is to say that the [g] is epenthetic, hence not belonging to either the verb or the object prefix.[16] The final option, which we adopt in the segmentation in (39), is to say that the [g] belongs to the 1ps prefix itself.This is supported by evidence from the Tuki subject prefixes, illustrated in (40).

(40)	a.	n-dìngà-ḿ	'I love'	b.	n-dángá-ḿ	'I lose'
		ò-dìngà-ḿ	'you sg. love'		ò-dángá-ḿ	'you sg. lose'
		à-dìngà-ḿ	'he loves'		à-dángá-ḿ	'he loses'
		tù-dìngà-ḿ	'we love'		tù-dángá-ḿ	'we lose'
		nù-dìngà-ḿ	'you pl. love'		nù-dángá-ḿ	'you pl. lose'
		vá-díngà-ḿ	'they love'		vá-dángá-ḿ	'they lose'

As seen from the above table of personal subject prefixes, the 1ps form again involves a nasal. In fact, the following forms show the same realization of the 1ps subject prefix as was observed with the 1ps object prefix:

(41)	a.	m-byònò-ḿ	'I follow'	b.	m-byáráfyà-ḿ	'I forget'
		n-dìngà-ḿ	'I love'		n-dángá-ḿ	'I lose'
		n-dzòdzènà-ḿ	'I play for'		n-dzúná-ḿ	'I subtract'
		ŋ-gùrà-ḿ	'I crush'		ŋ-gírá-ḿ	'I wait for'
					ŋ-gbóménà-ḿ	'I bark at'

(42)	a.	pùnùnà-ḿ	'I wake'	(-fùnuna)	b.	pá-ḿ	'I give'	(-fá)
		pòrènà-ḿ	'I untie'	(-fòrena)		pwá-ḿ	'I extinguish'	(-fwá)
		tsèyà-ḿ	'I abuse'	(-sèya)		tsúmbá-ḿ	'I cut'	(-súmba)
		tsùwà-ḿ	'I wash'	(-sùwa)		tsíyá-ḿ	'I rub'	(-síya)

(43)	a.	n-dàtènà-ḿ	'I sew'	(-ràtena)	b.	n-dáméyà-ḿ	'I lick'	(-rámeya)
		n-dàmà-ḿ	'I pull'	(-ràma)		n-dábénà-ḿ	'I insist'	(-rábena)
						n-jáánà-ḿ	'I pay'	(-yáana)
						n-jéérè-ḿ	'I teach'	(-yéere)

(44)	a.	kángénà-ḿ	'I fry for'	(-vángena)			
	b.	kúbá-ḿ	'I hit'	(-wúba)	kóró-ḿ	'I take'	(-wóro)
		kútá-ḿ	'I tie up'	(-wúta)	kwáá-ḿ	'I put'	(-wáa)

(45)	a.	pùmìyà-ḿ	'I whiten'	b.	pímbínà-ḿ	'I sweep for'
		tìrìnà-ḿ	'I write to'		tóménà-ḿ	'I send to'
		tsòrà-ḿ	'I pull'		tsómá-ḿ	'I stick'
		kòsènà-ḿ	'I buy for'		céndé-ḿ	'I alter'
					kásínì-ḿ	'I begin for'
					kpétá-ḿ	'I shoot at'

(46) a.	mwà-ḿ	'I shave'	b.	númá-ḿ	'I bite'
	ndèndènà-ḿ	'I walk for'		nyéná-ḿ	'I eat for'
	ŋgbààtì-ḿ	'I disdain'			

And as before, a [g] shows up when the 1ps subject prefix precedes a vowel-initial verb:

(47) a.	ŋg-èndènà-ḿ	'I go for'	b.	ŋg-ízímà-ḿ	'I know'
	ŋg-ònò-ḿ	'I laugh'		ŋg-íbínà-ḿ	'I steal for'
	ŋg-òfà-ḿ	'I throw'		ŋg-éná-ḿ	'I see'
	ŋg-àkà-ḿ	'I help'		ŋg-úná-ḿ	'I kill'
	ŋg-ùmbààǹà-ḿ[17]	'I seize'		ŋg-úbá-ḿ	'I hear'
				ŋg-ótéènà-ḿ	'I agree with'
				ŋg-áténà-ḿ	'I break for'

What is different about the 1ps subject prefix, however, is that it shows these realizations only if it is DIRECTLY followed by the verb stem. While this is always the case for the 1ps object prefix (since nothing can intervene between it and the following verb stem), subject prefixes may be followed by an object prefix or by a prefix that marks tense, aspect or polarity. Thus, consider the realization of the 1ps subject prefix when followed by an object prefix in (48).

(48) a.	ŋg-òò-dìngà-ḿ	b.	ŋg-òò-dángá-ḿ	'I love/lose you sg.'
	ŋgù-mù-dìngà-ḿ		ŋgù-mù-dángá-ḿ	'I love/lose him'
	ŋgù-sú-díngà-ḿ		ŋgù-sú-dángá-ḿ	'I love/lose us'
	ŋgù-nú-díngà-ḿ		ŋgù-nú-dángá-ḿ	'I love/lose you pl.'
	ŋgù-wú-díngà-ḿ		ŋgù-wú-dángá-ḿ	'I love/lose them'
	ŋg-á-díngà-ḿ		ŋg-á-dángá-ḿ	'I love/lose myself'

In the first and last forms, the object prefix consists of a vowel, and so it is not surprising to find the 1ps subject prefix realized as ŋg-. (It is less obvious whether the difference in vowel length is significant.) In the middle four cases it is surprising to find that the prefix is pronounced [ŋgù]. A similar form is observed when the subject prefix is directly followed by either a tense prefix or a negative prefix:

(49) a.	n-dìngà-ḿ	n-dángá-ḿ	'I love/lose'	Pr
	ŋgù-mú-díngà	ŋgù-mú-dángâ	'I loved/lost'	P1
	ŋgà-má-díngà	ŋgà-má-dángá	'I loved/lost'	P2
	ŋgà-mà-dìngá	ŋgà-mà-dángá	'I loved/lost'	P3
	ŋgù-nú-dìngà-ḿ	ŋgù-nû-dángá-ḿ	'I will love/lose'	F1
	ŋgù-mú-díngà-ḿ	ŋgù-mú-dángá-ḿ	'I will love/lose'	F2

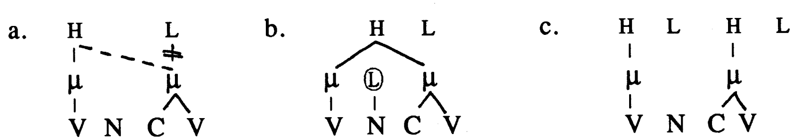
b.	ŋgà-tà-dìngá	ŋgà-tà-dángá	'I don't love/lose'	Pr
	ŋgà-tàá-díngà	ŋgà-tàá-dángâ	'I didn't love/lose'	P1
	ŋgà-tàá^!-díngá	ŋgà-tàá^!-dángá	'I didn't love/lose'	P2
	ŋgà-tà-má-díngà	ŋgà-tà-má-dángâ	'I didn't love/lose'	P3
	ŋgà-tà-nú-dìngà	ŋgà-tà-nû-dángâ	'I won't love/lose'	F1
	ŋgà-tà-mú-dìngà	ŋgà-tà-mû-dángâ	'I won't love/lose'	F2

In the affirmative tenses in (49a) the 1ps subject prefix has the shape ŋgV-, with the V agreeing in quality with the vowel of the following tense marker. (In the present affirmative, the 1ps subject prefix is n-, since it is directly followed by the verb stem.) In (49b), the 1ps subject prefix is uniformly ŋga-, since it is followed in all cases by the negative prefix tà(á)-.[18]

On the basis of the 1ps subject prefix forms in (48) and (49), we conclude that the [g] found before vowel-initial verb stems is part of the prefix, not part of the verb stem itself and not epenthetic. In order to derive the surface forms in (48) and (49), we assume that the [u] or [a] that follows [ŋg] is epenthetic. Of course, we must not derive [ŋgu-] or [ŋga-] immediately before a consonant-initial verb stem. This derivation can be blocked by either assuming that /g/ deletes before a consonant-initial verb stem or that there is an allomorphy in the 1ps prefix: N- before consonant-initial verb stems, Ng- elsewhere. The 1ps subject prefix is of course irrelevant for the study of transparent L tone, since it is the first prefix in any verb form. However, where we have obtained the object prefix ŋg- (before a vowel-initial verb stem), it is clear from the placement of the downstep that the L has to be associated with the nasal, not with the vowel that follows it. That is, there is no evidence that a form such as vá-ŋ^!-ákà-ḿ 'they help me' derives from va + ŋgV + aka + m. If it did, the V would have truncated by the normal rules of the language which derive a short vowel in such contexts. However, it would be necessary to ask what its tone is. It is clear from the output tones that the L of the 1ps object prefix cannot be affiliated with this V. Rather, it comes in somehow with the nasal part of the prefix in one of the ways we shall now discuss.

5. NC = a Depressor Consonant?

Having now examined the segmental properties of the 1ps prefix, we return to the tonal problem at hand. In §3 we considered three accounts of the transparent L tone: (i) a H simply spreads through a L tone nasal, presumably allowed because the H and L are on separate tiers; (ii) a second H tone is inserted to the right of the L nasal prefix, when the latter is preceded by a H tone; (iii) rather than HTS, the assimilation is described as a H tone copying rule which does not mind an intervening L tone nasal. In this section we consider—but reject—the possibility that the L of the nasal prefix is not present in the underlying representation at all. In this alternative, the L is inserted after HTS has applied, as in the derivation in (50).

(50)


Starting with a schematic VNCV sequence, HTS applies in (50a), delinking the L of the second mora. A (circled) L feature is inserted in (50b), induced by the nasality of the N prefix (whose moraic affiliation is not addressed in (50)). In (50c) the L acquires full tonal status, and must be linearized to both precede and follow the doubly linked H. As a result, the latter undergoes fission, as shown in (50c). The relevance of §4 to this analysis is that the nasal often deletes, but always leaves behind its L tone as a (potential) downstepper. Thus, if the insertion of L tone is induced by the preconsonantal nasal, it will be necessary for the appropriate insertion rule to apply before the nasal is effaced.

The idea behind this third alternative, then, is that the L is inserted later, much as Cassimjee and Kisseberth (1992) have proposed for the depressor consonant phenomenon in Mijikenda and Nguni Bantu languages. In these and other languages, certain consonants (e.g. voiced obstruents) are affiliated with L tone. They are, however, not TBU's in the normal sense, just as preconsonantal nasals are not TBU's in Tuki. We saw in (19) that a morphological symmetry would be achieved if we assumed all singular object prefixes to have an underlying L (i.e. including the 1ps nasal prefix). However, a number of phonological facts lend initial credence to the view that the L of the 1ps prefix is not underlying: (i) Whether preceded by a vowel or occurring postpausally, preconsonantal nasals are not syllabic. (ii) Preconsonantal nasals do not cause lengthening of a preceding vowel, as in other Bantu languages—nor do they condition compensatory lengthening when they drop out (see §4). (iii) Preconsonantal nasals never figure in tone linking or tone spreading. Thus, as we have seen, when a L tone verb such as -dìnga 'love' receives a suffixal H, the H goes on the FV -a, not on the nasal (cf. (8b)). Or, when the H of a verb stem such as /dáng-a/ 'lose' spreads to the right, it goes onto the FV -a, not onto the nasal, e.g. ò-dángâ 'to lose' (cf. (3b)). The situation is quite different in other Bantu languages, where the nasal frequently conditions compensatory lengthening and/or counts as a TBU (see Hyman 1992 for a recent discussion of some of the variation found in Bantu).

In further support of this hypothesis, it should also be noted that a number of Western Grassfields Bantu languages clearly show that preconsonantal nasals correlate with L tone. Although spoken also in Cameroon, these languages do not have object prefixes, and hence do not have a 1ps nasal object prefix. (In addition, the general 1ps subject prefix is mə-, whose tone is not necessarily L.) It is in the noun class system that the L tone effects are seen. Asongwed and Hyman (1976) and Hyman (1986) have shown for Ngamambo, for example, that tone is predictable on noun class prefixes in the following way: CV- prefixes are H, V- prefixes are M(id), and N- prefixes are L. In addition, in Kom, where prefixes are generally M on the surface, a preconsonantal nasal will condition a M to L contour tone (cf. ā-kém 'pliers' vs. ā-ŋ̀kém 'crab'). Can the induced L of the 1ps prefix in Tuki be part of a general phenomenon—or Cameroonian areal feature—according to which a preconsonantal nasal acts as a tone depressor?

The major obstacle in the way of this approach is that it is only the 1ps nasal that has this property in Tuki. While never a TBU, other preconsonantal nasals have different tonal properties, as follows:

(i) Tautomorphemic preconsonantal nasals do not acquire a L tone. This includes two sets of examples, already seen, but repeated in (51).

(51)	a.	vá-dángá-ḿ	'they lose'	*vá-dá!ngá-ḿ
		vá-vángénà-ḿ	'they fry for'	*vá-vá!ngénà-ḿ

b.	vá-ndéndènà-ḿ	'they walk for'	*vá-nꜝdéndènà-ḿ
	vá-ŋgbáàtì-ḿ	'they disdain'	*vá-ŋꜝgbáàtì-ḿ

In (51a) a H spreads from the first mora of the verb stem onto the second. The same HTS takes place in (51b), this time from the H subject prefix vá- onto the first mora of the two verbs that have been found to begin with a preconsonantal nasal. Although having a NC cluster, the following in the resulting output is not downstepped. This shows, minimally, that a tautomorphemic preconsonantal nasal does not automatically induce L tone.

(ii) Other nasal prefixes such as those found in the noun class system show no evidence for an inserted L tone. The forms in (50) clearly show that a verb-final H tone such as in the P2 will spread onto a following noun object:

(52)	a.	à-má-túmá mú-tù	'he sent a person'	(mù-tù)
		à-má-túmá námà	'he sent an animal'	(nàmà)
	b.	à-má-túmá máꜝ-nyá	'he sent food'	(mà-nyá)
		à-má-túmá mw-áꜝná	'he sent a child'	(mw-àná)
	c.	à-má-túmá sámꜝbê	'he sent God'	(sàmbê)
		à-má-túmá tóꜝ-nê	'he sent a leaf'	(tò-nê)
	d.	à-má-túmá ví-kòngá	'he sent letters'	(vì-kòngá)
		à-má-túmá wélètê	'he sent a tree'	(wèlètê)
	e.	à-má-túmá sáꜝpákà	'he sent fish'	(sàpákà)
		à-má-túmá váꜝ-síyà	'he sent chairs'	(và-síyà)
	f.	à-má-túmá káná	'he sent a crab'	(káná)
		à-má-túmá kónó	'he sent a tortoise'	(kónó)

Each pair of examples in (52) shows postlexical spreading of H tone onto a noun object of a different tone pattern. As seen, HTS may result in the delinking of a L tone, which triggers downstep on an immediately following H. The examples in (52f) show that when an object noun begins with a H tone, there is no tone change.

Now consider in (53) comparable noun objects that begin with a class 9 nasal prefix:

(53)	a.	à-má-túmá ŋ-gô	'he sent a leopard'	(ŋ-gò)
		à-má-túmá m-búŋgù	'he sent cassava'	(m-bùngù)
		à-má-túmá n-dónè	'he sent a cow'	(n-dònè)
	b.	à-má-túmá ŋ-gbáꜝtí	'he sent magic'	(ŋ-gbàtí)
	c.	à-má-túmá m-bwá	'he sent a dog'	(m-bwá)
		à-má-túmá ŋ-gárè	'he sent a gun'	(ŋ-gárè)
		à-má-túmá m-béré	'he sent a friend'	(m-béré)

In (53a) the H of the final vowel of the verb spreads across the nasal prefix, delinking the L of the first stem syllable of the noun object. As seen, there is no downstep effect. The same occurs in the example in (53b), where the noun stem is underlying L-H. In this case when the L is delinked, a downstep is created. Finally, in (53c), where the first syllable of the noun stem is H, there is no tonal change. While noun class prefixes otherwise carry L tone in Tuki (cf. the relevant examples in (52)), the class 9 nasal prefix shows no L tone effect at all in (53).

Instead, as seen in the following sample derivations in (54), the correct output is obtained even if no L tone is assigned to the nasal prefix:

```
(54) a.  -tuma m-buŋgu      -tuma ŋ-gbati      -tuma m-bere
          |  |     \/         |  |     | |       |  |    \/
          H  H     L          H  H     L H       H  H    H          UNDERLYING

     b.  -tuma m-buŋgu      -tuma ŋ-gbati      -tuma m-bere
          |  \  /    |        |  \  /   |        |  |    \/
          H    H     L        H    H L  H        H  H    H          HTS

        [-túmá m-búngù]    [-túmá ŋ-gbá!tí]    [-túmá m-béré]
```

If the class 9 prefix had a L tone—and crucially, if it were to follow the same tonal patterns as we saw for the 1ps object prefix, the outputs of (54) would have been *à-mà-túmá m!-búŋgù, à-mà-túmá ŋ!gbá!tí, and *à-mà-túmá m!-béré, i.e. with a downstep immediately after the nasal prefix.

However, there ARE reasons to believe that the nasal has a L tone. First, there is the fact that all other noun class prefixes have a L tone, as mentioned. Second, however, there is the fact that nouns that begin with L tone vowel prefixes (with or without a following nasal) show the patterns in (55).

(55)	a.	à-mà-túmá í-bwánà	'he sent a key'	(ì-bwànà)
		à-mà-túmá í-díŋgà	'he sent a concubine'	(ì-dìŋgà)
	b.	à-mà-túmá í-bá!nú	'he sent a kolanut'	(ì-bànú)
		à-mà-túmá óŋ-gáŋ!gá	'he sent a root'	(òŋ-gàŋgá)
		à-mà-túmá ón-dzí!í	'he sent a seat'	(òn-dzìí)

In examples such as these we see the H of the verb spreading through the vowel (+nasal) prefix onto the first stem syllable of the following noun. In (55a) we see that L-L-L nouns thus become H-H-L, while in (55b), L-L-H nouns become H-H-!H. It would appear that HTS is applying twice—or is it?

A clue as to what is behind the "double spreading" of H tone in (55) is seen from a comparison of the singular and plural noun forms in (56).

(56)	a.	à-mà-túmá í-nyó	'he sent a yam'	(ì-nyó)
		à-mà-túmá ví!-nyó	'he sent yams'	(vì-nyó)
	b.	à-mà-túmá í-gwá	'he sent a cadavre'	(ì-gwá)
		à-mà-túmá ví!-gwá	'he sent cadavres'	(vì-gwá)
	c.	à-mà-túmá í-támbû	'he sent a trap'	(ì-tàmbû)
		à-mà-túmá ví!-támbû	'he sent traps'	(vì-tàmbû)

In each case the noun stem begins H. In the singular the prefix is class 7 ì-, and the plural is class 8 vì-. Both are underlyingly L. In the singulars the prefix ì- assimilates to the preceding H without conditioning a following downstep. In the plurals, however, the prefix vì- assimilates to the preceding H, and there IS a downstep on the following H. The hypothesis we would like to advance is that when L tone V(N)- prefixes are preceded by a H tone, their L tone assimilates to the preceding H without a trace. A CV- prefix, on the other does not undergo this special rule, but rather the normal HTS rule that delinks its L, which is then freed up to condition a downstep on the following H.

What we would like to suggest is that the N- prefix of classes 9 and 10 undergoes this same special rule. This would explain why there is no downstep in the forms in (53c). In order to account for the double spreading in (53a) and (55), we would say that the special rule PRECEDES the regular HTS rule, such that the H of the verb spreads to both of the following two TBU's of the noun.[19] In the case of (53a) one doesn't see the double effect because the nasal is non-syllabic, i.e. not a TBU.[20] As a result of this special rule, there is of course no chance of seeing if HTS can cross the L of the noun prefix in such examples.

Since it is only the 1ps object prefix that shows the L tone effect under examination, it is unlikely that we would want to insert the L. To do so would require that we specifically target the 1ps morpheme, and not other preconsonantal nasals such as those seen in (51). This means that the L insertion rule should in principle be lexical—though presumably must follow HTS (to avoid "line crossing"), which also applies postlexically. This last fact indirectly suggests that L tone insertion should not apply to the class 9/10 nasal prefix whose tonal properties we have just investigated. Recall that L tone insertion must also apply prior to the deletion of the preconsonantal nasal before a voiceless stop or nasal. Given the highly morphologized nature of this putative rule of L tone insertion, it makes as much sense to include the information with the 1ps prefix itself. How this is to be done is the topic of our final section.

5. Conclusion

We conclude from the preceding that the 1ps object prefix has its own underlying L tone. This L is exactly identical to the L found in the other two singular object prefixes (recall (19a)), which allows us to draw the generalization that singular personal object prefixes are L tone, while the plural personal object prefixes are H (preceded by a floating L).[21] This means that a verb form such as vá-n$^{!}$-díngà-ḿ 'they love me' has the representation in (57a) just after tone linking:

(57) a. va-n-dinga-m
H L L H

b. va-n-dinga-m
H L L H

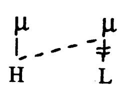
The question is how can we apply HTS as in (57b) without the L causing the indicated line-crossing? Or, put slightly differently: if (57b) is OK, why don't we find HTS regularly applying across linked L tones in other languages?

The answer, we believe, is that the L on the 1ps prefix is not the same kind of tone as the L that is linked to a vowel. As we have repeatedly said, a preconsonantal nasal is not a TBU. The HTS rule says that a H spreads onto the next TBU. Stated this way, the nasal is irrelevant to the rule. Although it has a tone, the nasal is skipped over because of its non-moraic status. At first blush this may seem surprising. In their classic study on opaque segments, Clements and Sezer (1982) show that some consonants have prelinked values of features that normally link to vowels and are involved in the familiar vowel harmony of Turkish. As a consequence, a consonant-linked [-back] feature can block the spreading [+back] from the preceding vowel onto the next. Why doesn't the L of the nasal have this opaque or blocking property?

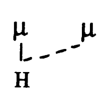
As mentioned in the introduction—and unlike the Turkish case—H and L involve two different tone features, say [+upper] and [-raised], in Tuki and most African tone languages. Consequently, they are on separate tiers. Being on separate tiers, they can in principle cross each other without this resulting in a violation of the line-crossing constraint. However, this rarely happens. The reason is that tone rules are typically local, i.e. the most common tone rules involve the (possibly iterative) spreading of a tone one TBU to the right or left. In languages where a H tone spreads long distance to a predesignated position (e.g. the penult), there typically are no intervening L tones anyway. We would claim that it would be possible to skip over such L's just in case the targeted position is identified on some basis other than adjacency. As a case in point, in Luganda there is a phrasal rule that spreads a H tone leftward just in case it can cross onto one or more toneless moras in the preceding word. While in most cases all of the preceding, affected moras are toneless, Hyman and Katamba (1990-91) show that there are constructions where one or more L moras precede the spreading H. In this case leftward HTS successfully applies across these TBU's, eradicating their L tone.

What this suggests is that line-crossing, if still valid in segmental phonology, has less of a role to play in tonology than previously suspected. Instead, the "line-crossing effects" frequently observed in tonology seem to have to do with the adjacency conditions that are placed on the tone rules themselves. In a crucial sense this is not surprising and fits right into the recent vogue of reinterpreting phonological features as privative or monovalent. If features such as H and L have only one value (with M being a fusion of the two, as say, in Hyman 1986), then they are free to spread right or left without being blocked by one another. Where there is blocking, the rule would have to be formulated accordingly. For example, where HTS is blocked by a floating L, the rule could be written as in (58a).

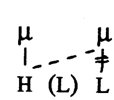
(58) a.



b.



c.



In (58a) a H will spread onto a following L mora, delinking that L. If a free L tone intervenes between the H and L, the structural description of the rule is not met, and hence the rule does not apply. If it is acceptable for a H to spread across a free L, then either the rule is written neutrally, as in (58b), or explicitly mentions the possibility of an intervening free L tone, as in (58c).

In either case the conditions should be clear under which it is possible to get a "line-crossing effect": only if the mora targeted by tone feature A is on the other side of a different tone feature B, will spreading of A be allowed to cross tone feature B. In this paper we have seen that a L feature linked to a non-TBU can be "crossed" by a H feature as it spreads across it to reach the next TBU.

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[1]In a typical African tone system, I assume that each tone feature links to a separate tonal node and that a tonal node is dominated in turn by a tonal root node. It is the tonal root node that then links to the TBU, here the mora. With the two tonal features on separate tiers, line-crossing will not prevent spreading rules such as in (2), independent of other details of tonal geometry.

[2]In addition to the case we shall discuss in this paper, we are aware of one other situation, in Luganda, where a H may spread (leftwards) through a L tone (see Hyman and Katamba 1990-91).

[3]The data are based on the speech of the second author. Previous work on Tuki includes Essono (1980) and Hyman (1980). See Biloa (1992) for recent work on Tuki syntax.

[4] These data differ from those reported for other dialects by Essono (1980) and Hyman (1980). For instance, while the Kombe dialect has a terrace-level system with downstepped H tones, the Bacenga dialect described by Hyman (1980) has a discrete level tone system with H, M and L.
[5] We assume that CGV sequences are underlying CVV in all cases, and that the cited verb roots might more abstractly be represented as -mu- 'shave', -bi- 'bring', -ni- 'eat' and -fa- 'give'. Although Tuki allows long vowels, in most morphological contexts in which vowel coalesence occurs, the result is a short vowel, not a long one.
[6] Below we shall see that this TBU may be either toneless or may have L tone, as indicated in (6).
[7] Other alternatives were considered—and rejected. These included assigning default L before HTS to create the HL contour, or conflating default L assignment with prepausal L%. These and other attempts led to complications. It is worth noting that the L in utterance final H-HL sequences is not observed except before pause. In all other cases, the sequence is realized H-H. As will be seen, if we were to delink the L of H-HL at the word level, a H-HL # H sequence would be incorrectly realized as H-H-!H (with downstep), rather than the observed H-H-H.
[8] Which we show as separate L features for clarity—notwithstanding the OCP.
[9] A seventh object prefix, reflexive -á-, also exists in the language: w-àá-díngà 'to love onself', w-àá-dángâ 'to lose oneself'.
[10] Assume that the H of vá- in (20a) spreads to the L TBU of -dìnga. The unlinked L tone of the 1ps prefix N- will now be temporally sequenced after the doubly linked H tone. As a result, it is followed by a L TBU, not a H, and there should be no downstep.
[11] A third candidate, which we would also reject, concerns Meeussen's (1967) "law of initials and finals". In many Bantu languages there is a tonal difference between different prefixes such as the one we have seen for Tuki. Unlike Tuki, however, there are tenses in which the final vowel of the verb stem acquires the same tone as the initial (subject prefix) tone. One could imagine placing this tone on a separate plane and spreading it from the subject prefix directly to the final vowel—potentially skipping over numerous intervening tones.
[12] Object prefixes may not cooccur or we would have attempted to place one of the (L)H tone plural object prefixes before the 1ps prefix.
[13] Unfortunately, both of the two verbs with initial /y/ in our corpus are underlyingly H, i.e.. ò-yáánà 'to pay', ò-yéérè 'to teach, learn'. We do not know if it is a coincidence that they both are followed by a long vowel.
[14] Again, all of the examples we have of initial /v/ or /w/ occur on H tone verbs. Note that where proto-Bantu reflexes of the items in (30) can be identified, they have been reconstructed with initial *k, e.g. *-kúb- 'hit', *-káng- 'fry', *-kút- 'tie'.
[15] One exception was found in the data: v-úmbàànà-ḿ 'they seize' vs. vá-!-kúmbàànà-ḿ 'they seize me'. Here the vowel-initial verb instead shows up with an initial [k], which conditions deletion of the preceding 1ps nasal.
[16] Also within the realm of logical possibilities would be for the /g/ to be a separate morpheme unto itself. There is no evidence for this—cf. however the discussion below of 1ps subject prefixes having a [ŋgV] realization.
[17] This time the verb -ùmbaana is regular (vs. its realization with the 1ps object prefix.)
[18] This includes the curious change of the negative marker when the 1sg is present vs. absent in the P2: à-tòó-díngà 's/he didn't love' vs. ngà-tàá-díngà 'I didn't love'.
[19] A similar situation obtains in Basaá, another Bantu language in Cameroon.
[20] The assimilation of V- prefixes to a preceding H tone may actually be in a state of flux. We have found that the vowel prefix a- tends not to undergo the special rule, while the prefixes i- and o- do. In addition, the second author allows for a certain amount of variation, e.g. à-mà-túmá ví-túmbá ~ à-mà-túmá ví-!túmbá 's/he sent goats' (< vì-túmbá).
[21] Among the non-personal noun classes, 4 and 9 have a L tone object prefix, while the remaining classes have a H object prefix.

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The Development of Falling Contours from Tone Bending in Hausa*

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0. Hausa has three surface tones: H(igh), which is notationally unmarked, L(ow), indicated by a grave accent (à), and F(alling), indicated by a circumflex (â). (With long vowels, indicated by double letters, tone is marked on the first vowel only.) Evidence from a number of areas, such as contractions, paradigmatic patterns, and morphological formations, shows clearly that the falling tone represents H + L on a single syllable, where, moreover, the level tones originally belonged to two separate syllables. For example, the items in (1) illustrate contours resulting from tone retention following vowel loss.

(1) kâr̃ = kadà 'don't', dâbgii = daabùgii [W dialect] 'anteater'; bêlbeelàa 'cattle egret' < *beelàbeelà; dândaanàa 'an herb' < *daanàdaana

The examples in (2) show falling tones occurring in H-L pronominal paradigms.

(2) a. zân (< zaanì) 'I will', zâi (< zaayà) 'he will', cf. zaakà ' you (m) will', zaatà 'she will'
b. mîn (= minì) 'to me', mâr̃ (= masà) 'to him', cf. makà 'to you (m)', musù 'to them'

The plurals in (3a) and the verbs in (3b) illustrate disyllabic F-H words corresponding to trisyllabic H-L-H words. For example, plurals of the form zôbbaa, which are derived from CVCV singular nouns, pattern with H-L-H plurals such as sir̃àadaa 'saddle(s)', derived from CVCCV nouns. Similarly, surface disyllabic verbs with the tone pattern F-H, e.g. mântaa 'forget' behave just like trisyllabic H-L-H verbs such as kar̃àntaa 'read'.

(3) a. zôbbaa (< *zoobàbaa) 'rings' (sg. zoobèe); sâssaa (< *saasàsaa) 'districts' (sg. saas(h)èe), cf. sir̃dìi, pl. sir̃àadaa 'saddle(s)', turkèe, pl. turàakaa 'tethering posts'
b. mântaa 'forget', shâidaa 'inform', shânyee 'drink up', cf. kar̃àntaa 'read', bayyànaa 'explain', bincìkee 'investigate'

Compelling evidence regarding the analysis of the falling tone in Hausa as HL is provided by the "stabilizer" nee/cee, whose tone is always opposite that of the immediately preceding tone. (The cee allomorph is used with feminine singular nouns; nee is used with masculine and with plural nouns.) After words with final H tone, nee/cee is L; after words with final L tone nee/cee is H, see 4a. The tonal polarity shows up particularly clearly with words that have tonal variants, see 4b.

(4) a. jàakii nèe 'it's a donkey', rìigaa cèe 'it's a gown'; zoobèe nee 'it's a ring', mootàa cee 'it's a car', huulunàa nee 'they're caps'
b. kèekè nee = kèeke(e) nèe 'it's a bicycle', ʔilmìi nee = ʔilìmii nèe 'it's knowledge'

As we would expect based on the interpretation of F as H + L, nee/cee after a word-final F is invariably H, e.g.

(5) hàr̃âm nee 'it's religiously unlawful', mâi nee 'it's oil'

Finally, the fact that falling tones in Hausa only occur on heavy syllables (Newman 1972), i.e. those with two potential tone-bearing-units, further supports the interpretation of F as consisting of two tones.

1. None of the above is controversial in Hausa studies: the treatment of F as a sequence of level tones has ben accepted for a long time. For example, over 50 years ago, R. C. Abraham, the remarkable lexicographer and grammarian wrote, "The falling tone . . . has arisen from the fusion into a single tone of an original *high* and *low* " (Abraham 1941:139, italics his). Greenberg (1941:320) commented similarly: "Examples of the compound [= falling] tone can be considered . . . as the results of a successeion of a high tone and a low tone." Thus, given a tone typology in which contour tones in some languages appear to constitute primes, the East Asian tone type, and in others are analyzable as sequences of level tones, the African tone type,[1] it is not surprising that Hausa is often taken as the prototype of the African type. What *is* surprising to discover is that historically F tones in Hausa do *not* all come from H-L sequences. Rather, in some cases F tone derived from a simple monotone by a process that I think of as "tone slurring", "tone slipping", or "tone bending". Specifically, F tone in monosyllabic nouns came directly from a single level H by a downglide in pitch comparable to the non-phonemic dipthongization of the long vowels /ee/ and /oo/ in English. According to this analysis, a word such as wâa 'elder brother', for example, did not come from a CVCV word with H-L tone, as has been implicitly assumed by all Hausaists, including myself, but rather from a monosyllabic word with simple H tone, i.e. [wâa] < */waa/.

2. First I shall describe some facts about Hausa that led to the historical hypothesis being presented here. Then, I shall show how this discovery elucidates certain synchronic tonal alternations that previously had been unexplained.

2.1. Excluding ideophones, monosyllabic words in Hausa are not very common. They are the norm in pronouns, with variable tone and vowel length depending on function, and in grammatical morphemes, e.g. dà 'with', sai 'until'. With content words, monosyllabics are limited to about ten, almost exclusively H tone, verbs, e.g. ci 'eat', shaa 'drink',[2] and about twice that number of nouns, some of which are H and some which have F tone. Surprisingly, with the nouns, the H tone words are the ones where it is easiest to find a disyllabic source, e.g.

(7) sau 'foot' < and = saawuu (cf. pl. saawàayee), ƙwai 'egg' < and = ƙwaayii (cf. pl. ƙwaayàayee); yau 'saliva' < and = yaawuu, sai 'urine' < ? = sanyii, shuu 'silence' = and < shiruu, jaa 'red(ness)' < *jaajaa by back formation (cf. pl. jaajàayee); 'yaa 'daughter' < *'yǎa < and = ɗìyaa.[3]

Most of the remaining monosyllabic nouns turn out to have F tone, e.g.

(8) dîi [W] 'bamboo canoe pole', kâi 'head', mâi 'oil', râi 'life', sâa 'ox, bull', sûu 'fishing', wâa 'elder brother', yâa 'elder sister', yâu 'today'

In some of the above words, the F tone may in fact reflect an old H-L sequence. For example râi 'life' is probably a deverbal noun, originally *raayìi, related to the verb raayàa 'give life', whereas kâi 'head' is probably a bimorphemic form consisting of the root *ka (which reflects the reconstructed Proto-Chadic form) plus the definite article suffix -ì. In others, however, there is no evidence to support the assumption of a disyllabic/ditonal source underlying the present F tone. Instead, one finds comparative evidence that indicates strongly that these words were always monosyllabic (and presumably monotonal). The Hausa word mâi 'oil', for example, is a direct reflex of a word reconstructed for Proto-Chadic with confidence as a monosyllabic form *mar (Newman 1977). Similarly, the Proto-Chadic word for 'bovine', *hla, of which Hausa sâa is probably a reflex, is invariably monosyllabic in present-day Chadic languages as it clearly was in the proto-language, e.g.

(9) mâi 'oil' < PC *mar ; sâa 'ox, bull' < PC *hla 'bovine' (hl = [ɬ])

In sum, the hypothesis being presented here is that *all* monosyllabic nouns in Old Hausa were originally monotonal (H) and all of them subsequently altered into falling tone words by a phonetic process of tone bending. The present-day monosyllabic nouns with H tone presumably all have a more recent origin, either from reduced disyllabic words, see (7) above, or from other tonal adjustments. Since the rule did not affect verbs, we now have an explanation for why monosyllabic verbs almost all have H tone whereas F tone is normal with monosyllabic nouns.

2.2. Additional evidence that F on monosyllabic nouns is an intrinsic tonal property of words of that shape rather than reflecting a tonal sequence comes from loanwords (see Hyman 1970). Although monosyllabic words in Hausa used to be uncommon, the language now has many more such words as a result of recent borrowing, e.g.

(10) bâl 'ball', bôm 'bomb', fîm 'film', kyât 'cake', nâs 'nurse', zûu 'zoo'

As one can see, all of the words have falling tone. One's first thought might be that the F is simply a reflection of the English intonation pattern. But note the following examples of French loanwords in the Hausa of Niger:

(11) bîk 'ballpoint pen', kâr 'bus', kyâs 'box'; pîl 'battery', sôo 'bucket'

Again we find the Hausa words with F tone, but in this case the donor language is not charactized by an intonational downglide at the end of words or phrases. So where does the F come from? My answer is that this is a further manifestation of the Hausa tendency to pronounce monosyllabic nouns with a falling contour.

3. Given the *H > F rule, we can now account for some anomalous falling tones that are found in a couple of common contractions, e.g.

(12) bâi F < baayaa H-H 'back' ; gûu F < gurii H-H 'place'

Previously, there seemed to be no reason at all why the monosyllabic forms should have F tone since the words from which they were derived contained level H tones. However, if we view these forms as old contractions that fed the tone slurring rule, then we have a plausible historical explananation for the modern-day alternations. Note, by the way, that we must assume that these were lexically specific old contractions, since more recent contractions, e.g. yaawuu > yau 'saliva' keep their original H tone. The hypothetical derivation is shown as follows:

(13) baayaa HH 'back' > (contraction) *bai H > (tone slippage) bâi F

4. While it is interesting to be able to explain scattered lexical anomalies, the real significance of the historical contour tone rule is that it throws a totally new perspective on the grammatically important formation of verbal nouns from finite verbs. In Hausa, "verbal nouns", which correspond to gerunds and progressive participles in English, are formed in a variety of ways. Those corresponding to simple H tone monosyllabic verbs all have a long vowel and falling tone, e.g,[4]

(14) shâa 'drinking' < shaa 'to drink', jâa 'pulling' < jaa 'to pull', sôo 'wanting' < soo 'to want', bîi 'following' < bi 'to follow'; cîi eating < ci to eat

As far as I am aware, no one has accounted for the tone/vowel length alternation in an explicit, formal way, but the common assumption has been that forms such as jâa and bîi were bimorphemic, made up of the verb root plus a verbal noun ending consisting of a floating L tone with length. What this analysis leaves unanswered is why the L tone resulting in the falling contour isn't added to verbal nouns formed from disyllabic verbs, which also under lengthening, e.g.

(15) fìtaa 'going out' (not *fìtâa) < fìta 'go out'; tsuufaa 'aging' < tsuufa 'to grow old', ƙòoshii 'being replete' < ƙòoshi 'be replete'

The explanation I would suggest is the following. In the course of Hausa linguistic history, all common nouns came to have long final vowels (see Schuh 1984, esp. 196-97, Newman 1979). As a result, verbal nouns automatically acquired long final vowels just by virtue of their being nouns. The change from fìta to fìtaa or bi to bîi, for example, was not due to the linear attachment of an additional morpheme; rather it was a consequence of a cateogy shift. What this means is that contrary to our usual view, regular verbal noun formation in Hausa was a case of zero derivation.

Verbs with an underlying short final vowel would have added length as an automatic result of a catogory shift from verb to noun. Verbs with an intrinsic long final vowel would initially have undergone no phonological change. On becoming nouns, however, the some of the erstwhile verbs would have been subject to the tone bending rule, thereby appearing with the falling tone that synchronically serves to mark verbal nouns.[5] Presumed sample derivations are as follows:

(16) [bi]$_V$ $\Rightarrow$ [bii]$_N$ > (by tone slippage) bîi 'following'
[jaa]$_V$ $\Rightarrow$ [jaa]$_N$ > (by tone slippage) jâa 'pulling'

Note that for the F tone to appear, the forms would have to be (a) nominal and (b) monosyllabic. Verb forms such as jaa 'to pull', although monosyllabic wouldn't have been affected, and disyllabic verbal nouns such as fitaa 'going out' and tsuufaa 'aging', although nouns, wouldn't have been affected. The tone rule would have applied to all and only monosyllabic verbal nouns—which is exactly what we find.

5. Originally, I had thought of contour tone formation in Hausa as manifesting weakening or intonational type downglide. I suspect that a better way to view the historical change, however, is as a strengthing phenomenon, which served to prop up monosyllabic nouns, all of which originally had H tone. This case would then fit in with the type of historical tonological process described by Hyman (1978:262–63): "A tone which occurs under the influence of an accent may change to make that tone (or syllable) more prominent. What this usually means is that a level tone will become a contour . . . ."

6. In describing the development of falling tones from high as a process of tone bending/slurring/slipping, my aim has been to show that the contours developed, not from the addition of a discrete L tone, nor even from the addition of a discrete, linear L feature, but rather from the phonetic deformation of a level H tone. The erstwhile H tone was modified, not added to. Once these falling tones appeared, however, they ultimately merged with falling tones produced by H + L sequences resulting from vowel loss, so that synchronically, all of the falling tones regardless of their origin behave like HL sequences on a single syllable. It is of course commonplace in African languages for HL tones to be phonetically realized as a fall. What happened in Hausa is the opposite, namely that in the specific case of monosyllabic nouns, basic contours that were produced by a low level phonetic process underwent phonological decomposition into H + L.

7. Synchronically, Hausa appears to be a typologically very typical, African-type tone language in which surface contours represent tone sequences. In this paper I have shown how a casual acceptance of such a typology can mask diachronic developments of a totally unsuspected and interesting nature.

NOTES

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1 In the terminology of Yip (1989:149-50), contours in African languages tend to be "tone clusters" whereas in East Asian languages they are "melodic units or branching tones".

[2] The pattern of monosyllabic verbs all having H tone, with no lexical contrast, is reconstructed by Schuh (1977) as a feature of proto-West Chadic.

[3] Hausa does not have surface rising tones. As first described by Parsons (1955), these generally simplify to high (although not always, as is normally assumed). Gwandara, a closely related creolized offshoot of Hausa, on the other hand, still preserves rising tones (Matsushita 1972), cf. *yǎ* 'daughter' and *pǎ* 'a flat rocky outcrop' with Hausa 'yaa and faa.

[4] The verbs zoo 'come' and jee 'go' are irregular in many respects and do not follow the pattern described here.

[5] The process described here only applies to "Primary verbal noun", i.e. phonologically regular gerundives. Hausa also has "Secondary verbal nouns", which are formed by suffixes and vowel ablaut patterns, the choice being lexically specific.

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Form and Function in Tone Languages

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1. Introduction. This paper is an overview of a tone language typology based on tone function and a discussion of some instructive challenges to the typology. To my knowledge, such a typology has not been attempted before. So far, the *phonological* aspects of tone have been used as bases for tone language typologies: for example, tone inventory size (Maddieson 1978), the basic components of tone (Pike 1948, Wang 1967, Woo 1969), the representation of tone in the underlying structure (Leben 1971, Voorhoeve 1973, Duanmu 1990), and the behavior of tone in phonological rules (Hyman and Schuh 1974, Schuh 1978). Typologies also exist in which tone languages as a type are contrasted with other types of languages which make different linguistically significant uses of pitch (McCawley 1970, 1978, VanderHulst and Smith 1988).

A typology which is organized around how tonal contrasts are used leads the investigator beyond tone itself to other related aspects of these languages. Morphological tone, or tone that carries a measure of independent meaning, is found in almost all tone languages. First, one must simply identify what kinds of morphological tone are found in different languages to counteract the mistaken idea that Asian tone languages have only lexical tone. Elsewhere (Ratliff 1991a, 1991b, 1992b) I have presented and defended the functions listed below as definitional for two language types, "A" and "B":

TYPE A	TYPE B
lexical; and	all type A functions; and
minor morphological uses of tone:	major morphological uses of tone:
--attitude of speaker toward referent	
--meaningful tone patterns in expressive (ideophonic) phrases	--derivation
--meaningful tone patterns in reduplicative phrases	--inflection
--tone sandhi compound formation	--major word class demarcation
--minor word class demarcation	(inventories and/or alternation patterns)

But the steps that come after the identification of morphological tone type are the most interesting: the delineation of the relationship between tone function and other structural properties of a tone language apart from tone, and the attempt to ascertain *why* certain types of morphological tone are found in tone languages that have other well-known characteristics. I will illustrate what I mean by this with a brief discussion of White Hmong, as typical of type A, and Kanuri, as typical of type B.

2. A type A tone language: White Hmong (Ratliff 1992a). White Hmong, a Hmong-Mien language of Yunnan province China and northern Southeast Asia, is a classic type A tone language. In addition to the tone functions listed above for type A languages, it has the following related structural features: almost no segmental morphology, primarily monosyllabic roots, low word-building resources, many tones, and a replacement type of tone sandhi.

TONE FUNCTION: as in A above
Major-lexical
Minor-morphological: attitude markers, meaningful tone patterns in expressive phrases, some tonally marked minor word classes, tone sandhi compounding

SEGMENTAL MORPHOLOGY: poor to nonexistent
There are no grammatical affixes. Only some "shape prefixes" with clear independent meaning are used with certain nouns.

ROOT SYLLABLE STRUCTURE: primarily monosyllabic
Except for loan words, bisyllabic words are compounds and compounds are transparent.

SEGMENTAL CONTRASTS/PHONOTACTICS: limited resources
58 onsets times 13 rimes = 754 possible combinations without tone factored in. Since syllables are usually coextensive with morphemes, almost all possible combinations need to be realized as morphemes. There is a high level of homophony as well.

NUMBER OF TONES: high (7: 55, 51, 24, 33, 22, 21ʔ, breathy-fall)

TONE SANDHI: paradigmatic (involving replacement of one tone in the inventory by another)
Morphemes are always identifiable, even if altered by the sandhi process. No spreading; no assimilation; no phonologically "natural" tone changes at all; for example:

22 > breathy-fall after 55:	24 > 33 after 51:
i^{55} tu^{22} $ne\eta^{F}$ > i^{55}- tu^{F} $ne\eta^{F}$	va^{51} $\check{c}e^{24}$ > va^{51}-$\check{c}e^{33}$
one CLF person 'one CLF person'	house garden 'house and grounds'

3. A type B tone language: Kanuri (Hutchison 1981). A representative of type B is Kanuri, a Nilo-Saharan language spoken in a wide area stretching from the Sudan to Nigeria. In addition to the tone functions listed above for type B tone languages, it has the following related structural features: extensive segmental morphology, roots which are primarily polysyllabic, great word-building resources given the possibility that each syllable can be found in either first or last position in the disyllabic word, few tones, and a spreading type of tone sandhi.

TONE FUNCTION: as in B above

Major-morphological:

Inflectional:

V: root tones determine affix tones in different verb classes

N: affixes change root tones: noun plurals

Derivational:

V > N: (1) Tone and affix changes dependent on verb class membership; (2) L_0H pattern to derive abstract nouns

Minor-lexical; expressive

SEGMENTAL MORPHOLOGY: rich

Inflectional:

V: tense, aspect, person and number agreement

N: case and number marking

Derivational:

V > N: (1) Nominalizing affixes with different semantic associations (abstraction, instrumentality, location, agency)

(2) Reduplication

N > Adj (by affixation)

basic V > derived V: applied, passive/reflexive, causative

ROOT SYLLABLE STRUCTURE: polysyllabic

"It seems that the optimal syllable structure for the Kanuri word is bisyllabic . . ." (Hutchison, p. 16). An analysis of one text yielded an average of 2.69 syllables per word.

SEGMENTAL CONTRASTS/PHONOTACTICS: extensive resources

27 onsets times 35 rimes = 945 possible combinations without tone factored in. When taken to the power of 2 (the optimal syllable structure for the Kanuri word being disyllabic), it becomes clear that Kanuri has considerable resources for the generation of new words.

NUMBER OF TONES: low (2: L, H)

TONE SANDHI: syntagmatic (spreading, assimilatory)

A tone melody language (="restricted" tone language) in part: spread of L tone over all but last syllable of many derived forms and compound nominals (Hutchison, p. 28):

fúfù 'lungs'	>	fùfú 'permanent cough'
Kànúrì 'Kanuri people'	>	Kànùrì 'Kanuri language'
mánəm 'you look for' + búi 'eat it'	>	mànəmbúi 'daily bread'

4. Further examples and a rationale. White Hmong and Kanuri may be grouped with many other languages which share similar structural properties and use tone in much the same way. Like White Hmong, there are Mandarin, Hakka, Cantonese, Thai, Vietnamese, and Biao Min in Asia and !Xũ on the Namibia/Botswana border in southern Africa. Like Kanuri, there are Kikuyu, Hausa, Kxoe in Africa, Burmese in Asia, and Otomi, Mazatec, Zapotec in Mesoamerica. They thus define two major tone language types. Why should most tone languages be of one type or the other? The answer comes from the fact that languages are designed to allow us to communicate successfully, and tone is a communicative tool. Tone must be used for lexical discrimination when there are not enough other resources available in a tone language to do the job. This is the case in what I have called "type A" tone languages. Non-tonal resources for word-building are low: there is no derivational morphology, words are short, and there is a low number of possible syllables, as determined by the phonemic inventory and constraints on syllable structure. It follows that if tone is needed for this important job, it will not be easily obscured by tonal alternation processes. If these exist, there will be one highly constrained predictable alternate for each lexical tone that undergoes alternation (and not all will). Assimilatory, or spreading tone rules do not develop because they would obscure lexical tone, as would morphological tone alternations that affect large word categories. Also, languages that need tone primarily to create new words can make good use of a high number of tonal contrasts. Type A tone languages typically have three tonal contrasts or more, up to twelve. Finally, the morphological tone one finds in these languages live on the "interesting outskirts" of the language proper: tones are used to define small closed word classes such as a run of numerals or a set of deictics, to form compounds (where the compound may differ semantically from the sum of its component parts) or to express speaker judgment. What I have called "type B" tone languages can do more with tone because they have rich internal resources for word-building: derivational morphology, longer words, a high number of segmental contrasts. Tone is not needed for lexical discrimination to as great an extent. Words are recoverable despite quite intricate disturbances to the underlying lexical tone. In these languages, tone is used in conjunction with segments to mark inflectional categories and membership in major word classes, and to derive new words.

5. Exceptions and challenges. Of course, what I have sketched here is a picture of two pure types, and what one finds in the real world are to an extent compromises of these idealizations. Nonetheless, most tone languages are surprisingly easy to classify as representative of either one type or the other --- I assume for the communicative reasons I have just presented. Given that this is true, I have found exceptional languages which mix elements from both feature sets to be both interesting and instructive. They fall into three categories:

1) Most tone languages will display marginal use of features from the opposite list. Examples are the presence of some disyllabic words in a primarily monosyllabic word language, and the presence of perhaps one derivational affix in a language otherwise morphology-free. I consider these facts of no importance in determining the basic classification of the language.

2) Some of these exceptional languages -- those that have characteristics of both types, and hence belie the claim that the structural properties outlined above necessarily hang together -- are languages which I claim have been caught in a change in progress which is moving them in the direction of the opposite type. The circumstances of the change actually help demonstrate that the features defining each type are linked: as one feature changes (for whatever reason), other features from the same set begin to develop as well. Shimen Hmong, a Hmong-Mien language, is one of these, and illustrates the development of type B features in a type A language (see extensive discussion in Ratliff 1991b). Gokana, a Benue-Congo language, is another. It illustrates the converse, a development of type A features in what was historically a type B language (see Ratliff 1992b). In both cases, however, the synchronic outcome is a type A language *with the exception* of tone function. In Shimen, the type B tone function is innovated; in Gokana, the type B tone function is preserved.

3) There is a third set of seemingly exceptional languages, however, that I would like to discuss here for the first time. These languages have been proposed to me by various people as constituting counter-evidence to my theory that tone language function is predictable on the basis of the non-tonal structural properties of a tone language. The challenges take the following form: language X has type B tone functions, yet its roots are monosyllabic. What is the explanation for this within a tone language typology which links tone function to root syllable structure? These challenges have proved most helpful, because they have led to a more subtle understanding of the relationship of form and function in tone languages than I could possibly have achieved by only looking at the classic examples of each type, such as Hmong and Kanuri. I will try to show that these languages are not exceptions at all, nor are they languages whose nature can be explained as the result of reconstructable change involving type A and type B feature sets. They are rather stable languages which well illustrate the point that tone function is related to other structural properties of a tone language, but not always primarily to root syllable structure. Accommodating these languages will require the refinement of the basic shape of the typology, rather than an abandonment of it.

6. Challenge #1: Dinka (Andersen 1987). Dinka, a Nilotic language spoken in the Sudan, poses a challenge to this typology: it is a monosyllabic root language, but it is characterized by a great deal of tonal morphology of the B type.[1] In Dinka, tone marks mood and agreement in the verbal system and location and possession in the nominal system. Other features of this language are from the B set rather than the A set, as exemplified below:

TONE FUNCTION: as in B above
<u>Major</u>: morphological
Inflectional: subject agreement

Derivational:
V > N
V > V (passive, imperative, relative, interrogative modes)

Noun, verb and adjective tonal classes
Minor: lexical

SEGMENTAL MORPHOLOGY: rich
Verbal: mood, tense, aspect; person and number agreement
Nominal: location, possession

ROOT SYLLABLE STRUCTURE: primarily monosyllabic
According to Andersen (p. 2), native roots are monosyllabic. Polysyllabic stems are the combination of derivational prefix plus monosyllabic roots or a compound of two monosyllabic roots. In one text examined, 73% of the words were monosyllabic, 25% disyllabic, 2% trisyllabic.

SEGMENTAL CONTRASTS/PHONOTACTICS: extensive resources
21 onsets times 84 nuclei times 13 finals = 22,932 possible combinations without tone factored in! The high number of possible nuclei comes from the fact that the vowel quality contrasts (7 monophthongs + 12 diphthongs = 19) must be multiplied times 2 voice qualities (breathy and creaky but not modal) and that number must be multiplied times three contrastive vowel lengths. A number of phonotactic constraints have already been built in.

NUMBER OF TONES: low (2: L, H)

TONE SANDHI: syntagmatic
Some spreading sandhi (involving bundling and unbundling of surface contour tones)
bundling: L > HL after H

mɔ̀c à-ꜜɡɛ̈ɛm thɔ̈ɔk — 'The man is giving a goat.'
L L H HL
man declar-give goat

unbundling: HL > H before L

à-nɔ̈ŋꜜcuâar kùꜜtiik — 'There are a thief and a woman.'
L L H L L
declar-have thief and woman — (Andersen, pp. 23-24)

In addition to the presence of type B tonal morphology, in Dinka segmental morphology is rich, phonological word-building resources are (extraordinarily) extensive, and the tonal inventory is small. This therefore *is* a type B language, since tone is clearly not particularly necessary for lexical discrimination. The key is the presence of one of the structural characteristics of type B languages other than polysyllabic root structure: segmental morphology, here ablaut (or gradation) morphology, involving both vowels and consonants. "To a large extent . . . inflexion is not realized by affixes but by vowel and tone changes in the stem and by changes in the stem-final consonant" (Andersen p. 3). It is common knowledge that in many well-attested cases inflectional and derivational tones, analyzed synchronically as "floating tones", are all that remain of old affixes. Comparative evidence suggests that Dinka experienced a great deal of compression, but not at the expense of its grammatical contrasts: to put it crudely, what had been spread out horizontally has piled up vertically in this language. The criteria for type B must therefore be modified in light of the existence of languages of this type: type B tone languages may have either polysyllabic roots (the usual case) or predominantly monosyllabic roots, if the language is characterized by segmental morphology of the ablaut type. A type of segmental morphology -- affixal or ablaut -- is, however, a necessary precondition for the presence of inflectional and derivational tone, since this kind of tonal morphology has its origin in segmental morphology.

Amuzgo (Smith-Stark and García 1986), an Oto-Manguean language of Mexico, is another language which should be classified as type B despite the fact that it has predominantly monosyllabic roots. Compared to Dinka, it has neither so much segmental nor so much tonal morphology, but it is significant that they seem to be present to roughly the same extent in this language. Smith-Stark (p.c.) believes Amuzgo has undergone the same kind of "compression experience" as Dinka has. So in Amuzgo as well, the key structural feature correlated with the presence of type B tonal morphology in a monosyllabic root language is the presence of segmental morphology.

7. Challenge #2: the Northern Wu dialects of Chinese.[2] Certain Chinese dialects pose another version of the same challenge posed by Dinka and Amuzgo. In the same family as the quintessential type A tone language, Mandarin, these dialects surprisingly have predominantly monosyllabic root structure and another type B tone function: major syntactic class demarcation. To quote Sagart (p.c.), "Chinese dialects in which monosyllables behave differently in sandhi according to the grammatical nature of the compound in which they occur are common in the Northern Wu area, [that is] more or less that part of Jiangsu province which lies south of the Yangtse river. Descriptions of dialects such as Chongming island in the Yangtse estuary, Suzhou, or Danyang state that these have a 'normal' or 'major' or broad' pattern of sandhi which applies generally, and a 'minor' or 'narrow' pattern which applies in certain [constructions]". I identify this tone function as harmonic in type B rather than type A tone languages. Type A tone languages may have syntactically conditioned tone sandhi, but it is usually different in two important respects. First, if they have any at all, type A languages have only highly restricted tone sandhi processes. Northern Wu type tone sandhi not only identifies certain constructions as candidates for tone sandhi alternations, but may contrast constructions by virtue of *which* tone sandhi pattern they will follow, thereby according tonal patterns syntactic meaning. Since major constructions are involved, this seems analogous to the identification of verbal and nominal class members in type B languages according to the type of tonal alternations they undergo.

Second and most important, tone sandhi in type A languages preserves lexical tone since each tone has at the most only one alternate drawn from the tonemic inventory, and these alternates can be learned by tone category pairings. In the Northern Wu type of tone sandhi which involves spreading tone and/or tone neutralization, lexical tone is obscured to the point of being irretrievable. Of Shanghai, Ballard reports: ". . . tone is becoming nondistinctive . . . Shanghai's isolation values are the fewest of any Wu dialect [3 tones with 2 checked tones for category D] . . . a lot of polysyllabic words must be learned as units 'with a particular overall contour'" (p. 44, quoting from Sherard 1972, 1980). Of Tang Xi, Kennedy writes: "It is beyond question that tone is word-distinctive on monosyllables . . . But these monosyllables form a very small percentage of the vocabulary. Most of the time the tonal pattern is functioning morphologically . . . one might be led to the broad guess that the function of tone in Tangsic is essentially not to distinguish otherwise homophonous syllables, but to express syntactic relationships. From spoken material alone and without reference to historical dictionaries it is extraordinarily difficult to make up a word list for Tangsic in terms of monosyllables with fixed tones" (p. 373). And of the Northern Wu group of dialects as a whole, Ballard writes: "It is at least possible that the tone sandhi groups are being treated as words, and thus receive a tone envelope that is equivalent to some single syllable tone value" (p. 210). The key to the appearance of a type B tone function in some dialects of Chinese, then, is the presence of two other structural characteristics of type B languages: syntagmatic (spreading) tone sandhi and the concomitant growth of polysyllabic roots.

For example, in **Tang Xi** (Kennedy 1953), a sketch of which appears below, there are two primary tone sandhi patterns. One tone sandhi pattern is used for attribute-head constructions and is left dominant (with rightward spreading of the tone of the first morpheme of the noun phrase) while the other tone sandhi pattern is used for verb-complement constructions and is right dominant (with neutralization of the tone of the verb on the left). According to Kennedy, these patterns arose from differential stress patterns in the two constructions.

TONE FUNCTION: as in B above
Lexical; yet major constructions characterized by different tone patterns which obscure lexical tone

SEGMENTAL MORPHOLOGY: poor
No significant segmental morphology

ROOT SYLLABLE STRUCTURE: monosyllabic > disyllabic

SEGMENTAL CONTRASTS/PHONOTACTICS: not predictive
The possibility of positioning syllables at the beginning or end of a disyllabic word increases the number of possible words exponentially.

NUMBER OF TONES: not predictive
Either 3 (if two "registers" factored out, which is possible since the initial consonant voicing contrast is retained), or 5 (if initial consonant class disregarded) on open syllables

TONE SANDHI: syntagmatic
Both a rightward, left-dominant (spreading) pattern for attribute-head constructions and leftward, right-dominant (neutralization of first unstressed syllable) pattern for verb-complement constructions. Neither pattern involves replacement sandhi; both patterns are syntactically defined. In certain collocations, this gives rise to different meanings (Kennedy, pp. 372-373):

ʔea^{24} 'love' + nyin^{24} 'man'

attribute-head pattern: ʔea-nyin^{2--4} 'sweetheart (loved person)'

verb-complement pattern: ʔea-nyin$^{\emptyset-24}$ 'to love people'

tsao^{51} 'fry' + vae^{24} 'rice'

attribute-head pattern: tsao-vae^{5--1} 'fried rice'

verb-complement pattern: tsao-vae$^{\emptyset-24}$ 'to fry rice'

8. Conclusion. We have seen that the unexpected cooccurrence of type B tone function and monosyllabic root structure is to be understood in the light of other information about these languages, namely information about segmental morphology for Dinka and Amuzgo and information about sandhi processes and the growth of the phonological word in the Northern Wu dialects of Chinese. Furthermore, of the two type B tone functions, it appears that inflectional and derivational tone may be most closely correlated with the presence of segmental morphology of the same type, whereas the marking of major constructions by tone may be correlated with stress-derived tone sandhi processes, and not with segmental morphology at all. In other words, within the type B group, languages can differ according to how tone is used and which of the other structural properties of the language is (or are) crucially involved.

Monosyllabicity, therefore, cannot be used as a necessary or sufficient condition for the presence of type A tone functions to the exclusion of type B tone functions in a tone language. Polysyllabicity, on the other hand, does seem to constitute a sufficient condition for the presence of type B tone functions. I have encountered no polysyllabic root tone language that does not display one or more of the type B tone functions. The presence of other type B structural features, especially the presence of segmental morphology, may also constitute sufficient condition for a tone language to have important grammatical functions.

This asymmetry in structural prerequisites for particular tone functions is reflected in two further facts. First, any type A tonal function (including lexical discrimination, of course) can appear in a type B language, but identification of a tone language as type A depends on that language *not* having type B functions. Second, the communicative explanation for the role of tone in a language only works for the A type: there is no clear communicative reason why tone should redundantly mark grammatical contrasts in a type B language.

Two of these asymmetries, (1) the use of monosyllabic roots in both types, but polysyllabic roots in just one, and (2) the use of lexical tone in both types, but substantial grammatical tone in just one, may help explain the fact that type B tone languages, of all the world's tone languages, appear to be more frequently encountered and more widely dispersed. We may want to identify type A as the marked and type B as the unmarked tone language type. As part of a formal characterization of these ideas I would like to propose the following implicational universals for mature tone languages. "Grammatical use of tone" in these statements refers to the major grammatical tone functions of type B:

1. If a tone language has only 2 contrastive tones, it will make grammatical use of tone.

2. If a tone language is characterized by significant spreading (assimilatory) tone sandhi, it will make grammatical use of tone.

3. If a tone language makes significant use of segmental morphology (either affixal or ablaut), it will make grammatical use of tone.

4. If a tone language is characterized by polysyllabic roots, it will make grammatical use of tone.

Notes

[1]With thanks to Keith Denning for suggesting that I look at Dinka, and Thomas Smith-Stark for suggesting that I look at Amuzgo.

[2]I am grateful to San Duanmu for raising the question of spreading tone in apparent type A languages and Laurent Sagart for calling my attention to tone behavior in a number of Wu dialects. Sagart also reports that syntactically governed tone sandhi can also be found in dialects from another area in China: Western Jiangxi and Southern Hunan.

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From atonal to tonal in Utsat (a Chamic language of Hainan)

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0. Introduction. Utsat, a Chamic Austronesian of Hainan, has undergone striking typological changes, going from polysyllabic and atonal to monosyllabic and tonal. These Utsat developments are of broad interest for their historical parallels and for their typological insights. They provide a historical model for the Tai-Kadai languages, a family now monosyllabic and tonal but believed to have been originally disyllabic and atonal. Utsat also provides a model for another more controversial change, the large Austronesian component Sagart (1991) has reported for Chinese. Here, as with Tai-Kadai, a model for the transition from disyllabic and atonal to monosyllabic and tonal is needed to account for the changes in the original Austronesian forms. However, the focus of this paper is not the historical but the typological insights which Utsat provides into tonogenesis. In the literature on Southeast Asian tonogenesis, the studies typically report individual stages in the tonogenetic process rather than report the whole process. There are examples of atonal languages becoming registral, registral languages becoming tonal, tonal languages undergoing tonal splits, and so on. It is usually only through extrapolation from various parts of the whole that a complete picture of tonogenesis can be complied. However, with the Chamic Utsat language of Hainan the complete transition from atonal to tonal is still recoverable: the closely related insular Austronesian (=PAN) languages are atonal; on the mainland of Southeast Asia under the influence of Austroasiatic (=Mon-Khmer) languages, the Chamic languages have become increasingly monosyllabic and, in some cases, registral; and, on Hainan island under the influence of various tonal languages (Solnit 1982), the Chamic dialect of Utsat has become monosyllabic and fully tonal. In the case of Utsat, these dual developments are recent enough and transparent enough for us to be able to outline the full transition from disyllabic and atonal to monosyllabic and tonal.

This analysis builds upon prior comparative analyses of Utsat and Utsat tonogenesis by expanding the bases for comparison and by expanding the database. Benedict (1984) and Haudricourt (1984) compared selected Utsat etyma directly with Old Cham, each providing an insightful set of suggestions about the origins of Utsat tones. Zheng (1986) compared Utsat directly with Rade, another Chamic language, but here the focus was not on tonogenesis. Most recently Ni Dabai (1988, 1990ab) compared Utsat directly with Indonesian, providing additional insights into Utsat tonogenesis. Unlike the two prior analyses of Utsat tonogenesis, this paper uses all of the available Utsat data and compares Utsat directly with proto-Chamic. Both Benedict (1984) and Ni Dabai (1988, 1990ab) used only part of the database. Unlike the earlier analyses which compare Utsat directly with specific individual languages, this analysis compares Utsat with reconstructed proto-Chamic, although an eye has also been kept on Malay and Indonesian cognates for insights they might provide.

The Utsat database used for this study consists of virtually all the forms found in the sources available to me: Ouyang and Zheng (1983), Zheng (1986), and Ni Dabai (1988, 1990ab). This amounted to some 500 forms. Of these, some 370 or so forms either can be related to proto-Chamic reconstructions or can be identified on one basis or another as loans from non-Austronesian languages.

Although describing the same language, the database represents two separate transcriptions: the transcription of Ouyang and Zheng (1983) and Zheng (1986), on the one hand, and the transcription of Ni Dabai, on the other. The two approaches agree in virtually all respects except in their choice of tone numbers to designate the tones:

Ouyang and Zheng	Ni Dabai	
55	55	high-level tone
53	42	high-falling tone
33	33	mid-level tone
35	24	low-rising tone
11	11	low-level tone

These notational differences are of limited significance, as both transcriptions show three level tones, one falling tone, and one rising tone.

Something that is necessary to mention but I suspect ultimately of no significance is the tonal designations that show up sporadically. Somewhat regularly Ouyang and Zheng have a 32 tone that only occurs with stopped rhymes and appears to be a variant of the 33 tone; in Ni Dabai, these same forms occur as one of his basic five tones but with a final glottal stop (indicating glottalization?). A 45 tone occurs twice in Ouyang and Zheng, but this makes sense as a variant of their 35 tone. Finally, a 21 tone occurs in both Ouyang and Zheng (several times) and in Ni Dabai (once), but I suspect this too is a variant of one of the five basic tones.

The proto-Chamic reconstructions used for comparison are our own modifications of the reconstructions in Lee's 1966 dissertation. Although Lee's reconstructions are basically sound, much has been learned about Chamic languages in the last quarter of a century. Thus, our Chamic reconstructions ended up differing from Lee's in a number of ways: (a) The database is larger. In addition to the mainland sources found in Lee, our database includes additional mainland languages: Chru (Jrang et al. 1977), Haroi (Goschnick et al. 1976), Eastern Cham (Blood and Blood, 1977), and another description of Rade (J. A. Tharp and Y-Bham Buon-Ya (1980). And, of course, the database now includes Utsat on Hainan (Ouyang and Zheng 1983; Zheng 1986; Ni Dabai 1988, 1990ab), although this last addition has had minimal effects on the reconstruction of proto-Chamic itself. (b) Numerous loans from Austroasiatic, Indo-European, and occasionally elsewhere have been culled out (e.g., Headley 1976). (c) Our phonetic knowledge of Chamic has been expanded through valuable instrumental studies of the registral nature of Western Cham (Jerold Edmondson, and Kenneth Gregerson, to appear) and of the tonal system of Eastern Cham (Phú Văn Hẳn, Jerold Edmondson, and Kenneth Gregerson, to appear). (d) Insights have been gained from an increased understanding of the relationships of Chamic with the rest of the Austronesian languages (e.g. Blood 1962; Pittman 1959; Thomas 1963; Ni

Dabai1988, 1990ab; Benedict 1941, 1984) and from comparisons with PAN (various works of Blust and of others).[2] (e) Instrumental work has been done on Utsat itself, clarifying at least some of the problems inherent in the transcriptions used by Ouyang and Zheng and by Ni Dabai (Maddieson and Pang, 1991).[3]

1.0 Evolution of the Utsat tones. In at least some ways, the evolution of Utsat tones is strikingly straightforward. The first tonal split was between the voiceless finals and the voiced finals. The voiceless finals again split into syllables ending in *-h and the dead syllables (dead syllables end in voiceless final stops); the dead syllables then underwent one more tone split. The live syllables, that is, the remaining syllables, also split into two (live syllables end in nasal finals or vowel finals; for *-s see sec. 2.0 below). The live syllable forms containing an initial voiced stop or affricate produced a low-tone class; those syllables without a voiced stop produced a contrasting mid-tone class.

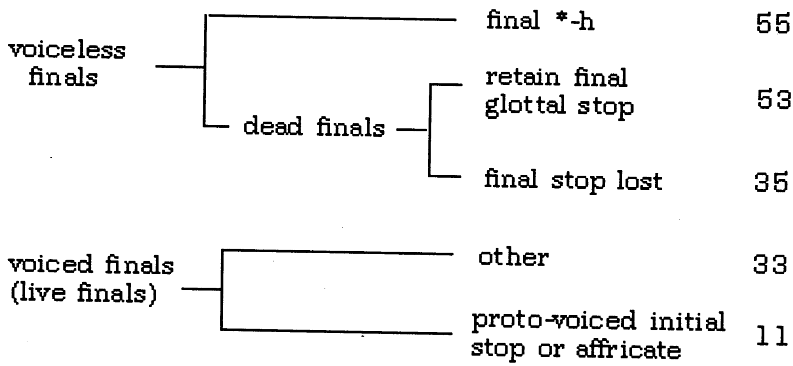

Chart 1.0: Utsat tonogenesis.

The remaining questions are mainly questions about individual etyma. Borrowings: In some cases, the non-Austronesian origin of particular forms has been suggested by Headley's work (1976) and other sources and confirmed by the existence of striking irregularities in proto-Chamic correspondence sets. Due to space limitations, words identified as borrowings are not dealt with in this shortened version of this paper. Some Austroasiatic and other borrowings were borrowed so early that they have perfectly regular reflexes within Chamic; as such forms behave regularly with respect to the Utsat developments, no effort have been made to cull these out. Anomalous forms: In any real data base, there are forms that occur with an unexpected initial, with an unanticipated vowel, or with an etymologically 'wrong' tone. This data base was no exception. However, the anomalous forms that occurred in this data base are just that—anomalous. None of these anomalies constitute problems for the analysis and thus most have, again for the lack of space, been simply left out of this shortened version of the paper.

1.1 From final *-h: (> tone 55). The regular Utsat reflex of Proto-Chamic final *-h is tone 55. This group contains 40 or so examples.

*kutũt	tu?^{53}	tu?^{42}	kətù	kutũk-f	ktŭt	'fart'
*?duai?	doi^{53}	---	ɗuaĭ	?duai?	ɗuĕ	'run; flee'
*hadip	---	thiu^{42}	hədiŭ	hadiu?	hdĭp	'live, alive'
*tiki?	---	ki?^{42}	təkì	tikī?	---	'few; little'

Tone 35. There are 31 examples of tone 35, a tone that correlates with the complete loss of final stops.

*mañak	ña^{35}	ña^{24}	---	mañã?	mñak	'oil'
*rok	zə^{35}	zə^{35}	rŏ	---	rô̆k	'grass'
*cə?	tsə^{35}	tsə^{24}	chŏ	cə?	cŭ -i	'mountain'
*hua?	hua^{35}	---	huă	hua?	huă	'eat, to'
*?asap	sau^{35}	sau^{35}	asă	?asa?	asăp	'smoke'
*pa:?	pa^{35}	pa^{24}	pà	pā?	pă	'four'
*phĩ?	phi^{35}	---	phì	phī^{n}? ^{n}?	phĭ	'bitter'
*laŋi:?	ŋi^{35}	ŋi^{24}	-ləngì	laŋī^{n}?	---	'sky'
*?ana:k	na^{35}	na^{24}	anà	?anā^{n}?	anak	'child'
*kle?	ke^{35}	---	klĕ	tle?	tlĕ	'steal'
*?ako?	ko^{35}	---	akŏ	---	kŏ; akŏ	'head'
*le?	le^{35}	---	lĕ	le?	lĕ	'fall'
*saki?	ki^{35}	ki^{24}	-səkì	sakī?	---	'sick, painful'
*?bu:k	?bu^{35}	?bu^{24}	'bù	?bū?	ɓŭk	'hair, head'
*mvbŭ	---	phu^{24}	məbŭ	---	---	'drunk'
*situk	---	tu^{24}	stŭ -i	situ?	atŭk	'cook'
*bruk	---	zo^{24}	brŭ	bɨũk	brŭ	'rotten'
*k_so?	so^{35}	---	kəlso ?o	sō?	ksŏ	'lungs'
*jhi:t	si^{35}	---	sì	chi?	jhĭt	'sew'
*chia:p	siau^{35}	---	siau'	---	siap	'wing'

1.3 Live finals: (i.e., non-stopped syllables). The live finals are those syllables ending in nasals or vowels. The basic division is between a low-toned reflex with a 11 pitch and a mid-toned reflex with a 33 pitch. The 11 tone is the conditioned tone with all live syllables containing a proto-voiced stop becoming 11. The remaining forms constitute the tonal residue class. All forms not containing a proto-voiced stop have the 33 tone, or what I view as one of its apparently-conditioned variants. Note: Proto-Chamic final *-as rhymes lost their *-s, thus behaving like live finals (section 2.0).

This analysis describes what happens to the vast majority of the live syllables. There remains, however, a thus-far puzzling residue of cases in which the Utsat reflexes have not the expected 33 tone but instead either a 32 tonal variant (or, much less frequently, a marginally-attested 21 tonal variant). In one subset of forms, however, the analysis is straightforward: the Proto-Austronesian (=PAN) final *-ay becomes *-a:i?^{32} in Utsat, with an epenthetic glottal stop. Analysis of this problem is complicated by the difficulties inherent in the identification of loans interacting with the limited size of the database.

Proto-Chamic	Utsat (Zheng)	Utsat (Ni)	Chru (Jrang)	Roglai (Lee)	Rade (Tharp)	gloss
*ʔbuh	ʔbu^{55}	---	'buh	ʔbuh	ƀuh	'see'
*ʔjuh	ʔiu^{55}	---	iuh	ʔjuh	djuh	'firewood'
*dilah	la^{55}	la^{55}	dəlah	dilah	êlah	'tongue'
*mumih	mi^{55}	mi^{55}	---	mumĩh	m'mih	'sweet'
*mumah	ma^{55}	ma^{55}	bəmah	mumãh	m'mah	'chew'
*tanah	na^{55}	na^{55}	tənah	tanãh	---	'earth, soil'
*lanah	na^{55}	lə^{11} na^{55}	---	lanãh	ênah	'pus'
*ʔabih	phi^{55} phi^{55}	---	abih	ʔabih	---	'all'
*buh	phu^{55}	---	buh	buh	buh	'wear'
*pəbah	-pha^{55}	---	ia pəbah	---	bah	'spittle'
*pluh	piu^{55}	---	spluh	pluh	pluh	'ten'
*pasah	sa^{55}	---	pəsah	pasah	msah	'wet; damp'
*bijeh	se^{55}	---	pəjeh -i	bijeh	mjeh	'seed'
*tijuh	su^{55}	---	təjuh	tijuh	kjuh	'seven'
*drah	sia^{55}	---	drah	diah	---	'fast'
*lupih	pi^{55}	pi^{55}	ləpih	lupih	êpih	'thin'
*wah	va^{55}	va^{55}	wah	uah	wah	'fish, to'
*mahirah	za^{55}	za^{55}	məriah	maiiah	hrah	'red'
*ʔurah	zua^{55}	---	arah	ʔuiah	areh	'bedbug'
*picah	tsa^{55}	tsa^{55}	pəchah	---	mčah	'broken'
*pitih	ti^{55}	ti^{55}	---	pitih	mtih	'white'
*labuh	phu^{55}	---	ləbuh	labuh	êbuh	'fall down'
*boh	pho^{55}	pho^{55}	boh 'egg'	boh	boh	'fruit, clf.'
*lagah	khe^{55}	---	ləgah	lagah	êgah	'tired'

1.2 From dead finals: (i.e., stopped syllables). The regular reflexes of the dead syllables (that is, those syllables ending in *-p, *-t, *-k, *-ʔ) are tones 53 and 35.

Tone 53. The 53 tone occurs when a stopped final has a glottal stop reflex in Utsat, or in the case of variant forms, if one of the variants retains a glottal stop as a reflex. Several forms no longer have an attested variant with a glottal stop, however, on the basis of comparative evidence it appears that this lack is due either to the limited size of my Utsat database or the recent loss of the glottal stop. Nine forms fit this pattern.

*bruãʔ	phua^{53}	---	bruă	buãʔ	bruă	'work'
*doːk	thoʔ^{53}	thoʔ^{42}	dò	dōʔ	dôk	'live; sit'
*lubaːt	pha^{53}	---	---	lubāʔ	êbat	'walk, go'
*pituk	tuʔ^{53}	tuʔ^{42}	pətŭ	pituʔ	mtŭk	'cough'

Tone 33: (a) with regular final reflexes.

*lapa	pa^{33}	pa^{33}	ləpa	lapa	êpa	'hungry'
*lupəi	pai^{33}	pai^{33}	ləpəi	lupəi	êpei	'dream'
*mata	ta^{33}	tiŋ^{33} ta^{33}	məta	---	---	'eye'
*ʔiku	---	ku^{33}	aku	ʔiku	aku	'tail'
*takuai	kuai^{33}	---	təkuai	takuai	k'kuê	'neck'
*ʔapui	pui^{33}	pui^{33}	apui	ʔapui	apui	'fire'
*ʔadhə̃i	thai^{33}	thai^{33}	thəi	thə̃i	dhei	'forehead'
*thun	thun^{33}	---	thun	thut	thŭn	'year'
*thu	thu^{33}	---	thu	---	thu	'dry'
*pha	-pha^{33}	pha^{33}	pha	pha	pha	'leg, thigh'
*ʔasəu	a^{11} sau^{33}	a^{11} sau^{33}	asəu	ʔasəu	asâo	'dog'
*saːŋ	saːŋ^{33}	---	sàng	sāk	sang	'house'
*sa	sa^{33}	sa^{33}	sa	sa	sa	'one'
*hia	hia^{33}	---	hia	hia	hia	'cry; weep'
*hã	ha^{33}	ha^{33}	hã	hã	ih	'you; thou'
*kəu	kau^{33}	kau^{33}	kəu, kəmi	---	kâo	'I'
*ʔikan	kaːn^{33}	---	akàn	ʔikāt	akan	'fish'
*ʔia	ʔia^{33}	ʔia^{33}	ia	ʔia	êa	'water'
*ʔiəu	ʔiə^{33}	---	---	ʔiəu	iêô	'call; cry'
*ʔbəu	---	ʔbə^{33}	'bəu	ʔbəu	ɓâo	'stench'
*ʔdau	dau^{33}	---	đau	---	---	'all'
*kami	mi^{33}	---	---	kamin	hmei -i	'we (ex.)'
*taŋaːn	ŋaːn^{33}	ŋaːn^{33}	təngàn	təŋan	kngan	'hand'
*tariŋa	ŋa^{33}	lə^{11} ŋa^{33}	tənia	iiŋiã	knga	'ear'
*ʔuni	ni^{33}	ni^{33}	ni	ʔunĩ	anei	'this'
*ʔaŋin	ŋin^{33}	ŋin^{33}	angin	ʔaŋin	angĭn	'wind, the'
*trun	tsun^{33}	---	trun	tiut	trŭn	'descend'
*paləi	piai^{33}	piai^{33}	pləi -v	pələi	----	'village'
*pila	pia^{33}	pia^{33}	pəla	pila	pla	'plant, to'
*haləu	lau^{33}	---	hələu	haləu	hlâo	'pestle'
*taləi	lai^{33}	lai^{33}	tələi	taləi	klei	'rope; string'
*tulak	---	la^{33}	təlŏ	---	klŏ, klŭ	'push, to'
*ʔula	a^{11} la^{33}	-la^{33}	ala	ʔula	ala	'snake'
*kləu	kiə^{33}	kiə^{33}	kləu	tləu	tlâo	'three'
*klau	kiau^{33}	---	klau	tlau	tlao	'laugh'
*kra	kia^{33}	---	kra	kia	kra	'monkey'
*kayəu	zau^{33}	---	kəyəu	---	kəyâo	'tree; wood'
*riya	za^{33}	za^{33}	lia	iiia	êya	'ginger'
*ruəi	zoi^{33}	---	---	iuəi	rui	'crawl, to'
*hurəi	zai^{33}	zai^{33}	hərəi	huiəi	hruê	'day; sun'
*mua	mua^{33}	---	mua	muã	muôr	'termite'

*miau	miau^{33}	---	miau	miãu	miêô	'cat'
*la	la^{33}	---	---	la	la	'spleen'
*lu:n	luan^{33}	luan^{33}	luən	luət	lun	'swallow, to'

(b) final nasal > Utsat stop (unexplained). The tonal reflex in these forms is 33, as expected. The problem is the denasalization of the final. In Utsat, the denasalization does not occur with tone 11 forms, only the 33 forms. Further, even here only some of the final proto-nasals have denasalized; many have not. The question is why just these forms?

*tia:n	tet^{33}	---	tiàn	---	tian	'stomach'
*proŋ	pyok^{33}	---	prong	piok	prŏng	'big'
*troŋ	tsyok^{33}	---	trong	tiok	trong	'eggplant'
*dhoŋ	thok^{33}	---	thong	thok	dhŏng	'knife'
*ʔuraŋ	za:k^{33}	za:nʔ^{33}	aràng	ʔuiăk	arăng	'person'
*ʔariaŋ	liak^{33}-i	---	rə-iang	ʔaiak	ariêng	'crab'

Tone 32 (PAN *-ay > -a:ʔ^{32} (and so on)). Tone 32 is variant of tone 33 that occurs with secondarily-derived final stops. Regular addition of a final glottal stop occurs with PAN *-ay syllables. And, although there is considerable unexplained and unexpected tonal variation, the tone assignment essentially matches that found with Utsat live syllables: 33 toned forms become 32 tones with the addition of the glottal final, while 11 toned forms remain 11 (only one example!).

*takay	ka:iʔ^{32}	kai^{11}	təkai	takai	---	'foot'
*məray	za:iʔ^{32}	za:iʔ^{33}	mərai	---	---	'come'
*haway	va:iʔ^{32}	va:iʔ^{11}	həwai	hauai	hwiê	'rattan'
*matay	ta:iʔ^{42}-t	taiʔ^{42}-t	mətai	---	mdjiê	'die'
*hatay	ta:iʔ^{32}	tai^{11}	hətai	hatai	atiê -i	'liver'
*paday	tha:iʔ^{32}; tha:iʔ$^{21/11}$	thaiʔ^{11}; thai^{11}	pədai	padai	mdiê	'paddy'
*glay	khiaiʔ^{11}	---	glai	---	dliê	'jungle'

*naw	na:uʔ^{32}	na:uʔ^{33}	nau	nãu	nao	'go; leave'

The final glottal stop with this form may reflect a PAN final *-aw, or it may simply be irregular. Without more data, it is not possible to tell.

Tone 11: (from proto-voiced obstruents). Tone 11 forms all show a proto-voiced stop (or affricate) either in the pre-syllable or in the main syllable. However, it cannot simply be voicing that causes these forms to have the low 11 tone, since voiced resonants are in the 33 tone class, not in the 11 tone class. Further, in some Utsat forms that descend from disyllabic forms, the main syllable originally had and still has a voiceless onset; the crucial voiced stops were in the now-lost pre-syllable. Thus, the voiced stop onset of the pre-syllable managed to affect the tone class of the main syllable, but without voicing the main syllables' voiceless initial. This strongly suggests that voiced stops produced a breathy phonation that lead to the 11 tonal reflex. When the voiced consonant occurred as the first consonant of the pre-syllable, the breathiness spread to the main syllable before the pre-syllable was lost. Whatever the explanation, it is clear that tone 11 is associated with proto-voiced stops and affricates.

*dua	thua^{11}	thua^{11}	dua	dua	dua	'two'
*dəŋ	thaŋ^{11}	---	dəng	dək	dǒ̃ng	'stand; stop'
*glay	khiaiʔ^{11}	---	glai	---	dliê	'jungle'
*habəu	phə^{11}	phə^{11}	həbəu	habəu	hbâo	'ashes'
*təbəu -v	phə^{11}	phə^{11}	tərbəu	tubəu	kbâo	'sugarcane'
*hubəi	phai^{11}	phei^{11}-f	həbəi	habuəi	hbei	'yam'
*babui	---	phui^{11}	pəbui -i	babui	---	'pig, wild'
*ʔada	tha^{11}	---	---	---	---	'have; be'
*ʔada	na^{11} tha^{11}	---	ada	---	---	'duck'
*dada	tha^{11}	tha^{11}	---	dada	đahda-i	'chest'
*ʔiduŋ	thuŋ^{11}	thuŋ^{11}	adung	ʔidŭ̃k	adŭ̃ŋ	'nose'
*sidɔm	-than^{11}	-than^{11}	adəm	sudəp	hdăm	'ant'
*padam	---	than^{11}	---	padap	---	'extinguish'
*digəi	khai^{11}	-khai^{33}-t	təgəi	digəi	êgei	'tooth'
*hujaːn	saːn^{11}	saːn^{11}	həjàn	hujāt	hjan	'rain'
*drəi	se^{11}	---	---	diəi	drei	'body; self'
*bara	phia^{11}	phia^{11}	bra	baia	mra	'shoulder'
*braːs	phia^{11}	phia^{11}	bràh	bia	braih	'paddy'
*bahrəu	phiə^{11}	phiə^{11}	bərhəu	bahiəu	mrâo	'new'
*bilaːn	phian^{11}	-phiaŋ^{11}	blàn -v	bilāt	mlan	'moon'
*biləu	phiə^{11}	phiə^{11}	bləu -v	biləu	mlâo	'body hair'
*jrãu	siau^{11}	---	jràːũ	jiãu	drao	'medicine'
*jalaːn	laːn^{11}	laːn^{11}	jəlàn	jalāt	êlan	'road; path'
*buŋa	ŋa^{11}	---	bənga	---	mnga	'flower'
*bitəi	tai^{11}	---	pətəi	pitəi	mtei	'banana'
*batəu	tau^{11}	tau^{11}	pətəu	patəu	tâo	'stone'
*bato	to^{11}	to^{11}	pəto -f	pato	mtô	'teach'
*bisəi	sai^{11}	sai^{11}	pəsəi	pisəi	msei	'iron'
*dupa	pa^{11}	---	təpa	tupa	êpa	'armspan'
*dihləu	lau^{11}	---	dərhəi	dihləu	êlâo	'first (go); formerly'

2.0 Proto-Chamic *-h versus *-s and subgrouping. In most cases, the distinction between the PAN finals *-s and *-h has been lost in Chamic with the two finals merging into proto-Chamic *-h. However, although the *-s is nowhere retained as an -s, evidence of its earlier presence is still found after the

Chamic vowels *u and *a. As a consequence, there is a distinction in Chamic between the vocalic reflexes of *-uh and *-us and the vocalic reflexes of *-ah and *-as.

The final *-s of the final *-us merged totally with proto-Chamic *-h, but not before causing the *-u- to diphthongize in Jorai and Rade. Thus, in these two languages, the old *-us results in a diphthongal -uih reflex, while the old *-uh results in a monophthongal -uh reflex. In a partially but not totally parallel way, the final *-s of the final *-as merged totally with proto-Chamic *-h, but not before causing the *-a- to diphthongize in Jorai and Rade. Thus, in these two languages, the old *-as results in a diphthongal -aih reflex, while the old *-ah results in a monophthongal -ah reflex.

gloss	proto-Chamic	Jorai (Lee)	Rade (Jrang)	Roglai (Lee)	Utsat (Zheng)
	*-as	**-aih**	**-aih**	**-a**	**-a$^{33/11}$**
'husked rice'	*bra:s	braih	braih	bia	phia^{11}
'escape'	*kla:s	klaih	tlaih	tla	---
'escape, c.'	*pakla:s	pəklaih	mtlaih	patla	---
'fish scales'	*kakăs	---	k'kaih	kaka	ka^{33}
'far'	*ʔatas	ʔataih	taih	ʔata	ta^{33}
'scratch'	*pras	---	praih	---	---
	*-ah	**-ah**	**-ah**	**-ah**	**-a^{55}**
'earth, soil'	*tanah	tənah	---	tanãh	na^{55}
'shoot bow'	*panah	pənah	mnah	panãh	na^{55}
'pus'	*lanah	rənah	ênah	lanãh	na^{55}
'middle'	*krãh	krah	krah	kiãh	kia^{55}
'chew'	*mumãh	məmah	m'mah	mumãh	ma^{55}
'mouth'	*mubah	məbah	mbah	mubah -i	pha^{55}
'leech'	*ritah	---	êtah	iitah	a^{11} ta^{55}
'blood'	*darah	drah	êrah	daiah	sia^{55}
'wet; damp'	*pasah	pəsah	msah	pasah	sa^{55}
'bedbug'	*ʔurah	ʔarăh	areh	ʔuiah	zua^{55}

The parallelism between the reflexes of *-us and *-as is broken in the Roglai and, as we shall see, in the Utsat reflexes. In Roglai, the final *-s in the rhyme *-as simply disappears, but **only** in the rhyme *-as. In other words, in Roglai, the Chamic final *-as simply lost its final *-s and became -a, an open syllable. In Utsat, the tonal reflexes indicate that it is also just those Utsat forms reconstructed with *-as that behave tonally as if *-as had lost its final *-s and become an open syllable. This loss of the final *-s in *-as rhymes, attested in Roglai, accounts for the tonal behavior of *-as finals in Utsat. Note: This shared, idiosyncratic innovation in the treatment of *-as finals at least suggests that it might have been Roglai speakers who originally migrated to Hainan and became the Utsat.

3.0 Disyllabic to monosyllabic. The Utsat monosyllabic forms resulted from the collapse of what were in most cases disyllabic Austronesian forms. Under the influence of the mainland Austroasiatic forms, stress came to rest on the final syllable, leaving the pre-syllable unstressed and subsequently, this unstressed vowel dropped. In most cases, the whole pre-syllable was eventually completely lost without any trace. However, sometimes a voiced obstruent in a pre-syllable left a tonal reflex before it dropped (see the discussion above of tone 11). In another subset of forms, the loss of the unstressed vowel in the pre-syllable resulted in a cluster consisting of a stop followed by -r- or -l-; in these cases, the -r- or -l- became Utsat -i-, allowing the initial stop of the pre-syllable to be reinterpreted as the onset in the newly-formed monosyllable (see examples above).

4.0 Summary. Although numerous details still remain to be worked out, the outlines of Utsat tonogenesis are clear. It is largely based on rhymes and finals, not initials. The initial division was into two groups on the basis of whether the proto-rhyme ended with a voiced or a voiceless final. Each of these then underwent further splits. The voiceless finals split into two depending upon whether the syllable ended in *-h or ended with a final stop (=dead syllables). Those proto-rhymes ending in *-h invariably went to Utsat tone 55; the dead syllables again split into two, with those rhymes still retaining a final glottal stop becoming tone 53, while those rhymes having completely lost their final stop became tone 35. The voiced finals (the live syllables) also split into two basic variants. Those syllables with a proto-voiced stop or affricate became tone 11. Most of the remaining live syllables became 33. The exceptions involve secondarily-derived final stops: PAN *-ay develops an epenthetic glottal stop in Utsat, with tone 33 forms becoming tone 32. Only this last tonal development can be interpreted as initial-based, and even here it may be more the phonation type than the initial itself (see earlier discussion).

Beyond their interest as a model of tonogenesis, the Utsat developments have historical implications for the history of the Tai-Kadai languages and, quite possibly, for understanding the apparently Austronesian component in Chinese.

Endnotes

[1]I shall be astonished if all my errors should prove minor and grateful to readers for their corrections. I wish to thank Bob Blust for a marvelous seminar he gave on Austronesian, for his feedback on this paper, and for his generous help finding the materials I needed for this paper; unless he wishes, he need take no responsibility for the positions in this paper. I also wish to thank Joel Nevis, Jerry Edmondson, Ian Maddieson, Gérard Diffloth, Jim Matisoff, Paul Benedict, Mark Durie, and Eric Oey for their useful feedback.

Symbols used: forms prefaced by a single asterisk (*) are proto-forms, forms followed by -i have an irregular initial, by -f have an irregular final, by -v have an irregular vowel, and by -t have an irregular tone. As the historical phonology is better understood, at least some of these apparent irregularities should disappear, while others will remain puzzles.

The data used in this paper has been normalized in only two ways: where the original sources used ơ for a ə, a ə has been substituted, and where the original sources used a ư for a -ɨ, a -ɨ has been substituted.

[2]The treatment of nasalized vowels in Chamic remains unsolved, but is happily irrelevant to the concerns of this paper.

[3]I first became aware of the Maddieson and Pang paper only after I sent Maddieson an earlier draft of this paper. Thus, its insights are not fully incorporated. Maddieson and I intend to collaborate on a joint effort on Utsat in the near future.

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The Spreading of Tonal Nodes and Tonal Features in Chinese Dialects

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In this paper I shall be concerned with the feature geometry of tonal features. There is some consensus that representing the range of level and contour contrasts found in natural language requires at least two binary features, which I will refer to as Register , or upper-case H/L, and Pitch , or lower-case h/l. There is less consensus on the relationship between these two features - that is, how they are arranged hierarchically with respect to each other within a model of feature geometry like that of Clements (1985), Sagey (1986) and McCarthy (1988). Two very interesting recent works (Bao 1990, Duanmu 1990) have studied a rich array of Chinese tonal systems and reawakened my interest in this topic. Much of the data in this thesis was brought to my attention by one or other of them.[1]

I will use as a diagnostic for constituency in feature geometry whether a group of features spreads together as a unit. By this criterion, I will conclude that we need a model that allows the entire tone to spread as a unit, and terminal Pitch features to spread, but nothing else. In particular, I will argue that there are no clear cases in East Asian languages of Register spreading independently of Pitch, and no clear cases of the shape of a contour (the property of being rising or falling) spreading independently of Register. The discussion in this paper is restricted to Chinese languages, and as a consequence certain of the conclusions may also only be valid for those languages. One conclusion seems reasonably robust cross-linguistically: clear instances of contour spreading without Register have not been reported in any language family. On the other hand, Hyman (1986, 1989), Inkelas, Leben and Cobler (1987) have found instances of Register spreading in African languages, so it may be necessary to allow for limited cross-linguistic variation in feature geometry, as suggested by Mester (1986), Selkirk (1988), Piggott (1988) and others.[2]

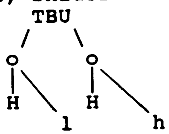
1.1 Tonal Feature Models: A variety of models have been proposed in recent years, and I have grouped them below into three categories according to the relationship between the two features: roughly, independence, sister-hood, or dominance. Some earlier models, notably those of Wang (1967), and Woo (1969), are not included here because their translation into autosegmental terms is non-obvious. I have represented a high rising (or 35) tone in each system.[3] In all models, 35 is a H Register, lh Pitch tone.

(1)
a. **Independence** (Yip 1980)

```
      H
      |
      σ
     / \
    l   h
```

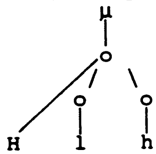
b. **"Sister-hood"** (Bao 1990, Duanmu 1990 , Clements 1989, Hyman 1989, Snider 1990) Note that for Clements, Snider and Hyman, H=h and L=l.

Clements, Snider:



Tonal Nodes

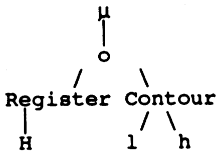
Hyman: (extrapolating from his fn 3 on EA contours)



Tonal Root Node

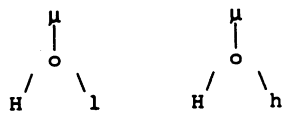
Tonal Node

Bao:



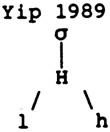
Tonal Node

Duanmu:



Laryngeal Node

c. Dominance (Yip 1989)



1.2 Spreading Predictions made by these Models:

All models allow terminal tones to spread, and I will have nothing to say on this topic. They differ as to which other features may spread as a unit, and the differences are sumarized below:

(2)	Whole Contour Tone	Register only	Contour as a whole, w/out Register
Yip 80		x	
Clements		x	
Hyman	x	x	
Yip 89	x		
Bao	x	x	x
Duanmu		x	

2.1 In Favor of Whole Tone Spreading: Changzhi:

Of the models in (1), three can represent rules which spread an entire contour tone as a unit. As can be seen in (2), these are the models of Hyman, Yip 1989, and Bao. I will argue that there are indeed rules that spread whole tones, so that one of these three models is required. Bao offers data from Changzhi as a case of whole tone spreading, but Duanmu has argued against this analysis. The data come from Hou 1983, Davison 1989, Bao 1990, Duanmu 1990.

Changzhi has two toneless suffixes, one of which attaches to nouns, and one to adjectives to form nouns. These suffixes surface with a complete copy of the root tone:

(3) Putative Spreading Before Nominal Suffixes:

suaŋ213	suaŋ213 ti213	'sour ones'
xuaŋ24	xuaŋ24 ti24	'yellow ones'
yaŋ535	yaŋ535 ti535	'soft ones'
laŋ53	laŋ53 ti53	'rotten ones'
aŋ44	aŋ44 ti535	'dark ones'

For the /44/ tone, I follow Bao in assuming this is the unmarked tone, and that after a toneless root these suffixes surface with an underlying /535/ tone (their reading pronunciation). Duanmu suggests that the data in (3) are not the result of tone spreading but rather tone copying or reduplication. However, this cannot be correct. If these tones were copied, we would expect to find tone sandhi changes affecting one of the tones, since in all other instances of two tones coming together Changzhi has tone sandhi rules. First, consider overt segmental reduplication:

(4) Verb Reduplication:

/213/	saŋ213 saŋ35	'fan'
/53/	tuŋ35 tuŋ53	'move'
/535/	tsɔ535 ts'ɔ35	'fry'
/24/	tɕ'iəu24 tɕ'iəu53	'ask for, beg'
/44/	k'ɑŋ31 k'ɑŋ53	'look'

The tone of the second syllable is not fixed by the reduplicative template, since it varies depending on the root tone. The simplest assumption (although not the only possible one) is that the root tone has been reduplicated along with the segments, and yet it contrasts strongly with the tone patterns in (3). (3) can therefore not be tonal reduplication.

Another set of tonal changes are found if two different syllables each with the same underlying tone are concatenated. The data are given below; for some tones, the patterns are different for modifier-noun constructions versus verb-object constructions.

(5) Bisyllables with Underlyingly identical tone sequences:

/213 213/	-> 213 53 (N)	ɕi kua	'Western melon'
	or 35 213 (V-O)	k'æ ts'ə	'drive a car'
/53 53/	-> 53 53	ta tiaŋ	'big palace'
/535 535/	-> 35 53 (N)	mu ma	'mare'
	or 35 535 (V-O)	suə tɕiəu	'count nine'
/24 24/	-> 24 24	xu tɕ'iŋ	'foreign celery'
/44 44/	-> 53 44	iɑŋ tɕ'i	'(lit) swallow breath'

If the data in (3) were the result of tone copying or reduplication, one might expect to find tonal changes like those in the underlying sequences of two identical tones in (5), and yet we do not.

On the other hand, if we follow Bao and take (3) to be tone spreading, there is only one tonal root node in the representation. Tonally, then, such cases are identical to single monosyllables, with one tone, and no sandhi are to be expected - indeed no sandhi are possible, since sandhi in Changzhi require the presence of two tones.[4]

I conclude that Changzhi requires us to admit whole tone spreading as a possibility, and thus to discard those tonal models which do not permit it.

2.2 Against Contour Spreading: Zhenjiang Phrases:

Of the three models which permit whole tone spreading, only one model allows contours to spread as a unit without Register: that of Bao 1990. He gives two cases that he claims involve such spreading. One of them, Zhenjiang, is discussed here; the other, Wenzhou, is discussed in Yip (1992). For both languages, I argue that no contour spreading is involved and that we should thus choose a more restricted model without the possibility of contour spreading. Zhenjiang is a Mandarin dialect, spoken in Jiangsu province. My data comes from Zhang 1985, Bao 1990, and Duanmu 1990.

In domains of two or three syllables, the following tonal changes take place: (i) final syllables are unchanged (ii) penultimate syllables change according to the chart below (iii) antepenultiamte syllables, if present, bear only level tones: /55, 5/ are unchanged, and all others become [33]. The chart should be read as follows: σ_1 is the penult, σ_2 is the final syllable, and the penult changes to the values shown in the body of the chart. For example, a 42 tone becomes 35 before 31, and 33 before 55.

(6)

$\sigma_1 \backslash \sigma_2$	42	31	35	55	5
42	35	35	33	33	33
31	35	35	22	22	22
35	35	35	35	22	22
55	55	55	55	55	55
5	5	5	5	5	5

Bao observes that the contour tones 42, 31 and 35 all level out to 33 or 22 before 55, and analyzes this as spreading the property of being level leftwards from the final syllable. There are several problems with this analysis. First, the levelling is also found before the rising tone in some cases. Second, Bao does not analyze the rest of the changes in the penult, nor the changes in the antepenult, so the changes are seen in isolation from the system as a whole.

Looking at the complete system, what we observe is progressively more neutralization as one moves away from the end of the word. Antepenultimate syllables are all level, penultimate ones allow level or rising, and only final syllables allow the full range of contrasts (probably because they are stressed, although Zhang does not say). This observation suggests the following analysis: (i) Neutralization to level is general in non-final syllables (ii) The 35 rise on some penults is the result of a later rule spreading /h/ left from a following /hl/ fall. (iii) 55 is the default H Register tone, with no specification for h/l, and thus does not spread, or change. The tonal representations are shown below, using the model of Yip (1989). I follow Bao in taking 35 to be L Register; the reason will become clear below. On the surface all rising tones, whether H or L Register, surface as 35.

(7) Underlying Representations:

```
35        L            55       H
         /\
        l h

42       H             31       L
        /\                     /\
       h  l                   h  l
```

(8) Surface:

```
33       H          22       L          L =   H      = 35
         |                   |         /\    /\
         l                   l        l  h  l  h
```

The rules are simple. (9i) shows delinking of /h/ from non-final syllables; this results in levelling. (9ii) shows /h/ spreading, which causes some level tones to become rising. (9iii) inserts H Register on antepenultimate syllables, resulting in even more neutralization. This last rule is feature-changing, since no syllable may have more than one value for Register.

(9) Rules:

```
(i)      σ  σ        (ii)  σ  σ       (iii) σ σ σ
         ≠                  `.|             :
         h                    h             H
```

Some derivations are given below. In (10), in all cases a /h/ delinks from the penult, and a /h/ spreads left from the final syllable, resulting in a surface rise, realized as 35 irrespective of Register.

```
(10)  42 42      H     H          35 42
               ≠  \`./  \
              h   l  `h  l

      31 42       L    H          35 42
                ≠  \`./ \
                h  l h  l

      35 42      L    H           35 42
                / ≠`./  \
               l  h `h  l
```

In (11), the /h/ still delinks, but there is no following /h/ to spread, so these surface as level, with the pitch depending on the Register (H gives 33, L gives 22); note that we now see why 35 is analyzed as L Register: its level allophone is 22, not 33.

```
(11)  42 35      H     L          33 35
               ≠  \   / \
              h   l  l   h

      42 55      H     H          33 55
               ≠  \
              h    l

      31 55      L     H          22 55
               ≠  \
              h   l
```

```
35 55        L    H          22 55
            /    ‡
           l      h
```

In (12), the antepenult loses its /h/; there is never any following /h/ to spread, since the penult has already been neutralized to /l/, and H Register is then inserted on the antepenult, forcing delinking of the L Register. Note that it is necessary to assume that the /l/ relinks left-to-right to the new Register, although it is not clear why this should be.

```
(12)  31 σ σ        σ      σ σ        33 σ σ
                 .·'‡
                H    L
                    ‡  \
                   h    l
```

This proposal has several advantages. First, it situates the changes within the context of the system as a whole, and explains the entire system. Specifically, it is viewed as increasing neutralization further to the left, first of /h/ Pitch, by the delinking rule in (9i), then of Register, by H-Register insertion in (9iii). The observed levelling before 35 is no longer a problem, and the change to rise is explained as the result of simple spreading of a /h/ from the final syllable, by rule (9ii).[5]

Since this analysis seems preferable, I conclude that the Zhenjiang data cannot be used as evidence supporting the need for spreading of a contour node, and that in the absence of any such cases the contour node should be eliminated from the feature geometry. We are thus left with two models powerful enough to deal with whole tone spreading, but restricted enough to eliminate contour node spreading: those of Hyman and Yip 1989.

3. Against Register Spread in Pingyao:

The primary difference between the models of Hyman and Yip 1989 is that Hyman's model permits spreading of Register independent of the other features, whereas Yip 1989 does not. In fact, all the models except Yip 1989 can spread just Register. I shall argue that there are no clear cases in East Asian languages of Register spreading on its own, and so we should opt for a model which does not permit such spreading. Bao gives two cases which he analyses as involving Register spreading. I will discuss one here, Pingyao. The other, Wuyi, is discussed in Yip 1992, where it is shown that Wuyi can equally well be analyzed as whole tone spreading. The argument in this section is due to Chen (1991). The data are from Hou 1980, Bao 1990, and Duanmu 1990.[6]

In bisyllabic phrases, the three underlying tones found on sonorant-final syllables in Pingyao change according to the following table. Apart from a change in final /53/ tones to [423], the changes are all on the first syllable.

(13)

$\sigma_1 \setminus \sigma_2$	13	35	53
13	13-13	<u>31-35</u>	35-423
35	13-13	<u>31-35</u>	35-423
53	53-13	53-35	<u>35-423</u>

Bao observes that in the bolded examples in (13) a rising tone remains rising, but changes Register to match the Register of the second syllable: /35-13/ becomes [13-13], and /13-53/ becomes [35-423]. He formulates a rule of Register Spread, given below:

(14) R-Spread:

```
        T    T
       /‡`. .|
      c r    r
     /\
    l h
```

Two other rules complete his analysis. The first, Metathesis, deals with the change from rising to falling and vice-versa found in the underlined examples above. Here it is viewed as dissimilatory:

(15)Metathesis:

```
                                      T
                                     / \
      c    -->  c   /  _____     c     r
     / \       / \              / \    |
    x   y     y   x            x   y   H
```

Secondly, there is a rule of Register Lowering to account for the lowering of 35 to 31 before 35:

(16)R-Lowering:

```
    r           T       T
    |          / \     / \
    H ---> L /--- c     c   r
              / \ / \
             l   h l  h
```

These rules are ordered as follows, with metathesis crucially preceding R-spread, since it may bleed it.

(17) a.	13-35	b.	35-35	
	--		13-35	R-Lowering
	31-35		31-35	Metathesis
	n/a		n/a	R-Spread

Chen (1991) offers an alternative. He retains Metathesis, and precedes it by a single rule of Register Neutralization for rising tones. I state the rule in my words as follows:

(18) <u>R-Neutralization</u> (my wording):
For rising tones, if a following syllable begins h,(l), replace Register with H (L).

That is, a syllable assimilates its <u>Register</u> to the <u>Pitch</u> value of the following syllable. Intuitively this seems reasonable enough, but it is rather unexpected within a theory in which Register and Pitch are two different features, and might constitute an argument for taking the position of Clements, Snider, and Hyman that we are dealing with one and the same feature arranged differently in the geometry. Indeed, a rather similar relationship between Register and Pitch features has been noted in Hausa in work by Inkelas, Leben, Cobler (1987). With this caveat, let us see how the rule works. I give some derivations below:

(19) Base Tone	R-Neutraliz.	Metathesis	
13-13	vacuous	n/a	
13-35	vacuous	31-35	
13-53	35-53	n/a	(--> [35-423])
35-13	13-13	n/a	
35-35	13-35	31-35	
35-53	vacuous	n/a	(--> [35-423]

53-13	n/a	n/a
53-35	n/a	vacuous
53-53	n/a	35-53 (--> [35-423])

I conclude that Pingyao is not a clear case of Register Spreading, and that at least for East Asian languages we must adopt a model which does not admit this option, such as that of Yip (1989). Since, as I mentioned earlier, Hyman and Inkelas, Leben and Cobler (1987) give evidence of Register-spreading in African languages, there may be a typological difference here, perhaps whether Register <u>is</u> the Tonal Root Node, (Yip 1989) or hangs off it (Hyman), for East Asian and African-type languages respectively.

Conclusion

I have argued that no clear cases of Register spreading without tone, or of Contour spreading without Register, are known to us, so that we should prefer a model which excludes these operations. I have also argued that we must allow for the spreading of an entire contour tone, as in Changzhi (although why this is so rare is something of a mystery). The only model with these properties represents Register as the tonal root node, dominating one or more Pitch features, and I conclude that in our present state of knowledge this model should be adopted as a working model of tonal geometry, at least for East Asian tone languages.

Endnotes

I would like to thank many people for comments on earlier versions of this paper; their comments resulted in many improvements. They include my audience at B.L.S., also Bao Zhiming, Matthew Chen, Duanmu San, John McCarthy, and Larry Hyman. All errors of fact and flights of fancy are of course to be blamed on me alone.

1. Both Bao and Duanmu discuss in depth the relationship of tonal and laryngeal features, but such issues are beyond the scope of this paper.

2. I use the terms East Asian-type and African-type as convenient labels, but there are languages of the first type in Africa, such as Grebo (see Newman 1986) and of the second type in China (such as perhaps Shanghai (see Duanmu 1990)).

3. 5 denotes high pitch, 1 low pitch and so on.

4. The details of the tone sandhi rules in (4-5) are not central to the main argument here.

5. There is one unresolved problem: 35 35 should change to 22 35, but instead it surfaces unchanged.

6. I accept here Bao's distillation of Hou's facts. However, it should be noted that there are some mysterious complications to Pingyao sandhi which are not discussed here. In particular, Hou notes that syllables with a /13/ tone come from two historical sources (Yin Ping and Yang Ping), and still betray their origins in some different sandhi patterns. Table (13) in the main text represents only those cases in which the second syllable is unchanged (ignoring the quite general change of /53/ to /423/), and

the first syllable changes without reference to historical origins. Additional systematic patterns are as follows:

$\sigma_1 \backslash \sigma_2$	13	35	53
13	13-35	13-13	31-53
35	35-53	35-53	35-423

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