

Re-examining Contour Tone Units in Chinese Languages

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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.<sup>2</sup> (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...]<sup>3</sup> 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) 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 HL or 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<sup>4</sup>






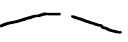
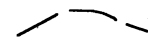
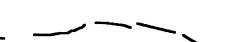



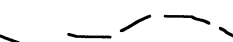
- (4) HL HL --> L HL  
       jian zhu        jian zhu        'building'

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], \*[LH LH], \*[HL 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 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.  $\begin{array}{c} \underline{L} \underline{LH} \\ \vee \\ \$ \end{array}$        $\begin{array}{c} \underline{L} \underline{LH} \\ | \quad | \\ \$ \quad \$ \end{array}$        $\begin{array}{c} \underline{L} \quad \underline{LH} \\ | \quad | \\ \$ \quad \$ \quad \$ \end{array}$        $\begin{array}{c} \underline{L} \quad \underline{LH} \\ | \quad | \\ \$ \quad \$ \quad \$ \quad \$ \end{array}$

- b.     $\frac{\text{LH}}{\vee} \text{L}$              $\frac{\text{LHL}}{\text{ | |}}$              $\frac{\text{LH}}{\text{ |}} \text{L}$              $\frac{\text{LH}}{\text{ |}} \text{L}$   
          \$                    \$ \$                    \$ \$ \$                    \$ \$ \$ \$
- c.     $\text{L} \frac{\text{HL}}{\vee}$              $\text{L} \frac{\text{HL}}{\text{ | |}}$              $\text{L} \frac{\text{HL}}{\text{ |}}$              $\text{L} \frac{\text{HL}}{\text{ |}}$   
          \$                    \$ \$                    \$ \$ \$                    \$ \$ \$ \$

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, LH must be a CTU. Similarly, Yip postulates a CTU LH in (7a) and HL 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.<sup>5</sup> 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.  $\frac{\text{HL}}{\text{ |}} \frac{\text{LH}}{\text{ |}}$             b.  $\frac{\text{HL}}{\text{ |}} \frac{\text{LH}}{\text{ |}}$             c.  $\frac{\text{HL}}{\text{ | \ \ |}} \frac{\text{LH}}{\text{ |}}$             d.  $\frac{\text{HL}}{\text{ / \ \ |}} \frac{\text{LH}}{\text{ |}}$   
          \$                    \$ \$                    \$ \$ \$                    \$ \$ \$ \$

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

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)<sup>7</sup>

	Monosyllabic	Bisyllabic	Trisyllabic	Quadrisyllabic
a.	HL	HL	H L	H L
	∨			
	\$	\$ \$	\$ \$ \$	\$ \$ \$ \$
b.	LH	L H	L H	L H
	∨			
	\$	\$ \$	\$ \$ \$	\$ \$ \$ \$

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

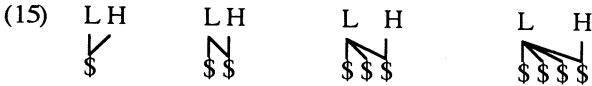
- (13) monosyll. bisyllabic trisyllabic quadrisyllabic
- a.
- b.
- c.

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

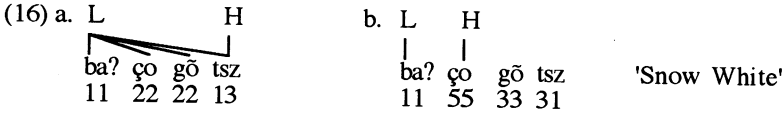
- (14) LH                    LH(L)                    LH                    LH  
 V/                    | |                    | |                    | |  
 \$                    \$ \$                    \$ \$ \$                    \$ \$ \$ \$

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

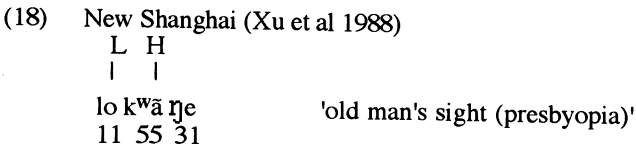
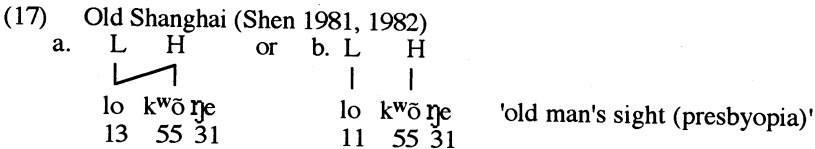


There are two level tones, L and H, which are linked to the first and last syllables by edge-in association. Then L spreads rightward to all syllables. One may wonder if it is possible for a language to have two ways of association, left-to-right in (14), and edge-in in (15). The answer is yes. Independent 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)



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)



The initial syllables in (13b), (17) and (18) have the same tone type<sup>8</sup> which is called Yang Shang.<sup>9</sup> 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.<sup>10</sup> 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 L H --> H L H      c. L H L H --> (L) H L H  
 | |      | / \ |      | \ /      | / \ |      \ /      \ /      | / \ |  
 \$ \$      \$ \$      \$ \$      \$ \$      \$ \$      \$ \$

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 [HL LH] 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.<sup>11</sup> 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
[\$][\$]->[\$][\$]		[\$][[\$][\$]]->[\$][[\$][\$]]			[\$][[\$][\$][\$]]->[\$][[\$][\$][\$]]			

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)

(29)

		x		(x 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.

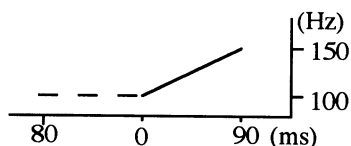
Now consider (28) again. In this analysis, the longer the domain, the greater stress the initial syllable has, and the more likely the tonal pattern will be determined by the initial syllable. This prediction agrees with the fact that the longer the domain, the fewer [42 42...24] we see. In fact, for 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).<sup>12</sup> 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

<sup>1</sup> 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.

<sup>2</sup> In this paper I use 'dialect' and 'languages' interchangeably.

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

<sup>4</sup> 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.

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

<sup>6</sup> 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.

<sup>7</sup> 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.

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

<sup>9</sup> 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.

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

<sup>11</sup> In Chinese most morphemes are monosyllabic.

<sup>12</sup> 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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