Teochow Tone Sandhi and the Representation of Tone*

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1. The Issue

In his definitive work on tone, Pike (1948) recognizes two tonal systems as typologically distinct: contour tone system typical of Asian languages and terraced-level tone system typical of African languages. Although Pike's typological distinction is descriptively uncontroversial, the phonological representation of tone remains a controversial issue in phonological theorizing. At the core of the controversy is the theoretical status of tonal contour, on which there are roughly two views: the Aficanist position treats contour as derivative, and the Asianist position treats contour as basic. This controversy precedes the development of autosegmental phonology. In the spirit of distinctive feature theories, Wang (1967) postulates contour features such as [rise] and [fall] as primitives in his feature system, whereas Woo (1969) recognizes only level features such as [high] and [low], and deriyes contour tones through the concatenation of level tones.

Early development of autosegmental phonology is largely motivated by tonal facts from African languages (Williams 1971/1976, Leben 1973, Goldsmith 1976), with the notable exception of Yip (1980). As is typical of African languages, tonal

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shape of words can be characterized in terms of H, M, and L,[1] and contour tones are mere concatenation of level tones, as exemplified by the data from Margi (Williams 1971/1976:464):

(1) a. bdle + na → bdlè-ná 'to forget'

b. bdle + na → bdle + na
   ∧ | |
   L H L H

The verb *bdle* surfaces with the rising tone in isolation; when it is suffixed with the toneless suffix *na*, *bdle* surfaces with the low tone, and *na* with the high tone. This kind of behavior can be understood if the rising tone is concatenated of L and H, as shown in (1b). It is clear from the autosegmental analysis of many African tonal systems that tonal contour is an epiphenomenon. Like the rising tone of Margi, contour tones are represented as concatenations of level tones, and there is no theoretical significance whatsoever to tonal contour. This is the central thesis of the Africanist viewpoint.

The phonological behavior of contour tones in Asian languages is, however, markedly different from that shown in (1), so is the Asianist position on the representation of tonal contour. Most linguists in traditional Chinese linguistics circle recognize register and contour as two essential components of tone (cf. Luo and Wang 1957, Wu 1984), either implicitly or explicitly. In fact, traditional notions such as *yin* and *yang*, and tone labels such as *ping* 'even', *shang* 'rising', *qu* 'departing' and *ru* 'entering', are related to register and contour. The exact meanings of the tone labels *ping*, *shang*, *qu* and *ru* are obscure, and modern dialect data are not illuminating in this respect; but almost certainly the tones are labeled in accordance with their contour (Wang 1980:102). Our knowledge of *yin* and *yang*

[1] In accordance with common practice, I use H for high tone, M for mid tone and L for low tone.

is more certain. Simplifying matters somewhat, *yin* tones, which are high-registered, co-occur with voiceless consonants, whereas *yang* tones, which are low-registered, co-occur with voiced consonants. Due to historical change modern Chinese dialects show varied tone-consonant correspondence, but in some Wu dialects where voicing is contrastive among consonants, the correspondence is quite good, as is dramatically demonstrated by the tone inventory of Songjiang, near Shanghai (*Jiangsu...* 1960):[2]

(2)

	ping	*shang*	*qu*	*ru*
a. with voiceless initials	53	44	35	5
b. with voiced initials	31	22	13	3

Examples:

53	ti	low	31	di	lift
	t'i	ladder			
44	ti	bottom	22	di	brother
	t'i	body			
35	ti	emperor	13	di	field
	t'i	tear			
5	pa?	hundred	3	ba?	white
	p'a?	tap			

The interaction between tones and consonants in syllable-initial position illustrated in (2) can be understood in physiological terms. It plays an important role in tonogenesis in languages such as Vietnamese (Haudricourt 1954, Halle and Stevens 1973, Matisoff 1973).

With respect to tone sandhi, Margi-type tonal alternation, though common in African languages, is not widely attested among Chinese dialects (cf. Hyman and Schuh 1974, Yip 1989, Bao 1992, Chen 1992, Duanmu 1995, among others). A

[2] The numbers represent pitch height, with 5 being the highest, 1 the lowest. Contour is indicated by the two numbers: 44 is a high level tone; 53 is a high falling tone, and so on.

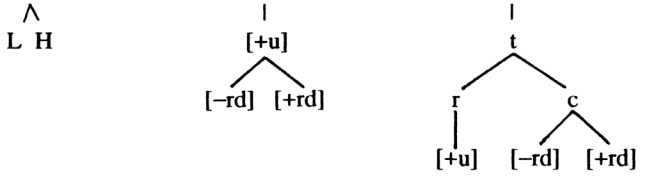
common tone sandhi process is the famous Tone 3 Rule of Mandarin, exemplified in (3) (Cheng 1973):

(3) mai ma 'to buy horses'
315 315 → 35 315

As shown above, the tone 315, classified as Tone 3 in the *Pinyin* system, changes to 35 (Tone 2) if followed by another 315. This type of tone sandhi is typical of Chinese, but not of African languages. [3]

The descriptive difference in tonal behavior between the Africanist tone system and the Asianist tone system is pretty well established, and serves as the empirical source for the analytical controversy surrounding the representation of contour. This controversy assumes a peculiar form in recent phonological research. With a richer representational repertoire than is available under classical, *SPE*-compatible phonological theories, nonlinear phonology allows more possibilities in representing tonal contour. A high rising tone, for instance, can be represented as follows (tbu: tone-bearing unit; u: upper; rd: raised; t: tone; r: register; c: contour):

(4) a. tbu b. tbu c. tbu

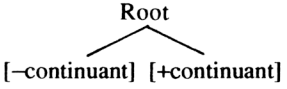


[3] The distinction between Africanist and Asianist tone systems is a descriptive convenience, and there is bound to be some overlap between the two systems. Upon careful analysis Margi-type tone sandhi can be found in some Wu dialects such as Shanghai (Zee and Maddieson 1979, Selkirk and Shen 1990), and Tibetan dialects as well (Hu 1982, Duanmu 1992, Edmondson *et al* 1995, and references cited therein). Among African languages there are sandhi processes which crucially depend on tonal contour, see Newman (1986).

Other models have been put forth, among them Clements (1983), Inkelas (1987), Snider (1990), and Hyman (1993). Here we will consider the three in (4).

(4a) is the representation one finds commonly in the autosegmental literature. Contour, in this case rise, is simply a result of two tones (H and L) being linked to a single tone bearing unit. This representation is at the core of the Africanist position; I will therefore call it the Africanist model. (4b) is the structure proposed by Yip (1989). In it, the register feature [upper] dominates ('licences') the branching feature specifications of [raised], which determine the contour. In other words, contour is dependent upon register. This is analogous to the representation of affricates proposed by Sagey (1986):

(5)



The representation in (4c), proposed in Bao (1990), is similar to (4b) in that both represent contour as an integral part of tone. Both structures mirror the traditional dichotomy between *yin/yang* registers and tonal shapes. The only difference is that in (4c) contour and register are independent of each other, and contour is no longer dependent upon register, as it is in (4b). I will refer to both as Asianist models.

The contour controversy surfaces in a new guise in nonlinear phonological theories. In terms of formal simplicity, (4a) has an edge over (4b,c). It consists of only two level tones, H and L, and the high rising tone is derived from them. By comparison, (4b,c) encode (slightly) more elaborate hierarchical structure between two tonal features, [register] and [raised]. Ontological parsimony dictates that we adopt simpler models in the absence of empirical data to the contrary. In what follows we will examine tone sandhi data from one Chinese dialect, namely Teochow, and show that the Africanist model (4a) is inadequate. The data, however, do not distinguish between the two Asianist models of (4b) and (4c).

2. The Teochow Facts

Teochow (Chaozhou in Mandarin) is a Southern Min dialect of Chinese spoken in the region between Fujian and Guangdong provinces, and due to emigration, in Southeast Asia. Unless otherwise noted all Teochow data come from Cai (1991). Teochow has eight citation tones, as follows:[4]

(6)	a. 33	hung	'divide'	A. 55	hung	'cloud'
	b. 53	hung	'powder'	B. 35	hung	'not clear'
	c. 213	hung	'discipline'	C. 11	hung	'part'
	d. 2	huk	'sudden'	D. 5	huk	'Buddha'

As shown in the data, the *ru* tones (6d,D) are the so-called checked tones, which are realized on syllables ending in *p/t/k/ʔ*. The other tones are realized on syllables which end either in a nasal (closed syllable), or in a vowel (open syllable). As is typical of Southern Min dialects, the Teochow tones, except 33 and 11 (cf. (6a,C)), undergo sandhi in phrase-initial position. Relevant data follow.

(7) a. hue 53 'fire'

53 → 35 / __ 53, 55, 5

hue ba	'torch'	hue lou	'stove'
35 53		35 55	
hue tsiʔ	'flame'		
35 5			

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[4] In traditional terms, the tones are as follows:

	ping	*shang*	*qu*	*ru*
yin	33	53	213	2
yang	55	35	11	5

In our notation, a,A, b,B,c,C and d,D represent *ping*, *shang*, *qu* and *ru*, respectively; lower-case letters represent *yin* tones, and upper-case letters *yang* tones.

53 → 24 / __ 33, 213, 35, 11, 2

hue suã	'volcano'	hue tsɪ	'rocket'
24 33		24 213	
hue kə	'torch'	hue ts'iu	*a kind of tree*
24 35		24 11	
hue sok	'speedy'		
24 2			

b. hue 213 'product'

213 → 53 / __ 53, 55, 5

hue k'uang	'money'	hue lung	'freight ship'
53 53		53 55	
hue mue?	'product'		
53 5			

213 → 42 / __ 33, 213, 35, 11, 2 [5]

hue ts'ng	'warehouse'	hue ke	'price'
42 33		42 213	
hue tsam	'freight station'	hue iõ	'sample'
42 35		42 11	
hue sek	'product quality'		
42 2			

c. hue 55 'back, return'

55 → 11

hue siu	'recollect'	hue t'au	'turn back'
11 53		11 55	
hue ha?	'meet'	hue tap	'answer'
11 5		11 2	
hue sim	'change mind'	hue po	'return favor'
11 33		11 213	
hue iong	'commission'	hue ue	'phone back'
11 35		11 11	

[5] Li (1959) gives 31 for 42. I follow Cai's notation, but treat it as low fall.

d. hue 35 'meet, club'

35 → 21

hue siu	'head of club'	hue t'au	'head of club'
21 53		21 55	
hue ha?	'gather'	hue k'e?	'meet guests'
21 5		21 2	
hue sim	'understanding'	hue po	'report'
21 33		21 213	
hue tsia	'membership'	hue ue	'dialogue'
21 35		21 11	

e. hue? 2 'blood'

2 → 5 / __ 53, 55, 5

hue? kuang	'vein'	hue? kiu	'globule'
5 53		5 55	
hue? ek	'blood'		
5 5			

2 → 3 / __ 33, 213, 35, 11, 2

hue? ts'eng	'plasma'	hue? tse	'blood debt'
3 33		3 213	
hue? t'i	'hemorrhoids'	hue? zio	'bloody urine'
3 35		3 11	
hue? tsia?	'blood stain'		
3 2			

f. tek 5 'special'

5 → 2

tek teng	'special grade'	tek su	'special'
2 53		2 55	
tek piak	'special'	tek io?	'arrangement'
2 5			
tek teng	'characteristics'	tek p'ai	'special envoy'
2 33		2 213	

tek zim	'special task'	tek hau	'special effect'
2 35		2 11	

For the sake of perspicuity, I summarize the facts below. The table is adapted from Cai (1991: 5).

(8)

	Tone label	Citation	Sandhi	Environment
a.	*yin ping*	33	33	
b.	*yin shang*	53	35	53, 55, 5
			~~2~~4	33, 213, 35, 11, 2
c.	*yin qu*	213	53	53, 55, 5
			42	33, 213, 35, 11, 2
d.	*yin ru*	2	5	53, 55, 5
			3	33, 213, 35, 11, 2
e.	*yang ping*	55	11	
f.	*yang shang*	35	21	
g.	*yang qu*	11	11	
h.	*yang ru*	5	2	

In the table, citation tones change to sandhi tones in phrase-initial position; the tones in the Environment column are phrase-final. The tones 33 and 11 do not change in phrase-initial position, so they appear in both the Citation and Sandhi columns. A few tones also undergo sandhi in phrase-final position, which is not indicated in the table. It does not bear on the central thesis of the paper.

It is clear from the data we have examined that *yin ru* 2 (8d) behaves like *yin qu* 213 (8c), and *yang ru* 5 (8h) behaves like *yang ping* 55 (8e); the lack of surface contour is obviously due to the short duration of the checked syllables. For this reason I will treat 2 and 213, 5 and 55 as allotones of the same underlying tones, even though 2 and 5 are both historically *ru* tones. For the purpose of tone sandhi, natural classes are formed on the basis of tonal pitch, rather than historical origin.

Teochow tone sandhi presents convincing evidence in support of the view that tonal contour must be represented as in integral part of tone, which I will now proceed to show.

3. The Analyses

The sandhi facts in (8e,f) are not sensitive to environmental factors. (8b,c), on the other hand, present interesting evidence which bears on the representation of tone. The analysis crucially depends on the representation of contour tones. In this section I first present an analysis based on the Africanist model (4a), which consists of only level tones, and then an analysis based on the Asianist models (4b,c), which contain contour in the representation of tone. I show that the Africanist model accounts for the sandhi facts with great difficulty, whereas the Asianist models provide a straightforward explication of the same range of facts.

3.1 *The Africanist Model*

Given the Africanist model of tone representation, the tonal inventory of Teochow is as follows:

(9)	a. 33	M	b. 53	HM	c. 213	LM	d. 2	L
	A. 55	H	B. 35	MH	C. 11	L	D. 5	H

The numerical difference between 2 and 1 is ignored, which is fine in Teochow given the fact that 2 and 1 are not contrastive. Li (1959) describes 213 as having very slight concavity, so treating it as underlyingly rising poses no descriptive

problem. In terms of features, we can use [upper] and [raised], and define H, M, and L as follows:[6]

(10)

	[upper]	[raised]
H	+	+
	+	–
M	–	+
L	–	–

M can be specified as either [+upper, –raised], or [–upper, +raised]. We arbitrarily define it as the latter. To account for (8a,b) we need a rule which turns a fall to a rise (53 → 35), and a rise to a fall (213 → 53) (the concave tone 213 is considered as a rising tone), another rule to determine the proper pitch register, i.e. between a high rise 35 and a low rise 24, or a high fall 53, and a low fall 42, on the basis of the pitch height of the following tone. The first rule, which we shall call *Contour Metathesis*, is stated in (11),

(11) Contour Metathesis: $X\ Y \rightarrow Y\ X$

where X, Y ∈ {H, M, L} and are associated with the same tone bearing unit. This rule gives us the partial derivation (using (7a) as example):

(12) a.

hue	ba	→	hue	ba
HM	HM		MH	HM

b.

hue	suã	→	hue	suã
HM	M		MH	M

[6] We use [upper] and [raised] for convenience. It is possible to define tones in terms of [high]/[low] as proposed in Wang (1967), Woo (1969), or Fromkin (1972). The choice of [upper] and [raised] of Yip (1980) and Pulleyblank (1986) is theoretically insignificant.

(12a) is complete; *Contour Metathesis* derives the correct surface form. (12b) needs a rule to lower the high rise 53 (MH) to a low rise 24 (LM), due to the influence of the following 33 (M). This rule, which we shall call *Pitch Lowering*, can be stated as follows:

(13) Pitch Lowering:

a. [+upper] → [−upper] / __ [−upper]
b. [+raised] → [−raised] / __ [−upper]

(12a) changes [+upper] to [−upper] if the following tone is also [−upper] (H to M); (12b) changes [+raised] to [−raised] just in case the tone is [−upper] (M to L). In other words, (12a) is conditioned by a hetero-morphemic tone, whereas (12b) is conditioned by a tauto-morphemic tone, and the two rules must be disjunctively ordered, since (12a) potentially feeds (12b):

(14) [+upper, +raised] M → [−upper, +raised] M by (13a)
→ [−upper, −raised] M by (13b)

The derivation of (12b) continues:

(15)

hue	suã	→	hue	suã	→	hue	suã	→	hue	suã
HM	M		MH	M		MM	M		LM	M

The long-distance assimilation effect we see in the above derivation can be accounted for only through the *simultaneous* lowering of H to M and M to L.

The pitch lowering rules in (13) are unsatisfactory for two reasons, one conceptual, the other empirical. Conceptually, the analysis is complex, invoking two disjunctively ordered rules to account for a descriptively simple assimilatory sandhi process. The non-local nature of Teochow pitch assimilation makes it necessary to apply the two sub-rules of *Pitch Lowering* not only disjunctively, but also iteratively from right to left (MH → MM → LM). Empirically, *Pitch*

Lowering need to be constrained, so that it does not apply to citation tone HM (cf. (9b)) to yield MM, or worse, to yield LM, by (13b) on a second iteration. The analysis based on the tone model (4a) succeeds only at considerable conceptual and formal cost.

3.2 *The Asianist Models*

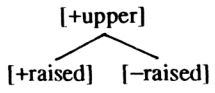
We now proceed to show how the models in (4b,c) account for the same facts. For convenience, I will use H, L for register, [+upper] and [–upper] respectively; and h ([+raised]) and l ([–raised]) for contour. Assuming that citation tones are underlying, we can specify Teochow tones as follows:

(16)	a.	33	L, h	A.	55	H, h
	b.	53	H, hl	B.	35	(H, lh)
	c.	213	L, lh	C.	11	L, l
	d.	2	L, l	D.	5	H, h

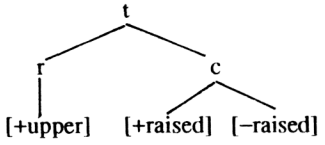
Note that the historical tonal categories (*ping, shang, qu, ru*) do not serve any function in conditioning tone sandhi. It is the pitch of the tones that serves to group tones into natural classes. Thus, *yin ru* (16d) has the same underlying structure as *yang qu* (16C), and *yang ru* (16D) has the same structure as *yang ping* (16A). Not only do they have similar pitch, but they behave in the same way in tone sandhi, as we have seen. We will have something to say about the representation of *yang shang* (16B) in Section 4, for now we will pretend it is a low-registered tone, even though it is a high rising tone.

The difference between (4b) and (4c) lies in the way register and contour are structured: in the former, contour is the daughter of register; in the latter, register and contour are sisters. H,hl, for instance, has the structures shown in (17):

(17) a. Based on (4b):



b. Based on (4c):



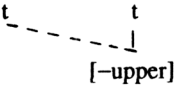
The two structures allow different formulations of the rules. *Contour Metathesis*, however, is formally similar:

(18) [αraised] [−αraised] → [−αraised] [αraised]

The only difference is that (18) applies to the branching [raised] specifications, rather than the entire tonal node (H, M, L in the model (4a), [upper] in the model (4b) and t in the model (4c)). The main difference is in the formulation of *Pitch Lowering*:

(19) a. [+upper] → [−upper] / __ [−upper]

b.



(19a) is based on the tone model in (4b), which is identical to (13a). (19b) is based on the tone model (4c), and accounts for assimilation in terms of feature spreading, rather than feature-changing operation. In both models, no additional rule is required. The derivation below illustrates.

(20)	a.	hue H, hl	ba H, hl	→	hue H, lh	ba H, hl	by *Contour Metathesis*
	b.	hue H, hl	suã L,h	→	hue H, lh	suã L, h	by *Contour Metathesis*
				→	hue L, lh	suã L, h	by *Pitch Lowering*

The difference between (4b) and (4c) can not be settled on the basis of Teochow tone sandhi data. We shall therefore leave the issue open. What remains clear is that phonological theory must be able to refer to contour as a component of tone. Contour determines the shape of a tone over time; register determines the pitch range in which contour is realized.

3.3 *Allotones or Allomorphs?*

The competing analyses presented in Sections 3.1 and 3.2 are phonologically oriented. Citation tones and their sandhi counterparts are considered as allotones of the same underlying tones ('tonemes'). *Contour Metathesis* and *Pitch Lowering* are proposed to account for the allotonic alternation involving *yin shang* 53 and *yin qu* 213. (Other tonal alternations are not discussed because they do not bear on the contour issue.) However, it is possible to give a morphological analysis of the citation/sandhi alternation. The basic idea is that the lexical specification of a lexical item contains two forms, one for use in phrase-final position (including citation), and the other for use in phrase-initial position. The relevant information may look like the following:

(21)	a.	hue	35, phrase-final 53, phrase-initial	'fire'
	b.	hue	213, phrase-final 53, phrase-initial	'product'

An allomorphy rule inserts the appropriate form into its phrasal environment.

Under this analysis, there is no need to rules such as *Contour Metathesis*, since the lexical items will appear with the appropriate tones. However, we still need *Pitch Lowering*, which takes place after the allomorphy rule has applied. The allomorphy analysis is not formally simpler than the purely phonological ones. The Teochow data do not favor either approach. One thing remains constant under both types of analysis, namely, contour is necessary in the representation of tone.

4. *Yang shang 35*

In the previous analyses we assumed that citation tones are underlying in Teochow; sandhi tones are derived. Under this assumption, the behavior of *yang shang* 35 is problematic. It is a high rise, which should be specified as *H,lh*; yet in triggering pitch lowering, it patterns with L-registered tones (cf. (8b,c,d)). This can be easily understood in the Africanist model, since 35 is represented as MH, and it is not mysterious why it triggers pitch lowering on the preceding tone. But in the Asianist models, this behavior is unexpected, and needs to be explained.

Ting (1982, 1989) notes that citation tones are not necessarily underlying; often it is the sandhi tones which are more basic than the citation tones. Notice that in Teochow, *yang ping*, *yang shang* and *yang ru* (cf. (16e,f,h)) are high-pitched in citation form, their sandhi counterparts are low-pitched, which are expected of *yang* tones (cf. (2)). Furthermore, *yin qu* and *yin ru* (cf. (16c,d)) are low-pitched in citation form, and their sandhi counterparts are high-pitched, which is expected of *yin* tones. These are cases of the so-called flip-flop (cf. Ting 1982, Yue-Hashimoto 1986). However, it complicates our analysis if we assume that *all* sandhi forms are underlying. Instead, we will simply assume that 35 is underlyingly a L-registered tone, much like its sandhi form. We now proceed to show that such an analysis is plausible.

There is, however, a technical difficulty. The Asianist models allow two contrastive contour tones and four level tones, as shown below:

(22)	a.	Fall:	H,hl	L,hl		
	b.	Rise:	H,lh	L,lh		
	c.	Level:	H,h	H,l	L,h	L,l

There are three sandhi tones which appear in falling contour, namely 53 and 42 (31) (cf. *yin qu* (8c)), and 21 (cf. *yang shang* (8f)). In addition, 11 is both the sandhi form of *yang ping* (8f) and the non-alternating *yang qu* (8g). The underlying representations of Teochow tonal contrasts must take these into consideration.

One formal device we can use is underspecification. We fully specify 35/24 and 53/42 (cf. (8b,c)), and underspecify the sandhi tones 11 and 21 (cf. (8e,f)). To see the tones clearly, I reproduce the non-checked tones in (8) in the table in (23), and add one column showing the underlying representation (UR) of the tones in the Sandhi column.

(23)		Label	Citation	Sandhi	UR	Environment
	a.	*yin ping*	33	33	L,h	
	b.	*yin shang*	53	35 24	H,hl	53, 55, 5 33, 213, 35, 11, 2
	c.	*yin qu*	213	53 42	L,lh	53, 55, 5 33, 213, 35, 11, 2
	d.	*yang ping*	55	11	H, h	
	e.	*yang shang*	35	21	L,#	
	f.	*yang qu*	11	11	L,l	

stands for the unspecified contour feature [raised], and *L,#* will eventually surface as 21 in sandhi position, and 35 in citation position (cf. (23d,e)). Given the underlying tones shown in (23), 33, 213, 35, 11, and 2 form a natural class in triggering *Pitch Lowering* by virtue of the shared [–upper].

5. Conclusion.

In the preceding sections we analyzed the tone sandhi data from Teochow, specifically, the sandhi behavior of *yin shang* 53 and *yin qu* 213, which bears on the representation of tonal contour. Crucial data are as follows:

(24) a. 53 → 35 / __ 53, 55, 5
24 / __ 33, 213, 35, 11, 2

b. 213 → 53 / __ 53, 55, 5
42 / __ 33, 213, 35, 11, 2

Three conclusions can be drawn from the discussion. First, the sandhi data bear on the controversy between the Africanist and Asianist models of tone shown in (4), which are repeated below:

(4) a. tbu
/\
L H

b. tbu
|
[+u]
/ \
[–rd] [+rd]

c. tbu
|
t
/ \
r c
| / \
[+u] [–rd] [+rd]

The data in (24) show that a tone can assimilate in register while keeping the contour intact. Such data provide strong evidence in favor of the Asianist models shown in (4b,c). Contour must be represented as an integral part of tone, either as daughter of register (4b), or as sister of register (4c). Second, our analyses show

that tones form natural classes on the basis of their pitch, not their historical origin. This is not only true of Teochow, but other dialects of Chinese as well (Bao 1990). Third, the citation tones, although listed in the dictionary as lexical tones of characters, are not necessarily the underlying (or basic) tones. The sandhi behavior of *yang shang* (citation: 35; sandhi: 21) supports this conclusion of Ting (1982).

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