Why should Markedness Constraints be Relative? - Four Case Studies in Tone Sandhi Directionality[1]

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Abstract

This paper presents a novel analysis on tone sandhi directionality, introducing a family of *relative* markedness constraints, i.e. MINMOD (minimize modulation) and MINAMP (minimize amplitude of contour tones), to account for the apparently ungoverned traffic of sandhi operations. A closer look at the data leads to the conclusion that tone sandhi directionality is not *output-driven* but *directionality-driven*. This observation echoes Hyman & VanBik's analysis on Hakha-Lai, according to which output-based generalizations fail to capture the input-output relations (2002).

Keywords: conflicting directionality, tone sandhi, Optimality theory.

1. Introduction

The increasing interest in conflicting directionality has heightened the need for phonological theories to account for such complex and apparently unpredictable phenomena. The material targeted can range from segmental elements (i.e. palatalization in Japanese mimetic words), stress placement (i.e. stress patterns in Selkup) to directional tone sandhi (i.e. Hakha Lai, some Chinese dialects).

The present study focuses on the third pattern of conflicting directionality, tone sandhi directionality. In some Chinese dialects, sandhi rules must apply from left to right to derive the outputs for some trisyllabic sequences and from right to left to account for the others. One common point among them is that morphosyntactic structures play no role, a left-branching string and a right-branching string generating the same surface form.

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We examined the trisyllabic sequences of four Chinese dialects: Boshan (Chen 2000), Tianjin (Chen 2000, Wee 2004), Sixian-Hakka (Hsu 1996, Hsiao 2000), and Chengtu (Lin 2004). We argue that rule application directionality is primarily determined by the lowest number of tonal modulations generated in the output, and propose a family of markedness constraints MINMOD (minimize modulation) and MINAMP (minimize amplitude of contour tones) to account for the apparently ungoverned traffic of sandhi operations. When the outputs generated by both directionalities have the same number of tonal modulations, *default rule application*[2] (RIGHTPROM, LEFTPROM), in latent state, is activated to select the winning candidate.

The present analysis has an interesting result compared with a classic OT analysis. Contrary to candidate selection, in which markedness is built into grammars by means of constraint violation before candidates are submitted to EVAL, in the present analysis, MINMOD and MINAMP cannot be said to be violated (nor satisfied) before EVAL takes place. The markedness constraints proposed here are intrinsically *relative*: an output having three tonal modulations does not, *per se*, violate MINMOD, but only in comparison to the output generated by the opposite directionality. This conception is reminiscent of structuralist linguistics (Hjelmslev 1935, Trubetzkoy 1939, Jakobson 1941), where markedness was defined in terms of *contrastive* specification, not in terms of constraint violation.

A related issue also emerges from the present analysis. A closer look at the data leads to the conclusion that tone sandhi directionality is not *output-driven* but *directionality-driven*. This observation echoes Hyman & VanBik's analysis on Hakha-Lai, according to which surface-based generalizations fail to capture the input-output relations (2002).

The paper is organized as follows. In section 2 we overview current analyses on conflicting directionality, with specific focus on directional tone sandhi. Previous hypotheses will be briefly reviewed as well. Section 3 lays out a new perspective of rule application directionality based on the facts captured in Boshan. An application to other languages will be presented in sections 4, 5, and 6, and a brief conclusion in 8.

2. The issue

Conflicting directionality is attested in a variety of unrelated languages and can take several patterns. In (1), three major types of directionality effects are classified

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[2] Thanks to Larry Hyman for suggesting this term.

according to the material that is targeted:

(1) Types of conflicting directionality in the literature

a. *Segmental phenomenon:*

In Japanese mimetic words, palatalization is preferentially realized on the rightmost of two coronal consonants, but on the leftmost consonant in a word without coronals (Hamano 1986/1998, Mester & Itô, 1989, Zoll 1997, Alderete & Kochetov to appear)

b. Stress placement

In Selkup, the rightmost heavy syllable (CVV) receives the stress, but if the word contains no heavy syllables, it is the leftmost syllables that is stressed (Halle & Clements 1983, Idsardi 1992, Zoll 1997)

c. *Tone sandhi directionality*

In some tonal languages, tone sandhi rules must apply from left to right to derive the outputs for some trisyllabic sequences and from right to left to account for the others (Chen 2000, Hyman & Vanbik 2002, Lin 2004, Wee 2004)

Rule application directionality in Chinese is notable for its insensitiveness to morphosyntactic structures, a left-branching string and a right-branching string generating the same surface form, as is shown in (2):

(2) Tianjin (Chen 2000)

Input	Output	[x x] x	x [x x]
HL+HL+L	L.H.L	[s.tɕi] tɕʰin "evergreen"	tswɔ [tiæn.tʂʌ] "take a tram"
LH+LH+LH	H.H.LH	[li.fa] swɔ "barber shop"	mu [law.hu] "tigress"
L+L+L	L.LH.L	[twɔ.la] tɕi "tractor"	kʰaj [fɛj.tɕi] "pilot a plane"

Cyclic application can be ruled out immediately given that directional tone sandhi is blind to morphosyntactic structures. Several theories have been proposed to account for conflicting directionalities. Howard (1972) first provides a comprehensive theory, proposing that it is applied from the direction of the trigger (determinant) towards the target (focus):

(3)

Phonological rule	Rule application directionality
a. X→Y/__Z	right-to-left ⇦
b. X→Y/Z__	left-to-right ⇨

In other words, rules should apply from right to left in a right-dominant language and from left to right in a left-dominant language.

Chen (2000) proposes six constraints determining directional tone sandhi in Chinese, i.e. Temporal Sequence, Well-formedness Conditions, Derivational Economy, Transparency, Structural Affinity and Simplicity (=Markedness). Temporal Sequence refers to the temporal sequence of speech organization; left-to-right directionality is thus preferred in trisyllabic sequences. Well-formedness Conditions requires that output must not contain marked tonal combinations. Derivational Economy chooses the shortest derivational path by simply counting the number of steps. Transparency favors feeding and bleeding. Structure Affinity refers to cyclicity following syntactic bracketing. Simplicity prefers simple (level) to complex (contour) tones.

One of the problems in Chen's analysis concerns markedness. He posits the rank order *Rising » *High » *Falling » *Low to account for tone sandhi directionality, recognizing that:

> "*markedness lacks any obvious intuitive motivation, especially in view of the fact that H is presumably the least marked in most tone languages. In a system where syllables/moras contrast only in being tone-bearing or toneless (but not in carrying one tone vs another tone), the tone is almost invariably H. With particular reference to Tianjin, the unmarked nature of H is suggested by the fact that whereas LL is banned by OCP, HH is not.*" (Chen 2000:134)

The origin of this paradox results from the fact that, in Chen's theory, markedness is motivated by output-based generalizations: *Rising outranks *High because, in the sequence /LH.LH.LH/, the output [<u>H</u>.H.LH] (⇨) is favored over *[<u>LH</u>.H.LH] (⇦).

Likewise, *High outranks *Falling given that the output [HL.LH.L] (⇦) is favored over *[H.LH.L] in the sequence /HL.L.L/. However, this generalization is not born out. In Boshan, in the sequence /55a.214.214/, the output [55.55.214] (⇨) is chosen rather than *[53.55.214] (⇦);in the sequence /55a.55a.55/, the output [55.53.55] (⇦) is chosen rather than *[53.53.55] (⇨).

The markedness hierarchy proposed by Chen also reveals a common problem to classic OT: each feature value (whether marked or unmarked) is prohibited by a separate constraint (e.g. *CORONAL, *LABIAL). It is *the ranking of these constraints* that indicates which is the most marked, i.e. *LABIAL » *CORONAL. Nevertheless, Kiparsky (1994) remarks that this approach cannot account for cases in which unmarked values delete in favor of marked ones. In other words, ranked constraints in OT cannot reflect the asymmetry between unmarked and marked feature values. Kiparsky suggests that constraints cannot specify unmarked feature values, proposing to incorporate underspecification in OT[3]. See §7.1 for more discussion on markedness in OT.

Lin (2004, 2008) proposes a Prosodic Correspondence model to account for tone sandhi directionality: normally tone sandhi applies from left to right for identity reasons. This is captured by the OO-faithfulness constraint IDENT-BOT, which requires identity between prosodically related outputs. The left-to-right directionality is sacrificed only when it would result in output forms that involve marked sequences or toneme deletion at the prominent edge of a tone, which are forbidden by the markedness constraint OCP-T and the positional IO-faithfulness constraint MAX -IO-t-R, respectively. Thus the rule application directionalities are predicted by the interaction of IDENT-BOT, OCP -T, and MAX-IO-t-R, where IDENT-BOT must be dominated by the latter two constraints.

While the above accounts could generate correct surface forms via constraint ranking, the proposed constraints are numerous, which weakens their explanatory power. We shall show in the following sections that rule application directionality can generally be reduced to one single constraint. Another constraint, in latent state, is activated if and only if there is indecidability.

[3] Following Kiparsky's idea, Inkelas (1995) proposes that, for languages in which alternation processes are predictable, underspecified features, i.e. [CORONAL], are not present in the hierarchy of constraints. Because not existing in the hierarchy, it will never have a chance to be violated.

3. Boshan

Boshan, a right-dominant language, is a Mandarin dialect spoken in Shandong province. Three lexical tones are observed in citation forms, i.e. /214/, /55/ and /31/ (Qian 1993, Chen 2000). It is noted that /55/ is derived from two historical tonal categories, *ping* and *shang*. Although their phonetic difference has merged in citation form, their underlying contrasts surface in tone sandhi contexts. Following Chen (2000), we use [55a] and [55b] to mark this underlying difference:

(4) a. 214+214→55.214
chun fen "spring equinox"

b. 55a+55→53.55
qi ma "horse-riding"

c. 55b+55→214.55
tan bai "to confess, be candid"

d. 214, 55, (31)+31→24.31
xiang xia "countryside" (214+31→24.31)
cheng shi "city" (55+31→24.31)
ban ye "midnight" (31+31→24.31)
dui xiang "target" (31+31→31.31) no change

(5)

<table>
<tr><td rowspan="2">1st tone</td><td colspan="3">2nd tone</td></tr>
<tr><td>214</td><td>55</td><td>31</td></tr>
<tr><td>214</td><td>55.214</td><td>no change</td><td rowspan="3">24.31</td></tr>
<tr><td>55a</td><td rowspan="3">no change</td><td>53.55</td></tr>
<tr><td>55b</td><td>214.55</td></tr>
<tr><td>31</td><td>no change</td><td>(24.31)</td></tr>
</table>

As can be seen in the above examples, two new tones surface in tone sandhi contexts: [53] and [24]. Besides, if the rule 214+214→55.214 can be explained by the incapacity for an unstressed syllable to carry a complex contour tone, it is intriguing that the complex contour tone 214 surfaces in the sequence 55b+55→214.55. This apparent irregularity does not seem to have any phonological motivations. However, if we compare Boshan with Mandarin Chinese, an interesting correspondence emerges:

(6)

Historical categories	Mandarin citation tones	Boshan	
		citation tones	sandhi tones
Yingping	**55**	214	**55**
Yangping	35	55a	53
Shang	**214**	55b	**214**
Qu	53	31	(31)

It can be observed in (6) that sandhi tones in Boshan often correspond to lexical tones in Mandarin Chinese. For example, the sandhi tone 55 in Boshan corresponds to 55 in Mandarin Chinese, and the sandhi tone 214 in Boshan and the lexical tone 214 in Mandarin Chinese both derive from *Shang* category. Moreover, in (4d), in the sequence *cheng shi* "city" where 55+31 yields 24.31, the word *cheng* on the first syllable is derived from *Yangping*. *Yangping* gives 24 in Mandarin, and 24 is exactly the sandhi tone in Boshan. On the other hand, two new tones emerge in tone sandhi contexts, 53 and 24, but there are only three lexical tones in citation forms. Ting (1984, 1998) suggests distinguishing lexical tones from base tones, and considers that a sandhi tone might be a basic tone in a language: sandhi tones are present in idioms and are used by speakers in colloquial speech; lexical tones are rarely used in isolation, which favors their tone change[4]. We suggest that sandhi tones in Boshan, completely

[4] In Jinjing (Min dialect) for example, there are seven lexical tones but eight sandhi tones. The tone category *Qu* (departing) has two sandhi tones:

(a) puã31 → puã55 lɔ31 « halfway »
(b) pŋ31 → pŋ11 si24 « spoon»

Ting (1984) remarks that, from a diachronic point of view, (a) had a high register and (b) had a low register; these two registers have merged into one lexical tone in the modern dialect. On the basis of sandhi tones, we can conclude that there are seven lexical tones but eight base tones in this dialect. Another example comes from two dialects of Lingao on the Hainan Island (Ting 1982): there are six lexical tones in these two dialects, five of which are the same. The remaining tone is 11 in the A dialect, and 35 in the B dialect. There is no sandhi tones in the A dialect, and the sandhi tone in the B dialect is just 11. A comparative analysis implies that the base tone in B is 11. Ting's position is echoed by Ballard (1988:107):

"Some scholars have alleged that there are always fewer tone distinctions in tone sandhi positions than in isolation, and this "fact" is used as an argument for taking isolation values as basic ou underlying in any given tone system. In a certain sense, tone sandhi does imply loss....however, this reduction is taken from the point of view of a tone system with eight tones, wherease Shanghai, Souzhou, Danyang, and Zhenhai already have isolation tone systems with fewer than eight tones....the isolation

lexicalized, are actually a sort of *proto-tones* of the language.

Nine tonal combinations give rise to tone sandhi in trisyllabic forms. Among these combinations, some tone sandhi must apply from left to right while other tone sandhi must apply from right to left, as we can see in (7) and (8). For clarity, here we adopt the notational convention of underlining the two-tone "window" that a local tone sandhi rule scans for possible application, and highlight a localized change with a vertical shaft which links an input to its corresponding output:

(7) Rules must apply from left to right:

	a. left-to-right	b. right-to-left
Input	214+214+214	214+214+214
	↓ (by 4a)	↓ (by 4a)
	55+214+214	214+55+214
	↓	↓ (n/a)
Output	55+55+214	*214+55+214

(8) Rules must apply from right to left:

	a. left-to-right	b. right-to-left
Input	55b+55a+55	55b+55a+55
	↓ (by 4c)	↓ (by 4b)
	214+55a+55	55+53+55
	↓ (by 4b)	↓ (n/a)
Output	*214+53+55	55+53+55

The first impression drawn from the above examples is that the complex contour tone /214/ is banned in the output; consequently, rules apply from left to right in (7) and from the opposite direction in (8). However, this generalization is not born out

system plus the sandhi system allow for the internal reconstruction of eight tones in all of the dialects... in other words, the tone sandhi systems often reflect distinctions that have been lost in the isolation values for the tones...."

This hypothesis is reminiscent of the liaison in French, a phenomenon of segmental sandhi, whose conservative character is largely admitted : take the word *grand* for example, it was written as *grant* and was pronounced [grɑ̃t] both in masculin and in feminin in the twelvth century. The final consonant, in weak position, dropped, but is preserved if the following word begins with a vowel. The change in spelling (*grant*→*grand*) can be explained by the influence of latin etymology *grandis*, and allows to illustrate the regular alternation between *grand* and *grande* (an alternation such as *gran* ~ *grande* or *grant* ~ *grande* would be weird and irregular) as well as the lexical relation with *grandeur*, *grandir*, *grandiloquent*, etc.

given that there is no tone sandhi in 214+55+214 and 214+53+214. We shall turn back to this point shortly. All possible trisyllabic combinations that give rise to tone sandhi are illustrated in (9):

(9) Some tone sandhi must apply from left to right:

⇨	(P1) 55a+214+214→55+214+214→55.55.214	[nan guan] jie "Nanguan street"
	(P2) 55b+214+214→55+214+214→55.55.214	gui [chui deng] "dirty tricks"
	(P3) 214+214+214→55+214+214→55.55.214	[shou yin] ji "radio"
	(P4) 214+214+31→55+214+31→55.24.31	[chuan yi] jing "full-length mirror"
⇦	(P1) 55a+214+214→55a+55+214→*53.55.214	
	(P2) 55b+214+214→55b+55+214→*214.55.214	
	(P3) 214+214+214→*214.55.214	
	(P4) 214+214+31→*214.24.31	

(10) Some other tone sandhi must apply from right to left:

⇦	(P5) 55a+55a+55→55.53.55	[tai tou] wen "wrinkles on one's forehead"
	(P6) 55b+55b+55→55.214.55	[guan li] yuan "person in charge"
	(P7) 55a+55+31→55.24.31	[chang jing] lu "giraffe"
	(P8) 55a+55b+55→55.214.55	chang [guo ren] "peanut"
	(P9) 55b+55a+55→55.53.55	[bi liang] gu "septum"
⇨	(P5) 55a+55a+55→53+55a+55→*53.53.55	
	(P6) 55b+55b+55→214+55b+55→*214.214.55	
	(P7) 55a+55+31→53+55+31→*53.24.31	
	(P8) 55a+55b+55→53+55b+55→*53.214.55	
	(P9) 55b+55a+55→214+55a+55→*214.53.55	

The symbol ⁀ , which we refer to as tonal modulation, indicates pitch change. For example, there are three tonal modulations in the attested form 55.24.31 whereas there are four tonal modulations in the illicit output *214.214.55. Comparing the number of tonal modulations between the attested outputs and the illicit forms in (11) and (12), it can be observed that the winning candidates always have fewer tonal modulations compared to their counterparts generated by the opposite directionality:

(11) Some tone sandhi must apply from left to right:

left-to-right ⇨		right-to-left ⇦	
55a+214+214→55+214+214→55.55.214	3	55a+214+214→55a+55+214→*53.55.214	5!
55b+214+214→55+214+214→55.55.214	3	55b+214+214→55b+55+214→*214.55.214	5!
214+214+214→55+214+214→55.55.214	3	214+214+214→*214.55.214	5!
214+214+31→55+214+31→55.24.31	3	214+214+31→*214.24.31	5!

(12) Some other tone sandhi must apply from right to left:

left-to-right ⇨		right-to-left ⇦	
55a+55a+55→53+55a+55→*53.53.55	3!	55a+55a+55→55.53.55	2
55b+55b+55→214+55b+55→*214.214.55	4!	55b+55b+55→55.214.55	3
55a+55+31→53+55+31→*53.24.31	4!	55a+55+31→55.24.31	3
55a+55b+55→53+55b+55→*53.214.55	4!	55a+55b+55→55.214.55	3
55b+55a+55→214+55a+55→*214.53.55	4!	55b+55a+55→55.53.55	2

We propose a constraint MinMod (minimize modulation) to capture the facts in Boshan:

(13) MinMod (minimize modulation)

The number of modulations generated by tone sandhi should be minimal.

This constraint is phonetically motivated: from an articulatory point of view, contour tones are more complicated to produce than level tones because the muscle contraction that is necessary for an articulatory movement needs time to be implemented (Duanmu 1994, Gordon 1998, Zhang 2002). It follows that the increase of number of modulations in one sequence complicates speakers' articulatory task. This constraint is in line with the principle of least effort (Zipf 1949, Martinet 1955, Lindblom 1986, 1990).

The constraint MinMod is dramatically confirmed in Sixian-Hakka, a right-dominant language, in which rules apply systematically from left to right.

4. Sixian-Hakka (Hsu 1996, Hsiao 2000)

Sixian-Hakka, a Hakka dialect, is a right-dominant language spoken in the south of Taiwan. Four lexical tones are observed in open syllables, i.e. LH, L, ML, H; two tones are found in closed syllables, i.e. M?, H?. Disyllabic tone sandhi rules in

Sixian-Hakka are given in (14):

(14) a. LH+LH→L.LH
tsu kon "pork liver"
b. LH+H(ʔ)→L.H(ʔ)
hi mong "hope"
sam sip "thirty"

It can be seen in (14) that the rising contour tone is forbidden on the unstressed syllable, except for the sequence LH+ML, in which tone sandhi does not take place. The question arises as to why the falling contour tone ML can tolerate a preceding rising contour tone. We conjecture that ML is unmarked in Sixian-Hakka, and thus does not trigger tone sandhi when it is on the second syllable. The unmarked nature of the falling contour tone is largely confirmed in typology: in a statistics on 187 tonal languages, Zhang (2002) noticed that 37 languages have a falling tone without a rising one. Only three languages have a rising tone without a falling one: Margi, Lealao Chinantec and Zengcheng. In a study on the tonal development of 480 Northern dialects of China, Lien (1986) notices as well that the high-register falling contour tone is the most numerous, occupying 25% among all tones, followed by the high level tone, with 17%. A similar result is observed in Cheng (1973) working on the distribution of contour tones in 737 Chinese dialects: there are 1125 falling tones, followed by 1086 level tones, 790 rising tones, 352 concave tones and 80 convex tones. Assuming the ML is unmarked in Sixian-Hakka, we can naturally explain why LH+ML does not undergo tone change.

Combinations in trisyllabic sequences are given in (15):

(15)

left-to-right ⇨		right-to-left ⇦	
(P1) LH+LH+LH→L+LH+LH→L.L.L͡H	1	(P1) LH+LH+LH→*L͡H+L͡+L͡H	3!
(P2) LH+LH+H→L+LH+H→L.L͡.H	1	(P2) LH+LH+H→*L͡H͡.L͡.H	3!
(P3) LH+LH+Hʔ→L+LH+H→L.L͡.H	1	(P3) LH+LH+Hʔ→*L͡H͡.L͡.Hʔ	3!

Sixian-Hakka is a right-dominant language; however, rules apply consistently from left to right since the opposite directionality would generate more tonal modulations. Sixian-Hakka also confirms our hypothesis that rule application directionality is governed by the lowest number of tonal modulations generated in the output.

5. Tianjin

Tianjin, a Mandarin dialect, is a right-dominant language spoken in a city located about 100 km south-east of Beijing. Four lexical tones are observed (Shi 1990): 11 (L), 55 (H), 24 (LH), 53 (HL). Chen (2000) reports that there are four tone sandhi rules in disyllabic forms:

(16) Dissimilation

a.	L+ L	→	LH. L	[fɛj tɕi] "airplane"
b.	LH+ LH	→	H. LH	[ɕi ljan] "wash one's face"
c.	HL +HL	→	L.HL	tɕiŋ tʂɔŋ] "net weight"

(17) Tonal absorption

d.	HL+L	→	H.L	[ʐʌn tʂʌn] "earnest"

Among 64 combinatorial possibilities (=4^3), seven tonal combinations give rise to tone sandhi in trisyllabic forms:

(18) Some tone sandhi must apply from left to right:

left-to-right ⇨		right-to-left ⇦	
(P1) HL+HL+L→L+HL+L→L.H.L	2	(P1) HL+HL+L→*HL.H.L	3!
(P2) LH+LH+LH→H+LH+LH→H.H.LH	2	(P2) LH+LH+LH→*LH+H+LH	3!

(19) Some other tone sandhi must apply from right to left:

right-to-left ⇦		left-to-right ⇨	
(P3) HL+HL+HL→HL+L+HL→H.L.HL	3	(P3)HL+HL+HL→L+HL+HL→L+L+HL→ *LH.L.HL	4!
(P4) L+L+L→L+LH+L	2	(P4) L+L+L→LH+L+L→LH+LH+L→*H.LH.L	3!

In P1-P4, the correct surface forms always have fewer tonal modulations compared with their counterparts generated by the opposite directionality. However, there are cases where both directionalities generate the same number of modulations, but rules must apply from right to left, as in (20). Moreover, in (P5) and (P6), the outputs generated by both directionalities are homophones[5]:

(20) Tone other sandhi must apply from right to left:

left-to-right ⇨		right-to-left ⇦	
(P5)LH+L+L→LH+L+L→LH+LH+L→ *H.LH.L	3	(P5)LH+L+L→LH+LH+L→H.LH.L	3
(P6)L+HL+HL→L+HL+HL→L+L+HL→ *LH.L.HL	4	(P6)L+HL+HL→L+L+HL→LH+L+HL	4
(P7)HL+L+L→ H+L+L→*H+LH+L	3	(P7) HL+L+L→HL+LH+L	3

The question is: why do rules apply from right to left in P5-P7?

Tianjin is a right-dominant language. Some tone sandhi must from right to left while some other tone sandhi must apply from the opposite directionality in accordance with MINMOD. In cases where the outputs generated by both directionalities have the same number of tonal modulations or in case of homophony, rules must apply from right to left. Following Howard (1972), we suggest that rules are applied from the direction of the trigger (determinant) towards the target (focus) when there is indecidability. This fact can be captured by the following constraint:

(21) Default Rule Application (RIGHTPROM, LEFTPROM)

Tone sandhi should apply from the direction of the trigger towards the target.

Put it differently, RIGHTPROM, in *latent* state, is activated if the outputs generated by both directionalities have the same number of tonal modulations or in case of homophony. MINMOD thus outranks RIGHTPROM:

(22) MINMOD » RIGHTPROM

MINMOD assigns one mark to every tonal modulation found in the output. For example, in (23), candidate (a) has two tonal modulations whereas candidate (b) has

[5] We are assuming that rules apply at every point in the derivation, so that any time their structural description is created, they immediately get changed (*Persistent rules*, Myers 1991).

three tonal modulations. Even candidate (b) satisfies RIGHTPROM, it is still ruled out due to the violation of the higher ranked constraint MINMOD.

(23)

(P1) HL+HL+L	MINMOD	RIGHTPROM
☞ a. $\overset{\frown}{\text{L}}$+$\overset{\frown}{\text{H}}$+L (⇨)	**	
b. $\overset{\frown}{\text{HL}}$+$\overset{\frown}{\text{H}}$+$\overset{\frown}{\text{L}}$ (⇦)	***	✓

In (24), both candidate (a) and candidate (b) have three tonal modulations. The constraint RIGHTPROM is activated in order to select the winning candidate.

(24)

(P7) HL+L+L	MINMOD	RIGHTPROM
☞ a. $\overset{\frown}{\text{HL}}$+$\overset{\frown}{\text{LH}}$+$\overset{\frown}{\text{L}}$ (⇦)	***	✓
b. $\overset{\frown}{\text{H}}$+$\overset{\frown}{\text{LH}}$+$\overset{\frown}{\text{L}}$ (⇨)	***	

Notice that Default Rule Application (RIGHTPROM, LEFTPROM) is a *positive* constraint, according to which tone sandhi should apply from the direction of the trigger towards the target, so evaluation by this constraint is indicated using the check mark, rather than violation marks in classic OT.

6. Chengtu

Chengtu, a Mandarin dialect, is spoken in Sichuan province. Four lexical tones are observed in citation form: MH, LM, HM, ML (Chang 1958, Lin 2004).

(25)

	H register	L register
Rising tones	MH	LM
Falling tones	HM	ML

The disyllabic tone sandhi rules in Chengtu are given below (Lin 2004):

(26)

	MH	ML	HM	LM
MH	MH.**M**			MH.**L**
ML	ML.**M**			ML.**L**
HM	**H**.**M**	**H**.ML	**H**.HM	**H**.**L**
LM	LM.**H**			LM.**L**

It can be observed that, in tone sandhi contexts, sandhi tone can be predicted from the register of its underlying contour. The high-register falling contour tone /HM/ becomes a high level tone, and the high-register rising contour tone /MH/ yields a mid level tone or a high level tone. Likewise, the low-register rising tone /LM/ is reduced to a low level tone in tone sandhi contexts. Given that tone sandhi can take place both on the first and the second syllable, we consider that Chengtu is a language with conflicting prominence, as opposed to Mandarin, Tianjin and Sixian-Hakka, in which the second syllable always retains its underlying tone.

Seven tone patterns are observed in trisyllabic sequences; three of them have right-to-left directionality while four others have the opposite directionality:

(27) Some tone sandhi must apply from right to left:

left-to-right ⇨		right-to-left ⇦	
(P1) MH+MH+MH→MH+M+MH→*MH.**M.H**	3!	(P1) MH+MH+MH→MH+MH+MH→MH.**M.M**	2
(P2) ML+MH+MH→MH+M+MH→*ML.**M.H**	3!	(P2) ML+MH+MH→ML+MH+M→ML.**M.M**	2
(P3) HM+MH+MH→MH+M+MH→*H.**M.H**	2!	(P3) HM+MH+MH→HM+MH+M→H.**M.M**	1

As can be seen in (27), the winners all have fewer tonal modulations compared to their counterparts. However, the analytical task becomes more challenging in P4-P7, in which the outputs generated by both directionalities have the same number of tonal modulations, and tone sandhi must apply from left to right, as in (28):

(28) Some other tone sandhi must apply from left to right:

left-to-right ⇨		right-to-left ⇦	
(P4) MH+LM+MH→MH+L+MH→MH.**L.M**	3	(P4) MH+LM+MH→MH+LM+H→*MH.**L.H**	3
(P5) ML+LM+MH→ML+L+MH→ML.**L.M**	2	(P5) ML+LM+MH→ML+LM+H→*ML.**L.H**	2
(P6) HM+LM+MH→HM+L+MH→H.**L.M**	2	(P6) HM+LM+MH→HM+LM+H→*H.**L.H**	2

(P7) <u>LM+LM</u>+MH→LM+<u>L+MH</u>→L͡M.**L͡.M**	3	(P7) LM+LM+MH→LM+LM+H→*L͡M.**L͡.H**	3

Taking a closer look at the outputs, we observe that all illicit forms have farther-apart pitch targets compared with the attested surface form. Sundberg (1973, 1979) has remarked that a complicated tonal contour involving more pitch targets would involve more complicated muscle state change. In other words, the principle of least effort is also the major criterion in governing the rule application directionality, the output with farther-apart pitch targets being eliminated. This observation can be formulated in (29):

(29) MINAMP: *minimize amplitude of contour tones*

A question arises as to a possible competition between MINAMP and MINMOD: both of them can be shown to be satisfied in P1-P3; these two constraints appear to be in competition.

Our solution is the following: MINAMP is sufficient in selecting the winning candidates in all cases, MINMOD being trivially satisfied in P1-P3. When the outputs generated by two directionalities have equal tonal modulations, and when default rule application fails to apply[6], MINAMP intervenes to selection the winner. Consequently, MINAMP dominates MINMOD:

(30)

(P4) MH+LM+MH	MINAMP	MINMOD
☞ a. M͡H+͡L+͡M(⇦)	✓	***
b. M͡H+͡L+͡H(⇨)		***

Two remarks are in order here: MINAMP operates in Chengtu which has distinctive tonal register (falling HM *vs* ML, rising MH *vs* LM). By contrast, in Boshan, Sixian-hakka and Tianjin, there is no register contrast in the tonal systems, and MINMOD is sufficient in selecting the winners.

On the other hand, MINMOD is generally sufficient in selecting candidates in the four languages that we just examined. In Tianjin, *default rule application* is activated

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[6] Recall that tone sandhi sometimes takes place on the first syllable and sometimes on the second syllable in disyllabic sequences. Consequently, it is difficult to determine whether Chengtu is a right-dominant or a left-dominant language.

when the outputs generated by both directionalities have the same number of tonal modulations, and MINAMP intervenes in Chengtu for the same reason. A question arises as to the hierarchy between MINAMP and *default rule application* in a language with distinctive tonal register but without conflicting prominence. Given that MINMOD outranks *default rule application* and that MINAMP outranks MINMOD, we predict that *default rule application* is the last resort in a language with distinctive tonal register but without conflicting prominence.

7. General discussion

7.1 Can markedness be reduced to surface constraint violation?

A related issue emerges from the present analysis. In OT, markedness is built into grammars in the form of universal *output constraints* which directly state marked or unmarked patterns (i.e. *CODA, *COMPLEX ONSET) before candidates are submitted to EVAL (*Categorical constraints*, McCarthy 2003). However, markedness has a long story in phonological theory, and existed long time before OT. In structuralist linguistics (Hjelmslev 1935, [1939] 1970, Trubetzkoy 1939, Jakobson 1941), markedness was defined in terms of contrastive specification based on *privative* oppositions:

> *«Les oppositions* privatives *sont celles dans lesquelles un des termes de l'opposition est caractérisé par l'existence d'une marque : par ex. « sonore »-« sourd », « nasalisé »-« non nasalisé », « arrondi »-« non arrondi ». Le terme de l'opposition caractérisé par la présence de la marque s'appellera « terme marqué » et celui qui est caractérisé par l'absence de la marque « terme non marqué ». Ce type d'opposition est pour la phonologie d'une extrême importance. »* (Trubetzkoy [1939] 1976, p. 77)

In other words, marked units bear a special distinctive mark which is absent from unmarked ones. A marked linguistic element is not (un)marked in itself, but only in comparison to other linguistic elements: /b/ is marked compared to /p/ (it has [voice]), but unmarked compared to /b^h/ in Hindi (it lacks [spread gl]) (Carvalho 2004).

Privative features have been explicitly introduced in the 1980's by several phonological frameworks such as Dependency phonology (Anderson & Ewen 1987), Government phonology (Kaye, Lowenstamm & Vergnaud 1985), and Particle phonology (Schane 1984). This line of thinking has been reintroduced into binary feature geometric approaches by underspecification theories (Kiparsky 1982 a, b, Steriade 1987, Clements 1987, Archangeli 1988, Pulleyblank 1988, Mester & Itô 1989) and implemented in OT (Kiparsky 1994, Itô *et al.* 1995, Inkelas 1995).

Structuralist thinking is also found in functionalist theories (Padgett 2001, Flemming 2004). As Flemming (2004:18) puts it, central vowels are highly marked in the presence of F2 contrasts, but are unmarked when F2 contrasts are neutralized: markedness of vowel qualities depends on the contrasts that they enter into.

Back in our analysis, MinAmp and MinMod cannot be said to be violated (nor satisfied) before Eval takes place, as shown in (31b):

(31) a. Classic OT

$cand_1$ $cand_2$... $cand_n$

Markedness/Faithfulness constraints

↓

Eval

↓

Output

b. Our analysis

$cand_1$ $cand_2$

Eval

↓

MinMod/MinAmp

↓

Output

In other words, markedness constraints proposed here are *relative*: an output having three tonal modulations does not, *per se*, violate MinMod, but only in comparison to the output generated by the opposite directionality. This approach is reminiscent of structuralist linguistics, where markedness was defined in terms of *contrastive* specification, not in terms of constraint violation.

Furthermore, a winner may have more tonal modulations compared to its input, but fewer modulations compared to its counterpart generated by the opposite directionality. Thus, in (32a) and (30b), the attested forms have more tonal modulations compared to their input. We shall turn back to this point in §7.3.

(32) a. P7 (Tianjin)

H͡L+L+L	MinMod	RightProm
☞ H͡L+L͡H+͡L (⇦)	***	✓
H͡+L͡H+͡L (⇨)	***	

b. P4 (Tianjin)

L+L+L	MinMod	RightProm
☞ L+L͡H+L(⇦)	**	✓
H͡+L͡H͡+L (⇨)	***!	

7.2 Objection I: constraints like *Mod, *AmpleMod do the job.

One possible objection to the present analysis is that categorical constraints such as *Mod and *AmpleMod do the same job: outputs with more tonal modulations will be assigned more violation marks. However, markedness constraints like *Mod and *AmpleMod are based on the assumption that contour tones are *universally* more marked than level tones, just as *Coda implies that closed syllables are structurally more marked than open syllables. Nevertheless, if African tonal languages do confirm this assumption, Chinese languages show two surprising characteristics. On the one hand, there is no system with only level tones in Chinese, while there is no system with only contour tones in African tonal languages. What happens in Chinese runs counter to the claims of markedness theory, according to which the presence of any single marked element without its unmarked counterpart is ruled out in phonological systems (Jakobson 1969, Clements 2005, 2007). On the other hand, while contour tones generally prefer a longer duration to facilitate implementation, the high level tone is not shorter than the falling contour tone in Mandarin (Kratochvil 1968, Xu 2004). These two paradoxes cannot be explained by purely substantial terms. Below is a list of languages with only contour tones in Chinese. While the list might not be exhaustive, it allows representing the structural difference between Chinese languages and African tonal languages:

(33)

Dialect	Tonal system
Shanghai (Chen 2000)	HL, LH
Zhenhai (Rose 1990)	HM, ML, LM, MH
Pingyao (Hou 1980)	LM, MH, HL
Dalian (Liu, in prep.)	HL, LH, HLH
Chengtu (Chang 1958, Lin 2004)	HM, ML, LM, MH
Longquan (Steed 2006)	HLH, HM, ML, LM, MH

Yencheng (Yu 2005)	HL(51), HLH(213), HHL(554), LH(24)
Wuxi (Chan & Ren 1986)	HL, LH, HLH[7]

One might say that the syllable structure of Chinese is CVV, hence Chinese dialects are capable of carrying contour tones. However, there is no correlation between vowel duration and the capability of bearing contour tones. In Taiwanese for example, stress falls on the final syllable, and the preceding syllables, unstressed and 40% less long than the syllable in the final position, are subject to tone sandhi. The unstressed syllables are still capable of bearing contour tones. Moreover, in Vietnamese and Thai, there is contrast between long and short vowels, but both can carry contours tones (Pham 2003). These facts suggest that syllable structure cannot explain why there are languages with only contour tones in Chinese.

Beyond Chinese, according to a database of 448 languages of Hyman[8], 159 languages have only level tones, whereas 289 languages have at least one contour tone. This finding suggests that most languages have a contour tone. Moreover, not counting Chinese, 12 languages have only contour tones without level tones: nine in the Southeast of Asia, two in New Guinea, and one in South America.

Assuming *MOD-like constraints, what happens in Chinese would be unexplainable.

However, why are there systems with only contour tones in Chinese?

This question is much the same as “why do retroflex stops, relatively rare in world’s languages, exist in almost all the Dravidian languages?

As Lass (1975) notes, Chomsky & Halle’s markedness theory represent “intrinsic content” of a feature, but is actually based on *statistical* generalizations:

> “...what the claim of the theory reduce to is this: if some value [βF] is *marked* because of its rarity, then what is *intrinsic* is the marking 'm' as a property of a matrix containing [βF] instead of [aF]. There is no *explanation* of anything here, only the assertion that on (ultimately) statistical grounds the interpretation [uF]→ [aF] is true....if it could be shown that 'm' and 'u' markings equated with anything other than statistical distribution, then the theory might be of some

[7] Chan & Ren (1986) consider that there are six tones in open syllables in Wuxi. However, since tonal register is conditioned by the laryngeal state of the onset, we propose that there are only three phonological tones.
[8] Data obtained as of July 22, 2008.

interest. (Lass, 1975: 487)"

Lass claims that "naturalness" can only be judged on *language-specific* grounds, not universal statistical ones: retroflex stops are rare in world's languages, but almost all the Dravidian languages have them, and show stability over time. These retroflex stops even influenced neighboring Indian languages such that these "marked" consonants emerge in Indo-Aryan languages, which are a subgroup of Indo-European languages. To account for the diversity of patterns in world's languages, he proposes *family universals*, i.e. specific well-formedness conditions in phonological inventories do not have any (necessary) universal or "intrinsic" motivations.

In line with Lass' position, we would like to suggest that contour tones are not intrinsically (un)marked in world's tonal languages, and should be judged on *language-specific* grounds. It is not because contour tones are phonetically more complicated that they should be universally less optimal. As Lass (1975) puts it: "*there should be no correlation between optimalness/simplicity and non-optimalness/complexity*."

7.3 Objection II: Positional constraints *MOD/-STRESS, *AMPLEMOD/-STRESS do the job.

Just as vowel reduction processes which often involve *effort minimization*[9], there is tonal reduction in tone sandhi processes, hence positive constraints MINAMP and MINMOD could be replaced by positional constraints such as *MOD/-STRESS and *AMPLEMOD/-STRESS. However, if it is the case that the stressed syllable always retains its underlying tone during tone sandhi processes, a contour tone might also emerge in an unstressed syllable. In Tianjin for example, L+L gives rise to LH.L. In Boshan, 55b+55 yields 214.55, and 55a+55 gives 53.55. On the other hand, in trisyllabic sequences, due to different *combinations* of tones, the output of unstressed syllables does not always have fewer tonal modulations compared to its input:

[9] Vowel contrasts are often neutralized to schwa in unstressed syllables in English (Hayes 1995), Southern Italian dialects (Maiden 1995) and Dutch (Booij 1995). Van Bergen (1994) and Kondo (1994), working respectively on Dutch and English, indicate that schwa can be analyzed as the result of *effort minimization* predominating where vowel contrasts are neutralized (Flemming 2004).

(34)

Language	Input	modulations	Output	modulations
Boshan	55a+55a+55	0	55.53.55	2
	55b+55b+55	0	55.214.55	3
	55a+55+31	2	55.24.31	3
	55a+55b+55	0	55.214.55	3
	55b+55a+55	0	55.53.55	2
Tianjin	L+L+L	0	L.LH.L	2
	HL+L+L	1	HL.LH.L	3

Furthermore, positional constraints *MOD/-STRESS and *AMPLEMOD/-STRESS cannot explains cases in which tone sandhi does not take place. For example, contrary to Tianjin where LH+LH yields H.LH and HL+HL gives L.HL, in Mandarin, LH+LH and HL+HL do not trigger tone changes[10]. In trisyllabic sequences in Tianjin, among 64 combinatorial possibilities (4^3), only seven combinations give rise to tone sandhi. While LH+LH+LH triggers tone change, it is intriguing that LH+LH+H and LH+LH+L remain unchanged. This fact leads to the conclusion that tone sandhi in trisyllabic sequences is not *output-driven* but *directionality-driven*. This observation echoes Hyman & VanBik's analysis on tone sandhi directionality in Hakha-Lai, according to which output-based generalizations fail to capture the input-output relations (2002).

The *directionality-driven* nature of tone sandhi in trisyllabic sequences is also confirmed in Boshan, in which the input 214+55+214 does not undergo tone sandhi, but *214+55+214 is not a possible output for the string 55b+214+214: rules must apply from left to right for the sequence 55b+214+214.

(33) Boshan

	Input		Output	
a.	214+55+214	→	no change	
b.	55b+214+214	→	55.55.214	(⇨)
		→	*214+55+214	(⇦)

[10] In OT, the reason why LH+LH and HL+HL are not subject to tone sandhi in Mandarin can only be explained by demoting OCP in favor of the constraint FAITHFULNESS.

8. Conclusion

This paper deals with tone sandhi directionality in four Chinese dialects, Boshan, Sixian-Hakka, Tianjin and Chengtu. We hope to have shown that rule application directionality is primarily determined by the lowest number of tonal modulations generated in the output, and propose a family of markedness constraints MINMOD (minimize modulation) and MINAMP (minimize amplitude of contour tones) to account for the apparently ungoverned traffic of sandhi operations. When the outputs generated by both directionalities have the same number of tonal modulations, *default rule application* (RIGHTPROM, LEFTPROM), in latent state, is activated to select the winning candidate.

A paradox arises from the present analysis: outputs with fewer tonal modulations are avoided by speakers; however, there is no system with only level tones in Chinese, while there are languages with only contour tones. Why are there systems with only contour tones in Chinese languages, contrary to what happens in African languages? In accord with Lass' position, we suggest that contour tones are not intrinsically (un)marked in world's tonal languages, and should be judged on *language-specific* grounds. Just as retroflex stops are extremely rare in typology but exist in almost all the Dravidian languages, the same thing goes for contour tones in Chinese. It is not because contour tones are phonetically more complicated that they are universally less optimal. Markedness should be judged on the ground of *family universals*.

As a final note, assuming that contour tones are unmarked in Chinese, how can unmarked contours be compatible with MINMOD and MINAMP? At any event, it seems that phonological markedness can hardly be accounted for in terms of constraint violation by surface forms.

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