

Tone Sandhi Directionality and Relative Markedness Constraints¹

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1. The issue

- ✓ In some Chinese dialects, disyllabic tone sandhi rules must apply from left to right to derive the outputs for some tri-tonal strings 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.

(1) Tianjin

Input	Output	[x x] x	x [x x]
HL+HL+L	L.H.L	[s.tɕi] tɕ ^h in "evergreen"	tswɔ [tiæn.tɕʌ] "take a tram"
LH+LH+LH	H.H.LH	[li.fa] swɔ "barber shop"	mu [law.hu] "tigress"
L+L+L	L.L.H.L	[twɔ.la] tɕi "tractor"	k ^h aj [fɛj.tɕi] "pilot a plane"

- ✓ We examined the trisyllabic sequences of four Chinese dialects: Boshan (Chen 2000), Tianjin (Chen 2000), Sixian-Hakka (Hsu 1996, Hsiao 2000), and Chengtu (Lin 2004). We argue that rule application directionality is primarily determined, in Boshan, Sixian-Hakka and Tianjin, by the lowest number of tonal modulations generated in the output.

2. Boshan (Chen 2000): right-dominant

- ✓ Three citation tones: /214/, /55²/, /31/
- ✓ Disyllabic tone sandhi rules (largely lexicalized):

¹ Our cordial thanks are due to Larry Hyman for his precious suggestions and comments. All inaccuracies and omissions are of course our own responsibility.

² The citation tone /55/ comes from two different historical tonal categories: /55a/ derives from Middle Chinese lower register *ping* category, whereas /55b/ is from Middle Chinese *shang* category.

- (2) 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

(3)

1 st tone	2 nd tone		
	214	55	31
214	55.214	no change	24.31
55a	no change	53.55	
55b		214.55	
31	no change	(24.31)	

- ✓ These sandhi rules govern the realization of tone sandhi in trisyllabic forms.
- ✓ Nine tonal combinations give rise to tone sandhi in trisyllabic forms:

(4) Rules must apply from left to right:

	a. left-to-right		b. right-to-left
Input	<u>214+214</u> +214		214+ <u>214+214</u>
	↓		↓
	55+ <u>214+214</u>		<u>214+55</u> +214
	↓		↓ (n/a)
Output	55+55+214		*214+55+214

- ✓ This is the case with the following sequences:

(5) Tone sandhi must apply from left to right (3 = 3 tonal modulations, i.e. pitch changes):

left-to-right ⇒		right-to-left ⇐	
$\underline{55a+214+214} \rightarrow \underline{55.214+214} \rightarrow \underline{55.55.214}$	3	$\underline{55a+214+214} \rightarrow \underline{55a+55.214} \rightarrow * \underline{53.55.214}$	5!
$\underline{55b+214+214} \rightarrow \underline{55.214+214} \rightarrow \underline{55.55.214}$	3	$\underline{55b+214+214} \rightarrow \underline{55b+55.214} \rightarrow * \underline{214.55.214}$	5!
$\underline{214+214+214} \rightarrow \underline{55.214+214} \rightarrow \underline{55.55.214}$	3	$\underline{214+214+214} \rightarrow * \underline{214.55.214}$	5!
$\underline{214+214+31} \rightarrow \underline{55.214+31} \rightarrow \underline{55.24.31}$	3	$\underline{214+214+31} \rightarrow * \underline{214.24.31}$	5!

(6) Rules must apply from right to left:

	a. left-to-right	b. right-to-left
Input	$\underline{55b+55a+55}$	$\underline{55b+55a+55}$
	↓	↓
	$\underline{214+55a+55}$	$\underline{55+53+55}$
	↓	↓ (n/a)
Output	* $\underline{214+53+55}$	$\underline{55+53+55}$

✓ This is the case with the following sequences:

(7) Tone sandhi must apply from right to left:

left-to-right ⇒		right-to-left ⇐	
$\underline{55a+55a+55} \rightarrow \underline{53.55a+55} \rightarrow * \underline{53.53.55}$	3!	$\underline{55a+55a+55} \rightarrow \underline{55.53.55}$	2
$\underline{55b+55b+55} \rightarrow \underline{214.55b+55} \rightarrow * \underline{214.214.55}$	4!	$\underline{55b+55b+55} \rightarrow \underline{55.214.55}$	3
$\underline{55a+55+31} \rightarrow \underline{53.55+31} \rightarrow * \underline{53.24.31}$	4!	$\underline{55a+55+31} \rightarrow \underline{55.24.31}$	3
$\underline{55a+55b+55} \rightarrow \underline{53.55b+55} \rightarrow * \underline{53.214.55}$	4!	$\underline{55a+55b+55} \rightarrow \underline{55.214.55}$	3
$\underline{55b+55a+55} \rightarrow \underline{214.55a+55} \rightarrow * \underline{214.53.55}$	4!	$\underline{55b+55a+55} \rightarrow \underline{55.53.55}$	2

✓ Observation: the winning candidates always have fewer tonal modulations compared with their counterparts generated by the opposite directionality. We propose a constraint MINMOD (minimize modulation) to capture the facts in Boshan.

(8) MINMOD (minimize modulation):

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

⇒ Motivation of the constraint: 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.

3. Sixian-Hakka (Hsu 1996, Hsiao 2000): right-dominant

✓ Four lexical tones are observed in CV, i.e. LH, L, ML, H; two tones in CVC, i.e. M?, H?.

✓ Disyllabic tone sandhi rules:

- (9) a. $\underline{LH+LH} \rightarrow \underline{L.LH}$
tsu kon "pork liver"
- b. $\underline{LH+H(?)}$ → $\underline{L.H(?)}$
hi mong "hope"
sam sip "thirty"

✓ Tone sandhi must apply from left to right in trisyllabic sequences:

(10)

left-to-right ⇒		right-to-left ⇐	
(P1) $\underline{LH+LH+LH} \rightarrow \underline{L.LH+LH} \rightarrow \underline{L.L.LH}$	1	(P1) $\underline{LH+LH+LH} \rightarrow * \underline{LH.L.LH}$	3!
(P2) $\underline{LH+LH+H} \rightarrow \underline{L.LH+H} \rightarrow \underline{L.L.H}$	1	(P2) $\underline{LH+LH+H} \rightarrow * \underline{LH.L.H}$	3!
(P3) $\underline{LH+LH+H?} \rightarrow \underline{L.LH+H} \rightarrow \underline{L.L.H}$	1	(P3) $\underline{LH+LH+H?} \rightarrow * \underline{LH.L.H?}$	3!

✓ Rules apply consistently from left to right in a right dominant language since the opposite directionality would generate more tonal modulations.

4. Tianjin: right-dominant

✓ Four lexical tones are observed (Shi 1990): 11 (L), 55 (H), 24 (LH), 53 (HL)

✓ Four tone sandhi rules in disyllabic forms (Chen 2000):

- (11) 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 tɕoŋ] "net weight"
- (12) Tonal absorption
- d. HL+L → H.L [ʒʌn tɕʌn] "earnest"

(13) 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!

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

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

- ✓ 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.

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

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

- ✓ Why do rules apply from right to left in P5-P7?

³ 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).

(16) Default Rule Application⁴ (RIGHTPROM, LEFTPROM):

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

⇨ Motivation of the constraint: A rule is applied across a string from the side corresponding to the location of the determinant to the side corresponding to the focus (Howard 1972:30).

(17)

Phonological rule	Rule application directionality
a. X → Y/ _Z	right-to-left ⇐
b. X → Y/Z _	left-to-right ⇨

- ✓ In a right-dominant language such as Tianjin, the phonological rule should apply from right to left when there is indecidability.

(18) MINMOD >> RIGHTPROM

⇨ 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).

5. Chengtu (Lin 2004)

- ✓ Four lexical tones in citation forms: MH, LM, HM, ML;

(18)

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

(19) Disyllabic tone sandhi rules:

	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

⁴ Thanks to Larry Hyman for suggesting this term.

- ✓ In (19), tone sandhi takes place sometimes on the first syllable and other times on the second syllable.

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

left-to-right ⇨		right-to-left ⇩	
(P1) $\overline{MH}+\overline{MH}+MH \rightarrow \overline{MH.M}+\overline{MH} \rightarrow * \overline{MH.M.H}$	3!	(P1) $MH+\overline{MH}+\overline{MH} \rightarrow \overline{MH}+\overline{MH.MH} \rightarrow \overline{MH.M.M}$	2
(P2) $\overline{ML}+\overline{MH}+MH \rightarrow \overline{MH.M}+\overline{MH} \rightarrow * \overline{ML.M.H}$	3!	(P2) $ML+\overline{MH}+\overline{MH} \rightarrow \overline{ML}+\overline{MH.M} \rightarrow \overline{ML.M.M}$	2
(P3) $\overline{HM}+\overline{MH}+MH \rightarrow \overline{MH.M}+\overline{MH} \rightarrow * \overline{H.M.H}$	2!	(P3) $HM+\overline{MH}+\overline{MH} \rightarrow \overline{HM}+\overline{MH.M} \rightarrow \overline{H.M.M}$	1

- ✓ The winners all have fewer tonal modulations compared to their counterparts.
- ✓ But in P4-P7, the outputs generated by both directionalities have the same number of tonal modulations, and tone sandhi must apply from left to right:

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

left-to-right ⇨		right-to-left ⇩	
(P4) $\overline{MH}+\overline{LM}+MH \rightarrow \overline{MH.L}+\overline{MH} \rightarrow \overline{MH.L.H}$	3	(P4) $MH+\overline{LM}+\overline{MH} \rightarrow \overline{MH}+\overline{LM.H} \rightarrow * \overline{MH.L.H}$	3
(P5) $\overline{ML}+\overline{LM}+MH \rightarrow \overline{ML.L}+\overline{MH} \rightarrow \overline{ML.L.H}$	2	(P5) $ML+\overline{LM}+\overline{MH} \rightarrow \overline{ML}+\overline{LM.H} \rightarrow * \overline{ML.L.H}$	2
(P6) $\overline{HM}+\overline{LM}+MH \rightarrow \overline{HM.L}+\overline{MH} \rightarrow \overline{H.L.H}$	2	(P6) $HM+\overline{LM}+\overline{MH} \rightarrow \overline{HM}+\overline{LM.H} \rightarrow * \overline{H.L.H}$	2
(P7) $\overline{LM}+\overline{LM}+MH \rightarrow \overline{LM.L}+\overline{MH} \rightarrow \overline{LM.L.H}$	3	(P7) $LM+\overline{LM}+\overline{MH} \rightarrow \overline{LM}+\overline{LM.H} \rightarrow * \overline{LM.L.H}$	3

- ✓ Taking a closer look at the outputs, we observe that all illicit forms have farther-apart pitch targets compared with the attested surface forms.
- ✓ 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. Hence:

(22) MINAMP: *Minimize amplitude of contour tones.*

- ✓ Challenge: both MINAMP and MINMOD can be shown to be satisfied in P1-P3. These two constraints appear to be in competition.

- ✓ Solution: MINAMP is sufficient in selecting the winning candidates in all cases, MINMOD being trivially satisfied in P1-P3.
- ✓ Contrary to Boshan, Sixian-hakka and Tianjin, Chengtu has distinctive tonal register (falling HM vs ML, rising MH vs LM). Hence, though this will not be discussed here, MINAMP dominates MINMOD.

6. The case for relative markedness

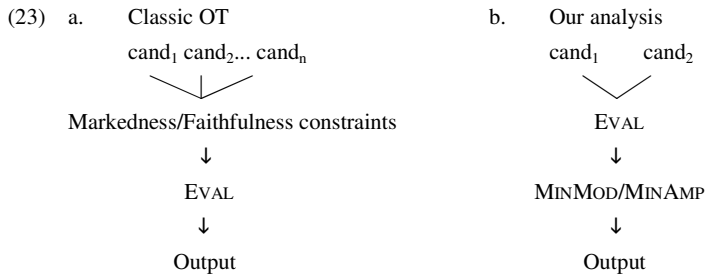
6.1 Can markedness be reduced to constraint violation?

- ✓ 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).
- ✓ Markedness existed 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)

- ✓ A marked linguistic element is not (un)marked in itself, but only in comparison to other linguistic elements: /b/ is marked w.r.t. /p/ (it has [voice]), but unmarked w.r.t. /b^h/ in Hindi (it lacks [spread gl]); /i/ and /u/ are marked w.r.t. /a/ (they have tonality features plus [high]), but unmarked w.r.t. /y/ (they have only one tonality feature, while /y/ has two) (Carvalho 2004).
- ✓ Privative features have been explicitly reintroduced in the 1980's by several phonological frameworks: Dependency phonology (Anderson & Ewen 1987), Government phonology (Kaye, Lowenstamm & Vergnaud 1985), and Particle phonology (Schane 1984).
- ✓ Various amounts of privativity have also been introduced into binary feature geometric approaches by underspecification theories (Kiparsky 1982a,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).
- ✓ In the present analysis, MINAMP and MINMOD cannot be said to be violated (nor satisfied) before EVAL takes place:



- ✓ 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.
- ✓ A winner may have more tonal modulations compared to its input, but fewer modulations compared to its counterpart generated by the opposite directionality, as in (24), where * = tonal modulation, not constraint violation:

(24) a. P7 (Tianjin)

$\widehat{HL}+L+L$	MINMOD	RIGHTPROM
$\Leftarrow \widehat{HL}+\widehat{LH}+\widehat{L} (\Leftarrow)$	***	✓
$\widehat{H}+\widehat{LH}+\widehat{L} (\Rightarrow)$	***	

b. P4 (Tianjin)

L+L+L	MINMOD	RIGHTPROM
$\Leftarrow L+\widehat{LH}+L (\Leftarrow)$	**	✓
$\widehat{H}+\widehat{LH}+\widehat{L} (\Rightarrow)$	***!	

6.2 Objection I: constraints like *MOD, *AMPLEMOD do the job.

- ✓ Just as *[voice], *[spread gl] or *[front], *[round] account for /b/ : /b^h/ and /i/ : /u/ :: /y/ oppositions, MINMOD and MINAMP could be replaced with *absolute* constraints such as *MOD and *AMPLEMOD, which would be more often violated by marked candidates.
- ✓ However, this would be empirically false. *MOD implies that contour tones are more marked than level tones. Yet, there is *no* language with only level tones in Chinese, but there are languages with *only* contour tones:

(25)

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 ⁵

- ✓ Beyond Chinese, according to a database of 448 languages of Hyman⁶, 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, then, run 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).

⁵ 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.

⁶ Data obtained as of July 22, 2008.

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

- ✓ Just as vowel reduction processes which often involve *effort minimization*⁷, there is tonal reduction in tone sandhi processes, hence *MOD/-STRESS, *AMPLEMOD/-STRESS. However:
 - ✧ The crucial trigger of tone sandhi is not positional; sandhi does not only follow from –stress, but also from certain *combinations* of tones. Hence, tone sandhi does *not* occur in most cases.
 - ✧ Even when it does, the unstressed syllables do not always have fewer tonal modulations compared to their input, as shown in (26). Modulation and amplitude of contour tones are minimized in unstressed syllables compared to their counterparts generated by the opposite directionality, not compared to input.

(26)

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
	H.L+L+L	1	H.L.LH.L	3

6.4 Conclusion

- ✓ *Phonological objects are not intrinsically marked.*
 - ⇒ MINMOD/MINAMP suppose that more modulations are more difficult to produce than fewer modulations, but this does not imply that tonal modulation is in itself a marked object; clearly, this is not the case in Chinese.

⁷ 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).

- ✓ Why are lexical contour tones unmarked in Chinese languages, contrary to what happens in African languages?
 - ✧ Lass (1975) claims that ‘naturalness’ can only be judged on language-specific grounds, not universal statistical ones, and proposes *family universals*, i.e. specific well-formedness conditions in phonological inventories which do not have any (necessary) universal or “intrinsic” motivations.
 - ✧ Contour tones are not intrinsically (un)marked in world’s tonal languages, and should be judged on *language-specific* grounds.
- ✓ How can (Chinese) 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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