Directionality and least effort principle in Tianjin

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Phenomenon: Tianjin, a northern Mandarin dialect, has four lexical tones: H, L, HL and LH. Four tone sandhi processes are observed in disyllabic strings (Chen 2000):

(1) Dissimilation

a. L + L → LH. L
b. LH + LH → H. LH
c. HL + HL → L.HL

Tonal absorption

d. HL + L → H.L

However, the analytical task becomes more challenging in longer constructions. Tone sandhi rules must apply from right to left to derive the outputs for some tri-tonal patterns and from left to right to account for the others (Chen 2000):

(2) [P = Pattern]

Right-to-left	Left-to-right
(P3) HL+<u>HL+HL</u>→<u>HL+L</u>+HL→H+L+HL	(P1) <u>HL+HL</u>+L→L+<u>HL+L</u>→L+H+L
(P4) L+<u>L+L</u>→L+LH+L	(P2) <u>LH+LH</u>+LH→H+<u>LH+LH</u>→<u>H+H+LH</u>
(P5) LH+<u>L+L</u>→<u>LH+LH</u>+L→H+LH+L	
(P6) L+<u>HL+HL</u>→<u>L+L</u>+HL→LH+L+HL	
(P7) HL+<u>L+L</u>→HL+LH+L	

Note that morphosyntactic structures play no role in the application of rules, since a left-branching string and a right-branching string will generate the same surface form.

Analysis: We claim that the varied manifestations of directionalities in Tianjin submit to a very simple analysis. Following Howard (1972) according to whom a rule is applied from the direction of the trigger towards the target, in a right-dominant language such as Tianjin, the phonological rule should apply from right to left. This accounts for the fact that five of the seven sequences apply rules from right to left, which can be captured by the constraint RIGHTPROM.

Concerning P1 and P2 where rules apply from left to right, we propose a second constraint, MINMOD (minimize modulation), i.e. the number of tonal modulations[1] generated by tone sandhi should be minimal. This is in line with the least effort principle (Zipf 1949, Martinet 1955, Lindblom 1986, 1990).

Hence, in P1 and P2, the right-to-left directionality would generate more tonal modulations than the converse directionality. After evaluation with a virtual output, speakers chose to violate RIGHTPROM in order to produce sequences with lesser tonal modulations, as is shown in (3).

(3)

a. P1 ←	b. P1 →	c. P2 ←	d. P2 →
HL+ (HL + L)	(HL + HL) + L	LH + (LH + LH)	(LH + LH) + LH
*HL + H+ L	L + (HL + L)	*LH + H + LH	H + LH + LH
	☞L + H + L		☞H + H + LH
3 modulations	2 modulations	3 modulations	2 modulations

[1] For exemple, HL and LH have one tonal modulation, whereas HLH and LHL have two tonal modulations. Level tones such as H and L have no modulation at all.

(P3-7) satisfy both RIGHTPROM and MINMOD. MINMOD is thus ranked over RIGHTPROM.

Further implications: Contrary to classical constraints in optimality theory, such as MAX and DEP, which focus on the correspondance between input and output, the case in Tianjin shows that evaluation exists not only between possible outputs, but might be *intrinsic* to the constraint. In order to satisfy MINMOD, an evaluation between two outputs is necessary. However, evaluation is only a *consequence* of the constraint.

References:

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