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Changting Hakka Tone Sandhi: Analytical Challenges

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The Hakka dialect of Changting exhibits extraordinarily complex tone sandhi patterns, that present daunting analytical challenges to any theory, including rule-based generative model as well as Optimality Theory. This paper examines the possible extensions and logical moves within both theories, and concludes that both theoretical models in their current form fall short of their descriptive goals. Hakka is a limiting case that severely tests the adequacy of conceptual tools at our disposal.

Key words: Hakka, tone sandhi, rule-based model, Optimality Theory

1. Introductory remarks

In a nutshell, the problem confronting us in Changting Hakka tone sandhi is sort of like asking, "What is two plus three times four?" The answer we get depends on whether we add (2+3) first or multiply (3×4) first. Likewise, given the tonal string ABC, the sandhi form depends on whether tone sandhi applies to AB or to BC first. The problem would be trivial, were tone sandhi to operate consistently in an orderly fashion (e.g., always AB first, or always BC first), or were it to apply cyclically on morpho-syntactically definable constituents. What is intriguing about Changting Hakka is the apparent unpredictable directionality of rule application: in some cases sandhi rules must apply to AB first and then to BC, while in other cases this order is reversed.[1]

The problem is brought into even sharper focus when cast in Optimality Theoretic (OT) terms. Recalling the algebraic metaphor, the value of "two plus three times four" is either 2+(3×4) = 14 or (2+3)×4 = 20, but not any other arbitrary number. Likewise, the sandhi form of ABC is the sum of elementary sandhi effects on AB then BC, or the order reversed, but not yielding any other random output via some unrelated correspon-

[1] I am indebted to Yan Xiuhong (嚴修鴻) and Wee Lian-Hee (黃良喜) for assembling an enormous amount of data, initial analysis, and long and very fruitful discussions. Our source of factual data for Changting was Luo Meizhen (羅美珍), a pioneering Hakka scholar in her own right. Research leading to this paper was supported in part by a Competitive Earmarked Research Grant, awarded by the Research Grant Council of Hong Kong, and a Strategic Research Grant, given by the City University of Hong Kong.

dence rule.[2] And yet in a truly parallel output-driven model, the procedural “before” and “after” are not even part of the vocabulary.

In short, Changting Hakka poses non-trivial analytical challenges to both OT and rule-based models.

2. Preliminaries

Hakka is spoken by more than thirty-five million people spread across southeast China. The western Fujian dialect of particular interest here is mother tongue to about 50,000 urban residents of the county seat in Changting. This Changting variety exhibits a directionality effect not reported elsewhere for Hakka.[3]

Changting has an unremarkable 5-tone system, consisting of three level tones /H, M, L/ and two contour tones /R, F/. Disyllabic strings undergo context-sensitive tonal substitutions, as summarized in Table 1.

Table 1

2nd / 1st	M	R	F	H	L
M		Lx			Lx
R	Hx				xF
F	Rx	Lx	Mx	Lx ; xM	RF
H	Fx	Fx			Fx
L	Mx		Mx	Mx	

Legend: x stands for an unchanged base tone
shaded cells indicate an absence of sandhi alternation

Thus the cell where the first column and the second row intersect is occupied by the input form /RM/, which shows up as [Hx], i.e., [HM]. In other words, /RM/ → [HM]. Each cell then stands for a two-tone sandhi rule (hereafter 2TS). The shaded cells indicate that the underlying lexical tones remain unchanged. For convenience, I shall refer to each correspondence rule by naming the input tones, e.g. RM rule (RM → HM), FL rule (HL → RF), and so forth.

[2] I ignore a dozen or so exceptional cases.

[3] Published data on Changting Hakka include Li (1965), Luo (1982), and Rao (1987). Hsu (1994) represents the first serious attempt to analyze Changting tone sandhi, followed up by Chen (2000, ch. 4). Hsu (2002) pursues the question of “One Step Principle”, based on Hakka.

I shall not exemplify 2TS, but shall proceed forthwith to the heart of the problem, namely how these elementary rules combine to produce more complex sandhi forms of multitonal strings.[4] Let us begin by considering /RML/, one of the 125 tritonal combinatorial possibilities. Four different sandhi forms are attested: [HML, HLL, RLL, RFL]. It is significant that some orderly application of the 2TS rules of Table 1 predicts exactly all and only those sandhi forms. This is demonstrated below:

(1) **AB first**, then BC

	RML	
	|	by RM rule
a.	HML	
	|	by ML rule
b.	HLL	

BC first, then AB

	RML	
	|	by ML rule
c.	RLL	
	|	by RL rule
d.	RFL	

Legend: TT = two-tone window representing the domain of 2TS
Vertical shaft links the target input tone (top) and its corresponding output (bottom)

(2) Examples:

a.	HML		[劉東] # 會	*[liu.dong] # hui* 'Liu Dong knows'
b.	HLL	i.	[長汀]話	*[chang.ting] hua* 'Changting dialect'
		ii.	談[心 事]	*tan [xin.shi]* 'to speak confidentially'
c.	RLL		行 # [公 路]	*xing [gong.lu]* 'take the highway'
d.	RFL	i.	[良心]壞	*[liang.xin] huai* 'have a bad conscience'
		ii.	來[開 會]	*lai [kai.hui]* 'come to attend a meeting'

4 For simplicity, we limit our discussion to tritonal strings.

(1/2a) is the output of a one-step left-to-right 2TS application, with sandhi rules optionally blocked, typically between constituents such as subject and predicate or verb and object. More often than not, 2TS scans further to the right and, where conditions are met, applies to the sandhi site between the 2nd and the 3rd tone, producing (1/2b) as output. Likewise, a right-to-left application of 2TS generates (1/2c) and (1/2d) in one and two steps respectively.

/RML/ is unique among the 125 tritonal patterns in admitting of sandhi outputs generated by 2TS rules applied in either direction or order. In all other cases, attested sandhi forms are derived from a unidirectional application of 2TS.[5] To simplify matters further, let us ignore the cases where 2TS is optionally truncated under morpho-syntactically defined conditions (1/2a and c). This means that the question boils down to this: In what order should 2TS apply?

3. Structure-neutrality

The problem would be trivial if orderly rule application were to mirror morpho-syntactic bracketing, i.e., if rules were to apply bottom-up, from the smallest constituents to increasingly larger ones. This is patently not the case. (1/2b) and (1/2d) sandhi forms are attested for both [AB]C (left-branching) and A[BC] (right-branching) constructions. This structure-neutrality can be further demonstrated by the following examples.

(3) /LFR/ → [MLR]

e.g. [代 表] 團 *[dai.biao] tuan*
‘group of delegates’

背[古 文] *bei [gu.wen]*
‘to memorize a classical Chinese text’

a. LFR
| by LF rule
MFR
| by FR rule
MLR

b. LFR
| by FR rule
LLR *
n/a

5 Except, of course, direction-neutral cases, where 2TS applied in either direction generates the same output.

(4) /RLF/ → [HMF]

e.g. [文 學]史 *[wen.xue] shi*
‘history of literature’

藍[墨 水] *lan [mo.shui]*
‘blue ink’

a.			b.		
	RLF			RLF	
	|	by LF rule		|	by RL rule
	RMF			RFF	
	|	by RM rule		|	by FF rule
	HMF			RMF *	

(3) and (4) instantiate sandhi outputs derivable by scanning input /ABC/ in one direction or the other—but not both—regardless of whether the construction is left- or right-branching.

4. Against rule ordering

(3a) and (4a) require that 2TS “parses” the tritonal sequences as /(LF)R/ and /R(LF)/ respectively, analogous to the notation (2+3)×4 vs. 2+(3×4). In other words, we might stipulate the ordering relations stated as (5).

(5) /(LF)R/ LF rule > FR rule
/R(LF)/ LF rule > RL rule, etc.

Legend: “>” stands for ‘precede’

Such an approach leads to ordering paradox of the kind illustrated below. Contrast /MRM/ with /RMR/. Only derivations (6a) and (7a) generate the right output.

(6) /MRM/ → [LHM]

e.g. [花 錢]多 *[hua.qian] duo*
‘spending a lot of money’

新[北 京] *xin [bei.jing]*
‘new Beijing’

a.	MRM		b.	MRM	
	|	by ***MR*** rule		|	by RM rule
	LRM			MHM	
	|	by ***RM*** rule			MR rule n/a
	LHM			*MHM	

(7) /RMR/ → [HLR]

e.g. [一斤]油 *[yi.jin] you*
‘one catty of oil’

出[風 頭] *chu [feng.tou]*
‘to show off’

a.	RMR		b.	RMR	
	|	by ***RM*** rule		|	by MR rule
	HMR			RLR	
	|	by ***MR*** rule		|	by RL rule
	HLR			*RFR	

In other words, (6a) requires that MR > RM, while (7a) entails that the order be reversed. Consider now a second palindrome pair /MLM/ and /LML/. Again, they lead to contradictory rule ordering relations, as demonstrated by (8) and (9).[6]

(8) /MLM/ → [MMM]

e.g. [甘 願]教 *[gan.yuan] jiao*
‘willing to teach’

我[食齋] *wo [shi.zhai]*
‘I am a vegetarian’

a.	MLM		b.	MLM	
	|	by ***LM*** rule		|	by ML rule
	MMM			LLM	
		ML rule n/a		|	by LM rule
	MMM			*LMM	

[6] Directionality here cannot be reduced to phonetic leveling nor can it be the reason for this tone sandhi because neither MH nor HM triggers similar alternations.

(9) /LML/ → [LLL]

e.g. [認 真]讀 *[ren.zhen] du*
'seriously study'

食[西 藥] *shi [xi.yao]*
'take western medication'

a.		b.	
L<u>ML</u>		<u>LM</u>L	
|	by ***ML*** rule	|	by LM rule
LLL		M<u>ML</u>	
	LM rule n/a	|	by ML rule
LLL		*MLL	

5. Directional rule application

The ordering paradox demonstrated above can be seen in a different light. It turns out that each of the two palindrome sets calls for a different directional rule application, left-to-right in the case of (6), (7), right-to-left in the case of (8), (9). This is summed up in (10).

(10) a. Left to right:

From (6)	/(MR)M/	MR rule	>	RM rule
From (7)	/(RM)R/	RM rule	>	MR rule

b. Right to left:

From (8)	/M(LM)/	LM rule	>	ML rule
From (9)	/L(ML)/	ML rule	>	LM rule

Legend: (AB)C and A(BC) indicate that 2TS applies first to (AB) and (BC) respectively.

It is clear that ordering paradoxes are but an epiphenomenon of directional rule application.[7] The question now becomes, how can one predict the directionality of tone sandhi? Table 2 cross-classifies the 125 three-tone configurations according to sandhi sites and directional effects. Not surprisingly, ABC patterns, without an appropriate sandhi site (marked with a hyphen), do not undergo tone sandhi; hence the question of

[7] Cf. Howard (1972) and Kenstowicz & Kisseberth (1977) for early treatments of iterative/directional rule application. Well-known instances of directional processes include syllabification and metrification (footing). For relevant literature, see Goldsmith (1995).

directionality does not arise. We have already alluded to the one single case of ambidirectional configuration, i.e., /RML/, which yields two equally acceptable sandhi forms depending on directionality (see (1), (2)). The direction-neutral category refers to tonal configurations that yield the same output regardless of which direction 2TS applies in. Finally, there are 12 tritonal patterns which behave in a way not predictable by 2TS. This leaves us with two crucial types of three-tone sequences that call for a unidirectional rule application, in some cases from left to right, in others from right to left (highlighted in Table 2).

Table 2

		ABC	A-B-C	A-BC	AB-C	Total
No sandhi		17				17
Left to Right	⇨		**16**	1	**5**	22
Right to Left	⇦		**11**	2	**11**	24
Ambidirectional	⇨/⇦		1			1
Direction-neutral	⇔		14	29	6	49
Other				1	11	12
Total		17	42	33	33	**125**

Legend: Hyphen ("X-Y") marks a potential sandhi site in accordance with Table 1.

What then determines directionality? A priori, one can think of a number of general principles that may bear on the issue. These are listed below.

(11) a. Structural affinity (SA)
b. Temporal sequencing (TEMP)
c. Derivational economy (ECON)
d. Transparency (TRANSP)
e. Simplicity (SIMP)
f. Well-formedness (WF)

SA is cyclicity by another name. TEMP refers to the sequencing of speech organization and execution; it therefore favors the uniformly left-to-right directionality (taking orthographic convention as a metaphor for temporality). ECON chooses the shortest derivational path (bleeding and counterfeeding), while TRANSP privileges feeding and bleeding. SIMP and WF are both output conditions: the former prefers simple (level) to complex (contour) tones, while the latter selects a derivation that yields unmarked tonal collocations, i.e., tonal strings that do not trigger further sandhi process.[8]

We can eliminate from further consideration SA, since for every tritonal template there is one unidirectional derivation that produces the correct output form that is valid for left-branching ([AB]C), right-branching (A[BC]), or flat structures ([ABC]). We may exploit the interaction of the five principles—which are in essence constraints on derivations—to predict the correct directionality effect observed in Changting Hakka. We could, for instance, postulate that, other things being equal, by default tone sandhi rules scan a multitonal string from left to right (pursuant to TEMP). This leaves the possibility that in some cases an overranking imperative may dictate the opposite directional mode of operation. We are in effect extending the classical rule-based model by introducing the powerful device of derivational constraints, and by importing from OT the concept of ranking hierarchy of these (derivational) constraints. In fact, in the following exposition, we shall adopt the OT convention of tableau as a scoreboard of constraint violations.

6. Ranking paradox of derivational constraints

While this extended model of classical generative phonology has proven successful in rendering a reasonable account of similar directionality effects reported in Tianjin (Chen 1999, 2000), it fails in the case of Changting Hakka. We can demonstrate this by showing the ranking paradox that holds between the constraints encapsulated in (11). Consider the case of /MRM/ → [LHM]. It calls for the default, left-to-right mode of sandhi operation, despite the fact that such a two-step derivation (12a) is longer and less economical than a one-step, right-to-left scan (12b). This means that TEMP >> ECON (where “>>” stands for ‘outrank’).

(12) TEMP >> ECON

/MRM/ → [LHM]

e.g. 金魚缸 *[jin.yu] gang*
‘goldfish tank’

新北京 *xin [bei.jing]*
‘new Beijing’

8 In other words, only two-tone substrings occupying the shaded cells of Table 1 are considered to be well-formed.

			TEMP	ECON
a.	⇨	MRM | LRM | LHM ☜		**
b.	⇦	MRM | MHM n/a	*	*

Unfortunately, exactly the reverse rank order is required for /MLM/ → [MMM]. This is shown below in (13).

(13) Econ >> Temp

/MLM/ → [MMM]

e.g. 司令官 *[si.ling] guan* 'commanding officer'

新地方 *xin [di.fang]* 'new place'

			ECON	TEMP
a.	⇨	MLM | LLM | LMM	**	
b.	⇦	MLM | MMM ☜ n/a	*	*

Conceivably, one could overcome ranking paradox by appealing to the notion of conjoint constraints. The idea is that even if TEMP >> ECON, ECON in conjunction with some other constraints may jointly override TEMP. In other words, it is logically possible to have a ranking hierarchy like {ECON + C1 (+ C2…)} >> TEMP >> ECON, where C1, C2 stand for some other constraints. This logical move is doomed to failure by the presence of cases like /HRM/ → [FHM]. As shown in (14), the attested output [FHM] calls for a left-to-right direction of 2TS—in accordance with TEMP, but in contravention of every one of the remaining four constraints. This means not only that TEMP must outrank each of the other constraints (ECON, TRANSP, SIMP, WF), but also that no conceivable subset of ECON, TRANSP, SIMP, or WF can jointly prevail over TEMP. A constraint hierarchy compatible with (14) would make the counterfactual prediction that 2TS operate on multitonal strings consistently from left to right.

(14) /HRM/ → [FHM]

e.g. 建築師 *[jian.zhu] shi* 'architect'

半元音 *ban [yuan.yin]* 'semi-vowel'

			TEMP	TRANSP	WF	ECON	MARK
a.	>	HRM | FRM | FHM ☜		*	**	**	*
b.	<	HRM | HHM n/a	*		*	*	

7. OT: simplifying stipulations

We have basically exhausted the possible logical moves that can be accommodated (with some generous stretch of imagination) within the classical rule-based model. Let us turn to Optimality Theory (OT) for inspiration. In derivational terms, the fundamental unmet challenge of Changting Hakka is our failure to predict directionality. Once we discover the key to the puzzle of what appears to be random directionality, we can tell a perfectly coherent story about Changting Hakka tone sandhi. But directionality, a metaphor for orderly, stepwise derivation, is not even part of OT vocabulary. What kind of a narrative can we construct out of the observable data in Changting Hakka?

Before we proceed, let us make a few simplifying assumptions and stipulations. First, let *M >> FAITH stand as a shorthand for */M/ : [X], that is, given a marked input /M/, disfavored by constraint *M, [X] is picked as the corresponding winning candidate at the expense of FAITH. We gloss over the exact nature of the constraints, which converge on [X], rather than any other candidate. For instance, *LF represents an ill-formed two-tone collocation, in that it automatically triggers 2TS (see Table 1). But, in addition to the attested sandhi form [MF] (15a), there are any number of other logical possibilities, for instance [RF] or [HF] (15b, c). Both [RF] and [HF] satisfy a constraint like H-Agreement (corresponding, in processual terms, to H-spread from F, standardly construed as HL). [RF] wins if MAX-L >> *COMPLEX (which bars contour tones); on the other hand, [HF] would be a better pick, if *COMPLEX >> MAX-L. I single out [RF] and [HF] as logical competitors in view of actually attested input/output correspondences *HL : FL and *MR : LR (16a, b). Here the analogous L-Agreement enforces what amounts to L-spread. In (16a), MAX-H >> *COMPLEX, as a result [FL] (=HL.L) wins out over, say, [L.L]; in (16b), on the other hand, *COMPLEX >> MAX-M, therefore [LR] emerges as the optimal candidates instead of a competitor like [ML.R], where ML represents a low falling tone. The precise nature of the requisite constraints and their rank order pose non-trivial problems that we cannot go into.

(15)	*LF :	a.	MF @	
		b.	RF	(H-AGR, MAX -L >> *COMPLEX)
		c.	HF	(H-AGR, *COMPLEX >> MAX-L)
(16)	a.	*HL : FL @		(L-AGR, MAX -H >> *COMPLEX)
	b.	*MR : LR @		(L-AGR, *COMPLEX >> MAX -M)

A second stipulation limits the candidate pool in all subsequent discussion to all and only those forms that appear at some stage of some orderly application of 2TS. For example, given an input like /HFH/, there are two legitimate derivations: left-to-right or right-to-left, with a total three distinct representations, namely HFH (i), HLH (ii) and FLH (iii). We exclude from the evaluation tableaux that follow such logically possible forms as HHH, except that it is not derivable by any combination of 2TS rules. In fact, HHH appears to be the optimal candidate on all counts: (a) H is arguably the unmarked tone; (b) it contains no ill-formed two-tone substring (cf. Table 1); (c) it incurs fewer Faithfulness violations than the actual attested winner [FLH]. Inclusion of such non-derivable candidates would otherwise wreak havoc with the OT model, and threaten to put an end to our attempt to find a reasonable OT account before we even begin.

(17)	a.	Left to right			b.	Right to left
		<u>HF</u>H	(i)			H<u>FH</u>	(i)
				n/a		|
		H<u>FH</u>	(i)			<u>HL</u>H	(ii)
		|				|
		HLH	(ii)			FLH @	(iii)

Finally, a simple model consisting of only *M >> FAITH would predict that 2TS would apply persistently until all *M disappear or are undone. Notice that, in accordance to Table 1, *HL > FL; but this FL is also marked, in that, according to the same Table 1, *FL > RF. That being the case, both /HL/ and /FL/ would converge on [RF], which is counterfactual. To overcome the problem of chain substitutions, we shall assume Comparative Markedness, which distinguishes inherited ($*_{O}M$) vs. non-inherited ($*_{N}M$) markedness (see McCarthy 2002):

(18) Comparative Markedness
$*_{O}M$ >> FAITH >> $*_{N}M$

The effect of incorporating Comparative Markedness in OT is illustrated in tableau (19).

(19) /HL/ : [FL]
/FL/ : [RF]

		$*_{O}HL$	$*_{O}FL$	FAITH	$*_{N}HL$	$*_{N}FL$
/FL /	FL		*			
	RF @			**		
/HL/	HL	*				
	FL @			*		*
	RF			**		

By separating and demoting $*_{N}M$ below Faith, non-inherited $*_{N}FL$ will no longer trigger further tonal substitution at the expense of FAITH. This makes it possible to correctly pick [FL] as the optimum for /HL/, while guaranteeing [RF] as the best output for /FL/. Loosely speaking, Comparative Markedness is functionally equivalent to the One Step Principle (Hsu 1994, 2002), No-Backtracking (Chen 1999, 2000), and the Moving Window Principle (Chen, Wee, & Yan 2002).[9]

8. OT: empirical coverage

We are now ready to confront a constraint-based model with the facts we find in Changting Hakka. Let us refer to classic OT, enriched with Comparative Markedness, as Model A.

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[9] These related constraints make empirically different claims. For a detailed discussion, see Chen, Wee & Yan 2002.

(20) **Model A**:
$*_{O}$M >> FAITH >> $*_{N}$M

Given FAITH as one of the controlling factors, Model A prefers forms that correspond to the output of 2TS rules applying in bleeding (B) rather than counterbleeding (CB) order: since both B and CB would undo $*_{O}$M violations, and B entails fewer infractions of FAITH. Since FAITH >> $*_{N}$M, Model A prefers candidates corresponding to the output of 2TS rules applying in counterfeeding (CF) rather than feeding (F) order. The reason is that by definition F involves a rule applying to derived (non-inherited) environments, i.e., to (sub)strings targeted by $*_{N}$M. Unfortunately, Model A makes counterfactual predictions. (21) and (22) instantiate cases where the attested output actually corresponds to the outputs of sandhi rules applying in CB and F orders.

(21) /HFM/ → [FRM]

e.g. 掃帚星 *[sao.zhou] xing*
‘broom-stick star’ (comet)

怕等車 *pa [deng.che]*
‘afraid of waiting for transport’

a.
HFM (i)
|
HRM (ii)
|
FRM (iii)

(F)

b.
HFM (i)
n/a
HFM (i)
|
*HRM (ii)

(CF)

/HFM/	$*_{O}$FM	FAITH	$*_{N}$HR
i. HFM	*!		
ii. $ HRM		*	*
iii. @ FRM		**!	

Legend: @ = attested candidate $ = predicted optimal

(22) /MRM/ → [LHM]

e.g. 金魚缸 *[jin.yu]gang*
‘gold-fish tank’

新北京 *xin [bei.jing]*
‘new Beijing’

a. MRM (i) b. MRM
| |
LRM (ii)   MHM (iv)
| n/a
LHM (iii)   *MHM

(CB)   (B)

/MRM/	*$_{O}$MR	*$_{O}$RM	FAITH	*$_{N}$HM	*$_{N}$LH
i. MRM	*!	*			
ii. LRM		*!	*		
iii. @ LHM			**!	*	*
iv. $ MHM			*	*	

In order to accommodate opaque rule ordering effects (CF and CB), Sympathy Theory (hereafter ST, see McCarthy 1998, 2000) enables OT to mimic certain derivational effects through the influence of a (set of) sympathetic candidate(s). In effect, the sympathetic candidate basically corresponds to the intermediate form of a derivation. Generally speaking, selectors ★FAITH-1 and ★FAITH-2, stated as (23), pick the intermediate form of a right-to-left and a left-to-right derivation, respectively.[10] ❀CUMUL (cumulativity) and ❀DIFF (differentiality) then ensure that the winner candidate share as much derivational history as compatible with *$_{N}$M. We call this OT-cum-ST as Model B (24). Model B successfully picks the right winner, as illustrated in (25).

(23) FAITH-1 Input tone in the first position must surface in the output.
FAITH -2 Input tone in the second position must surface in the output.

(24) **Model B**:
*$_{O}$M >> ❀CUMUL ; ❀DIFF >> ★ FAITH -1/2 >> *$_{N}$M

[10] This is so because, as seen in Table 1, most sandhi rules are "regressive" in nature—that is, tone substitutions tend to affect the tone on the left rather than the one on the right. Thus, in a right-to-left scan, ABC → AYC → XYC: the intermediate form AYC exhibits a first position stability (A remains unchanged), consistent with Faith-1. In a left-to-right scan, ABC → XBC → XYC, the intermediate form XBC displays a second position stability instead, in conformity with Faith-2.

(25) Counterfeeding: /LRM/ → [LHM]

e.g. 十條菸 *[shi.tiao] yan*
‘ten cartons of cigarettes’

大作家 *da [zuo.jia]*
‘famous writer’

a. LRM (i)
n/a
LRM (i)
|
LHM (ii)
(CF)

b. LRM
|
LHM (ii)
|
*MHM (iii)
(F)

/LRM/	$*_{O}$RM	❀CUMUL	❀DIFF	★FAITH-1	★FAITH-2	$*_{N}$HM	$*_{N}$LH
i. $_{❀faith\text{-}2}$LRM	*!	$*_{LHM}$					
ii. ☞ $_{❀faith\text{-}1}$LHM			*		*	*	*
iii. MHM			**!	*	*		*

Legend: ☞ = optimal and attested candidate
$_{❀FAITH\text{-}1,2}$ABC = sympathetic candidate selected by FAITH-1,2

Unfortunately tone sandhi in Changting Hakka does not operate in a consistently CF manner. In (26, = (21)) exactly the opposite F order prevails, contrary to what Model B predicts.

(26) Feeding: /HFM/ → [FRM]

e.g. 掃帚星 *[sao.zhou] xing*
‘broom-stick star’ (comet)

怕等車 *pa [deng.che]*
‘afraid of waiting for transport’

a. HFM (i)
|
HRM (ii)
|
FRM (iii)
(F)

b. HFM (i)
n/a
HFM (i)
|
*HRM (ii)
(CF)

/HFM/	*$_O$FM	⊛CUMUL	⊛DIFF	★FAITH-1	★FAITH-2	*$_N$HR
i. ⊛faith-2HFM	*!	*⊛HRM				
ii. $ ⊛faith-1HRM			*⊛HFM		*	*
iii. @ FRM			*⊛HRM*!*⊛HFM	*	*	

Legend: ⊛FAITH-1,2ABC = sympathetic candidate selected by FAITH-1,2
*⊛ABC = violation in reference to sympathetic candidate ABC

Likewise, Model B predicts a CB ordering relation, rightly in the case of (27, = (22)), but wrongly in the case of (28).

(27) Counterbleeding: /MRM/ → [LHM]

e.g. 金魚缸 *[jin.yu]gang*
‘gold-fish tank’

新北京 *xin [bei.jing]*
‘new Beijing’

a. MRM (i)
|
LRM (ii)
|
LHM (iii)
(CB)

b. MRM
|
MHM (iv)
n/a
*MHM (iv)
(B)

/MRM/	*$_O$MR	*$_O$RM	⊛CUMUL	⊛DIFF	★FAITH-1	★FAITH-2	*$_N$HM	*$_N$LH
i. MRM	*!	*	*⊛MHM *⊛LRM					
ii. ⊛faith-2LRM		*!	*⊛MHM	*⊛MHM	*			
iii. ☞ LHM				*⊛MHM *⊛LRM	*	*	*	*
iv. ⊛faith-1MHM			*⊛LRM!	*⊛LRM		*	*	

Legend: ☞ = attested optimal candidate
⊛FAITH-1,2ABC = sympathetic candidate selected by FAITH-1,2
*⊛ABC = violation in reference to sympathetic candidate ABC

(28) Bleeding: /MLM/ → [MMM]

e.g. 醫術高 *[yi.shu]gao*
'(to possess) excellent medical expertise'

我食齋 *wo [shi.zhai]*
'I am a vegetarian'

a. M<u>LM</u>	(i)		b. <u>ML</u>M	
|			|	
MMM	(ii)		L<u>LM</u>	(iii)
		n/a	|	
MMM	(ii)		*LMM	(iv)
(B)			(CB)	

/MLM/	*$_{O}$ML	*$_{O}$LM	❀CUMUL	❀DIFF	★FAITH-1	★FAITH-2	*$_{N}$LM
i. MLM	*!	*	*$_{❀LLM}$ *$_{❀MMM}$				
ii. @$_{❀faith\text{-}1}$MMM			*$_{❀LLM}$	*$_{❀LLM}$		*	
iii. $_{❀faith\text{-}2}$LLM		*!	*$_{❀MMM}$	*$_{❀MMM}$	*		
iv. $ LMM				*$_{❀MMM}$ *$_{❀LLM}$	*	*	*

Legend: $_{❀FAITH\text{-}1,2}$ABC = sympathetic candidate selected by FAITH-1,2
*$_{❀ABC}$ = violation in reference to sympathetic candidate ABC

In order to accommodate both B and F effects attested above, one may conceivably promote *$_{N}$M above ❀CUMUL and ❀DIFF, as shown in (29). Specifically, a high-ranking *$_{N}$M favors the F order, because it enforces the undoing of *M, inherited or otherwise, at the expense of FAITH.

(29) **Model C**
*$_{O}$M; *$_{N}$M >> ❀CUMUL ; ❀DIFF >> ★ FAITH-1/2

Quite apart from the problem that Model C defeats the purpose of separating *$_{N}$M from *$_{O}$M in the first place, it also makes the wrong prediction in the CF case illustrated in (30, = (25)).

(30) /LRM/ → [LHM]

e.g. 十條菸 *[shi.tiao] yan*
‘ten cartons of cigarettes’

大作家 *da [zuo.jia]*
‘famous writer’

a. LRM (i)
n/a
LRM (i)
|
LHM (ii)
(CF)

b. LRM
|
LHM (ii)
|
*MHM (iii)
(F)

/LRM/	$*_{O}M$	$*_{N}M$	❁CUM	❁DIFF	★F1	★F2
i. ❁Faith-2 LRM	*RM		*❁LHM			
ii. @ ❁Faith-1 LHM		*LH, *HM		*❁LRM		*
iii. $ MHM		*HM		*❁LRM *❁LHM	*	*

In short, each of Models A, B, and C predicts a distinct subset of F, B, CF, and CB relations, but none is capable of accommodating all four types of rule interactions, each of which has been attested in the examples given in this section: F (26), CF (30), B (28), and CB (27). In a nutshell, (31) captures the inadequate empirical coverage of the various OT models we have contemplated.

(31)

	F	B	CF	CB
Model A		x	x	
Model B			x	x
Model C	x	x		
Attested	x	x	x	x

Needless to say, not all rule ordering relations can be categorized as F, CF, B or CB. Thus, an input string like /RMR/ may follow two different derivational paths and yield, as a consequence, two possible outputs [HLR and RFR]. Both derivations involve two steps, and cannot be characterized as F or B in the usual sense. This is illustrated in (7), repeated here as (32). In such cases, OT-cum-ST would predict a degree of indeterminacy not borne out by the observed facts, given that both selectors ★ FAITH-1 and ★ FAITH-2 are in force, and consequently two different sympathy candidates exert some control over the choice of the optimal candidate.

(32) /RMR/ → [HLR]

e.g. [一斤]油 *[yi.jin] you*
'one catty of oil'

出[風 頭] *chu [feng.tou]*
'to show off'

a. RMR
|
HMR
|
HLR

b. RMR
|
RLR
|
*RFR

9. Concluding remarks

We have examined the Hakka data from both rule-based and OT perspectives, and found both theoretical models in their current form to fall short of their descriptive goals. Linguistic theorizing, just as theory building in any field, is advanced by limiting cases that severely test the adequacy of conceptual tools at our disposal. Changting Hakka is one of these cases.

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長汀客語的連調變化：分析上的挑戰

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長汀客語有非常複雜的連調變化，使得任何分析方法都爲之卻步，無論是以基於規律的生成模型或是優選理論。本文以最大的可能及合理的步驟進行檢視，發現目前上述兩種理論在描述上都有所不足。客語是嚴厲考驗我們概念工具是否妥適的僅見的例子。

關鍵詞：客語，連調變化，基於規律的模型，優選理論