LANGUAGE AND LINGUISTICS 12.2:313-357, 2011
2011-0-012-002-000312-1

Sequential and Tonal Markedness in Dongshi Hakka Tone Sandhi*

Hui-shan Lin
National Taiwan Normal University

This paper investigates Dongshi Hakka tone sandhi within the output-oriented framework of Optimality Theory (OT, Prince & Smolensky 1993[2004], McCarthy & Prince 1993). Two different forces are shown to motivate the tonal alternation in Dongshi Hakka. The first force is assimilatory in nature and forces intersyllabic tone features to agree. Completely contradictory to this force is a dissimilatory effect that requires elements at the tonal level and the contour level to be different. These facts are captured by NOJUMP-t, OCP-T(11), OCP-C(l), and OCP-C(hl), which regulate the well-formedness of tonal combination. In addition to tonal sequential markedness, the markedness status of a tone itself also plays a role. A low register tone occurring in a head position is shown to be marked and indirectly decides whether a tonal combination that violates a certain sequential markedness constraint will undergo tone sandhi. This can be explicitly captured by the conjunction of tonal and sequential markedness constraints.

Key words: tone sandhi, sequential markedness, tone-prominence interaction, Dongshi Hakka, Optimality Theory

1. Introduction

A major issue in the phonological studies of tone sandhi is what motivates tonal alternations. On the one hand, the markedness status of a tonal sequence can result in tonal change. Assimilation and dissimilation are two of the most common processes observed in tone sandhi. Tone sandhi can take place as a consequence of a syllable assimilating some features from a neighboring syllable. It can also result from the need

* An earlier version of this paper was presented at the *Conference on Field Research of Hakka Language and Culture* at National Kaohsiung Normal University, April 23-24, 2010. I would like to express my gratitude to Min-Hua Chiang, Chong-Chieh Wu, and the audience there for their insightful comments. My thanks also go to Yungching Wei and Pei-chih Wei, who are native Dongshi Hakka speakers, for helping with some of the language data. Finally, I would like to thank three anonymous reviewers whose detailed comments have helped improve the content of this paper greatly. All possible errors are my own responsibility.

for two adjacent tones to be different. Tone sandhi phenomena found in the Chinese dialects of Cantonese and Chaozhou and in Mandarin neutral tone sandhi are all the result of assimilation. The well-known Mandarin third tone sandhi and the tonal alternations found in Tianjin, Chengdu, and Boshan, on the other hand, are the result of dissimilation.

In addition to sequential well-formedness, the markedness status of a single tone can also result in tone sandhi. De Lacy (1999, 2002) examines the interaction between tone and prominence and shows that different positions have different tonal preferences. In a prosodic head position, H is preferred over M, which in turn is preferred over L. On the other hand, in a prosodic non-head position, the tonal preference is the reverse: L is preferred over M, which in turn is preferred over H. The insertion of H in the stressed syllable in Lithuanian and the movement of H to the stressed syllable in Zulu are triggered by the preference of H in the prominent position. On the other hand, the deletion of H in an unstressed syllable in Vedic Sanskrit and the movement of H away from a stressed syllable in Digo are caused by the dislike of H in the weak position.

Tone sandhi phenomena in Dongshi Hakka, a Hakka dialect spoken by the people who live in Dongshi village in Taichung County (Tung 1995, M. Chiang 1998), represents an interesting case to study because the forces mentioned above are intertwined and contribute to the alternation of tones. In an OT framework, this paper shows that both assimilation and dissimilation play a role in Dongshi Hakka. The assimilatory requirement forces intersyllabic tone features to agree while the dissimilatory requirement prohibits adjacent low and falling contours at the contour level and adjacent 11 tones at the tonal level. These are captured by the assimilation constraint (NOJUMP-t) and the dissimilation constraints (OCP-C(l), OCP-C(hl), and OCP-T(11)), respectively. Not all bi-tonal sequences that violate these requirements undergo tone sandhi, however. In general, tone sandhi will only occur when head positions contain marked tones. I shall demonstrate that this is properly accounted for by the conjunction of the tone-head markedness constraint *HD/Lr with sequential markedness constraints such as OCP-C(l) or NOJUMP-t.

The rest of the paper is organized as follows. In §2, I present the tonal facts of Dongshi Hakka and review previous OT analyses of the language data. I then propose an OT analysis to account for Dongshi Hakka tone sandhi in §3. In §4, the pairing of allotones in Dongshi Hakka is examined and analyzed through constraint interaction. The paper closes with §5 offering conclusive remarks.[1]

[1] The present paper focuses on disyllabic tone sandhi. For trisyllabic and tetrasyllabic tone sandhi in Dongshi Hakka, please refer to Hsiao & Chiu (2006), where the language data is analyzed within a derivational framework.

2. Dongshi Hakka tonal facts and previous OT analyses

2.1 Dongshi Hakka tones and tone sandhi

Dongshi Hakka is generally considered to have six tones, *yinping*, *yangping*, *yinshang*, *yinqu*, *yinru*, and *yangru*.[2] In the literature, while it is generally agreed that *yinping*, *yinshang*, and *yinqu* are represented as 33, 31, and 53, respectively, scholars disagree with respect to how *yangping* and the two *ru* tones are represented. *Yangping* is represented as 113 in J. Chiang (2003), M. Chiang (1998), and Hsiao & Chiu (2006). However, as pointed out in Tung (1995) and M. Chiang (1998), *yangping* does not end rising before another tone; thus non-final *yangping* is represented as 11 and referred to as '*banyangping*' in Tung. *Yangping* is also represented in M. Chiang (2002) as 11 because M. Chiang considers the final rising of *yangping* in the final position to be phonetic rather than phonological. Chung (2008:13-16), based on dialectal comparison between Dongshi Hakka and Dapu Hakka, proposes that *yangping* tone in Dongshi Hakka should be represented as 13, just like that of Dapu Hakka. However, Chung's acoustic study of Dongshi Hakka tones shows that *yangping* does not end with an obvious rise regardless of whether it occurs alone or is in the initial or final position of a bi-tonal sequence (Chung 2008:15). As a result, the present study considers *yangping* to be a low level tone 11 and regards the final rising in *yangping*, if any, as phonetic rather than phonological.[3]

In addition to *yangping*, the two *ru* tones in Dongshi Hakka are also represented differently in the literature. J. Chiang (2003) and Hsiao & Chiu (2006), respectively, consider *yinru* and *yangru* to be the short level 2 and 5 and 3 and 5. Tung (1995) and M.

---

[2] Some scholars consider that an additional tonal category, *chaoyinping* (with the tonal value of 35), exists in Dongshi Hakka. However, M. Chiang (1998, 2002) and Chung (2008) have convincingly argued against the lexical status of 35 in Dongshi Hakka. They argue that 35 is the sandhi form of 33. Historically, it was triggered by a following diminutive affix that carried 31 but disappeared through historical development. That is:

33 + 31 ---------------> 35 + 31 ------------------> 35
tone sandhi loss of diminutive affix

For detailed discussions on the status of the 35 tone, please refer to Tung (1995), J. Chiang (1996), Lo (1997), M. Chiang (1998, 2002), and Chung (2008).

[3] In phonological studies, it is very common to omit initial rising or falling. For instance, Chen (2000:126) points out that a 53 tone in Pingyao is accompanied by a small rise when it occurs in the final position of a word and sounds like a 423; such a phonetic detail is ignored by Chen when analyzing Pingyao tone sandhi. In Changting Hakka, *yinqu* and *yangqu* are taken as level tones in Chen (2000), Hsu (1995), Chen et al. (2004), and Lin (2007), despite the fact that these tones have a slight fall at the end.

Chiang (1998, 2002) also consider *yangru* to be a short level 5; however, Tung transcribes *yinru* as $\underline{32}$ and M. Chiang transcribes it as $\underline{31}$. Chung (2008), based on acoustic evidence, claims that *yinru* and *yangru*, apart from being shorter, are similar to *yinshang* (i.e. 31) and *yinqu* (transcribed as 51 in Chung), respectively, in terms of pitch height and contour. Chung thus transcribes *yinru* and *yangru* as $\underline{31}$ and $\underline{51}$, respectively. The present paper transcribes *yinru* and *yangru* as $\underline{32}$ and $\underline{54}$ based on the fact that the two *ru* tones are short and falling and the fact that *ru* tones in the Chinese dialects are usually realized on short syllables with not enough duration to license contour tones with drastic pitch change (cf. Zhang 1999).

In sum, the six tones in Dongshi Hakka are represented in the present study as *yinping* 33, *yangping* 11, *yinshang* 31, *yinqu* 53, *yinru* $\underline{32}$, and *yangru* $\underline{54}$. They can be illustrated by examples from M. Chiang (1998) in (1). Notice that *ru* tones are realized only in stop-closed syllables while the non-*ru* tones occur in nasal-closed or open syllables.

(1) *Dongshi Hakka tones*

a.	/33/			d.	/53/		
	i.	kie	'chicken'		i.	ɲi	'two'
	ii.	kaŋ	'to plow'		ii.	am	'dark'
b.	/11/			e.	/$\underline{32}$/		
	i.	liuŋ	'dragon'		i.	set	'color'
	ii.	ʃion	'boat'		ii.	muk	'eye'
c.	/31/			f.	/$\underline{54}$/		
	i.	ʃui	'water'		i.	ʒiok	'medicine'
	ii.	fun	'powder'		ii.	ʃip	'ten'

In the six-tone system, there are 36 (6 x 6) bi-tonal combinations, among which, eight pairs undergo tone sandhi, as illustrated by the bi-tonal examples from M. Chiang (1998) in (2).

(2) *Tonal combinations that undergo tone sandhi*

		Input		Output	Example	
a.	i.	33-11	→	**35-**11	t^{h}ien-ʃi	'weather'
	ii.	33-31	→	**35-**31	kie-lon	'chicken egg'
	iii.	33-$\underline{32}$	→	**35-**$\underline{32}$	pau-siuk	'corn'
b.		11-11	→	**33-**11	fuŋ-ʒiun	'afterglow'
c.	i.	53-31	→	**55-**31	ʃu-ʒiaŋ	'leafy shade'
	ii.	53-53	→	**55-**53	t^{h}ien-fa	'telephone'

iii. 53-32 → **55-**32 soi-muk ‘sleek’
iv. 53-54 → **55-**54 xon-ʒiok ‘Chinese medicine’
(Key: tones are separated by a hyphen; T = base tone; **T** = tones that undergo tone sandhi)

The tonal changes illustrated above can be captured by the three derivational rules in (3)-(5). A schematic summary of the changes is given in (6).

(3) *Yinping* tone sandhi rule: 33 → 35 / __ {11, 31, 32}

(4) *Yangping* tone sandhi rule: 11 → 33/ __ 11

(5) *Yinqu* tone sandhi rule: 53 → 55/ __ {31, 53, 32, 54}

(6) *Bi-tonal combinations – six-tone system*

$\sigma_1 \backslash \sigma_2$	*yinping* 33	*yangping* 11	*yinshang* 31	*yinqu* 53	*yinru* 32	*yangru* 54
yinping 33	33-33	**35-**11	**35-**31	33-53	**35-**32	33-54
yangping 11	11-33	**33-**11	11-31	11-53	11-32	11-54
yinshang 31	31-33	31-11	31-31	31-53	31-32	31-54
yinqu 53	53-33	53-11	**55-**31	**55-**53	**55-**32	**55-**54
yinru 32	32-33	32-11	32-31	32-53	32-32	32-54
yangru 54	54-33	54-11	54-31	54-53	54-32	54-54

(Key: shaded areas contain tonal combinations that do not change)

Though Dongshi Hakka is generally considered to have six lexical tones, Chung (2008) proposes a different but insightful view. Chung (2008) argues that the two *ru* tones in Dongshi Hakka, i.e. *yinru* and *yangru*, are derived from *yinshang* and *yinqu*, respectively. Chung bases this on two pieces of evidence: phonologically, both *yinshang* 31 and *yinru* 32 can trigger *yinping* and *yinqu* tone sandhi while both *yinqu* 53 and *yangru* 54 can trigger *yinqu* tone sandhi. Chung’s phonetic study of Dongshi Hakka tones shows that, aside from being relatively shorter, *yinru* 32 and *yangru* 54 do not differ phonetically from *yinshang* 31 and *yinqu* 53 in either pitch height or contour.

In addition to the phonetic and phonological evidence given in Chung, there are two additional pieces of evidence in support of *yinru* and *yangru* as being derived from *yinshang* and *yinqu*, respectively.[4] The first piece of evidence comes from the reduplication patterns of ABAB and ABCABC in Dongshi Hakka that display special tone sandhi. As M. Chiang (2002) points out, in the two patterns of reduplication, while the last syllable of the first repeated portion normally changes to a rising tone **35** (e.g. *vu33-kim33* → *vu33-kim***35**-*-vu33-kim33* 'black / somewhat black', *fun31-fuŋ11* → *fun31-fuŋ***35**-*-fun31-fuŋ11* 'pink / somewhat pink'), no **35** tone is found in the juncture of the reduplicant and the base when the final syllable of the root is *yinqu* or *yangru* (e.g. *xan11-liau53* → *xan11-liau55--xan11-liau53* 'at leisure / somewhat at leisure' *koŋ33-vat5* → *koŋ33-vat5--koŋ33-vat5* 'smooth / somewhat smooth' (*yangru* is represented as 5 in M. Chiang)). That *yinqu* and *yangru* are the only two exceptions to the tonal alternations in ABAB and ABCABC reduplications supports the theory that *yinqu* and *yangru* can be considered to be variants of a tone.

The second piece of evidence comes from the distribution of the *ru* tones and the non-*ru* tones. As mentioned, in Dongshi Hakka, the *ru* tones are realized in stop-closed syllables while the non-*ru* tones occur in nasal-closed or open syllables. It is a general tendency that stop-closed syllables are shorter than non-stop-closed syllables in Chinese dialects (Lin & Wang 1992, L. Wang 1985, Zhang 1999). The same is also true in Dongshi Hakka. Chung (2008:17) examines a group of Dongshi Hakka words that share similar segmental information but differ in tone (e.g. *ʃin33* 'new', *ʃin11* 'god', *ʃin53* 'believe', *ʃit32* 'rest', and *ʃit54* 'eat')[5] and points out that the two *ru* tones are significantly shorter than the non-*ru* tones in Dongshi Hakka. As Zhang (1999) points out, articulatorily speaking, it takes a longer duration of time to produce a contour with greater pitch change, but the rime duration of a stop-closed syllable is not long enough to license such a tone; as a result, tones realized on stop-closed syllables are usually either level or have a weak contour. Thus, the less pronounced transition in 32 and 54 in Dongshi Hakka should be the natural consequence of contour leveling off on stop-closed syllables and the result of a low level phonetic process. In other words, the two *ru* tones—32 and 54—should be analyzed as the phonetic variants of their non-*ru* counterparts—31 and 53—in stop-closed syllables.

By considering *yinru* and *yangru* to be the phonetic variants of *yinshang* and *yinqu*, respectively, Dongshi Hakka has only four lexical tones left: *yinping* 33, *yangping* 11,

---

[4] It is common to consider *ru* tones as the variants of non-*ru* tones in phonological studies of Chinese dialects. For example, Bao (1999), Chen (2000), and Zhang (1999) treat the two *ru* tones of Pingyao 23 and 54 as the variants of the two non-*ru* tones 13 and 53, respectively. This is because 23 and 13, and 54 and 53 are not only phonetically similar but also behave similarly in tone sandhi. When accounting for Shanghai tone sandhi, Duanmu (1997) also considers the short HL to be derived from HL.

[5] No examples of *ʃin31* are given in Chung (2008:17).

yinshang 31, and *yinqu* 53. The schematic summary of the tonal changes given in (6) above can be simplified as below, with only five tonal alternations left:

(7) *Bi-tonal combinations – four-tone system*

$\sigma_1 \backslash \sigma_2$	33	11	31	53
33	33-33	**35-**11	**35-**31	33-53
11	11-33	**33-**11	11-31	11-53
31	31-33	31-11	31-31	31-53
53	53-33	53-11	**55-**31	**55-**53

2.2 Previous OT analyses

Dongshi Hakka tone sandhi has been analyzed using OT in Hsiao (2006, 2008) and Chung (2008). These analyses use a relatively small set of constraints which, as insightful as they might be, fall short in two respects.

First, the mappings of allotones in Dongshi Hakka (e.g. the mapping of an input /33/ to [35], but not to [31]) are dealt with in these analyses not by means of constraint interactions but by a single constraint that technically enforces the mappings. Hsiao (2006), for instance, proposes the IO-COINDEXT constraint that requires an input tone (e.g. *yangping* input tone) to be co-indexed with the output tone (e.g. *yangping* sandhi tone). Chung (2008), on the other hand, proposes the T → T' constraint which asks an input tone to surface with its corresponding sandhi tone. The motivation behind the pairings of the allotones awaits further exploration.

Second, the constraints proposed in these analyses do not explain what motivates the tonal alternations in disyllabic strings. In particular, the constraints proposed in these analyses for *yinping* tone sandhi, which is the most complicated phenomena among the three, are not well motivated. For instance, Hsiao (2008) proposes the *M/ __ [+low] constraint to account for *yinping* tone sandhi (i.e. 33-11 → **35**-11 & 33-31 → **35**-31). Though the constraint correctly captures the fact that regardless of whether 33 (represented as M in Hsiao) changes before 11 or before 31, 33 undergoes tonal alternation before a tone that carries low register, what exactly has caused a low register tone to trigger 33 sandhi awaits explanation. Chung (2008) proposes the following four markedness constraints to account for Dongshi Hakka tone sandhi. (*Yangping* is considered as a low rising tone (i.e. 13) in Chung.) Among them, the M-L-Con constraint functions to account for *yinping* tone sandhi. This constraint is not independently motivated though it can technically work to trigger *yinping* tone sandhi. However, it remains unclear as to why a mid level tone cannot be followed by a mid contour tone.

(8) *Markedness constraints proposed in Chung* (*2008*) *for Dongshi Hakka tone sandhi*
  a. M-L-Con: *(ML)(MC) A mid contour tone cannot be preceded by a mid level tone.
  b. OCP$_{(HL)}$: *F$_{(HL)}$F$_{(HL)}$ No adjacent high falling tones.
  c. OCP$_{(LM)}$: No adjacent low mid tones.
  d. *(HL)(ML): A high falling tone cannot precede a mid falling tone.

In the present study, tone sandhi in Dongshi Hakka is re-analyzed and the motivations behind different types of tone sandhi as well as allotone mappings are examined in depth. In particular, it will be shown that the failure of offering an independently motivated constraint for *yinping* tone sandhi in the previous analyses is due to the fact that the 33-11 → **35**-11 change and the 33-31 → **35**-31 change in *yinping* tone sandhi are motivated by two contradictory forces—the former dissimilatory and the latter assimilatory. It will be shown that the two processes should be considered separately and can actually be accounted for by conjoining universal sequential markedness constraints such as OCP and NOJUMP with a tone-head markedness constraint which is also universal.

3. An Optimality-theoretic analysis

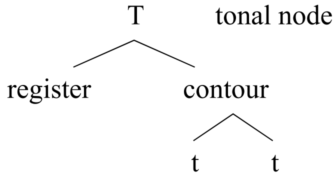
This section offers an OT analysis of the tone sandhi phenomena illustrated above. Since the structure of a tone plays a crucial role in the analysis of Dongshi Hakka tone sandhi, the internal structure of the tone is first examined.

3.1 The internal structure of tone

Bao (1999) argues that each tone should have an internal representation such as that in (9), in which tone features are dominated by a node called Contour, which is a sister of the Register feature; both Contour and Register are dominated by a Tonal Node.[6]

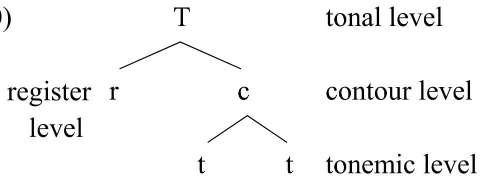
[6] For a detailed discussion/comparison of the different models of tonal geometry, please refer to Bao (1999), Chen (2000), and Yip (2002).

(9) *Tonal geometry proposed in Bao* (*1999*)



The present analysis adopts Bao's model with some labeling differences, as illustrated in (10).

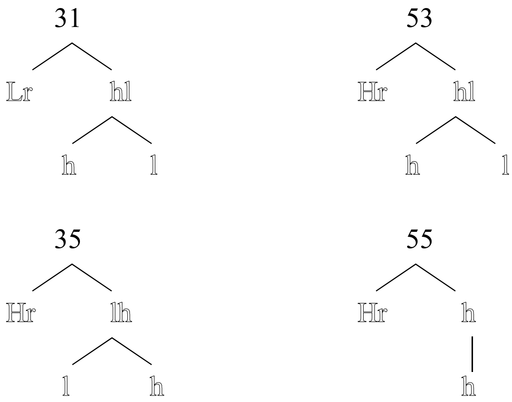
(10)



In this study, the tones, 33, 11, and 31, etc., belong to the tonal level. The high and low registers are represented as Hr and Lr, respectively. They belong to the register level. The tone features dominated by contour belong to the tonemic level and are represented as h and l. The four lexical tones and the two derived tones in Dongshi Hakka are represented below in (11).

(11) *The internal structure of Dongshi Hakka tones*

[7] Given that Dongshi Hakka only makes use of three even tones, a 33 tone can be either [Hr, l] or [Lr, h]. In the present paper, 33 is assumed to be [Hr, l] based on evidence from allotone mappings (cf. §4). In Dongshi Hakka, an input /33/ tone can change to a [**35**] tone; besides, an output [**33**] tone can be derived from a /11/ tone. As 11 is unambiguously [Lr, l], the 11 → **33** sandhi can either be regarded as involving a change of register if 33 has the structure [Hr, l], or as involving a change of contour if 33 has the structure [Lr, h]. On the other hand, since 35 is unambiguously [Hr, lh], if 33 has the structure [Hr, l], the 33 → **35** sandhi would only involve a change of contour. Nonetheless, if 33 is considered to have the structure [Lr, h], the 33 → **35** sandhi would involve both a change of register and a change of contour.



(Key: Hr = high register, Lr = low register)

The tonal changes provided in (7) can thus be summarized in more detail, as shown below:

(12) *Bi-tonal combinations – represented with register and contour features*

$\sigma_1 \backslash \sigma_2$	33 Hr, l	11 Lr, l	31 Lr, hl	53 Hr, hl
33 Hr, l	33-33 Hr-Hr l-l	**35**-11 Hr-Lr lh-l	**35**-31 Hr-Lr lh-hl	33-53 Hr-Hr l-hl
11 Lr, l	11-33 Lr-Hr l-l	**33**-11 Hr-Lr l-l	11-31 Lr-Lr l-hl	11-53 Lr-Hr l-hl
31 Lr, hl	31-33 Lr-Hr hl-l	31-11 Lr-Lr hl-l	31-31 Lr-Lr hl-hl	31-53 Lr-Hr hl-hl
53 Hr, hl	53-33 Hr-Hr hl-l	53-11 Hr-Lr hl-l	**55**-31 Hr-Lr h-hl	**55**-53 Hr-Hr h-hl

Careful examination of the five tonal combinations that undergo tone sandhi shows that both assimilation and dissimilation play a role in Dongshi Hakka. The assimilatory requirement forces intersyllabic tone features to agree and triggers the 33-31 → **35**-31 sandhi. On the other hand, the dissimilatory requirement prohibits adjacent identical elements at different levels of the tone and causes the 33-11 → **35**-11 sandhi, the 11-11 → **33**-11 sandhi, the 53-53 → **55**-53 sandhi, and the 53-31 → **55**-31 sandhi.

Before OT accounts for the dissimilation and assimilation processes are provided, it is worth noting that regardless of whether the tonal alternation is driven out of assimilation or dissimilation, it is always the tone on the left that undergoes tone sandhi and the tone on the right that preserves its underlying tone. In the literature, languages that tend to maintain the identity of the rightmost tone while allowing tones in other positions to change are referred to as *right prominent languages*; languages that tend to maintain the identity of the leftmost tone while allowing tones in other positions to change are referred to as *left prominent languages* (Chen 2000, Hyman & VanBik 2004, Lin 2004, among others). Thus, Dongshi Hakka, like Mandarin, Southern Min, Tianjin, and Sixian Hakka, is a right prominent language. The stability of the tone on the right edge suggests that Dongshi Hakka is right-headed.[8] The right prominent nature of Dongshi Hakka can be captured by the positional faithfulness constraint IDENT-IO-T-HD in (13).[9] IDENT-IO-T-HD is never violated by the attested output and is top-ranked. Item (14) illustrates the function of IDENT-IO-T-HD. For the sake of simplicity, in the tableaux that follow, I shall set this top-ranked constraint aside by not considering output candidates that involve changes of the head tone.

(13) IDENT-IO-T-HD: The tone standing at the head position (right edge) of a tonal sequence (at the tonal level) cannot be different from its corresponding tone in the output.

(14) IDENT-IO-T-HD
Input: 53-53
Output: **55**-53 > 53-**55**

[8] In Beijing Mandarin, in addition to tone stability, Wee (2001, 2004a, 2004b), further supports the right-headedness of the language by drawing evidence from lengthening in emphasis. Wee shows that in Beijing Mandarin, it is the syllable on the right that is lengthened when under emphasis (e.g. *ma che* → *ma* ***che*** ‘horse-drawn carriage’). Wee argues that since normally it is the stressed syllable that is lengthened in emphasis (e.g. *banana* → *ba****naaaaaa****na*), it must be the right syllable that receives stress in Beijing Mandarin. In Dongshi Hakka, when a disyllabic word is under emphasis, it is also the syllable on the right that is lengthened (e.g. *loi tʃu* → *loi* ***tʃu*** ‘come cook’, *sui ŋiu* → *sui* ***ŋiu*** ‘buffalo’, *fun fung* → *fun* ***fung*** ‘pink’). Thus, lengthening in emphasis also provides additional support for the right-headedness of Dongshi Hakka.

[9] Constraints like IDENT-IO-T-R that refer to the right edge of the tonal string are potentially problematic. As pointed out by one of the reviewers, based on the typological study in Nelson (1998, 2003), positional faithfulness applies to heads, left edges or both edges, but never to the right edge.

3.2 Dissimilation and OCP

This section examines tone sandhi phenomena that are dissimilatory in nature and shows that they can be accounted for by applying OCP at the different levels of a tone.

3.2.1 *Yangping* and *yinqu* tone sandhi

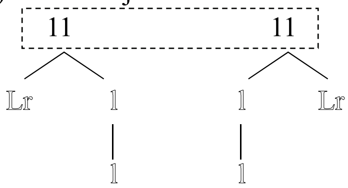
Let us consider *yangping* and *yinqu* tone sandhi first. It is quite obvious that the tonal alternations pertaining to 11 and 53 are dissimilatory in nature and belong to the common phenomenon of OCP (Obligatory Contour Principle; Leben 1973, Goldsmith 1976). 11-11 is forbidden because there are adjacent identical 11 tones at the tonal level.[10] 53-31 and 53-53 are disallowed because, since both 53 and 31 are falling tones and share hl contour, they produce an adjacent hl at the contour level. Both tone sandhi phenomena are dissimilation processes. The only difference between them is at which level of a tone adjacent identical elements are disallowed. For the former phenomenon, it is the identical elements at the tonal level that are forbidden; for the latter phenomenon, it is the identical elements at the contour level that are disallowed. These phenomena can be captured by the OCP-T(11) constraint and the OCP-C(hl) constraint in (15) and (16), respectively.[11]

---

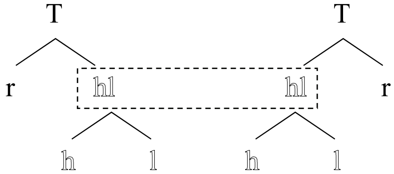
[10] Notice that since 11 is a level tone and since (in the tonal geometry adopted in the present paper (cf. 10)) the tonal level dominates the register level, the contour level, and the tonemic level, in the sequence of 11-11, the violation of OCP at the tonal level essentially implies the violation of OCP at every level dominated by the tonal node (i.e. the register level, the contour level, and the tonemic level). Thus, it is unclear how in the sequence of 11-11, OCP has applied to the tonal level but not to other levels. As will be shown in §3.2.3, even though 11-11 violates OCP at all levels, it is the violation of OCP at the tonal level that has resulted in the tonal alternation.

[11] Notice that the sequence of 53-53 also violates constraints like OCP-T(53). However, while OCP-T(11) plays a crucial role in Dongshi Hakka, OCP-T(53) need not. That is because the 53-53 sequence can be ruled out by the more general constraint OCP-C(hl), which predicts the tonal alternation not only in 53-53 but also in 53-31. On the other hand, constraints like OCP-T(31) and OCP-T(33) must be inactive in Dongshi Hakka (i.e. dominated by the IO faithfulness constraint) because 33-33 and 31-31 are legitimate sequences.

(15) OCP-T(11): Avoid adjacent 11 tones at the tonal level.



(16) OCP-C(hl): Avoid adjacent hl at the contour level.



Both OCP-T(11) and OCP-C(hl) are sequential markedness constraints because they regulate the well-formedness of a tonal sequence rather than that of a single tone. The two sequential markedness constraints must dominate the IO faithfulness constraint IDENT-IO-T in (17) in order to ensure the occurrence of tone sandhi.

(17) IDENT-IO-T: Input-Output corresponding tones (at the tonal level) are identical.

The tableau in (18) illustrates how OCP-T(11) functions to predict *yangping* tone sandhi.

(18) /11-11/ → [**33**-11]

11-11	OCP-T(11)	IDENT-IO-T
a. 11-11	*!	
☞ b. **33**-11		*

Notice, however, that unattested output candidates such as **31**-11 and **53**-11 cannot be ruled out in (18). This is because, similarly to the attested candidate **33**-11, they do not incur any violations in OCP-T(11), and because, like the optimal candidate, they both incur a violation in IDENT-IO-T. The answer to the problem is that while 33 is an allotone of an input /11/, neither 31 nor 53 are. The mappings between an input tone and its corresponding allotones are summarized in (19). Item (19) shows, for instance, that the allotones for an input /33/ tone are [33] or [35]. For simplicity, the discussion of how allotones are predicted by constraint interaction will be deferred until §4. Until then, I shall exclude candidates in the tableaux that are not formed by the corresponding allotones of the input tones.

(19) *Allotone mapping relationships*[12]

a. /33/: [33~35]
b. /11/: [11~33]
c. /31/: [31]
d. /53/: [53~55]

Tableau (20), on the other hand, illustrates how OCP-C(hl), when outranking IDENT-IO-T, properly explains *yinqu* tone sandhi.

(20) /53-53/ → [**55-**53]

53-53 Hr-Hr hl-hl	OCP-C(hl)	IDENT-IO-T
☞ a. **55-**53 Hr-Hr h-hl		*
b. 53-53 Hr-Hr hl-hl	*!	

Notice, however, that there exist two bi-tonal sequences in the language that contain falling contours in adjacent positions but are free from tonal alternations, i.e. 31-53 and 31-31. Due to IDENT-IO-T-HD, the central question is why 31 does not change to a non-falling tone before a falling tone. The answer to the question is simple. It is because an input /31/ tone can only be mapped to 31 (cf. (19)). As a matter of fact, 31 is the only tone in Dongshi Hakka that does not change. As will be shown in §4, the lack of change in 31 is due to the markedness constraint *NONHD/Hr.

3.2.2 Dissimilation and tone-head interaction in *yinping* tone sandhi

Consider now the 33-11 → **35-**11 alternation. The 33-11 → **35-**11 alternation actually constitutes part of *yinping* tone sandhi. In the literature, *yinping* tone sandhi (i.e. 33-11 → **35-**11 and 33-31 → **35-**31) are usually examined and accounted for together. For instance, researchers such as M. Chiang (1998) and Hsiao (2008) have observed

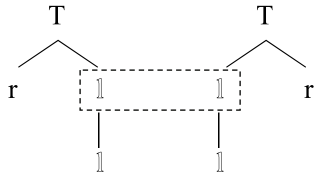
---

[12] Notice that <u>32</u> and <u>54</u> are the *phonetic* variants (but not the *allotonic* variants) of 31 and 53 and are derived by a low level phonetic implementation process. As the derivations of <u>32</u> and <u>54</u> are not phonological, they will not be treated in the present paper. For a formal OT account of *ru* tone realizations, please refer to Zhang (1999).

that regardless of whether the change takes place before 11 or before 31, 33 undergoes tonal alternation before a tone that carries Lr (or a low feature). Though the observation is correct, the reason behind why a Lr tone would trigger the alternation in 33 has yet to be explored. That 33 cannot be followed by a Lr tone might seem like an effect that forbids a Lr tone from being preceded by a Hr tone. However, this analysis fails to explain why 35, to which 33 turns, is also high in register but can precede a Lr tone. Alternatively, one could postulate that 33 is a Lr tone (i.e. [Lr, h] rather than [Hr, l]) and argue that the change pertaining to the 33-Lr sequence is a kind of dissimilation effect that prohibits Lr tones from being adjacent to each other. Although this analysis has no problem explaining why 35, but not 33, can precede a Lr tone, it does not answer why 33-33, a bi-tonal sequence that contains adjacent Lr at the register level, does not change to **35**-33.[13] The truth of the matter is, the 33-11 → **35**-11 change and the 33-31 → **35**-31 change that are grouped as *yinping* tone sandhi in the literature are motivated by two contradictory forces—the former dissimilatory and the latter assimilatory and should, therefore, be considered separately. Besides, as will be shown shortly, even though it is incorrect to consider the Lr feature to be a primary trigger of the two different forces in *yinping* tone sandhi, it is equally incorrect to assume that a right edge Lr tone plays no role in *yinping* tone sandhi. As will become clear, a right edge Lr tone does play a role, but only a secondary one.

The change of 33 to **35** before 11 (i.e. 33-11 → **35**-11) involves a dissimilation process in a way similar to *yangping* and *yinqu* tone sandhi. By examining the disfavored 33-11 sequence, one can find that both 33 and 11 contain the l contour at the contour level (i.e. 33[Hr, l]-[l, Lr]11). Thus, this is just another kind of OCP effect and can be accounted for by the OCP-C(l) constraint.

(21) OCP-C(l) : Avoid adjacent l at the contour level.



OCP-C(l), when outranking IDENT-IO-T, correctly predicts the change of 33-11 to **35**-11, as illustrated below:

[13] Notice that although the assumption 33 is unspecified at the register level (as proposed in Hsiao 2008) can technically account for *yinping* tone sandhi, it does not help explain the motivation behind the alternation of 33 before a Lr tone.

(22) /33-11/ → [**35-**11]

33-11 Hr-Lr l-l	OCP-C(l)	IDENT-IO-T
☞ a. **35-**11 Hr-Lr lh-l		*
b. 33-11 Hr-Lr l-l	*!	

Before concluding the analysis for the tonal change of 33 before 11, it is worth noting that not all bi-tonal combinations that have adjacent l at the contour level will undergo tone sandhi. In other words, without further confinement, OCP-C(l), though it can predict the change in 33-11 → **35**-11, will predict that all tonal sequences that have adjacent l at the contour level must change, which is counterfactual. Chart (23) summarizes all of the bi-tonal sequences that have adjacent l at the contour level in the underlying representation; the unshaded area contains the combinations that have tonal changes and that have been predicted by the analysis proposed so far; the shaded area contains bi-tonal combinations that stay intact. Notice that the output derived from 11-11 (i.e. **33**-11) still contains adjacent l at the contour level. Output **33**-11, although it does not repair the violation of OCP-C(l), does repair the violation of OCP-T(11). It is readily predicted by the current constraint ranking (cf. (18)). By comparing the tonal combinations that do change (i.e. in the unshaded area) with those that do not (i.e. in the shaded area), it can be seen that while the inputs of the former (i.e. /33[Hr, l]-[l, Lr]11/ and /11[Lr, l]-[l, Lr]11/) have Lr at the right edge, those of the latter (i.e. /33[Hr, l]-[l, Hr]33/ and /11[Lr, l]-[l, Hr]33/) have Hr at the same edge.

(23) *Combinations with adjacent l at the contour level in the UR*

$\sigma_1 \backslash \sigma_2$	33 Hr, l	11 Lr, l
33 Hr, l	33-33 Hr-Hr l-l	**35**-11 Hr-Lr lh-l
11 Lr, l	11-33 Lr-Hr l-l	**33**-11 Hr-Lr l-l

(shaded area contains tonal combinations that do not change)

Thus, one can make the following generalization:

(24) It is only when the tonal sequence contains a 𝕃𝕣 tone at the right edge that the adjacent 𝕝 at the contour level will be penalized.

This is exactly where a right edge 𝕃𝕣 tone extends its influence in Dongshi Hakka tone sandhi. However, what is wrong with a right edge 𝕃𝕣 tone?

De Lacy (1999, 2002) examines the interaction between tone and prominence and observes that different prosodic positions have different tonal preferences. As de Lacy points out, a H tone is preferred over a M tone, which in turn is preferred over a L tone in prosodically prominent (i.e. head) positions. In prosodically weak (i.e. non-head) positions, the tonal preference is the reverse, with L preferred over M, which in turn is preferred over H. To capture this, de Lacy (2002) proposes the two fixed constraint rankings in (25) and (26).

(25) *Tonal preference in the head position*
*HD/L » *HD/M

(26) *Tonal preference in the non-head position*
*NONHD/H » *NONHD/M

The first ranking predicts that L is the least preferred tone in a head position because *HD/L is the highest ranked; it also predicts that H is the most preferred tone in the same position because there is no constraint against having a H tone in a head position. Similarly, (26) predicts that H is the least preferred tone in a non-head position because *NONHD/H is highest ranked; constraint ranking (26) also predicts that L is the most preferred in the same position because there is no constraint against having a L in a non-head position.

As mentioned, Dongshi Hakka is a right-headed language. Thus, the reason adjacent 𝕝 at the contour level is not permitted in 33-11 and 11-11—but is permitted in 33-33 and 11-33—is that the former combinations contain a low tone (which is marked) in the head position, but the latter do not. De Lacy (2002) originally proposes to regulate the (non-)head tonal preferences in terms of H, M, and L. Since this study has adopted Bao's (1999) theory and has decomposed a tone into tonal level, contour level, and register level, the constraint ranking proposed in (25) and (26) have thus been modified to (27) and (28).[14] Because ℍ𝕣 tones in Dongshi Hakka are higher in pitch

---

[14] There is no need to propose a fixed constraint ranking like *HD/𝕃𝕣 » *HD/ℍ𝕣 and *NONHD/ℍ𝕣 » *NONHD/𝕃𝕣 to predict the preference of a ℍ𝕣 tone over a 𝕃𝕣 tone in a head position and the

than Lr tones, the modification is consistent with de Lacy's basic proposal (2002) that higher tones are preferred to lower tones in a head position and that lower tones are preferred to higher tones in a non-head position.

(27) *HD/Lr: No Lr tones in the head position.

(28) *NONHD/Hr: No Hr tones in the non-head position.

Thus, although the Lr tone at the right edge does not directly trigger tone sandhi, it indirectly decides whether tone sandhi will take place when there is adjacent l at the contour level. To capture the fact that, in Dongshi Hakka, adjacent l at the contour level will result in tone sandhi only when there is a Lr tone in the head position, the tone-head markedness constraint *HD/Lr and the sequential markedness constraint OCP-C(l) can be conjoined. That is, [OCP-C(l) & *HD/Lr]$_{\text{ADJ}}$.

(29) [OCP-C(l) & *HD/Lr]$_{\text{ADJ}}$: Adjacent tones must not violate both OCP-C(l) and *HD/Lr.

Under the theory of constraint conjunction (Smolensky 1993), only when both subparts of the constraint are violated will the conjoint constraint be violated. Thus, the constraint correctly predicts that 33-11 (i.e. 33[Hr, l]-[l, Lr]11) and 11-11 (i.e. 11[Lr, l]-[l, Lr]11), which simultaneously contain a Lr tone in the head position and adjacent l at the contour level, will undergo tone sandhi. In the same fashion, the conjoined constraint predicts that 33-33 (i.e. 33[Hr, l]-[l, Hr]33) and 11-33 (i.e. 11[Lr, l]-[l, Hr]33), although they have adjacent l at the contour level, will not undergo tone sandhi because the tones on the right edge are Hr tones rather than Lr tones.

[OCP-C(l) & *HD/Lr]$_{\text{ADJ}}$ replaces the original OCP-C(l) constraint and must outrank IDENT-IO-T to trigger tone sandhi. On the other hand, OCP-C(l) must be ranked lower than IDENT-IO-T in order to avoid wrongly forcing 33-33 and 11-33 with Hr tone in the head position but with adjacent l at the contour level from undergoing tonal alternation. Tableaux (30) to (32) illustrate that the substitution of [OCP-C(l) & *HD/Lr]$_{\text{ADJ}}$ for OCP-C(l) still correctly predicts the tonal changes in 33-11 and 11-11 as well as the lack of tonal alternation in 33-33 and 11-33.

---

preference of a Lr tone over a Hr tone in a non-head position. This is because, as de Lacy (2002) points out, constraints against the least marked tone-head combinations would result in an undesirable prediction of non-existing systems; assuming the ranking *HD/Lr » FAITH(tone) » *NONHD/H (where FAITH(tone) is a faithfulness constraint that preserves input tone), systems in which foot heads cannot bear tone, while non-heads can, would be wrongly predicted to exist.

(30) /33-11/ → [**35**-11]

33-11 ℍ𝕣-𝕃𝕣 𝕝-𝕝	[OCP-C(𝕝) & *HD/𝕃𝕣]$_{ADJ}$	IDENT-IO-T	OCP-C(𝕝)
☞ a. **35**-11 ℍ𝕣-𝕃𝕣 𝕝𝕙-𝕝		*	
b. 33-11 ℍ𝕣-𝕃𝕣 𝕝-𝕝	*!		*

(31) /11-11/ → [**33**-11]

11-11 𝕃𝕣-𝕃𝕣 𝕝-𝕝	OCP-T(11)	[OCP-C(𝕝) & *HD/𝕃𝕣]$_{ADJ}$	IDENT-IO-T	OCP-C(𝕝)
☞ a. **33**-11 ℍ𝕣-𝕃𝕣 𝕝-𝕝		*	*	*
b. 11-11 𝕃𝕣-𝕃𝕣 𝕝-𝕝	*	*!		*

(32) /33-33/ → [33-33]

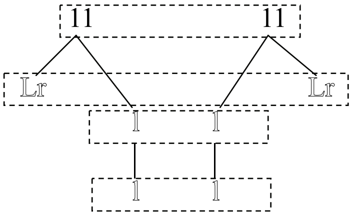
33-33 ℍ𝕣-ℍ𝕣 𝕝-𝕝	[OCP-C(𝕝) & *HD/𝕃𝕣]$_{ADJ}$	IDENT-IO-T	OCP-C(𝕝)
☞ a. 33-33 ℍ𝕣-ℍ𝕣 𝕝-𝕝			*
b. **35**-33 ℍ𝕣-ℍ𝕣 𝕝𝕙-𝕝		*!	

3.2.3 Interim conclusion

In this section, I have examined the tonal alternations that are dissimilatory, which include *yangping* tone sandhi, *yinqu* tone sandhi, and the 33-11 → **35**-11 change in *yinping* tone sandhi, and have shown that they can be accounted for by applying OCP at the tonal level and the contour level of the tone. Before ending the discussion of the dissimilatory effect in Dongshi Hakka tone sandhi, the nature of OCP-T(11) proposed to account for *yangping* tone sandhi deserves further discussion. As OCP-T(11) refers to a specific tone in Dongshi Hakka, the question that naturally arises is whether it is possible to replace such a constraint with something that is more general.

Since 11 is a level tone and since in the tonal geometry adopted in the present paper (cf. (10)) the tonal level dominates the register level, the contour level, and the tonemic level, in the sequence of 11-11, the violation of OCP at the tonal level essentially implies the violation of OCP at every level dominated by the tonal node. In other words, 11-11 not only violates OCP at the tonal level, it also violates OCP at the register level, at the contour level, and at the tonemic level, as illustrated in (33).

(33) *11-11 violates OCP at all levels*



Thus, the question would be whether the 11-11 → **33**-11 sandhi could be accounted for by universal constraints like OCP-T, OCP-𝕃𝕣, OCP-C(𝕝) or OCP-t(𝕝) that are more general. Applying OCP at the tonal level irrespective of the tone category (i.e. OCP-T) does not work. This is because 33-33 and 31-31 are free of tone sandhi. Although it is possible to explain the lack of tone sandhi in 31-31 by attributing it to the fact that 31 never undergoes tone sandhi, there is no natural explanation as to why 33-33 does not change to **35**-33 to avoid the OCP-T violation. Likewise, applying OCP at the register level (i.e. OCP-𝕃𝕣) does not work either. While OCP-𝕃𝕣 could rule out 11-11, it would also rule out a number of attested forms such as 11-31, 31-31, and 31-11 since both 11 and 31 are 𝕃𝕣 tones. In particular, it would be hard to explain why 11-31 does not change to **33**-31. Furthermore, applying OCP at the tonemic level (i.e. OCP-t(𝕝)) also fails. This is because features in intersyllabic tonemic level in Dongshi Hakka tend to agree rather than to disagree (cf. (12)). At intersyllabic tonemic level, it is very common for 𝕝 features to be adjacent; among the 16 bi-tonal combinations (cf. (12)), seven involve adjacent 𝕝 tone features at the intersyllabic tonemic level. In other words, OCP-t(𝕝) should be inactive and ranked very low in Dongshi Hakka.[15] Thus, it would be unlikely

15 Chen (2000:80-81) points out that in Chinese dialects, while contour dissimilation is quite common, register dissimilation is less so because while the former can minimize tonal ups and downs, the latter will only create more. If flattening out tonal contours, as pointed out by Chen, is the reason behind the asymmetry between register and contour dissimilation, why OCP-t is not as active as OCP-C in Dongshi Hakka can also be explained since it should also create more tonal ups and downs.

for OCP-t(𝟙) to trigger the 11-11 → **33**-11 change. Finally, applying OCP at the contour level (i.e. OCP-C(𝟙)) cannot replace OCP-T(11) unless Comparative Markedness (McCarthy 2003) is adopted. This is because, in dealing with the change from /11-11/ to **33**-11, both the unchanged form, 11-11, and the changed form, **33**-11, violate OCP-C(𝟙). If not for OCP-T(11), 11-11 (which is more faithful to the input) would be wrongly selected as the optimal output. Let us consider for a moment the alternative analysis that adopts McCarthy's Comparative Markedness Theory (2003).

In the Comparative Markedness Theory (McCarthy 2003), markedness constraints compare the output candidate under evaluation with another candidate that is fully faithful to the input. Markedness constraints are categorized into two types in this theory: markedness constraints that penalize marked structure that is also present in the fully faithful candidate ($*_{O}$M); and markedness constraints that penalize marked structure that is not present in the fully faithful candidate ($*_{N}$M). For instance, $_{\mathbf{O}}$NoVcdOb and $_{\mathbf{N}}$NoVcdOb are proposed in McCarthy (2003) to account for the phonological change in Mekkan Arabic. $_{\mathbf{O}}$NoVcdOb penalizes old instances of voiced obstruents that are already present in the fully faithful candidate; $_{\mathbf{N}}$NoVcdOb penalizes new instances of voiced obstruents that are not present in the fully faithful candidate. Thus, the mapping of /ab/ → [ab] violates $_{\mathbf{O}}$NoVcdOb while the mapping of /ampa/ → [amba] violates $_{\mathbf{N}}$NoVcdOb.

If Comparative Markedness is adopted and the OCP-C(𝟙) constraint is categorized into old and new markedness constraints (i.e. $_{O}$OCP-C(𝟙) and $_{N}$OCP-C(𝟙)), *yangping* tone sandhi 11-11 → **33**-11 would be predicted without resorting to OCP-T(11). This is because even though both 11-11 and **33**-11 contain adjacent 𝟙 at the contour level and violate OCP-C(𝟙), the violation is old in 11-11 but new in **33**-11. Thus, as long as $_{N}$OCP-C(𝟙) is outranked by oOCP-C(𝟙), 11-11 → **33**-11 will be correctly accounted for.

(34) An analysis based on Comparative Markedness

(a) $_{O}$OCP-C(𝟙): No old violations of OCP-C(𝟙).

(b) $_{N}$OCP-C(𝟙): No new violations of OCP-C(𝟙).

(c) /11-11/ → [**33**-11] (Fully Faithful Output: 11-11)

11-11 𝕃𝕣-𝕃𝕣 𝟙-𝟙	$_{O}$OCP-C(𝟙)	$_{N}$OCP-C(𝟙)
a. 11-11 𝕃𝕣-𝕃𝕣 𝟙-𝟙	*!	
☞ b. **33**-11 ℍ𝕣-𝕃𝕣 𝟙-𝟙		*

Even though a constraint based on Comparative Markedness (i.e. $_{O}$OCP-C(1)) can replace OCP-T(11), it is not adopted in the present analysis for two reasons. First, even though McCarthy (2003) has shown that Comparative Markedness can account for the grandfather effect, the non-iterative process, the derived environment effect, and chainshift, it is not free of problems. Yip (2003) and Crowhurst (2003), for instance, argue that Comparative Markedness is too powerful and will predict some non-existing structures; Blumenfeld (2003), on the other hand, considers that the theory is too restrictive and cannot predict some existing structures. In addition, since Comparative Markedness is required to compare the markedness of the output and the fully faithful output, it will blur the boundary between the faithfulness constraint and the markedness constraint that, in classical OT, are inherently in conflict (cf. Li 2005). Second, even though the OCP-T(11) constraint refers to all and only the *yangping* tone in Dongshi Hakka, it is not uncommon for OCP to refer to a specific tone in the literature (Chen 2000, Lin 2008, Wee 2004b, among others). For instance, in Beijing Mandarin, only a sequence of adjacent L tones is prohibited. In other words, OCP in Beijing Mandarin applies only to L tone. In Tianjin, while adjacent L, LH, and HL tones are prohibited, adjacent H tones are allowed to occur freely. Thus, OCP applies to all of the tones in Tianjin but H tone. Besides, since 11 is a common tone in tone languages, the reference of OCP to this common tone should have some basis.

3.3 Assimilation and tone-head interaction in *yinping* tone sandhi

Unlike the change from 33 to **35** before 11, which has been shown to be dissimilatory in nature, the change from 33 to **35** before 31 is an assimilation effect and is done out of the desire to make intersyllabic features agree at the tonemic level. By changing to a **35** tone, the derived combination (i.e. **35**[Hr, lh-hl, Lr]31) will agree in feature at the intersyllabic tonemic level.

In accounting for tone sandhi in Hakha Lai, Hyman & VanBik (2004) propose a No Jumping Principle to capture the fact that in Hakha Lai, changing of tone level tends to occur within syllables but not between syllables.

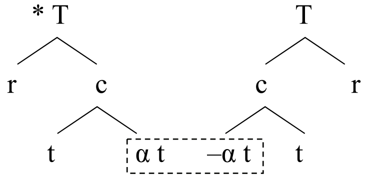
(35) No Jumping Principle (NOJUMP): (Hyman & VanBik 2004:826)

```
*  σ        σ
   |        |
  α H     –α H
```

i.e. Hakha Lai, a contour tone language, likes tone changes to take place <u>within</u> syllables.

The fact that Dongshi Hakka prefers intersyllabic features to agree at the tonemic level can also be captured by the No Jumping Principle. The NOJUMP-t constraint is proposed for Dongshi Hakka and is defined in (36).

(36) NOJUMP-t: No change of tone features at intersyllabic tonemic level.[16]



As shown in (37), the domination of NOJUMP-t above IDENT-IO-T correctly predicts the tonal change in 33-31 that disagrees at the intersyllabic tonemic level. Tableau (38), on the other hand, shows that NOJUMP-t must be outranked by [OCP-C(l) & *HD/Lr]$_{ADJ}$ because tonal combinations that disagree at the intersyllabic tonemic level might be created while repairing a [OCP-C(l) & *HD/Lr]$_{ADJ}$ violation.

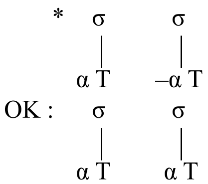
(37) /33-31/ → [**35-**31]

33-31 Hr-Lr l-hl	NOJUMP-t	IDENT-IO-T
☞ a. **35-**31 Hr-Lr lh-hl		*
b. 33-31 Hr-Lr l-hl	*!	

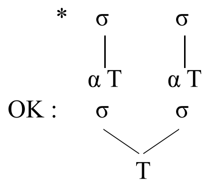
[16] Hyman & VanBik (2004) actually propose two versions of the No Jumping Principle, as illustrated below:

Hyman & VanBik (2004:853)

a.



b.



Version (a) is the one adopted in the present paper. It requires tone features of successive syllables to be identical. Version (b), on the other hand, requires there to be a single tone feature spanning two successive syllables. Though (b) has the advantage of avoiding violations of OCP at the tonemic level, the present paper adopts (a) due to the fact that in Dongshi OCP-t is inactive and that one-to-many association is disfavored (as captured by *MULTI-ASSOCIATIONS in (56)).

(38) /33-11/ → [**35**-11]

	33-11 Hr-Lr l-l	[OCP-C(l) & *HD/Lr]$_{ADJ}$	NOJUMP-t
☞	a. **35**-11 Hr-Lr lh-l		*
	b. 33-11 Hr-Lr l-l	*!	

In addition to the disagreement of intersyllabic tone features that result from repairing [OCP-C(l) & *HD/Lr]$_{ADJ}$ violations, Dongshi Hakka contains a number of bi-tonal combinations that disagree at the intersyllabic tonemic level. In other words, like OCP-C(l), NOJUMP-t must be further confined in order to avoid wrongly forcing every bi-tonal combination that disagrees at the intersyllabic tonemic level to change. In (39), the unshaded area marks bi-tonal sequences that disagree at the intersyllabic tonemic level.

(39) *Bi-tonal combinations that disagree at the intersyllabic tonemic level*

$\sigma_1 \backslash \sigma_2$	33 Hr, l	11 Lr, l	31 Lr, hl	53 Hr, hl
33 Hr, l	33-33 Hr-Hr l-l	**35**-11 Hr-Lr lh-l	**35**-31 Hr-Lr lh-hl	33-53 Hr-Hr l-hl
11 Lr, l	11-33 Lr-Hr l-l	**33**-11 Hr-Lr l-l	11-31 Lr-Lr l-hl	11-53 Lr-Hr l-hl
31 Lr, hl	31-33 Lr-Hr hl-l	31-11 Lr-Lr hl-l	31-31 Lr-Lr hl-hl	31-53 Lr-Hr hl-hl
53 Hr, hl	53-33 Hr-Hr hl-l	53-11 Hr-Lr hl-l	**55**-31 Hr-Lr h-hl	**55**-53 Hr-Hr h-hl

Among the bi-tonal sequences that disagree at the intersyllabic tonemic, **35**-11 (derived from /33-11/) is the result of repairing the [OCP-C(l) & *HD/Lr]$_{ADJ}$ violation and is readily predicted by the constraint ranking ||[OCP-C(l) & *HD/Lr]$_{ADJ}$ » NOJUMP-t||. Consider next the lack of change in 31-31, 31-53, 11-31, 11-53, and 33-53. The lack of change in 31-31 and 31-53 can be easily explained by the fact that 31 does not have variants. As for 11-31 and 11-53, they could be changed to **33-**31 and **33-**53 (i.e. ***33**[Hr, l]-[hl, Lr] 31 and ***33**[Hr, l]-[hl, Hr] 53), respectively. However, the change would not only fail to repair the NOJUMP-t violation but would also incur additional violations in IDENT-IO-T; the lack of change in the combinations falls naturally. The only tonal combination that needs explanation is 33-53, which could have changed to **35-**53 (i.e. ***35**[Hr, lh]-[hl, Hr] 53) to achieve the agreement of features at the intersyllabic tonemic level.

If one compares 33-31, which undergoes alternation, and 33-53, which does not, one can find that the former combination contains a marked Lr tone in the head position while the latter does not. Thus, the right edge Lr comes into play again and also indirectly decides whether tone sandhi will take place when certain sequential markedness constraints are violated. To capture the fact that, in Dongshi Hakka, only when there is a Lr tone in the head position will feature disagreement at the intersyllabic tonemic level be penalized, the tone-head markedness constraint *HD/Lr and the sequential constraint NOJUMP-t can be conjoined, that is, [NOJUMP-t & *HD/Lr]$_{ADJ}$.

(40) [NOJUMP-t & *HD/Lr]$_{ADJ}$: Adjacent tones must not violate both NOJUMP-t and *HD/Lr.

[NOJUMP-t & *HD/Lr]$_{ADJ}$ must outrank IDENT-IO-T to trigger tone sandhi, as illustrated in (41). On the other hand, NOJUMP-t must be ranked lower than IDENT-IO-T in order to predict the lack of tonal change in examples like 33-53, which disagrees at the intersyllabic tonemic level but has a Hr tone in the head position, as illustrated in (42).

(41) /33-31/ → [**35-**31]

33-31 Hr-Lr l-hl	[NOJUMP-t & *HD/Lr]$_{ADJ}$	IDENT-IO-T
☞ a. **35-**31 Hr-Lr lh-hl		*
b. 33-31 Hr-Lr l-hl	*!	

(42) /33-53/ → [33-53]

	33-53 Hr-Hr l-hl	IDENT-IO-T	NOJUMP-t
	a. **35**-53 Hr-Hr lh-hl	*!	
☞	b. 33-53 Hr-Hr l-hl		*

Tableau (42) summarizes the current constraint ranking proposed for Dongshi Hakka tone sandhi. The constraint ranking can account for *yinping* tone sandhi, *yangping* tone sandhi, and *yinqu* tone sandhi.

(43) *Current constraint ranking* (*to be revised*)

IDENT-IO-T-HD »
OCP-T(11), OCP-C(hl), [OCP-C(l) & *HD/Lr]$_{ADJ}$ »
[NOJUMP-t & *HD/Lr]$_{ADJ}$ »
IDENT-IO-T »
OCP-C(l), NOJUMP-t

4. Allotone mappings in Dongshi Hakka

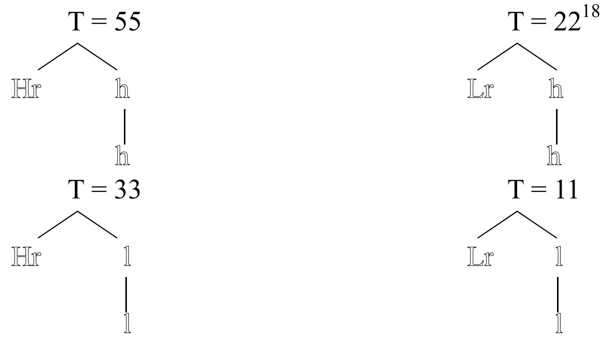
An in-depth examination of how Dongshi Hakka allotones are selected has been avoided in previous analyses of Dongshi Hakka tone sandhi (M. Chiang 1998, Hsiao 2006, 2008, Chung 2008). Up to now, the present paper has also assumed the correct mapping between an input and its corresponding allotones. In this section, I shall propose constraints to regulate allotone mappings. The allotone mapping relationships in (19) are repeated below for ease of reference.

(44) *Allotone mapping relationships* (= (19))

a. /33/: [33~35]
b. /11/: [11~33]
c. /31/: [31]
d. /53/: [53~55]

As a matter of fact, the sequential markedness constraints whose ranking is summarized in (43) above play a role in deciding into which tone an underlying tone would turn in the process of tone sandhi. Since the tonal geometry adopted in the present paper is capable of generating two registers and three counters, according to Bao (1999), eight possible tones can be derived, as shown in (45). In other words, each Dongshi Hakka input tone has eight possible tonal outputs.[17]

(45) Even tones



Falling tones

Rising tones

Consider inputs that undergo tone sandhi. Chart (46) lists all the possible outputs into which each underlying tone might turn. Some of the outputs are readily ruled out by the sequential markedness constraints proposed so far. For instance, in (46a), the attested output of /33-31/, i.e. **35-**31 (46ai), does not violate any of the constraints in (43); however, the unattested outputs (46aii-v) violate some of the constraints in (43);

[17] Bao (1999:47) assumes that "underlyingly the contour node may have at most two branches." His assumption is based on the observation that complex contours such as concaves (hlh) and convexes (lhl) are less common than less complex contours. In an OT analysis, this can be predicted by constraints against complex contours. Other tones such as 51 and 15 that have contours crossing the upper and lower half of the pitch range may be ruled out by constraints that prohibit a syllable from crossing two pitch ranges (cf. Yip 2002:49).

[18] As the present paper assumes 33 as featurally [Hr, l], [Lr, h] is assumed to refer to 22.

thus they are correctly ruled out. Take (46b) as another example; although the attested output of /33-11/, i.e. **35-**11 (46bi), violates [NoJump-t & *Hd/Lr]$_{\text{ADJ}}$, the unattested outputs (46bii and 46biii) violate constraints that are higher ranked than [NoJump-t & *Hd/Lr]$_{\text{ADJ}}$ and can still be correctly ruled out.

(46) *Sequential markedness constraints vs. allotone pairing*

Input tones	Input combinations which do change	Outputs they change to	Sequential Markedness Constraints violated[19]	Ruled out by (43)
33	a. i. 33-31 → [Hr, l]-[hl, Lr]	**35-**31 [Hr, lh]-[hl, Lr]		
	ii.	***33-**31 *[Hr, l]-[hl, Lr]	[NoJump-t & *Hd/Lr]$_{\text{ADJ}}$	Yes
	iii.	***11-**31 *[Lr, l]-[hl, Lr]	[NoJump-t & *Hd/Lr]$_{\text{ADJ}}$	Yes
	iv.	***31-**31 *[Lr, hl]-[hl, Lr]	OCP-c(hl), [NoJump-t & *Hd/Lr]$_{\text{ADJ}}$	Yes
	v.	***53-**31 *[Hr, hl]-[hl, Lr]	OCP-c(hl), [NoJump-t & *Hd/Lr]$_{\text{ADJ}}$	Yes
	vi.	***55-**31 *[Hr, h]-[hl, Lr]		💣
	vii.	***13-**31 *[Lr, lh]-[hl, Lr]		💣
	viii.	***22-**31 *[Lr, h]-[hl, Lr]		💣
	b. i. 33-11 → [Hr, l]-[l, Lr]	**35-**11 [Hr, lh]-[l, Lr]	[NoJump-t & *Hd/Lr]$_{\text{ADJ}}$	
	ii.	***33-**11 *[Hr, l]-[l, Lr]	[OCP-c(l) & *Hd/Lr]$_{\text{ADJ}}$	Yes
	iii.	***11-**11 *[Lr, l]-[l, Lr]	OCP-T(11), [OCP-c(l) & *Hd/Lr]$_{\text{ADJ}}$	Yes
	iv.	***31-**11 *[Lr, hl]-[l, Lr]		💣

[19] As the attested outputs essentially violate Ident-IO-T, only violations of sequential markedness constraints that outrank Ident-IO-T are considered.

	v.			***53-**11 *[Hr, hl]-[l, Lr]		💣
	vi.			***55-**11 *[Hr, h]-[l, Lr]	[NoJump-t & *Hd/Lr]$_{ADJ}$	💣
	vii.			***13-**11 *[Lr, lh]-[l, Lr]	[NoJump-t & *Hd/Lr]$_{ADJ}$	💣
	viii.			***22-**11 *[Lr, h]-[l, Lr]	[NoJump-t & *Hd/Lr]$_{ADJ}$	💣
11	c. i.	11-11 [Lr, l]-[l, Lr]	→	**33-**11 [Hr, l]-[l, Lr]	[OCP-c(l) & *Hd/Lr]$_{ADJ}$	
	ii.			*11-11 *[Lr, l]-[l, Lr]	OCP-T(11), [OCP-c(l) & *Hd/Lr]$_{ADJ}$	Yes
	iii.			***35-**11 *[Hr, lh]-[l, Lr]	[NoJump-t & *Hd/Lr]$_{ADJ}$	💣
	iv.			***31-**11 *[Lr, hl]-[l, Lr]		💣
	v.			***53-**11 *[Hr, hl]-[l, Lr]		💣
	vi.			***55-**11 *[Hr, h]-[l, Lr]	[NoJump-t & *Hd/Lr]$_{ADJ}$	💣
	vii.			***13-**11 *[Lr, lh]-[l, Lr]	[NoJump-t & *Hd/Lr]$_{ADJ}$	💣
	viii.			***22-**11 *[Lr, h]-[l, Lr]	[NoJump-t & *Hd/Lr]$_{ADJ}$	💣
53	d. i.	53-31 [Hr, hl]-[hl, Lr]	→	**55-**31 [Hr, h)-(hl, Lr]		
	ii.			***53-**31 *[Hr, hl]-[hl, Lr]	OCP-c(hl), [NoJump-t & *Hd/Lr]$_{ADJ}$	Yes
	iii.			***33-**31 *[Hr, l]-[hl, Lr]	[NoJump-t & *Hd/Lr]$_{ADJ}$	Yes
	iv.			***35-**31 *[Hr, lh]-[hl, Lr]		💣
	v.			***11-**31 *[Lr, l]-[hl, Lr]	[NoJump-t & *Hd/Lr]$_{ADJ}$	Yes
	vi.			***31-**31 *[Lr, hl]-[hl, Lr]	OCP-c(hl), [NoJump-t & *Hd/Lr]$_{ADJ}$	Yes
	vii.			***13-**31 *[Lr, lh]-[hl, Lr]		💣

	viii. *22-31 *[Lr, h)-(hl, Lr]		💣
e.	i. 53-53 → 55-53 [Hr, hl]-[hl, Hr] [Hr, h)-(hl, Hr]		
	ii. *53-53 *[Hr, hl]-[hl, Hr]	OCP-C(hl)	Yes
	iii. *33-53 *[Hr, l)-(hl, Hr]		💣
	vi. *35-53 *[Hr, lh)-(hl, Hr]		💣
	v. *11-53 *[Lr, l)-(hl, Hr]		💣
	vi. *31-53 *[Lr, hl]-[hl, Hr]	OCP-C(hl)	Yes
	vii. *13-53 *[Lr, lh)-(hl, Hr]		💣
	viii. *22-53 *[Lr, h)-(hl, Hr]		💣

(Key: 💣 = unattested candidates failed to be ruled out by (43))

Though the sequential markedness constraints in (43) help rule out some of the unattested allotones, there are still some unattested tonal outputs (marked by 💣) that cannot be ruled out by appealing to the sequential markedness constraints. A careful examination of the allotone pairings in (44) reveals that the allotones of an input tone always share the left tone feature with the input. For example, the two allotones [33] and [35] of /33/ share l with the input at the left edge of the tonemic level; the two allotones [53] and [55] of input /53/ also share h with the input at the left edge of the tonemic level. The preservation of the left tone feature can be captured by the positional faithfulness constraint IDENT-IO-t-L in (47).[20] IDENT-IO-t-L is never violated by the attested outputs and is, therefore, top-ranked in the language.

(47) IDENT-IO-t-L: The tone feature standing at the left edge of a tone cannot be different from its corresponding tone feature in the output.

The inclusion of IDENT-IO-t-L helps rule out some of the 💣 candidates, but not all of them, as shown in (48).

[20] Universally, it is very common for elements at the left edge to stay intact (Beckman 1998, Nelson 1998, 2003).

(48) *Allotone pairing*

Input tones	Input combinations which do change	Outputs they change to	Ruled out by (43) and (47)
33	a. i. 33-31 → [Hr, l]-[hl, Lr]	**35**-31 [Hr, lh]-[hl, Lr]	
	vii.	****13**-31 *[Lr, lh]-[hl, Lr]	💣
	b. i. 33-11 → [Hr, l]-[l, Lr]	**35**-11 [Hr, lh]-[l, Lr]	
	vii.	***13**-11 *[Lr, lh]-[l, Lr]	💣
11	c. i. 11-11 → [Lr, l]-[l, Lr]	**33**-11 [Hr, l]-[l, Lr]	
	iii.	***35**-11 *[Hr, lh]-[l, Lr]	💣
	vii.	***13**-11 *[Lr, lh]-[l, Lr]	💣
53	d. i. 53-31 → [Hr, hl]-[hl, Lr]	**55**-31 [Hr, h)-(hl, Lr]	
	viii.	***22**-31 *[Lr, h)-(hl, Lr]	💣
	e. i. 53-53 → [Hr, hl]-[hl, Hr]	**55**-53 [Hr, h)-(hl, Hr]	
	viii.	***22**-53 *[Lr, h)-(hl, Hr]	💣

Among the unattested tonal outputs that fail to be ruled out, why 11 changes to **33** before 11 (i.e. 11-11 → **33**-11) but not to **35** (cf. (48ciii)) deserves special attention. In Dongshi Hakka, an input /33-11/ sequence changes to [**35**-11]. However, an output [**33**-11] derived from /11-11/ will not change further to [**35**-11]. As a matter of fact, the tonal change of /11-11/ to [**33**-11] and the tonal change of /33-11/ to [**35**-11] constitute chainshift (i.e. 11-11 → 33-11 → 35-11), as far as the tonal sequence undergoing tone sandhi is concerned. If one focuses on the tone itself that undergoes alternation, the change of /11/ to **33** and /33/ to **35** also constitute chainshift (i.e. 11 → 33 → 35).

Kirchner (1996) shows that linear chainshift can be accounted for by the local conjunction of two faithfulness constraints. As Kirchner points out, in Nzɛbi, verbs before certain tenses and aspect affixes will involve the shift of vowels: a → ɛ → e → i. Kirchner observes that each step of vowel change involves a change of either height or

ATR, but never both. Thus, Kirchner proposes constraints that conjoin IDENT[ATR] (which requires identity between Input-Output ATR features) with IDENT[LOW] and IDENT[HI] (which requires identity between Input-Output height features); that is, IDENT[HI] & IDENT[ATR] and IDENT[LOW] & IDENT[ATR]. He shows that as long as the conjoined constraints are ranked above the constraint that raises vowels (i.e. RAISING), it will limit each change of vowel to differing in a single step. As shown in (49), given the input /a/, the conjoined constraints correctly predict the output to be [ɛ] that involves the change of [+low]. Candidates [e] and [i] that would better satisfy RAISING are correctly ruled out because they involve the change of both [low] and [ATR].

(49) *Constraint conjunction and Nzɛbi vowel chainshift*

/a/	IDENT[LOW]& IDENT[ATR]	IDENT[HI] & IDENT[ATR]	RAISING	IDENT F
a. [a]			***!	
☞ b. [ɛ]			**	*
c. [e]	*!		*	**
d. [i]	*!	*		***

The chainshift in Dongshi Hakka tone (i.e. 11 → 33 → 35) can also be accounted for in the same fashion. In Dongshi Hakka, among the tones that change, 11 → **33** changes the feature at the register level (i.e. from Lr to Hr) and 33 → **35** and 53 → **55** change the feature at the contour level (i.e. l to lh in the former and hl to h in the latter). If 11 changed to **35**, it would involve the change of both register (from Lr to Hr) and contour (from l to lh). Therefore, the conjunction of IDENT-IO-REG, which requires identity between the Input-Output register features, and IDENT-IO-CON, which requires identity between the Input-Output contour features (i.e. [IDENT-IO-REG & IDENT-IO-CON]$_{SEG}$) can help predict the fact that 11 does not change to **35**. [IDENT-IO-REG & IDENT-IO-CON]$_{SEG}$ is never violated by the attested outputs and is, therefore, top-ranked in the language.

(50) *Constraint conjunction and Dongshi Hakka tonal chainshift*

11-11 𝕃𝕣-𝕃𝕣 𝟙-𝟙	[IDENT-IO-REG & IDENT-IO-CON]$_{\text{SEG}}$	OCP-T(11)
a. **35**-11 ℍ𝕣-𝕃𝕣 𝟙𝕙-𝟙	*!	
b. 11-11 𝕃𝕣-𝕃𝕣 𝟙-𝟙		*!
☞ c. **33**-11 ℍ𝕣-𝕃𝕣 𝟙-𝟙		

The inclusion of [IDENT-IO-REG & IDENT-IO-CON]$_{\text{SEG}}$ can actually help rule out other unattested 💣 candidates listed in (48) as well, except for one. The only tonal alternation that still needs an explanation is (48cvii), where 11 does not change to 13 before 11. **13**-11 would be a better candidate than the attested output **33**-11 because, unlike the attested output, it does not violate [OCP-C(𝟙) & *HD/𝕃𝕣]$_{\text{ADJ}}$. Ruling out **13**-11 may only need to rely on a tonal markedness constraint *RISE that ranks above [OCP-C(𝟙) & *HD/𝕃𝕣]$_{\text{ADJ}}$, as illustrated in (51a). However, the same constraint would wrongly predict **35**-11 derived from 33-11 to be illformed, as illustrated in (51b).

(51) *RISE » [OCP-C(𝟙) & *HD/𝕃𝕣]$_{\text{ADJ}}$

a. 11-11 → **33**-11
Input: 11-11
Output: **33**-11 > **13**-11
ℍ𝕣-𝕃𝕣 𝕃𝕣-𝕃𝕣
𝟙-𝟙 𝟙𝕙-𝟙

b. 33-11 → **35**-11
Input: 33-11
Output: 33-11 > **35**-11 (wrong prediction!)
ℍ𝕣-𝕃𝕣 ℍ𝕣-𝕃𝕣
𝟙-𝟙 𝟙𝕙-𝟙

As **13**-11 and **35**-11 differ only in that the former sequence is formed by tones belonging to the same register whereas the latter does not, the conjunction of *RISE with OCP-REG (i.e. [OCP-REG & *RISE]$_{\text{ADJ}}$), when outranking [OCP-C(𝟙) & *HD/𝕃𝕣]$_{\text{ADJ}}$, can help rule out **13**-11 derived from 11-11 but not **35**-11 derived from 33-11, as illustrated in (53).

(52) [OCP-REG & *RISE]$_{ADJ}$: When adjacent tones have the same register, neither of the tones can be a rising tone.

(53) [OCP-REG & *RISE]$_{ADJ}$ » [OCP-C(𝕝) & *HD/𝕃𝕣]$_{ADJ}$

a. 11-11 → **33**-11
Input: 11-11
Output: **33**-11 > **13**-11
ℍ𝕣-𝕃𝕣 𝕃𝕣-𝕃𝕣
𝕝-𝕝 𝕝𝕙-𝕝

b. 33-11 → **35**-11
Input: 33-11
Output: **35**-11 > **33**-11
ℍ𝕣-𝕃𝕣 ℍ𝕣-𝕃𝕣
𝕝𝕙-𝕝 𝕝-𝕝

Before giving an account for the lack of alternation of /31/, there is one last type of candidate that should be considered—candidates that involve deletion of one of the tones of the offending sequence. By tone deletion, such candidates would no longer violate any of the sequential markedness constraints and would be the least marked, as illustrated below.[21]

(54) /11-11/ → [**33**-11]

σ σ | | 11 11	OCP-T(11)	OCP-C(𝕙𝕝)	[OCP-C(𝕝) & *HD/𝕃𝕣]$_{ADJ}$	[NOJUMP-t & *HD/𝕃𝕣]$_{ADJ}$	IDENT-IO-T	OCP-C(𝕝)	NOJUMP-t	*RISE
💣 a. σ σ (second σ | 11)								
💣 b. σ σ (both linked to 11)								
c. σ σ | | **33** 11			*!			*		

21 Due to IDENT-IO-T-HD, the tone being deleted would be the tone in the non-head (left) position.

In (54), both candidates (a) and (b) involve the deletion of the left tone. In (54a), the first syllable surfaces toneless; in (54b), the first syllable surfaces with tone spread from the second syllable. With only one tone in the output, neither candidate violates any of the sequential markedness constraints. As neither (54a) nor (54b) is attested, the following two constraints are proposed to rule them out.

(55) SPECIFY-T: A tone bearing unit (TBU) must be associated with a tone. (cf. Yip 2002:83)

(56) *MULTI-ASSOCIATIONS: A tone cannot spread to more than one syllable (i.e. no one-to-many associations).

Candidate (54a) would violate SPECIFY-T because the first tone is not associated with a tone. Candidate (54b), on the other hand, would violate *MULTI-ASSOCIATIONS because the tone is associated to more than one syllable. Tableau (57) illustrates how the two constraints rule out the unattested outputs in (54) when top-ranked.

(57) /11-11/ → [**33**-11]

σ σ (11 11)	SPECIFY-T	*MULTI-ASSOCIATIONS	OCP-T(11)	OCP-C(hl)	[OCP-C(l) & *HD/Lr]ADJ
a. σ σ (second σ linked to 11)	*!				
b. σ σ (both σ linked to one 11)		*!			
☞ c. σ σ (**33** 11)					*

Finally, the lack of alternation of /31/ should be considered. /31/ is the only tone in Dongshi Hakka that does not change. Given that tones in the head position never change (as predicted by IDENT-IO-T-HD), the issue can be reduced to the lack of alternation of /31/ in the non-head position. As mentioned, Lr tones are preferred to Hr tones in the non-head position. Thus, the reason why /31/ does not change could be due to its Lr status. Due to the top-ranked constraints, IDENT-IO-t-L and [IDENT-IO-REG &

IDENT-IO-CON]$_{SEG}$, only 31 and 53 are possible allotones of /31/. As 53 is a Hr tone, *NONHD/Hr can help rule out 53 and pick out 31.

*NONHD/Hr, though it plays the key role in predicting the lack of tone sandhi in 31, must be dominated by a number of constraints. It must be dominated by IDENT-IO-t-L, and [NOJUMP-t & *HD/Lr]$_{ADJ}$ to avoid Hr tones such as 33 and 53 from changing to Lr tones in the non-head position, as illustrated in (58). Besides, as shown in (59), the domination of [IDENT-IO-REG & IDENT-IO-CON]$_{SEG}$, IDENT-IO-t-L, and OCP-T(11) over *NONHD/Hr can also help predict the change of 11 to 33 before 11, even though 33 is a Hr tone.

(58) /33-31/ → [**35-**31]

33-31 Hr-Lr l-hl	IDENT-IO-t-L	[NOJUMP-t & *HD/Lr]$_{ADJ}$	*NONHD/Hr
a. **31**-31 Lr-Lr hl-hl	*!	*	
b. **11**-31 Lr-Lr l-hl		*!	
☞ c. **35**-31 Hr-Lr lh-hl			*

(59) /11-11/ → [**33-**11]

11-11 Lr-Lr l-l	[IDENT-IO-REG & IDENT-IO-CON]$_{SEG}$	IDENT-IO-t-L	OCP-T(11)	*NONHD/Hr
a. **35**-11 Hr-Lr lh-l	*!			*
b. **31**-11 Lr-Lr hl-l		*!		
c. 11-11 Lr-Lr l-l			*!	
☞ d. **33**-11 Hr-Lr l-l				*

*NONHD/Hr, though it ranks low, can still function to predict the lack of change in 31. That is because the only possible allotones of an input /31/ are 31 and 53 (due to the top-ranked constraints IDENT-IO-t-L and [IDENT-IO-REG & IDENT-IO-CON]$_{\text{SEG}}$). Since 31 and 53 differ only in register, they will be tied until *NONHD/Hr is evaluated. When it comes to *NONHD/Hr, 53 loses immediately because it is high in register.

Item (60) summarizes the constraint ranking for Dongshi Hakka disyllabic tone sandhi. Tableaux (61) and (62) illustrate how the ranking proposed in (60) accounts for dissimilation and assimilation in Dongshi Hakka tone sandhi, respectively. To simplify the presentation, in these tableaux, IDENT-IO-T-HD, SPECIFY-T, *MULTI-ASSOCIATIONS, which are dominant, are not listed and only the candidates that do not violate these high ranking constraints are entertained.

(60) *Final constraint hierarchy*
IDENT-IO-T-HD, SPECIFY-T, *MULTI-ASSOCIATIONS,
[IDENT-IO-REG & IDENT-IO-CON]$_{\text{SEG}}$, IDENT-IO-t-L, [OCP-REG & *RISE]$_{\text{ADJ}}$
» OCP-T(11), OCP-C(hl), [OCP-C(l) & *HD/Lr]$_{\text{ADJ}}$
» [NOJUMP-t & *HD/Lr]$_{\text{ADJ}}$
» *NONHD/Hr
» IDENT-IO-T
» OCP-C(l), NOJUMP-t

(61) /11-11/ → [**33**-11]

11-11 Lr-Lr l-l	[IDENT-IO-REG & IDENT-IO-CON]$_{\text{SEG}}$	IDENT-IO-t-L	[OCP-REG & *RISE]$_{\text{ADJ}}$	OCP-T(11)	OCP-C(hl)	[OCP-C(l) & *HD/Lr]$_{\text{ADJ}}$	[NOJUMP-t & *HD/Lr]$_{\text{ADJ}}$	*NONHD/Hr	IDENT-IO-T	OCP-C(l)	NOJUMP-t
a. **53**-11 Hr-Lr hl-l	*!	*						*	*		
b. **55**-11 Hr-Lr h-l	*!	*					*	*	*		*
c. **35**-11 Hr-Lr lh-l	*!						*	*	*		*

d. **31**-11 Lr-Lr hl-l		*!							*		
e. **22**-11 Lr-Lr h-l		*!					*		*		*
f. **13**-11 Lr-Lr lh-l			*!				*		*		*
g. 11-11 Lr-Lr l-l				*		*!				*	
☞ h. **33**-11 Hr-Lr l-l						*		*	*	*	

(62) /33-31/ → [**35**-31]

33-31 Hr-Lr l-hl	[Ident-IO-Reg & Ident-IO-Con]$_{SEG}$	Ident-IO-t-L	[OCP-Reg & *Rise]$_{ADJ}$	OCP-T(11)	OCP-c(hl)	[OCP-c(l) & *Hd/Lr]$_{ADJ}$	[NoJump-t & *Hd/Lr]$_{ADJ}$	*NonHd/Hr	Ident-IO-T	OCP-c(l)	NoJump-t
a. **31**-31 Lr-Lr hl-hl	*!	*			*		*		*		*
b. **22**-31 Lr-Lr h-hl	*!	*							*		
c. **13**-31 Lr-Lr lh-hl	*!		*						*		
d. **53**-31 Hr-Lr hl-hl		*!			*		*	*	*		*
e. **55**-31 Hr-Lr h-hl		*!						*	*		

f. **11**-31 Lr-Lr l-hl							*!		*		*
g. 33-31 Hr-Lr l-hl							*!	*			*
☞ h. **35**-31 Hr-Lr lh-hl								*	*		

5. Conclusion

In this paper, markedness and faithfulness constraints have been proposed to account for Dongshi Hakka tone sandhi. The markedness constraints govern the well-formedness of a tonal sequence as well as of a single tone; the faithfulness constraints govern the input-output identity of elements at different levels of a tone. Among the markedness constraints proposed, there are constraints that require adjacent elements to be identical (captured by NOJUMP) and constraints that force adjacent elements to be different (captured by OCP). The former require assimilation while the latter enforce dissimilation. Assimilation and dissimilation are two conflicting forces, yet they simultaneously exist in Dongshi Hakka tone sandhi. The two forces can co-exist in Dongshi Hakka because they refer to different levels of a tone. OCP requires disagreement at the tonal level (captured by OCP-T(11)) and the contour level (captured by OCP-C(l) and OCP-C(hl)) while the assimilation constraint requires agreement at the tonemic level (captured by NOJUMP-t). Under the premise of not violating OCP, Dongshi Hakka seeks to reach agreement at the intersyllabic tonemic level. This is reflected in the fact that of the four tonal combinations that undergo tone sandhi to meet OCP requirements (i.e. 33-11, 11-11, 53-31, 53-53), three reach agreement at the intersyllabic tonemic level in the output representation. Dongshi Hakka tone sandhi is thus the result of seeking a balance between assimilation and dissimilation.

It has also been shown that the well-formedness of a tone, in addition to sequential markedness, plays a role in Dongshi Hakka tone sandhi. The occurrence of a marked Lr tone in the head position has been shown to decide indirectly whether tone sandhi will take place when a certain sequential markedness constraint is violated. Tone-(non-)head preference plays only a secondary role in Dongshi Hakka as no tonal changes ever take place to repair the markedness in the tone itself. Instead, tonal changes always take place to repair markedness in the tonal combination. Thus, a marked Lr tone occurring in the head position will not change to a Hr tone and a marked Hr tone occurring in the non-head position will not change to a Lr tone. The reason for the former is due to the top ranking of IDENT-IO-T-HD in the language, which forbids any tonal changes from taking place in the head position. The latter can be explained by allotone mapping requirements that force a non-head tone to surface with its allotones, even if the allotones are high in register.

In addition to analyzing how allotones are selected in different tonal environments, how allotones are paired is also accounted for. In tone sandhi, while it has generally been agreed that allotone selection can be controlled by phonological markedness, there are two different views concerning how allotones are generated. One is that the allotone pairings are phonologically determined and can thus be predicted by rules, as in the derivational theory or by constraint interactions, as in the Optimality Theory. The other view is that allotone pairings cannot be determined by synchronic phonological conditions. They are determined by information in historical tonal categories (Chen 2000) or are just arbitrarily decided and listed in the mental lexicon (Tsay & Myers 1996, Yip 2002). The fact that the pairings of allotones can be predicted by constraint interaction in Dongshi Hakka shows that allotone generation in the language is not lexicalized but is phonologically governed.

References

Bao, Zhiming. 1999. *The Structure of Tone*. New York & Oxford: Oxford University Press.

Beckman, Jill N. 1998. *Positional Faithfulness*. Amherst: University of Massachusetts dissertation.

Benua, Laura. 1997. *Transderivational Identity: Phonological Relations Between Words*. Amherst: University of Massachusetts dissertation.

Blumenfeld, Lev. 2003. Counterfeeding, derived environment effects, and comparative markedness. *Theoretical Linguistics* 29.1-2:89-99.

Chen, Matthew Y. 2000. *Tone Sandhi: Patterns Across Chinese Dialects*. Cambridge & New York: Cambridge University Press.

Chen, Matthew Y., Lian-Hee Wee, and Xiuhong Yan. 2008. The paradox of Hakka tone sandhi. *Interfaces in Chinese Phonology: Festschrift in Honor of Matthew Y. Chen on His 70th Birthday*, ed. by Yuchau E. Hsiao, Hui-chuan Hsu, Lian-Hee Wee & Dah-an Ho, 1-45. Taipei: Institute of Linguistics, Academia Sinica.

Chen, Matthew Y., Xiuhong Yan, and Lian-Hee Wee. 2004. *Hakka Tone Sandhi: Corpus and Analytical Challenges*. Berkeley: Project on Linguistic Analysis, University of California.

Chiang, Jiun-Long. 1996. *Taizhong Dongshi Kejia Fangyan Cihui Yanjiu* [*The Morphological Study in Taichung Dongshi Hakka*]. Chiayi: National Chung Cheng University MA thesis. (In Chinese)

Chiang, Jiun-Long. 2003. *Liangan Dapu Kejiahua Yanjiu* [*The Study of Dapu Hakka in Taiwan and China*]. Chiayi: National Chung Cheng University dissertation. (In Chinese)

Chiang, Min-Hua. 1998. *Taizhongxian Dongshi Keyu Yinyun Yanjiu* [*Aspects of the Phonology of TungChi Hakka Language*]. Taipei: National Taiwan University MA thesis. (In Chinese)

Chiang, Min-Hua. 2002. Dongshi Kejiahua de chongdie jiegou yu biandiao [Reduplication and tone-sandhi in the Tungshih Hakka dialect]. *Language and Linguistics* 3.3:543-567. (In Chinese)

Chung, Raung-fu. 2008. Taiwan Dongshi Kejiahua de shengdiao yu biandiao: yuyin yu yinyun de guandian [Tone and tone sandhi in Dongshi Hakka: aspects of phonetics and phonology]. Paper presented at the 8th International Conference on Hakka Language Studies in Taiwan. Taoyuan: National Central University. (In Chinese)

Crowhurst, Megan. 2003. Comparative markedness and identity effects in reduplication. *Theoretical Linguistics* 29.1-2:77-87.

de Lacy, Paul. 1999. Tone and prominence. Manuscript. Amherst: University of Massachusetts. ROA#333. (http://roa.rutgers.edu/)

de Lacy, Paul. 2002. The interaction of tone and stress in Optimality Theory. *Phonology* 19.1:1-32.

Duanmu, San. 1997. Recursive constraint evaluation in Optimality Theory: evidence from cyclic compounds in Shanghai. *Natural Language and Linguistic Theory* 15.3:465-507.

Goldsmith, John A. 1976. *Autosegmental Phonology.* Cambridge: MIT dissertation.

Hayes, Bruce. 1990. Precompiled phrasal phonology. *The Phonology-Syntax Connection*, ed. by Sharon Inkelas & Draga Zec, 85-108. Chicago: University of Chicago Press.

Hsiao, Yuchau E. 2004. Dongshi Kejiahua zhi shengdiao lianbing yanjiu [Tonal contraction of Dongshi Hakka]. Technical Report. Taipei: Council for Hakka Affairs, Executive Yuan. (In Chinese)

Hsiao, Yuchau E. 2006. An Optimality Theory approach to tone sandhi in Dapu Hakka. NSC Technical Report.

Hsiao, Yuchau E. 2008. Yinping tone sandhi in two Hakka dialects. *Interfaces in Chinese Phonology: Festschrift in Honor of Matthew Y. Chen on His 70th Birthday*, ed. by Yuchau E. Hsiao, Hui-chuan Hsu, Lian-Hee Wee & Dah-an Ho, 79-97. Taipei: Institute of Linguistics, Academia Sinica.

Hsiao, Yuchau E., and Yunyi Chiu. 2006. Dongshi Keyu biandiao: san zhi sizizu fenxi [Trisyllabic and tetrasyllabic tone sandhi in Dongshi Hakka]. *Language and Linguistics* 7.2:455-482. (In Chinese)

Hsu, Hui-chuan. 1995. Trisyllabic tone sandhi in the Changting Hakka dialect. *Journal of Chinese Linguistics* 23.1:42-86.

Hyman, Larry M., and Kenneth VanBik. 2004. Directional rule application and output problems in Hakha Lai tone. *Language and Linguistics* 5.4:821-861.

Kirchner, Robert. 1996. Synchronic chain shifts in Optimality Theory. *Linguistic Inquiry* 27.2:341-350.

Leben, William Ronald. 1973. *Suprasegmental Phonology*. Cambridge: MIT dissertation.

Li, Bing. 2005. Youxuanlun zhong de yixi huianxing: wenti yu fazhan [Phonological opacity in Optimality Theory: problems and approaches]. *Foreign Language Teaching and Research* 2005.3:170-178. (In Chinese)

Lin, Hui-shan. 2004. *Directionality in Tone Sandhi and the Effect of Identity Preservation*. Hsinchu: National Tsing Hua University dissertation.

Lin, Hui-shan. 2007. Changting Kejiahua de liandu biandiao xianxiang [Changting Hakka tone sandhi]. *Tsing Hua Journal of Chinese Studies*, New Series 37.1: 175-226. (In Chinese)

Lin, Hui-shan. 2008. Variable directional applications in Tianjin tone sandhi. *Journal of East Asian Linguistics* 17.3:181-226.

Lin, Tao, and Lijia Wang. 1992. *Yuyinxue Jiaocheng* [*A Course in Phonetics*]. Beijing: Peking University Press. (In Chinese)

Lo, Seo-Gim. 1997. Cong Taiwan yuyan shengdiao xianxiang lun Hanyu shengdiao de yanbian de jige guilu [Some principles governing the development of Chinese tones]. Paper presented at the Conference on Taiwan Language Development. Hsinchu: National Hsinchu University of Education. (In Chinese)

McCarthy, John J. 2003. Comparative markedness. *Theoretical Linguistics* 29.1-2:1-51.

McCarthy, John J., and Alan S. Prince. 1993. Prosodic morphology I: constraint interaction and satisfaction. Technical Report. Amherst: University of Massachusetts; New Brunswick: Rutgers University.

McCarthy, John J., and Alan S. Prince. 1995. Faithfulness and reduplicative identity. *University of Massachusetts Occasional Papers in Linguistics 18: Papers in Optimality Theory*, ed. by Jill N. Beckman, Suzanne Urbanczyk & Laura Walsh Dickey, 249-384. Amherst: GLSA.

Nelson, Nicole Alice. 1998. Right anchor, aweigh. Manuscript. ROA#284. (http://roa.rutgers.edu/)

Nelson, Nicole Alice. 2003. *Asymmetric Anchoring*. New Brunswick: Rutgers University dissertation.

Perlmutter, David M. 1998. Interfaces: explanation of allomorphy and the architecture of grammars. *Morphology and Its Relation to Phonology and Syntax*, ed. by Steven G. Lapointe, Diane K. Brentari & Patrick M. Farrell, 307-338. Stanford: CSLI.

Prince, Alan S., and Paul Smolensky. 1993. *Optimality Theory: Constraint Interaction in Generative Grammar*. Report No. RuCCS-TR-2. New Brunswick: Center for Cognitive Science, Rutgers University.
[Revised version published as Prince, Alan S., and Paul Smolensky. 2004. *Optimality Theory: Constraint Interaction in Generative Grammar*. Malden: Blackwell.]

Smolensky, Paul. 1993. Harmony, markedness, and phonological activity. Manuscript. ROA#87. (http://roa.rutgers.edu/)

Tsay, Jane, and James Myers. 1996. Taiwanese tone sandhi as allomorph selection. *Berkeley Linguistics Society* (*BLS*) 22:394-405.

Tung, Chung-szu. 1995. Dongshi Kejiayu yinxi ji qi yinbiao fangan [The description and phonetic system in Dongshi Hakka]. *Papers from the 1994 Conference on Language Teaching and Linguistics in Taiwan*, Vol. 2: *Hakka*, ed. by Feng-fu Tsao & Mei-hui Tsai, 113-126. Taipei: Crane. (In Chinese)

Wang, Li. 1985. *Hanyu Yuyinshi* [*A History of Chinese Phonetics*]. Beijing: Chinese Academy of Social Sciences Press. (In Chinese)

Wang, William S-Y. 1967. Phonological features of tone. *International Journal of American Linguistics* 33:93-105.

Wee, Lian-Hee. 2001. Faithfulness as percolation—Evidence from tone sandhi in Mandarin. *RuLing Papers 2: Working Papers from Rutgers University*, ed. by Graham Horwood & Se-kyung Kim, 163-196. New Brunswick: Rutgers University.

Wee, Lian-Hee. 2004a. Xuanlu zhong de shengdiao: lun qiang ci xiangying guanxi [Unraveling the relation between Mandarin tones and musical melody]. Occasional Papers No. 152. Singapore: Department of Chinese Studies, National University of Singapore. (In Chinese)

Wee, Lian-Hee. 2004b. *Inter-tier Correspondence Theory*. New Brunswick: Rutgers University dissertation.

Yip, Moira. 1980. *The Tonal Phonology of Chinese*. Cambridge: MIT dissertation.

Yip, Moira. 2002. *Tone*. Cambridge & New York: Cambridge University Press.

Yip, Moira. 2003. Some real and not-so real consequences of comparative markedness. *Theoretical Linguistics* 29.1-2:53-64.

Yip, Moira. 2004. Phonological markedness and allomorph selection in Zahao. *Language and Linguistics* 5.4:969-1001.

Zee, Eric, and Ian Maddieson. 1979. Tones and tone sandhi in Shanghai: phonetic evidence and phonological analysis. *UCLA Working Papers in Phonetics* 45: 93-129.

Zhang, Jie. 1999. Duration in the tonal phonology of Pingyao Chinese. *Papers in Phonology* 3, ed. by Matthew K. Gordon, 147-206. UCLA Working Papers in Linguistics 2. Los Angeles: Department of Linguistics, University of California, Los Angeles.

[Received 19 May 2010; revised 13 September 2010; accepted 24 November 2010]

Department of English
National Taiwan Normal University
162, Sec. 1, Hoping East Road
Taipei 106, Taiwan
hslin@ntnu.edu.tw

東勢客語的連讀變調現象

林蕙珊
國立台灣師範大學

本文以優選理論 (Optimality Theory, Prince & Smolensky 1993[2004], McCarthy & Prince 1993) 分析東勢客語的連讀變調現象。本文指出，東勢客語中有兩股促使聲調產生變化的力量。這兩股力量一是希望相鄰聲調在調素層 (tonemic tier) 一致，屬於同化作用，並反映在 NoJump-t 這個音韻制約上；另一是希望相鄰聲調在聲調層 (tonal tier) 及曲拱層 (contour tier) 不要相同，屬於異化作用，並反映在 OCP-T(11)、OCP-c(𝕝) 以及 OCP-c(𝕙𝕝) 這三個音韻制約上。然而，並非所有違反這些要求的聲調組合均會產生變調。一般而言，只有在領頭 (head) 位置出現有標聲調時，變調才易產生。這樣的現象可以運用 de Lacy (2002) 領頭標記聲調的概念，透過聯合領頭標記制約 *Hd/𝕃r 以及 OCP-c(𝕝) 和 NoJump-t 制約來補捉。

關鍵詞：東勢客語，連讀變調，音韻制約，聲調–重音互動，優選理論