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以優選理論分析兩個客語方言之連讀變調

An Optimality Theory Approach to the Tone Sandhi in Two Hakka Dialects

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AN OPTIMALITY THEORY APPROACH TO THE TONE SANDHI IN TWO HAKKA DIALECTS

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Wei-Han Chen

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TABLE OF CONTENTS

Acknowledgement ..... **v**

VITA ..... **vii**

Table of Contents ..... **ix**

Chinese Abstract ..... **xiii**

English Abstract ..... **xv**

CHAPTER 1 INTRODUCTION **1**

CHAPTER 2 LITERATURE REVIEW **5**

2.1 Theoretical Background 5

2.1.1 Optimality Theory 5

2.1.2 Correspondence Theory 7

2.1.3 Indexed constraint approach 8

2.1.4 Local conjunction 10

2.2 Tone 12

2.2.1 Tonal markedness 12

2.2.2 Internal structure of tone 14

2.3 Previous studies 16

2.3.1 Bao (2011) 17

2.3.2 Zhang (1999) 18

2.3.3 Hsieh (2005).. 19

2.3.4 Lin (2011, 2012) 19

CHAPTER 3 LIUJIA RAOPING HAKKA 23

3.1 Tone inventory... 23

3.2 Tone sandhi patterns.. 25

3.3 OT analysis.. 32

3.3.1 Positional tone sandhi... 32

3.3.2 Contextual tone sandhi of *Yangping* 39

3.3.2.1 *Yangping-Yinping* contextual tone sandhi................................ 39

3.3.2.2 *Yangping-Yinshang* contextual tone sandhi 47

3.3.2.3 *Yangping-Yinru* contextual tone sandhi 53

3.3.3 *Ru* tone sandhi 59

3.4 Summary.. 62

CHAPTER 4 NINGDU TIANTOU HAKKA.. 65

4.1 Tone inventory... 65

4.2 Tone sandhi patterns.. 69

4.2.1 Tone sandhi patterns of construction 𝔸 70

4.2.2 Tone sandhi patterns of construction 𝔹 73

4.3 OT analysis.. 77

4.3.1 OT analysis of Tone sandhi in construction 𝔸.................................. 77

4.3.2 OT analysis of Tone sandhi in construction 𝔹.................................. 86

4.3.2.1 The second syllable tone sandhi.. 86

4.3.2.2 The first syllable tone sandhi... 97

4.3.2.3 Both syllables tone sandhi.. 103

4.3.2.4 Wrong predictions of [*IsRise & *T]$_{ADJ}$............................... 105

4.3.2.5 *Ru* tone sandhi 117

4.3.3 OT analysis of Tone sandhi in construction $\mathbb{A}$ and $\mathbb{B}$ 125

4.4 Summary 127

CHAPTER 5 CONCLUSION 129

5.1 Summary of the thesis 129

5.2 Future issues 134

REFERENCES 135

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本論文以優選理論分析六家饒平客語和寧都田頭客語雙音節詞之連讀變調，並藉由聲調內部結構說明變調的動機。在六家饒平客語方面，主要是呈現位置變調(positional tone sandhi)，較有標(more marked)的聲調位於前字時發生變調。另外，此方言的陽平和陽去因歷史演變，兩者的本調(citation tone)同為 HH，但兩者因不同的變調形式而產生不同的變調(sandhi tone)。陽去的變調形式為位置變調，而陽平的變調形式為環境變調(contextual tone sandhi)。本文採用聯合制約(Local Constraint Conjunction)捕捉環境變調制約運作的環境。另外，運用「詞素特定音韻」(morpheme-specific phonology)標記聯合制約，解釋陽平和陽去不同的變調規則。在寧都田頭客語方面，變調受詞法結構影響，且兩個音節皆有可能發生變調。本文利用標記制約理論(indexed constraints approach)解釋不同結構的變調情形。另藉由位置信實制約不同的排序，嘗試說明聲調的保留屬於類型差異

(typological differences)。而此方言的變調類型包含位置變調和環境變調，同樣要求較有標的聲調改變，並使用聯合制約說明在環境變調的情況下制約運作的環境。

ABSTRACT

This thesis investigates the tone sandhi in Liujia Raoping Hakka and Ningdu Tiantou Hakka under the framework of Optimality Theory. The internal structure of the tone reveals the motivation and the mechanism of tone sandhi. In terms of the tone sandhi in Liujia Raoping Hakka, the universal tonal markedness tendency could be regarded as the motivation triggering the positional tone sandhi in the left syllable. Moreover, the morpheme-specific phonology is adapted to account for the tone sandhi of historical merged tones, *Yangping* and *Yangqu*. *Yangping* and *Yangqu* are both high level tones; however, they display different tone sandhi patterns. *Yangping* displays the contextual tone sandhi whereas *Yangqu* displays the positional tone sandhi. Local conjunction constraints are posited to restrict markedness constraints to specific contexts in order to account for the mechanism of contextual tone sandhi. On the other hand, in terms of the tone sandhi in Ningdu Tiantou Hakka, the tone sandhi is construction sensitive and takes place in both syllables. The indexed constraint approach is adopted to explain the tone sandhi in different constructions. In addition, the preservation of tone is argued to be the typological difference according to

different rankings of the positional faithfulness constraints. Finally, the tonal markedness tendency motivates the positional tone sandhi and the conjoined constraints are posited to govern the contextual tone sandhi in this dialect.

CHAPTER 1

INTRODUCTION

This thesis investigates the disyllabic tone sandhi in two Hakka dialects under the theoretical framework of Optimality Theory (hereafter OT). Tone sandhi refers to the tonal alternation in certain contexts in a connected speech. It is one of the issues which has attracted great interests from phonologists, such as Hsiao (1991, 1995, 2000, 2006), Chen (2000), Lin (2006, 2008, 2011, 2012), Bao (2011), among others. This thesis discusses the tone sandhi in two Hakka dialects, Liujia Raoping Hakka and Ningdu Tiantou Hakka, in terms of the internal structure of tone (Bao 1999).

Liujia Raoping Hakka is a Hakka dialect spoken in Hsinchu City, Taiwan, used only among family members. Most of the speakers are bilingual. They are capable of communicating in a more dominant Hakka dialect, Sixian Hakka or Hailu Hakka, in public. Tone sandhi in this language is interesting because there are two tones merging in a single citation form but remaining distinct in the sandhi forms. It is due to the historical changes of tones (Xu 2008). *Yangping* HH and *Yangqu* HH are both high level tones as a citation tone. In terms of the sandhi tone, *Yangping* HH changes to HM when it is followed by LL, HM or *M*. On the other hand, *Yangqu* HH becomes MM regardless of the following tones. Previous studies, such as Xu (2005, 2008), did not discuss the motivation and mechanism of tone sandhi in this language. Besides, it brings the challenge for classic OT to deal with the situation which two output forms are generated from the identical input. These issues are the main concerns in this thesis.

In terms of Ningdu Tiantou Hakka, it is a Hakka dialect spoken in Jiangxi Province, China. Tone sandhi in this language is interesting because it is construction sensitive. The verb-object construction displays different tone sandhi patterns from the modifier-head and conjunction constructions. Tone sandhi in the verb-object construction only takes place in the first syllable while it may occur in both syllables in the modifier-head and conjunction constructions. The preservation of citation tones in the tone sandhi processes in different constructions supports the concept that the preservation of tone contrast should be of typological difference instead of the assignment of stress. Besides, this chapter illustrates how conjunction constraints trigger tone sandhi and how they preserve the unchanged tonal pairs.

The issues which will be discussed in this thesis are as follows. First, what are the motivation and mechanism of tone sandhi in both Hakka dialects? Second, how does OT deal with the historical merged tones in Liujia Raoping Hakka?

The organization of this thesis is as follows. Chapter 1 introduces the research problems. Chapter 2 reviews some relevant studies on the tonal structure and tone sandhi. Chapter 3 discusses how OT deals with the tone sandhi and merged tones in Liujia Raoping Hakka. Chapter 4 discusses how OT deals with the tone sandhi in Ningdu Tiantou Hakka. Chapter 5 concludes this thesis.

CHAPTER 2

LITERATURE REVIEW

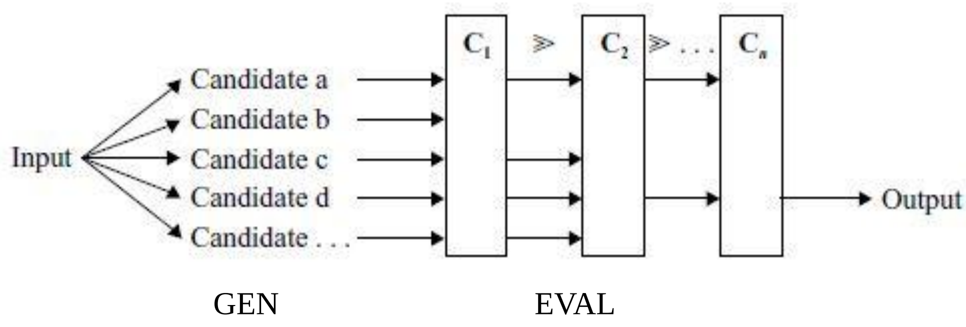
This chapter comprises four sections. Section 2.1 discusses related theories, including Optimality Theory, Correspondence Theory, Indexed constraint approach, and Local conjunction. Section 2.2 discusses the tonal markedness and the internal structure of tone. Section 2.3 reviews previous studies on tone sandhi.

2.1 Theoretical Background

2.1.1 Optimality Theory

Optimality Theory is a constraint-based framework (Prince and Smolensky 1993/2004, McCarthy and Prince 1993, McCarthy 2008) which is different from traditional derivational approach. In the framework of OT, two main systems are involved, namely Generator (GEN) and Evaluator (EVAL). The Generator (GEN) produces infinite candidates for an input. Then the candidates are evaluated by hierarchically ranked constraints, as shown in (1).

(1) OT Schema (Kager 1999:8)



Unlike the derivational approach, these constraints are universal and violable. Constraints exist universally but they could be ranked differently in different languages. The violation of the higher ranked constraints is fatal. The candidate having the minimal violation is selected as the optimal output.

The operation of OT is demonstrated with tableaux as shown in (2).

(2) Operation of OT

/Input/	Constraint A	Constraint B	Constraint C	Constraint D
☞Candidate (a)			*	
Candidate (b)	*!			*
Candidate (c)		*!		

In (2), the input is placed in the left top space and the possible candidates generated by GEN are placed in the left column. In terms of the right columns, each constraint is placed in an individual column. The constraint ranked left represents that it is ranked higher. On the other hand, the constraint near the right side of the tableau represents that it is ranked lower, i.e. constraint A is ranked higher than constraint B. The dotted line between constraint C and constraint D represents that there is no crucial ranking between these two constraints. The finger marker points out the optimal output form. Every asterisk mark represents one violation. The exclamation mark highlights the fatal violation. The shade area represents that the violation does not influence the elimination because there is a fatal violation for the high-ranked constraint.

Take the tableau in (2) as an example, candidate (b) is ruled out because it violates the undominated constraint A. Candidate (c) violates the highly ranked constraint B. In this case, even though candidate (a) violates constraint C, it is still selected as the optimal output.

2.1.2 Correspondence Theory

The concept of Correspondence Theory was developed by McCarthy and Prince (1995) which defines the identification between two language representations, such as input and output. The schema of Correspondence is shown as (3).

(3) The schema of Correspondence (McCarthy and Prince 1995:262)

Given two strings S1 and S2, correspondence is a relation ℜ from the elements of

S1 to those of S2. Element $\alpha \in$ S1 and $\beta \in$ S2 are referred to as correspondence of one another when $\alpha\, \mathcal{R}\, \beta$.

Based on the schema, each relationship between two representations is governed by a faithfulness constraint. The faithfulness constraints governing the relationship between strings are given in (4).

(4) a. MAX (maximality): Every segment in S1 has a correspondent in S2.

b. DEP (dependence): Every segment in S2 has a correspondent in S1.

c. IDENT[F] (identity): Correspondent segments are identical with respect to feature F.

2.1.3 Indexed constraint approach

According to Inkelas (2007), the phonology of a language might not be absolutely uniform. It could be influenced by factors, such as lexical stratum (e.g., native vs. foreign), and part of speech. Within OT, the indexed constraint approach is one of the approaches to capture the language internal variation.

In the indexed constraint approach, instead of constraint reranking, there is only one fix constraint ranking to capture the morphologically conditioned phonology. The constraints could be divided into several different indexed constraints. Alderete (2001) indexed ¬OO-MAX-(Accent) as ¬OO_{dom}-MAX-(Accent) in dealing with the Japanese high tone. The indexed ¬OO_{dom}-MAX-(Accent) targets the specific domain where there is a dominant suffix in the input.

Additionally, Itô and Mester (1999) also used the indexed constraint approach in dealing with the four lexical strata in Japanese. Itô and Mester (1999) mentioned that Japanese lexicon could be divided into four different strata according to the phonotactic differences. They proposed $Faith_{UF}$, $Faith_{AF}$, $Faith_{SJ}$ and $Faith_{Y}$ and ranked them in one fix constraint ranking to capture the different preservation of different lexical strata.

Besides, Pater (2000, 2010) pointed out that both the markedness and faithfulness constraints could be indexed. Moreover, Pater (2000, 2007, 2010) named the indexed constraint approach "morpheme specific phonology". Pater (2010) used this approach in handling the syncope in Yine. It is the condition that indistinguishable morphemes exhibit different phonological behaviors, such as undergo different phonological processes. The indexed constraints suggest that the speakers own the intuition to distinguish the morphemes. In this thesis, we will follow the concept of Pater (2010) because the merged tones are indistinguishable and undergo different phonological processes.

2.1.4 Local conjunction

In terms of local conjunction, it is proposed by Smolensky (1993, 1995) that every constraint in CON could be locally conjoined with another constraint. Lubowicz (2005) mentioned that the idea behind local conjunction is for constraints to exclude the worst of the worst. Itô and Mester (1998) defined the local conjunction, as shown in (5).

(5) Local conjunction of Constraints (Itô and Mester 1998:10)

a. Definition

Local conjunction is an operation on the constraint set forming composite constraints:

Let C1 and C2 be members of the constraint set Con. Then their local conjunction C1 & C2 is also a member of Con.

b. Interpretation

The local conjunction C1 & C2 is violated if and only if both *C1 and *C2 are violated in some domain δ.

c. Ranking (universal)

C1 & C2 » C1

C1 & C2 » C2

In (5b), it diaplays that the conjunction constraint will be violated if the component constraints are all violated. In (5c), it is the conjunction schema that the conjunction constraints have to dominate the component constraints universally. Besides, Lubowicz (2005) mentioned that there should be some restrictions of the component constraints; therefore, she proposed a restricted version of local conjunction.

(6) Restricted local conjunction (Lubowicz 2005:259)

C=C1&C2 is violated iff

a. $LOC_{C1} \cap LOC_{C2} \neq \emptyset$

b. C1 results in C2 if C1 is Faithfulness and C2 is Markedness.

In (6), Lubowicz (2005) imposed two restrictions on the component constraints. First, the loci of violation of both component constraints could not be empty, i.e. the loci of violation of both component constraints should intersect. Second, if there is a faithfulness constraint, the faithfulness constraint has to lead to the violation of the markedness constraint.

2.2 Tone

In this section, two issues will be discussed, namely tonal markedness and the internal structure of tone.

2.2.1 Tonal markedness

Universally, contour tones are more marked than level tones. There are three main rationales to claim it. First of all, according to Zhang (2001), Yip (2001, 2002) and Bao (2003), languages are more common to have level tones than contour tones, i.e. level tones are typologically more unmarked than contour tones. Second, in terms of acquisition, contour tones tend to be level off (Yip 2001). It suggests that level tones are relatively easier. Last, in terms of articulation, contour tones require more articulatory efforts and longer duration (Zhang 1999). Accordingly, Yip (2001, 2002) proposed a tonal markedness tendency based on minimizing the articulatory effort, as shown in (7).

(7) Minimize articulatory effort (Yip 2001:315)

a. Contour tones are more marked than level tones: *CONTOUR

b. Rising tones are more marked than falling tones: *RISE » *FALL

c. High tones are more marked than low tones: *H » *L

In (7), it shows that contour tones are more marked than level tones in terms of the articulatory effort. Furthermore, rising tones cost more efforts than falling tones do while high level tones cost more efforts than low level tones do.

Nonetheless, de Lacy (1999, 2002) posited the positional tonal markedness tendency, as shown in (8) and (9), to account for the stress system of Ayutla Mixtec.

(8) Tonal preference in the head position

*HD/L » *HD/M

(9) Tonal preference in the non-head position

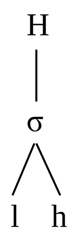
*NonHD/H » *NonHD/M

In (8), it shows that the low level tone is the least preferred in the prosodic head position while in (9), the high level tone is the least preferred in the prosodic non-head position. The positional tonal markedness tendency was originally used to discuss the interaction between stress and tones. Since the existence of stress in Chinese dialects is controversial, it will not be considered in this thesis. The tonal markedness tendency proposed by Yip (2001, 2002) will be applied and regarded as the motivation of tone sandhi in Liujia Raoping Hakka and Ningdu Tiantou Hakka.

2.2.2 Internal structure of tone

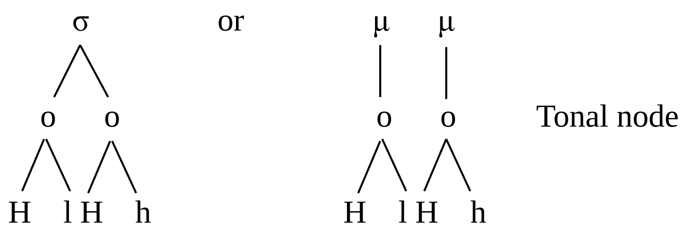
It is believed that tones have their internal structures. The four different possible models of tonal geometry summarized by Yip (2002) will be discussed as follows.

(10) Tonal geometry 1 (Yip 1980, Hyman 1993)



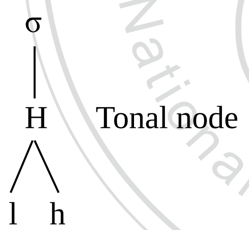
In (10), the tone melodies are not regarded as one unit. They are independent of each other. Moreover, they are not dominated by a tonal node. In this model, the register is free to spread alone. However, the whole tone could not spread as a unit and the contour could not spread without the register.

(11) Tonal geometry 2 (Clements 1981, Duanmu 1990, 1994, Snider 1990)



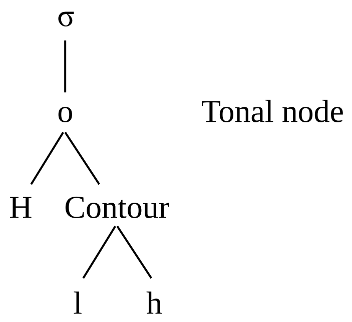
In (11), two tone melodies are dominated by a tonal node and each of them is still independent of each other. In terms of spreading, the model in (11) exhibits the same case as the model in (10) does.

(12) Tonal geometry 3 (Yip 1989, Hyman 1993)



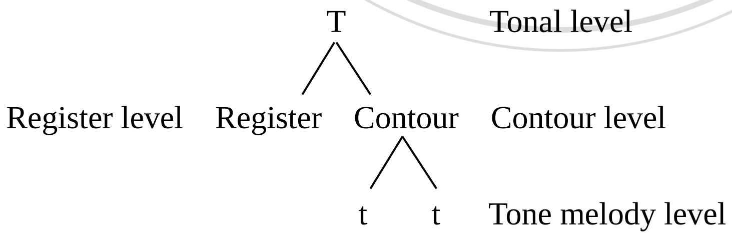
In (12), the register node is the tonal node. Also the tone melodies are dominated by the tonal node. In this model, the whole tone is allowed to spread as a unit. However, the register and the contour could not spread without each other.

(13) Tonal geometry 4 (Bao 1990, 1999, Snider 1999)



In the model in (13), the tone melodies are dominated by the contour node. Both contour node and register node are dominated by the tonal node. In this model, unlike the models discussed above, each node is able to spread alone; besides, the whole tone could still spread as a unit. In this case, the model in (13) will be adopted with some labeling differences in the analysis in chapter three and four, as in (14).

(14) Labeling the tonal structure proposed in Bao (1990, 1999)



2.3 Previous studies

In this section, some of the previous studies focusing on tone sandhi issues will be discussed.

2.3.1 Bao (2011)

Based on previous studies (Chen 1987, 2000), Bao (2011) classified Chinese tone sandhi patterns into four types, namely contextual tone sandhi, positional tone sandhi, templatic tone sandhi and tone spread. In terms of the contextual tone sandhi, the tone sandhi is sensitive to the adjacent tone elements. Besides, this type of tone sandhi could target the register and contour separately. The tone sandhi targets the register in languages such as Luoyang (He 1996) while the tone sandhi targets the contour in languages such as Pingyao (Hou 1980). Moreover, contextual tone sandhi could target both register and contour in languages such as Gaomi (Li 2004). Second, positional tone sandhi refers to the condition which tones undergoing tone sandhi are conditioned by the position. The tone sandhi in the Southern Min dialect of Xiamen (Chen 2000) is positional. All the citation tones in the non-utterance final position undergo tone sandhi. In addition to the contextual and positional tone sandhi, templatic tone sandhi is another tone sandhi type. It occurs in the polysyllabic compounds or phrases. The sandhi tones could not be derived from the citation tones in the input. The sandhi tones are prespecified. Harbin Mandarin (Jiang 1997) belongs to this type. Last, unlike the contextual and templatic tone sandhi, the citation tone and sandhi tone in tone spread are not confined in a specific syllable. The sandhi tone spreads to neighboring syllables in tone spread. Wu dialects (Chen 2000) are examples of this type of tone sandhi.

In chapter three, the analyses reveal that the tone sandhi in Liujia Raoping Hakka tends to be positional. The contextual tone sandhi only occurs when the citation tone is the historically merged Yangping HH1. Furthermore, the tone sandhi in Ningdu Tiantou Hakka illustrates both positional and contextual tone sandhi.

2.3.2 Zhang (1999)

Zhang (1999) proposed the duration constraint family to account for the tone sandhi in Pingyao. This constraint family comprises three sub families, i.e. duration (rime), duration (word) and duration (boundary). Duration (rime) pointed out the different rime duration between *ru* tones and non-*ru* tones. Zhang (1999) mentioned that it is how *ru* tones and non-*ru* tones are distinct from each other. Duration (word) confined the numbers of the tonal inflection point in disyllabic words. The tonal inflection points remain the tonal contrast; however, the total numbers of the inflection point is confined in disyllabic words owing to the limited word length. Last, duration (boundary) defined the restrictions at the syllable boundary. In terms of articulation, the duration between two rimes is considerably shorter than the average syllable. Therefore, it is hard to realize the abrupt pitch change at the syllable boundary. The constraint targets the pitch change at the syllable boundary will be applied to handle the tone sandhi in Ningdu Tiantou Hakka in chapter four.

2.3.3 Hsieh (2005)

Hsieh (2005) investigated the tonal chain shift in the tone sandhi in two dialects of Southern Min, Coastal Taiwanese and Mainstream Taiwanese. In both dialects, tone sandhi only occurs in the non-phrase final position. The tone in the phrase final position never undergoes tone sandhi. Hsieh (2005) mentioned that it is because the phrase final syllable is 40% longer than the phrase internal syllable (Peng 1996). The tone in the longer syllable tends to stay static. It could account for the tone sandhi in these two dialects; however, it could not explain the disyllabic tone sandhi in Ningdu Tiantou Hakka. Since both syllables in the disyllabic tone sandhi in Ningdu Tiantou Hakka may undergo tone sandhi, the preservation of tone in the phrase final position may not always due to the syllable length. Hence, in this thesis, the preservation of tone is argued to be the typological difference among languages.

2.3.4 Lin (2011, 2012)

Lin (2011) analyzed the disyllabic tone sandhi in Dongshi Hakka under the framework of OT. Lin (2011) posited NoJump-t to capture the assimilation at the tone melody level. Besides, OCP-T(11), OCP-c(𝕝) and OCP-C(𝕙𝕝) are posited to capture the dissimilation at the tonal level and the contour level. However, the dissimilation of the 𝕝 tone melody and the assimilation of adjacent tone melodies only occur when there is a low register tone in the head position. Therefore, Lin (2011) posited conjunction constraints, such as [NoJump-t & *HD/Lr]$_{ADJ}$, to specified the contexts where the markedness constraints are active. The situation is also found in both dialects discussed in this thesis. The triggers of tone sandhi in merged tones in Liujia Raoping Hakka and the contextual tone sandhi in Ningdu Tiantou Hakka are confined to certain contexts. Accordingly, the conjunction constraints will be applied in this thesis. Besides, the domain of the conjunction constraints will be defined as the adjacent tones.

Additionally, Lin (2012) investigated the construction sensitive tone sandhi in Pingyao. In Pingyao, the register is influential in dealing with the tonal preservation in the head syllable, i.e. high register tones and low register tones display different cases of preservation in the head syllable. In this case, IDENT-IO-T-HD(Hr) and IDENT-IO-T-HD(Lr) were posited. Since the register is influential in the tonal preservation in both Hakka dialects in this thesis as well, constraints targeting the register and tonal preservation are applied in the analyses in the following chapters.

Moreover, in Pingyao, the subject-predicate and verb-object construction exhibit the same tone sandhi pattern whereas the modifier-head, conjunction, verb-complement construction and the reduplicated nouns exhibit the same tone sandhi pattern. Nevertheless, this correspondence relation is different from the one in Ningdu Tiantou Hakka. The subject-predicate and verb-complement construction do not undergo tone sandhi in Ningdu Tiantou Hakka whose tone sandhi is construction sensitive as well. Therefore, the correspondence relation between tone sandhi patterns and constructions is argued to be the language specific phenomenon.

CHAPTER 3

LIUJIA RAOPING HAKKA

This chapter investigates the disyllabic tone sandhi in Taiwan Liujia Raoping Hakka. The data are mainly from Lü (1993), Hsu (2005, 2008) and Lin (2007). These data were confirmed by the teaching materials[1] provided by Hakka Affairs Council, Executive Yuan.

The rest of this chapter will be arranged as follows. Section 3.1 introduces the tone inventory and section 3.2 introduces tone sandhi patterns. Section 3.3 provides the OT analysis for the tone sandhi patterns. Section 3.4 provides the summary of this chapter.

3.1 Tone Inventory

There are six citation tones in Raoping Hakka, namely *Yinping* LL, *Yinshang* HM, *Yinru* *M*[2], *Yangping* HH, *Yangqu* HH[3], and *Yangru* *H*. In Chao's (1930) system, tones

[1] The link of the material is as follows:
http://elearning.hakka.gov.tw/attclass/cprofile.aspx?param=10000127

[2] The italic and underlined tones are *ru* tones. *Ru* tones end with voiceless unreleased stops.

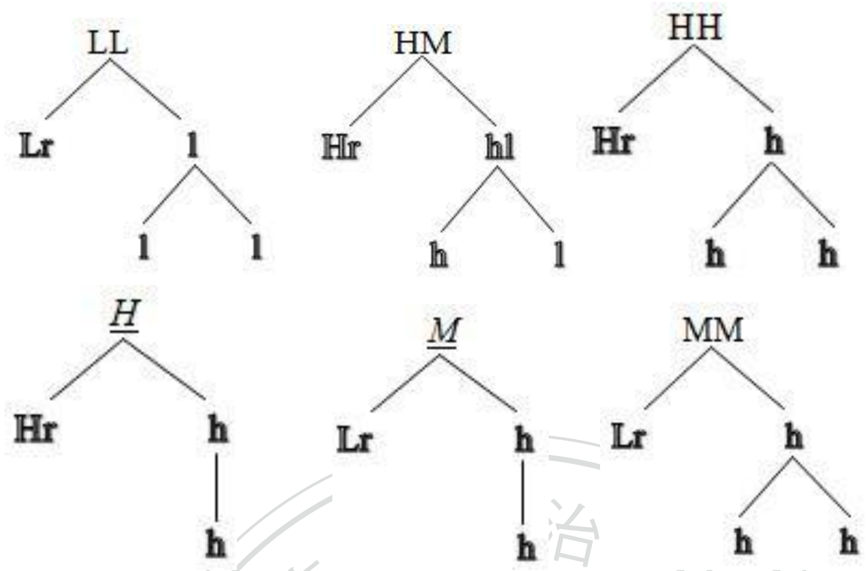
are ranged from 1 to 5. 1 represents the lowest tone while 5 represents the highest tone. In this thesis, tones are converted into Yip's (2001) system. We marked 4 and 5 as H, marked 3 as M and marked 1 and 2 as L.

In terms of the tone categories, the historical tonal changes of Raoping Hakka are different from other Hakka dialects. *Yangshang* has partially merged into *Yinping* and partially merged into *Yangqu*. *Yinqu* had merged into *Yinshang* in the diachronic process (Hsu 2008). On the other hand, what is interesting in Liujia Raoping Hakka is the identical citation tones of *Yangping* and *Yangqu*. Both *Yangping* and *Yangqu* are high level tones, HH. However, their sandhi tones are different when they precede *Yin* tones. When they precede *Yin* tones, *Yangping* becomes HM and *Yangqu* becomes MM. Hsu (2008) points out that it is due to the diachronic tonal change.

Since the internal structure of tone will be concerned in dealing with the tone sandhi, the internal structures of tones are presented as follows:

[3] *Yangqu* in Lü (1993) was specified as MM; however, according to the teaching materials, Hsu (2005, 2008) and Lin (2007), the citation tone of *Yangqu* should be HH.

(1) The internal structure of Liujia Raoping Hakka tones



3.2 Tone Sandhi Patterns

The disyllabic tone sandhi patterns of Liujia Raoping Hakka are illustrated as follows:

(2) Liujia Raoping tone sandhi patterns

2nd σ 1st σ	Yinping LL [Lr, l]	Yinshang HM [Hr, hl]	Yinru *M* [Lr, h]	Yangping HH1 [Hr, h]	Yangqu HH2 [Hr, h]	Yangru *H* [Hr, h]
Yinping LL [Lr, l]	LL-LL Lr-Lr l-l	LL-HM Lr-Hr l-hl	LL-*M* Lr-Lr l-h	LL-HH Lr- Hr l-h	LL-HH Lr-Hr l-h	LL-*H* Lr-Hr l-h
Yinshang HM [Hr, hl]	**MM**-LL **Lr**-Lr **h**-l	**MM**-HM **Lr**-Hr **h**-hl	**MM**-*M* **Lr**-Lr **h**-h	**MM**-HH **Lr**-Hr **h**-h	**MM**-HH **Lr**-Hr **h**-h	**MM**-*H* **Lr**-Hr **h**-h
Yinru *M* [Lr, h]	***H***-LL **Hr**-Lr **h**-l	***H***-HM **Hr**-Hr **h**-hl	***H***-*M* **Hr**-Lr **h**-h	***H***-HH **Hr**-Hr **h**-h	***H***-HH **Hr**-Hr **h**-h	***H***-*H* **Hr**-Hr **h**-h
Yangping HH1 [H, h]	**HM**-LL **Hr**-Lr **hl**-l	**HM**-HM **Hr**-Hr **hl**-hl	**HM**-*M* **Hr**-Lr **hl**-h	**MM**-HH **Lr**-Hr **h**-h	**MM**-HH **Lr**-Hr **h**-h	**MM**-*H* **Lr**-Hr **h**-h
Yangqu HH2 [Hr, h]	**MM**-LL **Lr**-Lr **h**-l	**MM**-HM **Lr**-Hr **h**-hl	**MM**-*M* **Lr**-Lr **h**-h	**MM**-HH **Lr**-Hr **h**-h	**MM**-HH **Lr**-Hr **h**-h	**MM**-*H* **Lr**-Hr **h**-h
Yangru *H* [Hr, h]	***M***-LL **Lr**-Lr **h**-l	***M***-HM **Lr**-Hr **h**-hl	***M***-*M* **Lr**-Lr **h**-h	***M***-HH **Lr**-Hr **h**-h	***M***-H **Lr**-Hr **h**-h	***M***-*H* **Lr**-Hr **h**-h

The bold tones are ones which undergo tone sandhi. *Yangping* and *Yangqu* are indexed as HH1 and HH2 respectively in order to avoid confusion. Among the six tones, LL never changes, but the other five tones change in the first syllable. The tone sandhi process does not occur in the second syllable. In this case, tone sandhi in this language can basically be regarded as the positional tone sandhi (Chen 1987, 2000, Bao 2011). Positional tone sandhi refers to the sandhi behavior which is conditioned by the position of the tone undergoing tone sandhi.

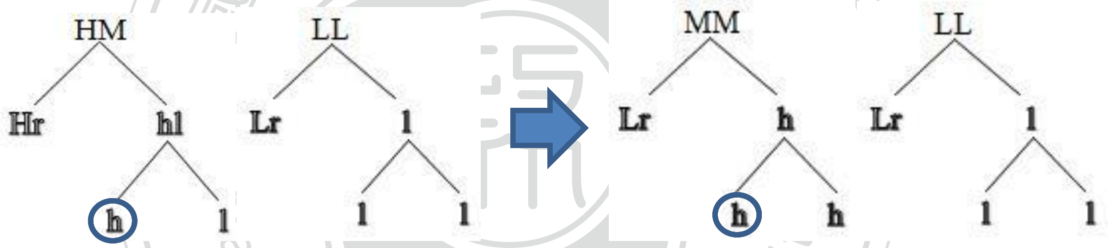
That HM and HH2 becomes MM is consistent with the universal tonal markedness, i.e. falling tones and high tones are relatively more marked tones in terms of minimizing articulatory effort (Yip 2001, 2002). This universal tendency could be regarded as the motivation of tone sandhi. In this language, the requirement of no falling tone and no high level tone is the trigger of tone sandhi. The mechanism of how the output MM is produced will be illustrated in (3).

(3) *Yinshang* and *Yangqu* tone sandhi mechanism

a. *Yinshang* + *Yinping*

HM-LL → **MM**-LL

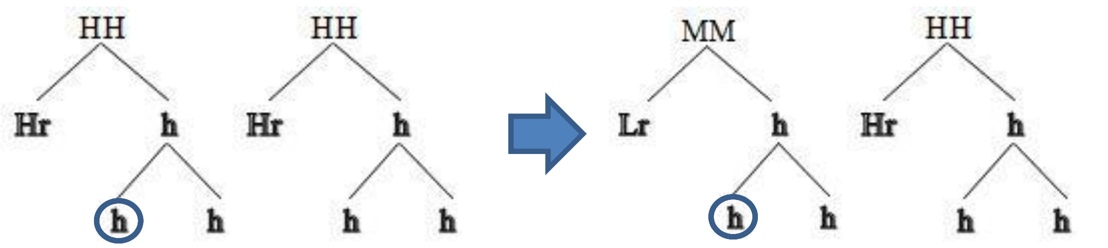
[fo tʃʰa] 'train'



b. *Yangqu* + *Yangping*

HH2- HH1 → **MM**-HH1

[kʰiu ŋien] 'last year'

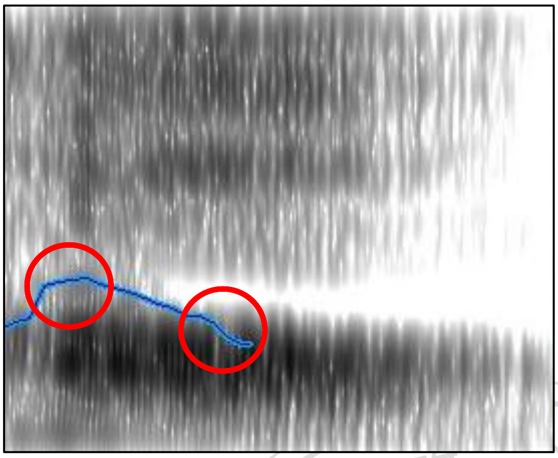


In (3), example (a) illustrates *Yinshang* HM followed by *Yinping* LL and example

(b) illustrates *Yangqu* HH2 followed by *Yangping* LL. Both of them follow the requirement of no falling tone and no high level tone; therefore, they will not map into HM and HH. In (3a), the HM [Hr, hl] becomes MM [Lr, h] instead of LL [Lr, l] because of preserving the left tone melody of the citation tone. Also in (3b), the HH2 becomes MM owning to the preservation of the left tone melody. The tonal markedness tendency and the left tone melody preservation require MM to be a low register high tone, [Lr, h], in this language. I argue that MM is a low register high tone, [Lr, h], in this language. If it is a high register low tone [Hr, l], HM [Hr, hl] would become LL [Lr, L]. In addition, the preservation is based on Yip's (2001) argument of tonal target. Yip (2001) mentioned that most contour tones in Chinese languages only have the initial target, and the contour moves away from the target. According to the spetrogram in (4), the falling tone here is lack of the final target. In (4), the falling tone HM has a short high plateau in the beginning but no low plateau in the final position. Hence, it is reasonable to believe that contour tones in this language have only initial target in this language. In this case, the left tone melody is preserved since a tone (contour or level) always has the initial tonal target, but only the level tone has two targets.

(4) The initail target of *Yinshang*

[ho] HM ‘good’



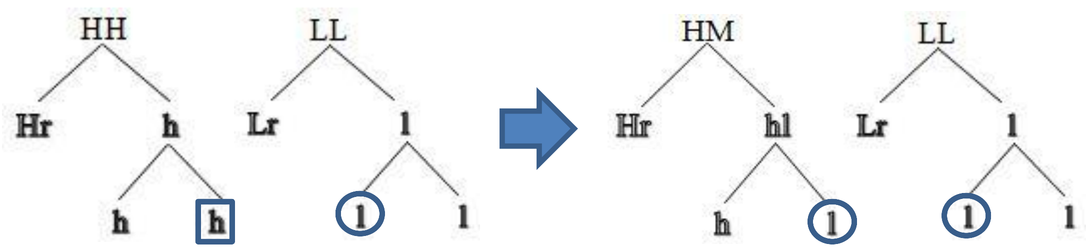
The two *ru* tones alternate with each other in the first syllable. It follows the positional tone sandhi pattern. The motivation for the *ru* tone sandhi may be the requirement which prevents citation *ru* tones from surfacing. This kind of motivation can be seen in the Taiwanese tone sandhi which forbids citation tone surfacing in the non-final position.

As for the *Yangping* tone sandhi, it is influenced by the following *Yin* tones. The mechanisms of how the *Yangping* tone sandhi is influenced by the context are illustrated in (5) and (6) respectively.

(5) *Yangping-Yinping* contextual tone sandhi

HH1-LL → **HM**-LL

[vu ʃin] ‘body’



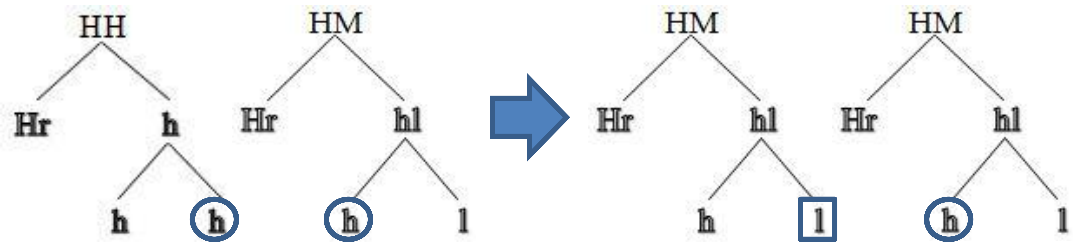
In (5), *Yangping* is followed by *Yinping*. In this context, the intersyllabic **h**-melody of *Yangping* is assimilated by the **l**-melody of *Yinping*; therefore, the HH-to-HM mapping is an assimilation process. Furthermore, when the second syllable does not contain an **l** tone melody in the intersyllabic position, this assimilation process will not occur.

There is an **h** dissimilation at the tone melody level when HH1 is followed by HM and *M*. Adjacent **h** tone melodies are not allowed, so the **h** tone melody in the first syllable is dissimilated to **l**. The mechanism is shown in (6a) and (6b).

(6) Dissimilation tone sandhi mechanism

a. HH1-HM → **HM**-HM

[voŋ geu] 'yellow dog'



b. HH1-<u>*M*</u> → **HM**-<u>*M*</u>

[ʃau ŋit] 'tomorrow'

Both (6a) and (6b) show that two adjacent **h** melodies in the intersyllabic position are forbidden in these two particular situations. The right tone melody of the first tone is then dissimilated to **l**.

What is interesting in (5-6) is that the two phonological processes, assimilation and dissimilation, take place at the same level, and it correctly accounts for the tone sandhi patterns.

3.3 OT analysis

3.3.1 Positional tone sandhi

According to the analyses in section 3.2, the tone sandhi is mainly positional and the tonal markedness tendency is the motivation. In terms of the positional tone sandhi, tone sandhi processes only occur in the first syllable in Liujia Raoping Hakka, i.e. the second syllable never undergoes tone sandhi. Under the framework of OT, we need a constraint to prevent the tone in the right syllable from alternating. Therefore, the constraint, IDENT-IO-T-R, is needed. IDENT-IO-T-R is adopted from Hsiao (2000). This constraint penalizes candidates whose tone in the second syllable is not identical with its corresponding tone in the output. Its definition will be shown in (7).

(7) IDENT-IO-T-R (ID-T-R):

Assign one violation mark for every input tone at the right edge which is not identical with its corresponding tone in the output (Hsiao 2000).

The constraint in (7) follows the concept of edge prominence (Li 2003). Lin (2011) investigated the disyllabic tone sandhi in Dongshi-Hakka and posited IDENT-IO-T-HD to capture the preservation of the tone in the right syllable. This constraint is not adopted here because the term “head” may easily mislead readers to the idea of stress. The syllable with stress may be regarded as head in languages with stress. Duanmu (1990) proposed the non-head stress principle (NHS) to govern the stress in Chinese. In NHS, the stress is assigned to the syntactic non-head position. It may account for the tone sandhi which is sensitive to the syntactic structure. However, Raoping tone sandhi is syntactically insensitive, which makes it hard to determine the stress assignment according to the NHS. Since the existence of stress in Chinese dialects is still controversial, the term "head" is not adopted in order to avoid confusion.

In this thesis, the preservation of tone is argued to be a typologically different phenomenon. Languages retaining the tone in the left syllable are attested, such as Hakha-Lai (Lin 2005a) and Chengdu (Lin 2006). Besides, languages retaining the tone in the right syllable are attested as well. Beijing Mandarin (Hsiao 2000, Lin 2008), Taiwanese (Hsiao 2000), Boshan (Lin 2004), Sixian-Hakka (Lin 2005b) and Dongshi-Hakka (Lin 2011) are all languages which preserve the tone in the right syllable in the disyllabic tone sandhi process. In this case, the retained tone may be considered to be typologically different. The analyses in chapter four will support this argument.

In addition to the position, the tonal markedness may be regarded as one of the factors influencing the tone sandhi. Yip (2001) mentioned that falling tones and high tones are comparatively more marked than mid and low tones in terms of minimizing the articulatory effort. Accordingly, *Fall and *HH are posited. The definitions will be shown in (8) and (9).

(8) *Fall

Assign one violation mark for every output falling tone.

(9) *HH

Assign one violation mark for every output high level tone.

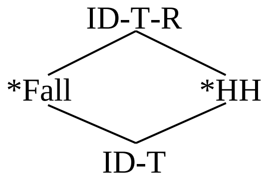
Furthermore, IDENT-IO-T is needed to interact with the markedness constraints in (8) and (9). Its definition will be shown in (10).

(10) IDENT-IO-T (ID-T):

Assign one violation mark for every input tone which is not identical with its corresponding tone in the output (Hsiao 2000, Lin 2011).

The interactions among constraint (7), (8), (9) and (10) is displayed in (11).

(11) Temporal ranking 1



ID-T-R is always undominated in this language because the tone in the right syllable never undergoes tone sandhi. All the candidates whose tone in the second syllable is changed will be ruled out by ID-T-R. Due to the undominated ranking, these situations will no longer be discussed in the rest of this chapter. The ranking ID-T-R » *Fall, *HH illustrates the feature of positional tone sandhi and universal tonal markedness. ID-T-R placed undominated exhibits that tone sandhi always occurs in the left syllable. As for the universal tonal markedness, *Fall and *HH are comparatively more marked due to the ease of articulation. In this case, it is easier to preserve unmarked tones, MM and LL. Furthermore, As for markedness constraints, according to Yip (2001), *Fall should have outranked *HH. However, in this language, there is no crucial ranking between *Fall and *HH nonetheless. The markedness conflation proposed by de Lacy (2004) is then considered, i.e. in this language, *Fall and *HH are equally ranked.

Yinshang HM will be the example to display the violation of constraints in (11) and the tableau is in (12).

(12) *Yinshang* HM in the temporal ranking 1

HM-LL → **MM**-LL

[fo tʃ^{h}a] ‘train’

HM-LL [Hr, hl]-[Lr, l]	*Fall	*HH	ID-T
a.HM-LL [Hr, hl]-[Lr, l]	*!		
b.ML-LL [Lr, hl]-[Lr, l]	*!		
c.HH-LL [Hr, h]-[Lr, l]		*!	*
? d.LL-LL [Lr, l]-[Lr, l]			*
☞e.MM-LL [Lr, h]-[Lr, l]			*

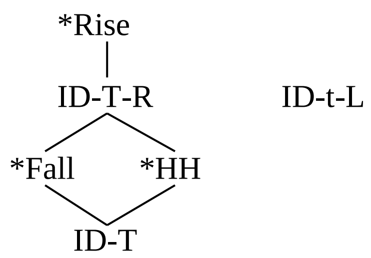
In (12), tones such as MH and LM are not considered because they are not allowed to appear in the output in this language. They may automatically be ruled out by the undominated phonotactic constraint, *Rise. Moreover, although the ML in candidate (b) does not exist in this language, either, it is unnecessary to posit a constraint like *ML. It is because the ML will be rule out by *Fall as it is shown in (12). Since ML and HM perform identically in terms of the constraint violation, only HM which is in the tone inventory will be discussed in the following tableaux. Besides, the *ru* tone candidates will be discussed in the next section. In this tableau, *Fall rules out candidate (a) and (b) due to the falling tones whereas *HH ruled out candidate (c) due to the high level tone. The constraints in (11) illustrate the motivation and the preservation of the tone sandhi clearly, yet this temporal ranking fails to choose the optimal output between candidate (d) and candidate (e). Hence, the preservation mechanism in (3) should be considered. In (3), the left tone melody is preserved in tone sandhi based on the tonal target proposed by Yip (2001). According to Yip (2001) and the spectrogram in (4), the falling tone only has the initial target. The tonal target needs to be preserved in the tone sandhi process. In this case, the constraint IDENT-IO-t-L is important here. Its definition is in (13).

(13) IDENT-IO-t-L (ID-t-L):

Assign one violation mark for every input tone whose left tone melody is different from its corresponding tone melody in the output (Lin 2011).

The ID-t-L in (13) is originally posited by Lin (2011). Lin (2011) proposed this constraint based on Beckman (1998) and Nelson (1998, 2003) who consider the left element preservation to be the universal tendency. However, in this thesis, the preservation of the tone element is regarded as the typological difference. That languages have different sides of syllable undego tone sandhi is due to different rankings of preservation constraints, as it will be presented in chapter four. Therefore, the constraint in (13) is based on Yip (2001) and adapted to preserve the initial tonal target. Including ID-t-L, the temporal ranking should be revised as in (14).

(14) Temporal ranking 2



In (14), there is no interaction among ID-t-L and other constraints so far in this temporal ranking. The ranking of ID-t-L will be revised in the next section. With ID-t-L, LL will be ruled out and MM will successfully be chosen as the optimal output. The tableau is given in (15).

(15) *Yinshang* HM in the temporal ranking 2
HM-LL → **MM**-LL
[fo tʃʰa] 'train'

HM-LL [Hr, hl]-[Lr, l]	*Fall	*HH	ID-T	ID-t-L
c.LL-LL [Lr, l]-[Lr, l]			*	*!
☞d.MM-LL [Lr, h]-[Lr, l]			*	

In (15), candidate (c) is ruled out by ID-t-L because the **l**-melody of LL is different from the **h**-melody of HM. Therefore, MM is selected as the optimal output. The tableau in (15) explains why the comparatively more marked MM, rather than the least marked LL, is chosen as the sandhi tone.

In (15), it suggests that the tonal markedness tendency could be regarded as the motivation of the positional tone sandhi (Chen 1987, 2000, Bao 2011). In this language, *Fall and *HH are ranked equally which may be considered to be the markedness conflation (de Lacy 2004). Moreover, in the tone sandhi process, the left tone melody, the initial tonal target, is preserved.

3.3.2 Contextual tone sandhi of *Yangping*

The residual issue about non-*ru* tones is how OT deals with the assimilation and dissimilation process proposed in (5) and (6).

3.3.2.1 *Yangping-Yinping* contextual tone sandhi

In (5), *Yangping* HH1 illustrates the assimilation at the tone melody level when it is followed by LL. The constraint ranking in (14) fails to select the optimal output for HH1-LL. The optimal output of HH1-LL is **HM**-LL which will be ruled out by *Fall in the temporal ranking. Since it is an assimilation process, the constraint, Agree-t (Lin 2011), is considered.

(16) Agree-t:

Assign one violation mark for adjacent tones which have different tone melodies in the intersyllabic position.

As for the ranking of Agree-t, it has to be ranked at the lowest level with ID-T and dominated by ID-t-L. If Agree-t is ranked higher, it will predict the wrong output forms for unchanged tonal pairs, such as LL-HM or LL-*M*. In order to illustrate the assimilation, a higher ranked constraint is needed. Notice that Agree-t has to be confined to a specific context, i.e. where HH1 precedes LL; otherwise, **HM**-HM, the optimal output of HH1-HM, will be wrongly eliminated. To solve this problem, [Agree-t & *LL]$_{ADJ}$ is posited.

(17) [Agree-t & *LL]$_{ADJ}$:

Assign one violation mark for adjacent tones which violate both Agree-t and *LL.

In (17), the component constraint, *LL, has to be ranked lower than ID-T so that the unchanged tonal pair, LL-LL, will not be incorrectly eliminated. [Agree-t & *LL]$_{ADJ}$ penalizes adjacent tones which violate both Agree-t and *LL. Therefore, only adjacent tones including a low level tone may violate this constraint. The domain, two adjacent tones, is based on Lin (2011) and Lubowicz (2002). Lin (2011) has proposed constraints, such as [NoJump-t & *HD/Lr]$_{ADJ}$, to account for Dongshi Hakka. The domain of this constraint focuses on two adjacent tones. Therefore, the constraint in (17) follows Lin's (2011) idea and its domain is defined as two adjacent tones. This constraint has to dominate *Fall to preserve the optimal output **HM**-LL. Tableau (18) displays how [Agree-t & *LL]$_{ADJ}$ works.

(18) [Agree-t & *LL]$_{ADJ}$ predicts the output of HH1-LL

HH1-LL → **HM**-LL

[vu ʃin] 'body'

HH1-LL [Hr, h]-[Lr, l]	ID-t-L	[Agree-t & *LL]$_{ADJ}$	*Fall	*HH	Agree-t	ID-T	*LL
☞a.HM-LL [Hr, hl]-[Lr, l]			*			*	*
b.HH-LL [Hr, h]-[Lr, l]		*!		*	*		*
c.LL-LL [Lr, l]-[Lr, l]	*!					*	**
d.MM-LL [Lr, h]-[Lr, l]		*!			*	*	*

[Agree-t & *LL]$_{ADJ}$ has to outrank *Fall for producing the optimal output, HM.

Also, it has to be dominated by ID-T-R in order not to rule out unchanged tonal pairs, such as LL-HM or LL-HH. Besides, ID-t-L dominates *Fall in order to prevent HH1 and HH2 from mapping to LL. Candidates (b) and (d) violate [Agree-t & *LL]$_{ADJ}$ because there is a low level tone and the intersyllabic tone melodies are different. For both candidates, the right tone melody of the first syllable is **h** which shows no agreement with the left tone melody of the second syllable, **l**. Candidate (c) is ruled out by ID-t-L because the **l**-melody of LL is not identical with the left tone melody of the input. This conjunction constraint successfully selects the optimal output; it would have the wrong prediction if the input were not *Yangping* HH1. The example is given in (19).

(19) [Agree-t & *LL]$_{ADJ}$ has the wrong prediction

HH2-LL → **MM**-LL

[t^{h}ien $tʃ^{h}$a] 'tram'

HH2-LL [Hr, h]-[Lr, l]	ID-t-L	[Agree-t & *LL]$_{ADJ}$	*Fall	*HH	Agree-t	ID-T	*LL
?a.HM-LL [Hr, hl]-[Lr, l]			*			*	*
b.HH-LL [Hr, h]-[Lr, l]		*!		*	*		*
c.LL-LL [Lr, l]-[Lr, l]	*!					*	**
☞d.MM-LL [Lr, h]-[Lr, l]		*?			*	*	*

In (19), the input is *Yangqu* HH2 which is identical with *Yangping* in the citation form, but their sandhi tones are different. HH2 always changes to MM in the first syllable. Then [Agree-t & *LL]$_{ADJ}$ fails to select the right output. In order to solve this problem, [Agree-t & *LL]$_{ADJ}$ should be indexed to *Yangping*, i.e. only when the input contains *Yangping* HH1, [Agree-t & *LL]$_{ADJ}$ works. Accordingly, [Agree-t & *LL]$_{ADJ}$ then should be [Agree-t & *LL]$_{ADJ(Yangping)}$. The constraint dominating *Fall is actually [Agree-t & *LL]$_{ADJ(Yangping)}$ instead of [Agree-t & *LL]$_{ADJ}$. This constraint is indexed and specifically targeting the input containing *Yangping*. It follows the idea of Pater’s (2007, 2010) morpheme specific phonology. Pater (2007, 2010) argued that if two indistinguishable morphemes undergo or trigger different processes, it is hard to explain purely phonologically. The issue here is not about indistinguishable morphemes but the diachronically merged tones. Since *Yangping* and *Yangqu* are indistinguishable and they undergo or trigger different processes, they conform to the requirement of Pater’s (2007, 2010) morpheme specific phonology. The indexed constraint suggests that the distinction between HH1 and HH2 does exist in native speakers’ intuition.

Moreover, Fukuzawa (1999) and Itô and Mester (1999, 2001) believe that the indexed approach can only be applied on faithfulness constraints. However, Pater (2010) investigated the Yine syncope and argued that both markedness and faithfulness constraints are able to be indexed. Hence, the markedness constraint in (17) is defined as an indexed constraint.

To deal with the morpheme specific issue, researchers, such as Orgun (1996, 1998, 1999), Anttila (1997, 2002), Inkelas (1998), Anttila and Cho (1998), Orgun and Inkelas (2002), Inkelas and Zoll (2005, 2007) among others, argue for the morpheme specific rankings, namely cophonologies. Nevertheless, this approach is not appropriate for predicting historically merged tones. Cophonology requires the morphological motivation or the partially unranked constraints. The merged tones do not provide the morphological motivation. Moreover, there are no partially unranked constraints; thus, the indexed approach is preferred in this thesis.

The situation in (19) is no longer a problem in (20).

(20) [Agree-t & *LL]$_{ADJ(\textit{Yangping})}$ predicts the output of HH2-LL

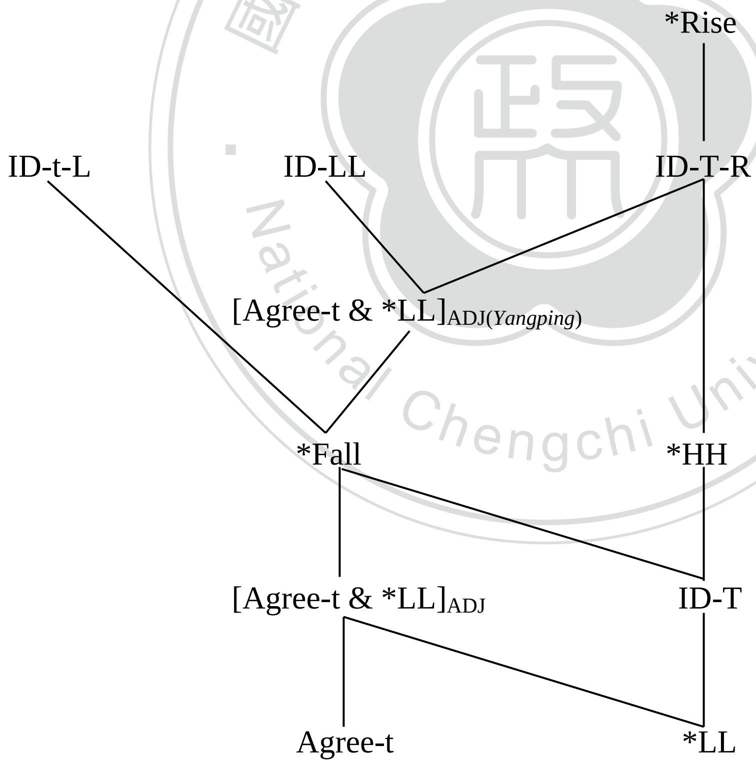
HH2-LL → **MM**-LL

[tʰien tʃʰa] 'tram'

HH2-LL [Hr, h]-[Lr, l]	ID-t-L	[Agree-t & *LL]$_{ADJ}$ *(Yangping)*	*Fall	*HH	[Agree-t & *LL]$_{ADJ}$	Agree-t	ID-T	*LL
a.HM-LL [Hr, hl]-[Lr, l]			*!				*	*
☞d.MM-LL [Lr, h]-[Lr, l]					*	*	*	*

In (20), [Agree-t & *LL]$_{ADJ(\textit{Yangping})}$ has to outrank *Fall whereas *Fall has to outrank [Agree-t & *LL]$_{ADJ}$. [Agree-t & *LL]$_{ADJ(\textit{Yangping})}$ outranks *Fall in order to deal with the situation where HH1 is the input, as in (18). *Fall has to outrank [Agree-t & *LL]$_{ADJ}$; otherwise, candidate (d), **MM**-LL, cannot be the optimal output. Moreover, according to the indexed approach schema (Fukuzawa 1999, Itô and Mester 1999, 2001, Pater 2000, 2007, 2010), the indexed constraint should outrank the general constraint. On the other hand, [Agree-t & *LL]$_{ADJ}$ must dominate Agree-t, according to the conjunction schema (Smolensky 1993) that component constraints has to ranked lower than the conjunction constraint. Last, in order to preserve the unchanged tonal combination, such as LL-HH1, IDENT-LL is proposed. It prevents LL from changing. Since LL never undergoes tone sandhi, IDENT-LL is undominated. The constraint ranking is revised as in (21).

(21) Temporal constraint ranking 3



3.3.2.2 *Yangping-Yinshang* contextual tone sandhi

There is a dissimilation process at the contour level when *Yangping* HH1 is followed by *Yinshang* HM. In OT, the dissimilation of high tone melodies can be captured by OCP-**h**.

(22) OCP-**h**:

Assign one violation mark for adjacent **h** tone melody.

OCP-**h** has to be dominated by Agree-t; otherwise, it will incorrectly rule out **MM**-HM, the optimal output of HH2-HM. However, if it is ranked this low, the optimal output of HH1-HM will be wrongly predicted, as in (23).

(23) OCP-**h** has the wrong prediction

HH1-HM → **HM**-HM

[voŋ geu] 'yellow dog'

HH1-HM [Hr, h]-[Hr, hl]	ID-t-L	(*Yangping*) [Agree-t & *LL]$_{ADJ}$	*Fall	*HH	[Agree-t & *LL]$_{ADJ}$	Agree-t	ID-T	OCP-**h**	*LL
☞a.HM-HM [Hr, hl]-[Hr, hl]			**?			*	*		
b.HH-HM [Hr, h]-[Hr, hl]			*	*!				*	
c.LL-HM [Lr, l]-[Hr, hl]	*!	*	*		*	*	*		*
?d.MM-HM [Lr, h]-[Hr, hl]			*				*		

In (23), candidate (c) violates ID-t-L because the left tone melody of LL is different from the left tone melody of HH1. Candidate (b) is ruled out because it violates both *Fall and *HH. Candidate (a) should have been the optimal output, but it consists of two falling tones and violates *Fall twice. In this case, candidate (d) is wrongly selected as the optimal output. In order to capture the dissimilation and promote the effect of OCP-**h**, OCP-**h** needs to target this specific context, i.e., where HH1 followed by HM. Therefore, [OCP-**h** & *Fall]$_{ADJ}$ is posited.

(24) [OCP-**h** & *Fall]$_{ADJ}$:

Assign one violation mark for adjacent tones which violate both OCP-**h** and *Fall.

*Fall has to be dominated by [OCP-**h** & *Fall]$_{ADJ(\textit{Yangping})}$ based on the constraint conjunction schema (Smolensky 1993). Besides, *Fall restricts the domain of OCP-**h** when they are conjoined. [OCP-**h** & *Fall]$_{ADJ}$ has to be dominated by ID-T-R in order to confirm that the tone in the second syllable will not be changed.

As in (18) and (19), the conjunction constraints could account for the specific situation, but it could rule out other optimal output forms whose input are not *Yangping*. Tableaux in (25) and (26) will illustrate the situations which [OCP-**h** & *Fall]$_{ADJ}$ may have a right or wrong prediction.

(25) [OCP-**h** & *Fall]$_{ADJ}$ predicts the output of HH1-HM

HH1-HM → **HM**-HM

[voŋ geu] 'yellow dog'

HH1-HM [Hr, h]-[Hr, hl]	ID-t-L	[OCP-**h** & *Fall]$_{ADJ}$	[Agree-t & *LL]$_{ADJ}$ *(Yangping)*	*Fall	*HH	[Agree-t & *LL]$_{ADJ}$	Agree-t	ID-T	OCP-**h**	*LL
☞a.HM-HM [Hr, hl]-[Hr, hl]				**			*	*		
b.HH-HM [Hr, h]-[Hr, hl]		*!		*	*				*	
c.LL-HM [Lr, l]-[Hr, hl]	*!		*	*		*	*	*		*
d.MM-HM [Lr, h]-[Hr, hl]		*!		*				*	*	

In (25), it displays that [OCP-**h** & *Fall]$_{ADJ}$ has to dominate *Fall in order not to rule out the optimal output. Candidate (c) violates ID-t-L because the left tone melody of LL is different from the left tone melody of input HH1. Candidate (b) and (d) are ruled out by [OCP-**h** & *Fall]$_{ADJ}$ because they contain HM and the adjacent tone melodies are **h**'s. In this case, candidate (a) is successfully selected as the optimal output. This is where [OCP-**h** & *Fall]$_{ADJ}$ has the correct prediction. However, it faces a challenge in (26).

(26) [OCP-**ħ** & *Fall]$_{ADJ}$ has the wrong prediction

HH2-HM → **MM**-HM

[ŋi ʃiu] ‘second-hand’

HH2-HM [Hr, h]-[Hr, hl]	ID-t-L	[OCP-**ħ** & *Fall]$_{ADJ}$	[Agree-t & *LL]$_{ADJ}$ *(Yangping)*	*Fall	*HH	[Agree-t & *LL]$_{ADJ}$	Agree-t	ID-T	OCP-**ħ**	*LL
?a.HM-HM [Hr, hl]-[Hr, hl]				**			*	*		
b.HH-HM [Hr, h]-[Hr, hl]		*!		*	*				*	
c.LL-HM [Lr, l]-[Hr, hl]	*!			*		*	*	*		*
☞d.MM-HM [Lr, h]-[Hr, hl]		*?		*				*	*	

In (26), [OCP-**ħ** & *Fall]$_{ADJ}$ has the wrong prediction when the input is *Yangqu* HH2 instead of *Yangping* HH1. The optimal output of *Yangqu* HH2 is **MM**-HM. However, it is eliminated by [OCP-**ħ** & *Fall]$_{ADJ}$ due to the existing contour tone and the adjacent **ħ** tone melody. Candidate (a) is thus incorrectly predicted as the optimal output. Hence, [OCP-**ħ** & *Fall]$_{ADJ}$ should be confined to the situation which *Yangping* is the input form. In this case, it should be indexed as [OCP-**ħ** & *Fall]$_{ADJ(Yangping)}$ based on the concept of morpheme specific phonology (Pater 2007, 2010). Including [OCP-**ħ** & *Fall]$_{ADJ(Yangping)}$, the situation in (26) will be solved, as in

(27).

(27) [OCP-**ħ** & *Fall]$_{ADJ(\mathit{Yangping})}$ predicts the output of HH2-HM

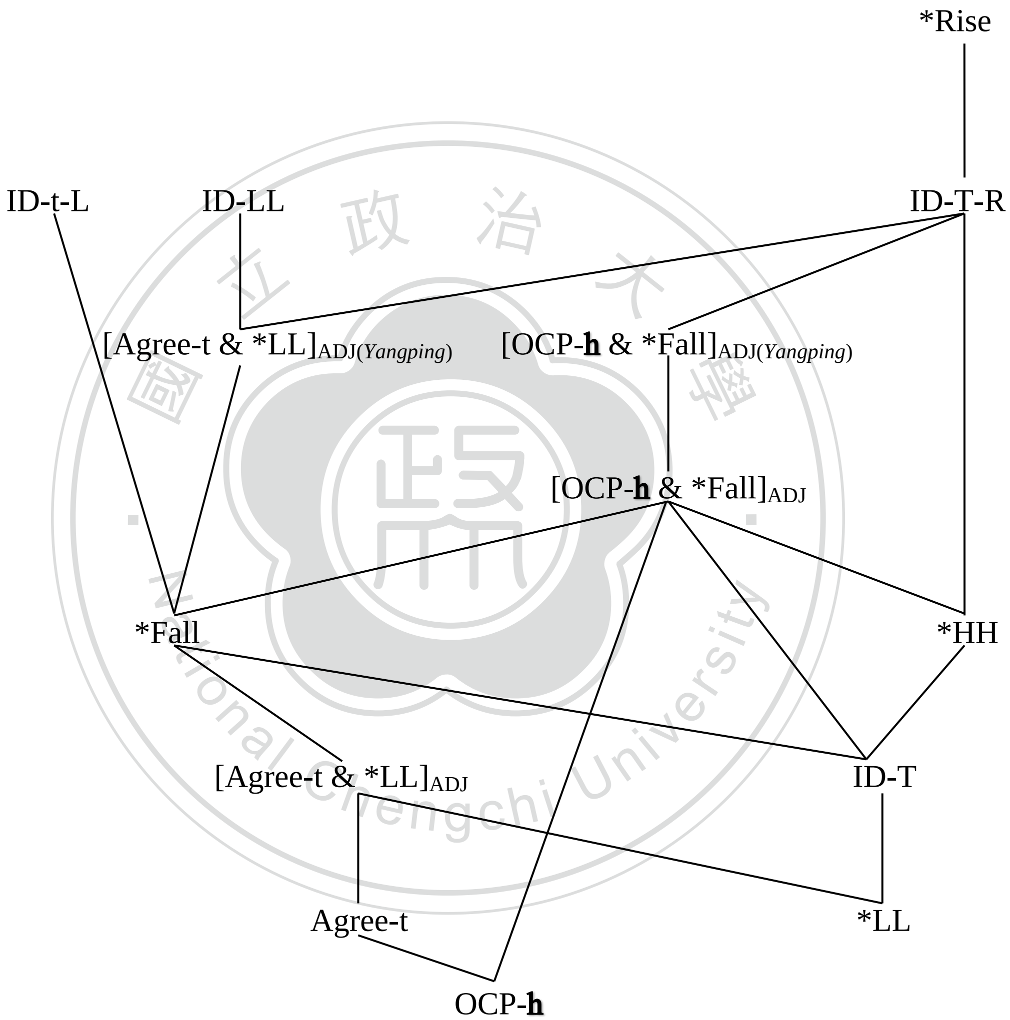
HH2-HM → **MM**-HM

[ŋi ʃiu] 'second-hand'

HH2-HM [Hr, h]-[Hr, hl]	ID-t-L	[OCP-**ħ** & *Fall]$_{ADJ}$ *(Yangping)*	[Agree-t & *LL]$_{ADJ}$ *(Yangping)*	[OCP-**ħ** & *Fall]$_{ADJ}$	*Fall	*HH	[Agree-t & *LL]$_{ADJ}$	Agree-t	ID-T	OCP-**ħ**	*LL
a.HM-HM [Hr, hl]-[Hr, hl]					**			*	*		
b.HH-HM [Hr, h]-[Hr, hl]				*	*	*!				*	
c.LL-HM [Lr, l]-[Hr, hl]	*!			*	*		*	*	*		*
☞d.MM-HM [Lr, h]-[Hr, hl]				*	*				*	*	

In (27), that [OCP-**ħ** & *Fall]$_{ADJ(\mathit{Yangping})}$ dominates [OCP-**ħ** & *Ctr]$_{ADJ}$ follows the indexed approach schema (Fukuzawa 1999, Itô and Mester 1999, 2001, Pater 2000, 2007, 2010). The indexed constraint need to dominate the original one. On the other hand, that [OCP-**ħ** & *Fall]$_{ADJ(\mathit{Yangping})}$ dominates *Fall follows the constraint conjunction schema (Smolensky 1993), i.e. the conjunction constraint needs to dominate the component constraints. Moreover, this ranking prevents the optimal output of HH1-HM from being eliminated by *Fall, as it is shown in (26). The temporal constraint ranking is revised and illustrated in (28).

(28) Temporal ranking 4



3.3.2.3 *Yangping-Yinru* contextual tone sandhi

As for the *Yangping-Yinru* contextual tone sandhi, there is a dissimilation at the intersyllabic tone melody level. The mechanism was shown in (6b). It encounters similar situation as it is shown in (23), i.e. the ranking of OCP-**h** is too low to capture the dissimilation of two adjacent **h** tone melodies. Therefore, [OCP-**h** & *<u>*M*</u>]$_{ADJ}$ is posited.

(29) [OCP-**h** & *<u>*M*</u>]$_{ADJ}$:

Assign one violation mark for adjacent tones which violate both OCP-**h** and *<u>*M*</u>.

OCP-**h** conjoined with *<u>*M*</u>. *<u>*M*</u> has to be ranked at the same level with ID-T and be ranked lower than *T which will be discussed later; otherwise, <u>***M***</u>-LL, the optimal output of <u>*H*</u>-LL will be ruled out. [OCP-**h** & *<u>*M*</u>]$_{ADJ}$ has to be ranked lower than ID-T-R in order not to change tones in the right syllable. This constraint accounts for the situations where the input is *Yangping* HH1; however, it exhibits the wrong prediction when the input is not *Yangping*. The situations are given in (30) and (31).

(30) [OCP-**h** & *<u>*M*</u>]$_{ADJ}$ predicts the output of HH1- <u>*M*</u>

HH1-<u>*M*</u> → **HM**-<u>*M*</u>

[ʃau ŋit] 'tomorrow'

HH1-<u>*M*</u> [Hr, h]-[Lr, h]	ID-t-L	[OCP-**h** & *<u>*M*</u>]$_{ADJ}$	[OCP-**h** & *Fall]$_{ADJ}$ (*Yangping*)	[Agree-t & *LL]$_{ADJ}$ (*Yangping*)	[OCP-**h** & *Fall]$_{ADJ}$	*Fall	*HH	[Agree-t & *LL]$_{ADJ}$	Agree-t	*<u>*M*</u>	ID-T	OCP-**h**	*LL
☞a.HM-<u>*M*</u> [Hr, hl]-[Lr, h]					*	*			*	*	*		
b.HH-<u>*M*</u> [Hr, h]-[Lr, h]		*!	*				*			*		*	
c.LL-<u>*M*</u> [Lr, l]-[Lr, h]	*!			*				*	*	*	*		*
d.MM-<u>*M*</u> [Lr, h]-[Lr, h]		*!	*							*	*	*	

In (30), it illustrates the condition which HH1-<u>*M*</u> is in the input. Candidate (b) and candidate (d) violate [OCP-**h** & *<u>*M*</u>]$_{ADJ}$ because there are *Yinru* <u>*M*</u> and adjacent **h** in the intersyllabic position. Candidate (c) is ruled out by ID-t-L because the left tone melody of LL is different from the left tone melody of the input HH1. This is the case [OCP-**h** & *<u>*M*</u>]$_{ADJ}$ exhibit the correct prediction. However, it fails to deal with situations which the input is not *Yangping* HH1. The example will be given in (31).

(31) [OCP-**h** & *<u>*M*</u>]$_{ADJ}$ has the wrong prediction

HH2-<u>*M*</u> → **MM**-<u>*M*</u>

[heu ŋit] 'the day after tomorrow'

HH2-<u>*M*</u> [Hr, h]-[Lr, h]	ID-t-L	[OCP-**h** & *<u>*M*</u>]$_{ADJ}$	[OCP-**h** & *Fall]$_{ADJ(Yangping)}$	[Agree-t & *LL]$_{ADJ(Yangping)}$	[OCP-**h** & *Fall]$_{ADJ}$	*Fall	*HH	[Agree-t & *LL]$_{ADJ}$	Agree-t	*<u>*M*</u>	ID-T	OCP-**h**	*LL
?a.HM-<u>*M*</u> [Hr, hl]-[Lr, h]						*			*	*	*		
b.HH-<u>*M*</u> [Hr, h]-[Lr, h]		*!					*			*		*	
c.LL-<u>*M*</u> [Lr, l]-[Lr, h]	*!							*	*	*	*		*
☞d.MM-<u>*M*</u> [Lr, h]-[Lr, h]		*?								*	*	*	

In (31), the optimal output should have been candidate (d), but it is wrongly eliminated by [OCP-**h** & *<u>*M*</u>]$_{ADJ}$. Candidate (b) and (d) violate [OCP-**h** & *<u>*M*</u>]$_{ADJ}$ because there are <u>*M*</u> and adjacent **h** in the intersyllabic position. Hence, candidate (a) is incorrectly predicted as the optimal output. Based on Pater's (2007, 2010) morpheme specific phonology, [OCP-**h** & *<u>*M*</u>]$_{ADJ}$ must be indexed as [OCP-**h** & *<u>*M*</u>]$_{ADJ(Yangping)}$ to target at the specific *Yangping*. The situation in (31) is solved in (32).

(32) [OCP-**h** & *<u>*M*</u>]$_{\mathrm{ADJ}(\mathit{Yangping})}$ predicts the output of HH2-<u>*M*</u>

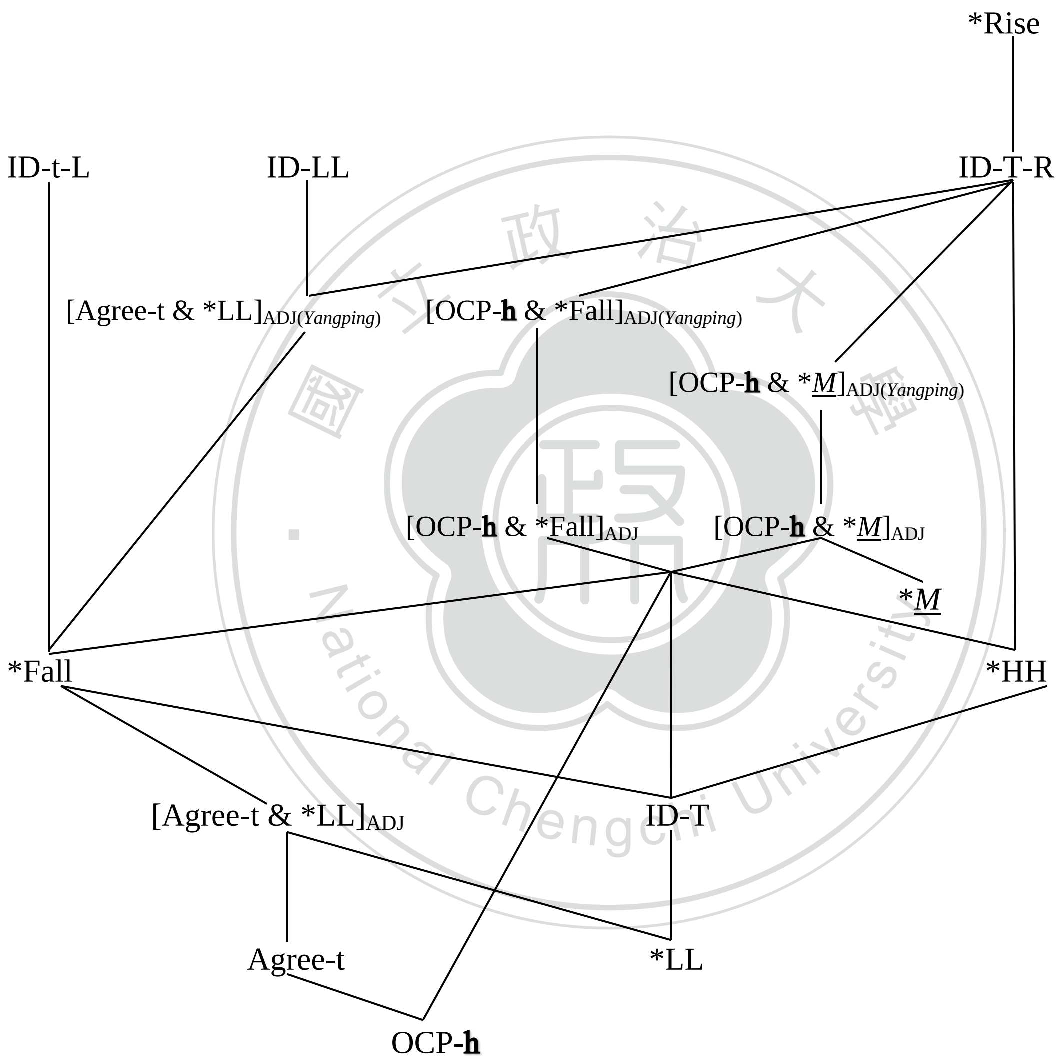
HH2-<u>*M*</u> → **MM**-<u>*M*</u>

[heu ŋit] ‘the day after tomorrow’

HH2-<u>*M*</u> [Hr, h]-[Lr, h]	ID-t-L	[OCP-**h** & *<u>*M*</u>]$_{\mathrm{ADJ}(\mathit{Yangping})}$	[OCP-**h** & *Fall]$_{\mathrm{ADJ}(\mathit{Yangping})}$	[Agree-t & *LL]$_{\mathrm{ADJ}(\mathit{Yangping})}$	[OCP-**h** & *<u>*M*</u>]$_{\mathrm{ADJ}}$	[OCP-**h** & *Fall]$_{\mathrm{ADJ}}$	*Fall	*HH	[Agree-t & *LL]$_{\mathrm{ADJ}}$	Agree-t	*<u>*M*</u>	ID-T	OCP-**h**	*LL
a.HM-<u>*M*</u> [Hr, hl]-[Lr, h]						*	*!			*	*	*		
b.HH-<u>*M*</u> [Hr, h]-[Lr, h]					*			*!			*		*	
c.LL-<u>*M*</u> [Lr, l]-[Lr, h]	*!								*	*	*	*		*
☞d.MM-<u>*M*</u> [Lr, h]-[Lr, h]					*						*	*	*	

In (32), [OCP-**h** & *<u>*M*</u>]$_{\mathrm{ADJ}}$ has to be ranked lower than [OCP-**h** & *<u>*M*</u>]$_{\mathrm{ADJ}(\mathit{Yangping})}$ according to the indexed approach schema (Fukuzawa 1999, Itô and Mester 1999, 2001, Pater 2000, 2007, 2010), i.e. the indexed constraint should outrank the original constraint. The three constraints which target *Yangping* do not work here owing to that the input is not a *Yangping* tone. Candidate (a) is ruled out because it violates *Fall. Candidate (b) is eliminated because it violates *HH. Candidate (c) is ruled out by ID-t-L in that the left tone melody of LL differs from the left tone melody of the input HH2. In this case, candidate (d) is successfully selected as the optimal output. Including [OCP-h & *M]$_{ADJ(Yangping)}$, the ranking is revised and illustrated in (33).

(33) Complete ranking of non-*ru* tone sandhi



The indexed constraints can account for the contextual tone sandhi, i.e. HH1 is followed by *Yin* tones. Furthermore, these indexed constraints have illustrated that the distinction between HH1 and HH2 does exist in native speakers' intuition.

3.3.3 *Ru* tone sandhi

In the OT analyses in previous sections, *ru* tones are not considered to be candidates for non-*ru* tone inputs. The tone sandhi patterns for *ru* tones and non-ru tones belong to different systems based on Chen's (2000) point of view, who mentioned that these two types of tones belong to different syllable types. *Ru* tones belong to syllables which end with a voiceless obstruent while non-*ru* tones belong to syllables which do not end with a voiceless obstruent. *Ru* tone syllables tend to have an impoverished tonal inventory and illustrate different tone sandhi behavior compared to non-*ru* tone syllables, i.e. *ru* tones can only be realized by *ru* tone syllables. Hence, *ru* tones are not considered to be possible candidates in the non-*ru* tone sandhi. Also, *ru* tone and non-*ru* tone sandhi should be regarded as different systems.

Researchers, such as Lin (2011, 2012), consider *ru* tones to be allotones of non-*ru* tones. However, in this language, it is hard to define <u>*M*</u> as an allotone of a non-*ru* tone in terms of the phonological tonal similarity. Besides, *Yinru* <u>*M*</u> exhibits a very different tone sandhi behavior from non-*ru* tones. Accordingly, *ru* tones and non-*ru* tones are considered to be different tones belonging to different syllable types and exhibiting different tone sandhi patterns.

As for the *ru* tone sandhi, it seems to lack the influence of universal tonal markedness tendency and the preservation of the left tone melody. The motivation for non-*ru* tone sandhi mentioned above does not work.

Notice that the *ru* tone sandhi also follows the positional tone sandhi tendency in this language. The tone sandhi process only occurs in the left syllable while the right syllable remains unchanged. Moreover, the sandhi tones are insensitive to the context. *Ru* tones alternate with each other in tone sandhi, i.e. *M* changes to *H* whereas *H* changes to *M*. This phenomenon can be considered as the requirement of no citation tones in the output. Under the OT framework, *T is posited in (34).

(34) *T:

Assign one violation mark for every output citation tone (Lin 2000).

This constraint is originally *TT and it follows the concept of anti-faithfulness (Alderete 1999, 2001). The ranking of the *ru* tone sandhi is illustrated in (35).

(35) *Ru* tone sandhi ranking

ID-T-R
|
*T
|
ID-T

The ranking in (35) illustrates the mechanism of the *ru* tone sandhi. ID-T-R is still undominated because the tone sandhi only takes place in the left syllable. *T governs the *ru* tone sandhi. It forbids the citation tone in the output. The violations are illustrated in (36).

(36) *Yinru* M in the *ru* tone sandhi ranking

tʃok *M* sam LL 'wear clothes '

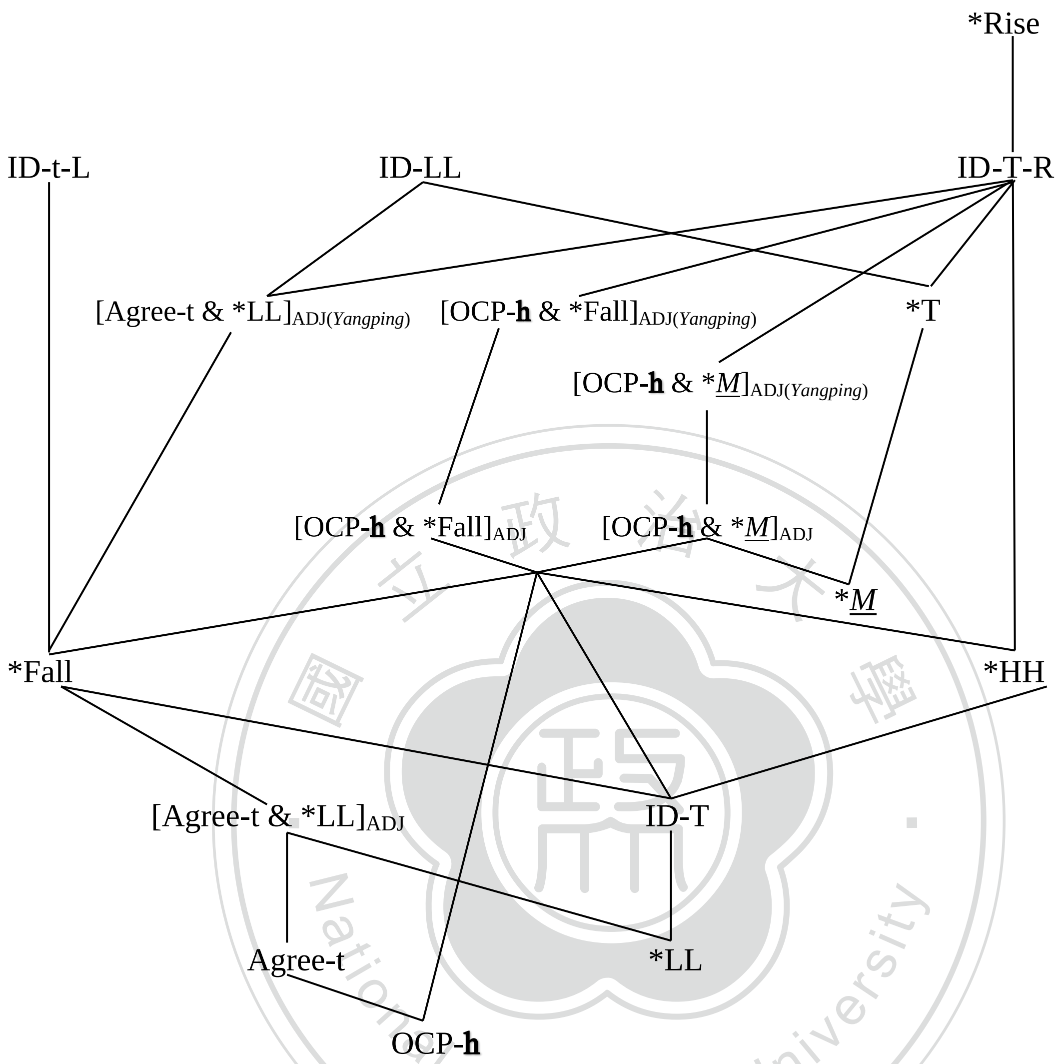
M –LL [Lr, h]-[Lr, l]	ID-T-R	*T	ID-T
a.*M* –LL [Lr, h]-[Lr, l]		*!*	
☞b.*H* –LL [Hr, h]-[Lr, l]		*	*

In (36), candidate (a) violates *T twice because both tones are citation tones. Therefore, even though candidate (b) violates *T once, it still emerges as the optimal output.

In the *ru* tone sandhi, *T triggers the input *ru* tone to change. To combine the rankings of the *ru* tone sandhi and the non-ru tone sandhi, *T has to be dominated by ID-LL so that the unchanged tonal pairs, such as LL-HM, will not be wrongly eliminated.

The rankings of *Ru* tone and non-*ru* tone sandhi are combined and given in (37).

(37) The complete ranking of Liujia Raoping Hakka



3.4 Summary

This chapter investigates the tone sandhi in Liujia Raoping Hakka. Tone sandhi in this language is positional. All the tones of the right syllables are preserved. In terms of the non-*ru* tone sandhi, the universal tonal markedness is the trigger of the tone sandhi. *Fall and *HH are ranked equally based on the markedness conflation (de Lacy 2004). However, it is not enough to account for the historically merged tones, *Yangping* and *Yangqu*, which share an identical citation tone, but undergo different tone sandhi patterns. *Yangqu* tone sandhi is totally positional whereas *Yangping* tone sandhi is partially positional and partially contextual. When *Yangping* is followed by *Yin* tones, the tone sandhi patterns are contextual. In order to account for the tone sandhi of the merged tones under the OT framework, I argue for the indexed constraints (Pater 2007, 2010). On the other hand, the requirement of no citation tone exists in the *ru* tone sandhi. It is captured by *T following the idea of anti-faithfulness (Alderete 1999, 2001).

CHAPTER 4

NINGDU TIANTOU HAKKA

This chapter investigates the disyllabic tone sandhi in Ningdu Tiantou Hakka spoken in Jiangxi Province, China. The data are mainly from Huang (2010). Data from Li and Zhang (1992), Luo and Deng (1997), Liu (2001), Xie (2003), Chang (2003), and Huang (2006), are also considered. Most of the tone sandhi patterns are confirmed in the recoded data provided by Dr. Xiaoping Huang who is a native speaker of this language.

The rest of this chapter will be arranged as followed. Section 4.1 introduces the tone inventory and section 4.2 introduces tone sandhi patterns. Section 4.3 provides an OT analysis on the tone sandhi patterns. Finally, section 4.4 is the summary for this chapter.

4.1 Tone Inventory

There are seven citation tones in this language, namely *Yinping* HM, *Yangping*

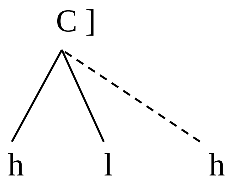
LM, *Shang* MLM, *Yinqu* ML, *Yangqu* MH[4], *Yinru* L, and *Yangru* H. The tones transcribed in terms of Yip's (2001) system as well.

In terms of *Yinping*, Huang (2010) transcribed it as 51. However, Huang used to specify it as 43 in 2006; moreover, other studies (Li and Zhang 1992, Luo and Deng 1997, Liu 2001, Xie 2003, Chang 2003) transcribed *Yinping* as 42 or 43. In Lin's (2007) point of view, 51 is usually perceived as 53 in a speech. This tone starts in a high pitch range, and ends in a mid-pitch range. *Yinping* in this dialect displays a similar pattern; therefore, *Yinping* is transcribed as HM in this thesis. As for *Yangping*, Huang (2010) originally specified it as 324 which is different from his own study in 2006. Huang (2006) transcribed *Yangping* as 24. According to him and his recorded data, *Yangping* can be regarded as 24 or 13. The 3 in 324 can be considered a phonetic detail which is not significant in the phonological distinction. Furthermore, Duanmu (2007) mentioned that 24 is close to both 35 and 13. To determine its tone value, the four-contour system proposed by Yip (2001) is adopted. According to Yip (2001), since there is already a 35 tone in this language, the 24 should actually be transcribed as 13. Hence, *Yangping* is transcribed as LM. There is no distinction between *Yinshang* and *Yangshang*. It is originally transcribed as 214 (Huang 2010) and 213 (Huang 2006) respectively; thus, it is converted as MLM here. Also, it only surfaces

[4] In addition to Huang (2006, 2010), other studies transcribe *Yangqu* as a high level tone. Nevertheless, according to the recorded data, *Yangqu* is more like a MH. It is closer to the transcription in Huang (2006, 2010).

as MLM when it is in the prosodically final position. It follows the contour formation of Bao (1999), who took Pingyao as the example, as in (1).

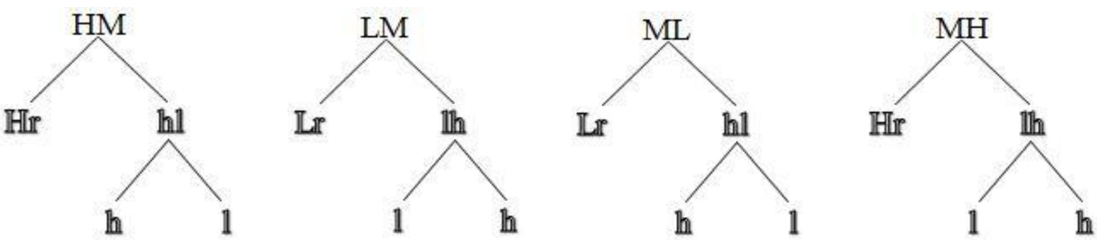
(1) Contour formation

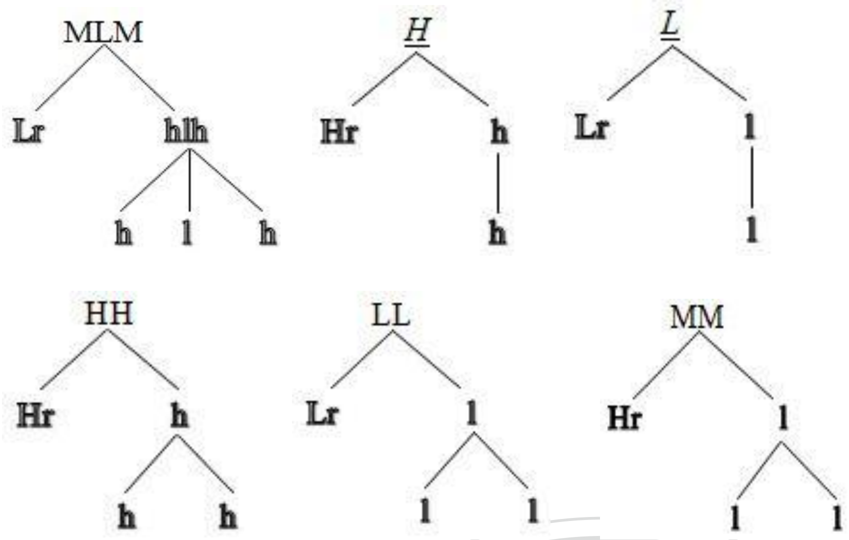


In (1), the concave tone is from the falling tone in the phrase final position. Following Duanmu's (2007) viewpoint, each TBU can carry just one tone. Therefore, the final tone "M" is realized by the extra mora in the phrase final position.

As in chapter three, the internal structures of the tones in this dialect are given in (2).

(2) The internal structure of Ningdu Tiantou Hakka tones





In (2), the level tones are not in the tone inventory. The high level tone HH only surfaces as a sandhi tone in this language. The mid-level tone and the low level tone are presented in order to clarify the tonal structures of possible candidates. Besides, the mid-level tone in this language is specified as a high registered low tone according to Yip (2001). Although the mid-level tone could be specified as either [Hr, l] or [Lr, h], [Hr, l] better explains the tone sandhi patterns in this language. In this dialect, the constraints, *Fall and *Concave, in the verb-object construction trigger HM and MLM to undergo tone sandhi. Then ID-t-L preserves the left tone melody of the input tone and form the optimal output, HH. If MM is specified as [Lr, h], the optimal output, HH, could not be successfully selected. Therefore, MM is considered [Hr, l] in this dialect.

4.2 Tone Sandhi Patterns

Tone sandhi in this language is construction sensitive. Disyllabic words with different grammatical constructions undergo different tone sandhi processes. The grammatical constructions of disyllabic subject-predicate and verb-complement words do not undergo tone sandhi. In the verb-object constructions (henceforth construction $\mathbb{A}$), tone sandhi takes place in the left syllable. On the other hand, in the modifier-head and conjunction constructions (henceforth construction $\mathbb{B}$), tone sandhi may take place in either side or both sides of the disyllabic words. According to Huang (2010), disyllabic subject-predicate and verb-complement words do not undergo tone sandhi because these two constructions are structurally looser than other constructions. However, Huang (2010) did not explain how their constructions are looser. Besides, if the internal construction influences tone sandhi patterns, what is the mechanism that decides different tone sandhi patterns in construction $\mathbb{A}$ and construction $\mathbb{B}$. Additionally, if the so called looser constructions do not undergo tone sandhi, it faces difficulties in explaining Pingyao tone sandhi. Lin (2012) investigated the construction sensitive tone sandhi in Pingyao. In Pingyao, subject-predicate and verb-object constructions display the same tone sandhi pattern whereas modifier-head, conjunction and verb-complement construction display the other tone sandhi pattern. It shows that the claim proposed by Huang (2010) is not necessarily true. In this case, the mapping among constructions and tone sandhi patterns will be considered a language specific phenomenon. The tone sandhi patterns of construction 𝔸 and construction 𝔹 will be discussed respectively in the following section of this chapter.

4.2.1 Tone sandhi patterns of construction 𝔸

The disyllabic tone sandhi patterns of construction 𝔸 are illustrated as follows:

(3) Tone sandhi patterns of construction 𝔸

2nd σ 1st σ	Yinping HM [Hr, hl]	Yangping LM [Lr, lh]	Shang MLM [Lr, hlh]	Yinqu ML [Lr, hl]	Yangqu MH [Hr, lh]	Yinru *L* [Lr, l]	Yangru *H* [Hr, h]
Yinping HM [Hr, hl]	**HH**-HM **Hr**-Hr **h**-hl	**HH**-LM **Hr**-Lr **h**-lh	**HH**-MLM **Hr**-Lr **h**-hlh	**HH**-ML **Hr**-Lr **h**-hl	**HH**-MH **Hr**-Hr **h**-lh	**HH**-*L* **Hr**-Lr **h**-l	**HH**-*H* **Hr**-Hr **h**-h
Yangping LM [Lr, lh]	LM-HM Lr-Hr lh-hl	LM-LM Lr-Lr lh-lh	LM-MLM Lr-Lr lh-hlh	LM-ML Lr-Lr lh-hl	LM-MH Lr-Hr lh-lh	LM-*L* Lr-Lr lh-l	LM-*H* Lr-Hr lh-h
Shang MLM [Lr, hlh]	**HH**-HM **Hr**-Hr **h**-hl	**HH**-LM **Hr**-Lr **h**-lh	**HH**-MLM **Hr**-Lr **h**-hlh	**HH**-ML **Hr**-Lr **h**-hl	**HH**-MH **Hr**-Hr **h**-lh	**HH**-*L* **Hr**-Lr **h**-l	**HH**-*H* **Hr**-Hr **h**-h
Yinqu ML [Lr, hl]	ML-MH Lr-Hr hl-lh	ML-LM Lr-Lr hl-lh	ML-MLM Lr-Lr hl-hlh	ML-ML Lr-Lr hl-hl	ML-MH Lr-Hr hl-lh	ML-*L* Lr-Lr hl-l	ML-*H* Lr-Hr hl-h
Yangqu MH [Hr, lh]	MH-HM Hr-Hr lh-hl	MH-LM Hr-Lr lh-lh	MH-MLM Hr-Lr lh-hlh	MH-ML Hr-Lr lh-hl	MH-MH Hr-Hr lh-lh	MH-*L* Hr-Lr lh-l	MH-*H* Hr-Hr lh-h
Yinru *L* [Lr, l]	*L*-HM Lr-Hr l-hl	*L*-LM Lr-Lr l-lh	*L*-MLM Lr-Lr l-hlh	*L*-ML Lr-Lr l-hl	*L*-MH Lr-Hr l-lh	*L*-*L* Lr-Lr l-l	*L*-*H* Lr-Hr l-h
Yangru *H* [Hr, h]	*H*-HM Hr-Hr h-hl	*H*-LM Hr-Lr h-lh	*H*-MLM Hr-Lr h-hlh	*H*-ML Hr-Lr h-hl	*H*-MH Hr-Hr h-lh	*H*-*L* Hr-Lr h-l	*H*-*H* Hr-Hr h-h

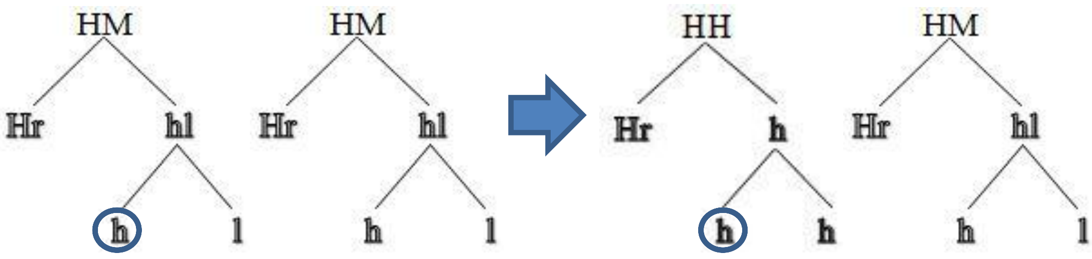
The bold tones are those that undergo tone sandhi. In (3), it demonstrates that tone sandhi occurs only when *Yinping* HM and *Shang* MLM are in the first syllable in construction 𝔸. Then the requirement of no falling tones and no concave tones will be regarded as the motivation for tone sandhi in construction 𝔸. It follows the universal tonal markedness tendency postulated by Yip (2001, 2002). In this tonal markedness tendency, contour tones are more marked. Moreover, the rising tone is more marked than the falling tone. If the falling tone is not allowed in the surface, the more marked rising tone should have been forbidden. In (3), the tone sandhi patterns obviously do not follow this tendency, i.e. the rising tones do surface. This tonal preservation tendency could be considered a specific tendency for this construction in this dialect. It only occurs in construction 𝔸. Generally, the tone sandhi patterns of construction 𝔸 are similar to the tone sandhi patterns in Liujia Raoping Hakka, except for the preservation of rising tones. Tone sandhi in both dialects can be regarded as positional tone sandhi. The motivation for tone sandhi is not due to adjacent tones but the position. The position decides the syllables which undergo tone sandhi.

In addition to the motivation of tone sandhi, the mechanism of the emergence of the high level tone is preserving the left tone melody of the input tone, as in (4).

(4) Construction ***A*** tone sandhi mechanism

HM-HM → **HH**-HM

[k^hwai $tʃ^h$a] 'drive the car'



In (4), the left tone melody of the first HM is **h**. It is preserved to form a level tone. The left tone melody preservation follows the tonal target (Yip 2001) as it is argued in the last chapter. The example of the initial taget is in (5).

(5) The initial target of *Yinping*

ʃɔŋ HM 'fragrant'

In (5), there is a short high plateau in the initial of the tone. It follows the description of initial target in Yip (2001). The left tone melody preservation then is due to the initial tonal target in this dialect.

The competition among the high level tone and other level tones will be demonstrated in the OT analyses in 4.3.

4.2.2 Tone sandhi patterns of construction 𝔹

Tone sandhi patterns in construction 𝔹 are more complicated than it is in construction 𝔸. Both left and right syllables may undergo tone sandhi. The disyllabic tone sandhi patterns of construction 𝔹 are illustrated as follows:

(6) Tone sandhi patterns of construction 𝔹

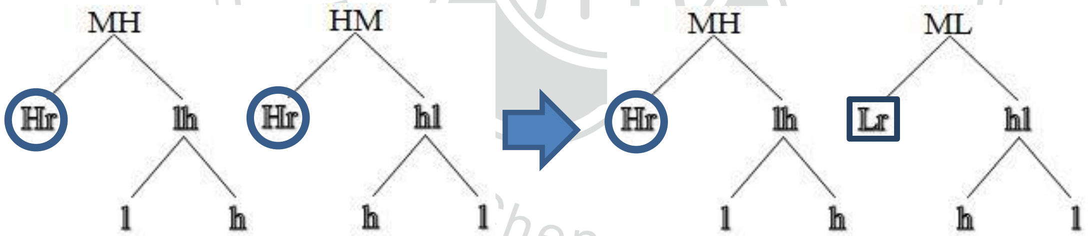
2nd σ 1st σ	Yinping HM [Hr, hl]	Yangping LM [Lr, lh]	Shang MLM [Lr, hlh]	Yinqu ML [Lr, hl]	Yangqu MH [Hr, lh]	Yinru *L* [Lr, l]	Yangru *H* [Hr, h]
Yinping HM [Hr, hl]	**ML-ML** **Lr-Lr** **hl-h**	HM-LM Hr-Lr hl-lh	HM-MLM Hr-Lr hl-hlh	HM-ML Hr-Lr hl-hl	**ML-ML** **Lr-Lr** **hl-h**	HM-L Hr-Lr hl-l	**ML-L** **Lr-Lr** **hl-l**
Yangping LM [Lr, lh]	LM-HM Lr-Hr lh-hl	LM-LM Lr-Lr lh-lh	LM-MLM Lr-Lr lh-hlh	LM-ML Lr-Lr lh-hl	LM-MH Lr-Hr lh-lh	LM-*L* Lr-Lr lh-l	LM-*H* Lr-Hr lh-h
Shang MLM [Lr, hlh]	**ML-ML** **Lr-Lr** **hl-h**	**HM**-LM **Hr**-Lr **hl**-lh	**HM**-MLM **Hr**-Lr **hl**-hlh	**HM**-ML **Hr**-Lr **hl**-hl	**ML-ML** **Lr-Lr** **hl-h**	**HM**-L **Hr**-Lr **hl**-l	**ML-L** **Lr-Lr** **hl-l**
Yinqu ML [Lr, hl]	ML-**LM** Lr-**Lr** hl-**lh**	ML-LM Lr-Lr hl-lh	ML-MLM Lr-Lr hl-hlh	ML-ML Lr-Lr hl-hl	ML-MH Lr-Hr hl-lh	ML-*L* Lr-Lr hl-l	ML-*H* Lr-Hr hl-h
Yangqu MH [Hr, lh]	MH-**ML** Hr-**Lr** lh-**hl**	MH-LM Hr-Lr lh-lh	MH-MLM Hr-Lr lh-hlh	MH-ML Hr-Lr lh-hl	MH-**ML** Hr-**Lr** lh-**hl**	MH-*L* Hr-Lr lh-l	MH-***L*** Hr-**Lr** lh-**l**
Yinru *L* [Lr, l]	*L*-**LM** Lr-**Lr** l-**lh**	*L*-LM Lr-Lr l-lh	*L*-MLM Lr-Lr l-hlh	*L*-ML Lr-Lr l-hl	*L*-MH Lr-Hr l-lh	*L*-*L* Lr-Lr l-l	*L*-*H* Lr-Hr l-h
Yangru *H* [Hr, h]	*H*-**ML** Hr-**Lr** h-**hl**	*H*-LM Hr-Lr h-lh	*H*-MLM Hr-Lr h-hlh	*H*-ML Hr-Lr h-hl	*H*-**ML** Hr-**Lr** h-**hl**	*H*-*L* Hr-Lr h-l	*H*-***L*** Hr-**Lr** h-**l**

In (6), both the first and the second syllables may undergo tone sandhi. All the low register tones, LM, ML and L, have no change, except for MLM. It displays a tendency that low tones in this dialect tend to stay invariant. In terms of the second-syllable tone sandhi, it takes place when high register tones are in the second syllable. This kind of tone sandhi results from the avoidance of two adjacent high register tones or the requirement of no tone rising in the syllable boundary. The mechanism is given in (7) and (8).

(7) The avoidance of two adjacent high register tones

MH-HM → MH-**ML**

[t^hien tin] 'light'

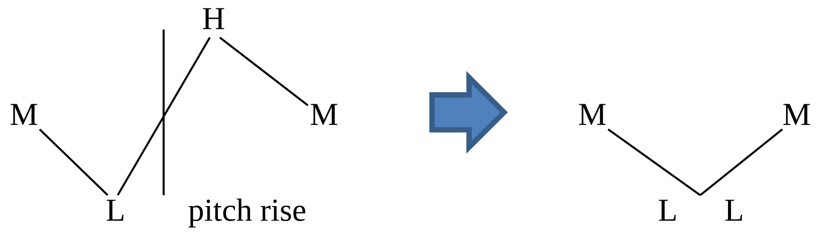


In (7), it is an example of the second-syllable tone sandhi. The trigger of the tone sandhi is the avoidance of two adjacent high register tones. The high register tone in the second syllable is then dissimilated into a low register tone. The other type of the second-syllable tone sandhi is in (8).

(8) No tone rising during the syllable boundary

ML-HM → ML-**LM**

[tʃʰi tʃʰa] ‘car’



In (8), the right tonal feature of the first syllable is L while the left tonal feature of the second syllable is H. The pitch across these two syllables is an abrupt rising. In order to prevent the rising pitch in the intersyllabic position, the second syllable is changed to LM. This phenomenon only takes place when there is one tone staying unchanged in the tonal pair during the tone sandhi process, as in (8)[5]. However, the tonal pair in which both tones undergo tone sandhi does not display the pattern in (8). As for **ML-ML**, the optimal output of HM-MH, it does not display the pattern in (8) because **ML-ML** here does not contain any citation tones. This analysis is based on Lin (2006) and Zhang (1999). Lin (2006) mentioned that, in terms of articulation, it is difficult for speakers to produce intersyllabic tone melodies with wide distance apart. Besides, Zhang (1999) pointed out that the duration of the intersyllabic position is shorter than a syllable. Hence, it is harder for the rising pitch to be realized in the

[5] The unchanged tonal pair, ML-MH, will be discussed in 4.3.2.

intersyllabic position. On the other hand, the tone sandhi of ML-HM is not regarded as the requirement of the agreement of intersyllabic tone melodies because it will face difficulties in the OT framework. If so, the optimal output, ML-**LM**, will be eliminated by the candidate, ML-**ML**.

As for the first-syllable tone sandhi, it occurs when MLM is followed by low register tones. Since MLM needs an extra TBU to realize the last tonal feature M, it only occurs in the second syllable. The mechanism is shown in (1). Therefore, the tone sandhi may be triggered by the requirement of no concave tone in the non-phrase final position.

Last, the both-syllable tone sandhi takes place in two contexts. One is when HM is followed by a high register tone. The other is when MLM is followed by a high register tone. The triggers for the tone sandhi patterns are the avoidance of two adjacent high register tones, the requirement of no high tones and the avoidance of MLM in the non-phrase final position. First of all, the avoidance of two adjacent high register tones could trigger the tone sandhi when HM is followed by a high register tone. Second, the requirement of no high tones prevents the sandhi tones from becoming high register tones. Therefore, both syllables undergo tone sandhi. Since most of the sandhi tones in construction $\mathbb{B}$ are low-registered, this requirement exists. Third, the avoidance of MLM in the non-phrase final position triggers the tone sandhi of MLM in the first syllable. The high register tones following MLM change because of the requirement of no high tones.

4.3 OT analysis

According to 4.2, constructions 𝔸 and construction 𝔹 display very different tone sandhi patterns. In the framework of OT, because of different morphological structures, different constraint rankings may be proposed. It follows the idea of cophonology (Orgun 1996, 1998, 1999, Anttila 1997, Anttila and Cho 1998, Inkelas and Zoll 2005, 2007, among others) that different rankings do exist. Besides, the indexed approach (McCarthy and Prince 1995, Itô and Mester 1999, 2001, Alderete 2001, Pater 2000, 2007, 2010, among others) also works in dealing with different constructions with different tone sandhi patterns. However, cophonology fails to account for situations where the indexed approach could successfully solve. In this case, the indexed approach is adopted.

4.3.1 OT analysis of Tone sandhi in construction 𝔸

To account for the tone sandhi in construction 𝔸, several constraints will be posited in (9)-(15).

(9) IDENT-IO-T-R(Hr) (abbr. ID-T-R(Hr)):

Assign one violation mark for every Hr tone standing at the right edge which is different from its corresponding tone in the output.

(10) IDENT-IO-T-R(Lr) (abbr. ID-T-R(Lr)):

Assign one violation mark for every Lr tone standing at the right edge which is different from its corresponding tone in the output.

(11) IDENT-IO-T-L(Hr) (abbr. ID-T-L(Hr)):

Assign one violation mark for every Hr tone standing at the left edge which is different from its corresponding tone in the output.

(12) IDENT-IO-T-L(Lr) (abbr. ID-T-L(Lr)):

Assign one violation mark for every Lr tone standing at the left edge which is different from its corresponding tone in the output.

(13) IDENT-IO-t-L (abbr. ID-t-L):

Assign one violation mark for an output tone which the tone melody at the left edge of the tone melody level is different its corresponding input (Lin 2011).

(14) *Fall

Assign one violation mark for every output falling tone.

(15) *Concave

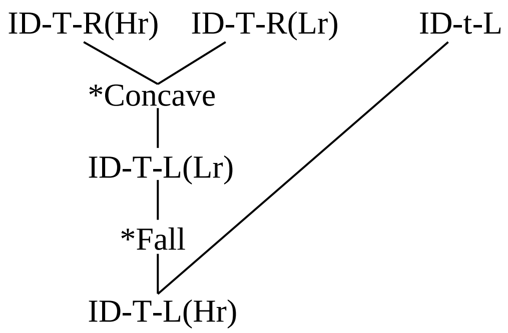
Assign one violation mark for every output concave tone.

Constraints in (9)-(12) are based on Lin's (2012) work. Lin (2012) investigated the tone sandhi in Pingyao. In Pingyao, the tone sandhi may take place in both the first and the second syllable. Lin (2012) then posited the faithfulness constraints which target the register. However, in Pingyao tone sandhi, Lin (2012) defined the preserved syllable as "head" and the "head" follows the tonal preference tendency proposed by de Lacy (1999, 2002), i.e. the high tone is preferred in the head position. However, as it is mentioned in chapter three, the "head" is easily misled to the stress issue. Besides, the preservation of register in is a different case in Ningdu Tiantou Hakka. In this dialect, low register tones are preserved in both construction $\mathbb{A}$ and construction $\mathbb{B}$. In this case, the tonal preference tendency proposed by de Lacy (1999, 2002) fails to account for this. Accordingly, the tonal preservation is regarded as a typological difference.

In OT, the syllable preservation is due to the interaction among faithfulness constraints and markedness constraints. Hence, in this dialect, the tone sandhi takes place in both syllable because of the interaction among faithfulness constraints, (9)-(13), and markedness constraints.

In this construction, the second syllable never changes; therefore, ID-T-R(Hr) and ID-T-R(Lr) are undominated. All the candidates whose tone in the second syllable undergoes tone sandhi must be ruled out by ID-T-R(Hr) and ID-T-R(Lr). In this case, the violation of ID-T-R(Hr) and ID-T-R(Lr) will no longer be discussed in the rest of this chapter. ID-t-L captures the fact that the optimal output forms preserve the left tone melody of the input form. *Fall and *Concave prevent the output falling tones and concave tones. *Concave needs to dominate ID-T-L(Lr) so that MLM may not surface in the first syllable. *Fall has to be dominated by ID-T-L(Lr). In this case, *Fall will only influence high register tones. Due to that HM in the first syllable undergoes tone sandhi, *Fall dominates ID-T-L(Hr). In this case, *Fall only rule out high register falling tones instead of low register falling tones. The constraint ranking is given in (16).

(16) The constraint ranking of Construction ***A***



In (16), it demonstrates that ID-T-R(Hr) and ID-T-R(Lr) needs to dominate markedness constraints because tones in the second syllable never change. Moreover, ID-t-L does not have crucial ranking with markedness constraints. It only dominates ID-T to confirm that the optimal output is selected and the left tone melody of the input form is preserved. The tableau in (17), (18) and (19) provide examples in the ranking in (16).

(17) *Yinqu* ML in the ranking

ML-HM → ML-HM

[kua tsʰiaŋ] ‘sweep the tomb’

ML-HM [Lr, hl]-[Hr, hl]	ID-t-L	*Concave	ID-T-L (Lr)	*Fall	ID-T-L (Hr)
a.HM-HM [Hr, hl]-[Hr, hl]			*!	**	
b.MH-HM [Hr, lh]-[Hr, hl]	*!		*	*	
☞c.ML-HM [Lr, hl]-[Hr, hl]				**	
d.LM-HM [Lr, lh]-[Hr, hl]	*!		*	*	
e.MLM-HM [Lr, hlh]-[Hr, hl]		*!	*	*	
f.HH-HM [Hr, h]-[Hr, hl]			*!	*	
g.MM-HM [Hr, l]-[Hr, hl]	*!		*	*	
h.LL-HM [Lr, l]-[Hr, hl]	*!		*	*	

ML-HM is a tonal pair which does not undergo tone sandhi. In (17), level tones are discussed because they are possible outputs in construction ***A***. Moreover, the tableau in (17) illustrates that ID-T-L(Lr) needs to dominate *Fall so that candidate (c), the optimal output, will not be eliminated by candidate (f). ID-t-L rules out candidates (b), (d), (g) and (h) because the left tone **l**-melody of these candidates is different from the left tone melody of the input form, which is **h**. Candidate (e) violates *Concave due to MLM in the first syllable. Candidates (a) and (f) are eliminated by ID-T-L(Lr) because the tone in the first syllable is not identical to the input ML. Tableau (18) will diaplay the tone sandhi process of *Yinping* HM and the ranking between *Fall and ID-T-L(Hr).

(18) *Yinping* HM in the ranking

HM-HM → **HH**-HM

[kʰuai tʃʰa] 'drive the car'

HM-HM [Hr, hl]-[Hr, hl]	ID-t-L	*Concave	ID-T-L (Lr)	*Fall	ID-T-L (Hr)
a.HM-HM [Hr, hl]-[Hr, hl]				**!	
b.MH-HM [Hr, lh]-[Hr, hl]	*!			*	*
c.ML-HM [Lr, hl]-[Hr, hl]				**!	*
d.LM-HM [Lr, lh]-[Hr, hl]	*!			*	*
e.MLM-HM [Lr, hlh]-[Hr, hl]		*!		*	*
☞f.HH-HM [Hr, h]-[Hr, hl]				*	*
g.MM-HM [Hr, l]-[Hr, hl]	*!			*	*
h.LL-HM [Lr, l]-[Hr, hl]	*!			*	*

In (18), it illustrates the reason why the mid-level tone is defined as the high register low tone, [Hr, l]. If the mid-level tone is defined as [Lr, H], it will not violate ID-t-L and candidate (f) and (g) will tie. If so, the optimal output could not be predicted successfully. On the other hand, tableau (18) demonstrates that *Fall has to dominate ID-T-L(Hr); otherwise, candidate (a), HM-HM, will be wrongly predicted as the optimal output. Candidates (b), (d), (g) and (h) are ruled out by ID-t-L because the left tone **l**-melody in the output is different from the left tone melody of the input form, which is **h**. Candidate (e) contains MLM, so it violates *Concave. Candidate (a) and (c) contain two falling tones; therefore, they violate *Fall twice. Even candidate (f) violates *Fall once, it is still chosen as the optimal output. Furthermore, in (19), the tone sandhi pattern of *Shang* MLM and the ranking between *Concave and ID-T-L(Lr) will be illustrated.

(19) *Shang* MLM in the ranking

MLM-HM → **HH**-HM

[sie sam] 'wash clothes'

MLM-HM [Lr, hlh]-[Hr, hl]	ID-t-L	*Concave	ID-T-L (Lr)	*Fall	ID-T-L (Hr)
a.HM-HM [Hr, hl]-[Hr, hl]			*	**!	
b.MH-HM [Hr, lh]-[Hr, hl]	*!		*	*	*
c.ML-HM [Lr, hl]-[Hr, hl]			*	**!	*
d.LM-HM [Lr, lh]-[Hr, hl]	*!		*	*	*
e.MLM-HM [Lr, hlh]-[Hr, hl]		*!		*	*
☞f.HH-HM [Hr, h]-[Hr, hl]			*	*	*
g.MM-HM [Hr, l]-[Hr, hl]	*!		*	*	*
h.LL-HM [Lr, l]-[Hr, hl]	*!		*	*	*

In (19), it demonstrates that *Concave should dominate ID-T-L(Lr). If there is no crucial ranking, candidate (e) and candidate (f) will tie. Besides, if *Concave is dominated by ID-T-L(Lr), candidate (e) will be incorrectly predicted as the optimal output. In this tableau, the left tone melody of candidates (b), (d), (g) and (h) are different from the corresponding **h** tone melody in the input; hence, they are eliminated by ID-t-L. Candidate (e) is eliminated by *Concave because of MLM in the first syllable. In candidates (a) and (c), both syllables are falling tones, and thus violate *Fall twice. Since candidate (f) only violates *Fall only once, it is selected as the optimal output.

According to (14) and (15), it is obvious that the triggers for the positional tone sandhi in construction 𝔸 are *Fall and *Concave. The preservation of the first syllable is captured by ID-T-L(Lr) and ID-T-L(Hr).

4.3.2 OT analysis of Tone sandhi in construction 𝔹

In construction 𝔹, tone sandhi could take place in both first and second syllable. In this case, constraints preserving the input tones have to target both syllable as in construction 𝔸 in 4.3.1. In this dialect, there is a tendency for low register tones to stay unchanged. In this case, the register must be considered. Four constraints posited in (9), (10), (11), and (12) are still needed in construction 𝔹. They are ID-T-R(Hr), ID-T-R(Lr), ID-T-L(Hr) and ID-T-L(Lr) respectively.

4.3.2.1 The second-syllable tone sandhi

In this construction, the tonal markedness tendency (Yip 2001, 2002) still works. The concave tone is the most marked. Rising tones are more marked than falling tones. The constraints for concave tones and falling tones have already been posited in (14) and (15). The constraint which targets rising tones will be posited.

(20) *Rise

Assign one violation mark for every output concave tone.

Moreover, to account for MH-MH, the second-syllable tone sandhi in this construction, the following constraints are necessary.

(21) OCP-Hr:

Assign one violation mark for every adjacent high register tones.

(22) *Hr:

Assign one violation mark for every output high register tone.

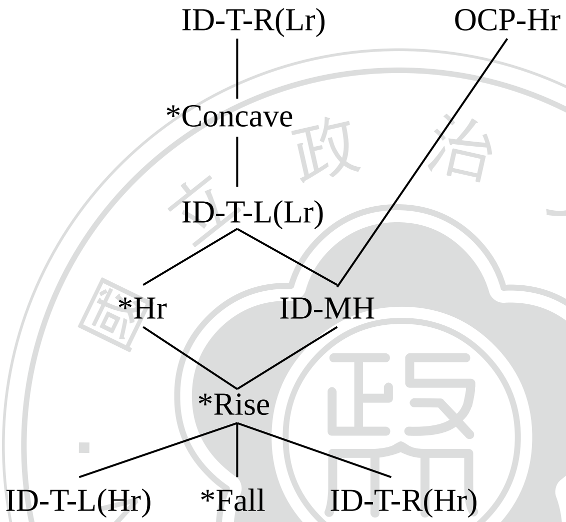
(23) IDENT-IO-MH (abbr. ID-MH):

Assign one violation mark for every input MH which is not identical with its corresponding tone in the output.

OCP-Hr is posited because there are no adjacent high register tones, as in (7). As for *Hr, since high register tones tend to be more unstable, it is posited. ID-MH is necessary to prevent MH from changing in the tonal pairs, such as MH-HM and

MH-MH. The reason why ID-MH is posited instead of ID-Rise is because the former targets the specific preservation of MH instead of all rising tones. As for the ranking of the constraints, OCP-Hr and ID-T-R(Lr) are placed as undominated. It is because no adjacent high register tones are allowed and the low register tones in the second syllable never change. OCP-Hr needs to dominate ID-MH to ascertain that **ML**-**ML**, the optimal output of HM-MH, may not be eliminated by **LM**-MH. ID-T-R(Lr) has to dominate *Concave which dominates ID-T-L(Lr). This ranking requires the concave tone to occur only in the second syllable. ID-T-L(Lr) has to dominate ID-MH; otherwise, **ML**-**ML**, the optimal output of HM-MH, will be ruled out by **LM**-MH. Also, ID-T-L(Lr) has to dominate *Hr so that ML-MH, the unchanged tonal pair, will not be wrongly changed into ML-**ML**. Besides, there is no crucial ranking between ID-MH and *Hr. If ID-MH is ranked higher than *Hr, **ML**-**ML**, the optimal output of MLM-MH, will be eliminated by **LM**-MH which is a possible candidate. On the other hand, if *Hr dominates ID-MH, MH-**ML**, the optimal output of MH-HM, will be ruled out by **ML**-**ML** which is a possible candidate. These two constraints have to dominate *Rise in order not to rule out the tonal pairs, such as ML-MH. As for the ranking between *Rise and *Fall, it follows the schema of tonal markedness tendency (Yip 2001, 2002), i.e. *Rise has to be ranked higher. The evidence will be provided in the tone sandhi process of MLM-MH which will change to **ML**-**ML**. If there is no ranking between *Rise and *Fall or *Fall dominates *Rise, **ML**-**ML** will be eliminated by **LM**-MH. Finally, there is no crucial ranking between *Fall, ID-T-L(Hr) and ID-T-L(Lr). The constraint ranking is illustrated in (24).

(24) Temporal ranking 1



The tableau in (25) will demonstrate how the constraint ranking in (24) accounts for the second-syllable tone sandhi of MH-MH.

(25) *Yangqu* MH- *Yangqu* MH in the temporal ranking 1

MH-MH → MH-**ML**

[tʰai ʃu] ‘big tree’

MH-MH [Hr, lh]-[Hr, lh]	OCP-Hr	*Concave	ID-T-L(Lr)	ID-MH	*Hr	*Rise	*Fall	ID-T-R(Hr)	ID-T-L(Hr)
a.MH-MH [Hr, lh]-[Hr, lh]	*!				**	**			
b.MH-MLM [Hr, lh]-[Lr, hlh]		*!		*	*	*		*	
c.HM-ML [Hr, hl]-[Lr, hl]				**	*!		**	*	*
d.LM-MH [Lr, lh]-[Hr, lh]				*	*	**!			*
e.LM-ML [Lr, lh]-[Lr, hl]				**		*	*	*	*!
☞f.MH-ML [Hr, lh]-[Lr, hl]				*	*	*?	*	*	
?g.ML-ML [Lr, hl]-[Lr, hl]				**			**	*	*

Since low register tones in the second syllable never undergo tone sandhi, the violation of ID-T-R(Lr) will not be discussed. Candidate (a) in (25) is ruled out by OCP-Hr because it consists of two high register tones. Candidate (b) contains a MLM in the second syllable so it violates *Concave. Candidate (c) violates ID-MH twice because two rising tones in the input are not preserved in the output. Besides, there is a high register tone, HM, in the first syllable of candidate (c) which causes one violation to *Hr. Therefore, there are three violation marks for candidate (c) which cause the elimination. Candidate (d) contains two rising tones so it violates *Rise twice; hence, it is eliminated. Candidate (e) has a falling tone in the first syllable. It violates *Fall once. Also, both syllables in candidate (e) are not identical to their corresponding high register input. Therefore, both ID-T-R(Hr) and ID-T-L(Hr) are violated by candidate (e). Candidate (e) then has three violation marks and gets eliminated. Since there is no rising tone in candidate (g), it incorrectly wins the competition as the optimal output. To ensure that the optimal output is selected, candidate (g) must be ruled out. However, ML-ML is a possible tonal pair in the output. Constraints cannot target the output form only. Notice that the optimal output preserves the input MH in the first syllable. In this case, the conjoined constraint, [ID-T-L(Hr) & *Fall]$_{SEG}$ is posited.

(26) [ID-T-L(Hr) & *Fall]$_{SEG}$:

Assign one violation mark for a tone which violates both ID-T-L(Hr) and *Fall.

The constraint in (26) consists of ID-T-L(Hr) instead of the ID-MH in order not to wrongly rule out **ML-ML**, the optimal output of HM-MH. According to the schema of constraint conjunction (Smolensky 1993), conjoined constraints need to dominate component constraints. If the constraint was posited as [ID-MH & *Fall]$_{SEG}$, it has to be ranked higher than ID-MH. However, **ML**-**ML**, the optimal output of HM-MH, will be eliminated by **LM**-MH which is a possible candidate. In this case, [ID-T-L(Hr) & *Fall]$_{SEG}$ is posited and ranked below ID-MH and *Hr to avoid the wrong prediction. Nonetheless, **ML**-**ML**, the optimal output of HM-HM, seems to be ruled out by this constraint. This case will be discussed in tableau (40). The tableau in (27) demonstrates how [ID-T-L(Hr) & *Fall]$_{SEG}$ rules out candidate (g).

(27) [ID-T-L(Hr) & *Fall]$_{SEG}$ rules out ML-ML

MH-MH → MH-**ML**

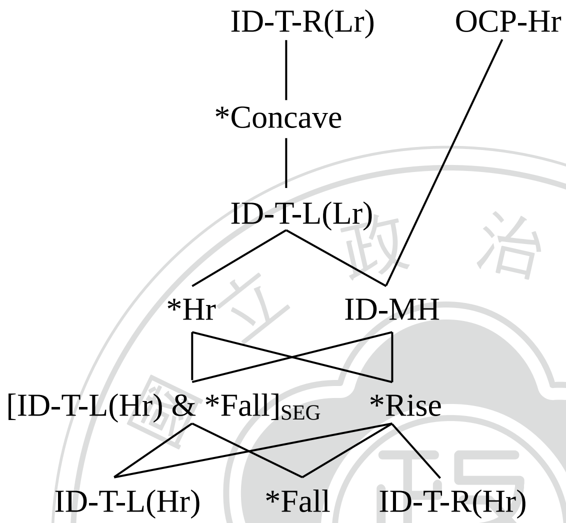
[tʰai ʃu] ‘big tree’

MH-MH [Hr, lh]-[Hr, lh]	OCP-Hr	*Concave	ID-T-L(Lr)	ID-MH	*Hr	[ID-T-L(Hr) & *Fall]$_{SEG}$	*Rise	*Fall	ID-T-R(Hr)	ID-T-L(Hr)
☞f.MH-ML [Hr, lh]-[Lr, hl]				*	*		*	*	*	
g.ML-ML [Lr, hl]-[Lr, hl]				**		*		**	*!	*

In (27), candidate (g) violates [ID-T-L(Hr) & *Fall]$_{SEG}$ because the input MH in the first syllable is not preserved and there is a falling tone in the first syllable. Candidate (g) has four violation marks whereas candidate (f) only has two; therefore, candidate (f) is selected as the optimal output.

The revised ranking will be given in (28).

(28) Temporal ranking 2



Nevertheless, the temporal ranking shown in (28) is challenged in dealing with the tone sandhi of ML-HM.

(29) *Yinqu* ML- *Yinping* HM in the temporal ranking 2

ML-HM → ML-**LM**

[tʃʰi tʃʰa] ‘car’

ML-HM [Lr, hl]-[Hr, hl]	OCP-Hr	*Concave	ID-T-L(Lr)	ID-MH	*Hr	[ID-T-L(Hr) & *Fall]$_{SEG}$	*Rise	*Fall	ID-T-R(Hr)	ID-T-L(Hr)
a.ML-HM [Lr, hl]-[Hr, hl]					*!			**		
b.ML-MH [Lr, hl]-[Hr, lh]					*!		*	*	*	
?c.ML-ML [Lr, hl]-[Lr, hl]								**	*	
☞d.ML-LM [Lr, hl]-[Lr, lh]							*?	*	*	

In (29), only four candidates are discussed because other candidates are ruled out by higher ranked constraints, OCP-Hr, *Concave and ID-T-L(Lr). Candidate (a) and (b) are ruled out by *Hr because there are high register tones, HM and MH, in the tonal pairs. The optimal output violates *Rise because of LM. Candidate (c) is incorrectly predicted as the optimal output. Notice that both candidates (c) and (d) prefer low register tones. The difference between them is in the intersyllabic position, as in (8). The pitch in the intersyllabic position of candidate (c) is rising while the pitch in the intersyllabic position of candidate (d) is not rising. Based on this difference, the constraint in (30) is posited to solve the problem in (29).

(30) *IntersyllabicRise (abbr. *IsRise):

Assign one violation mark for adjacent tones which have a rising pitch between two tones.

*IsRise is based on Zhang (1999). It is originally targeting the tonal coarticulation; however, Zhang (1999) also mentioned that, in terms of articulation, the duration of the syllable boundary is shorter than a syllable. In this case, it is harder to realize a rising tone. Besides, Lin (2006) posited *Polar which also targets the syllable boundary. It prohibits the big pitch change across the syllable boundary. Hence, *IsRise is used to account for the tone sandhi in (8). *IsRise has to be dominated by *Hr to ensure that **ML-ML**, the optimal output of MLM-HM, does not lose to other candidates, such as **HM-ML**. Then the wrong prediction in (29) can be solved.

(31) Competition between ML-ML and ML-LM

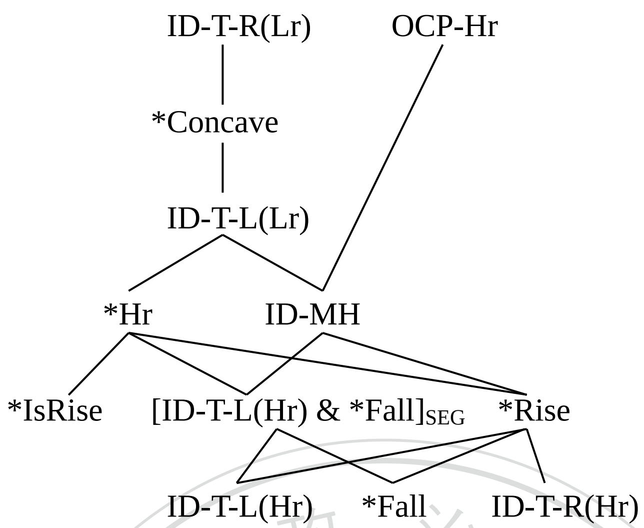
ML-HM → ML-**LM**

[tʃʰi tʃʰa] 'car'

ML-HM [Lr, hl]-[Hr, hl]	OCP-Hr	*Concave	ID-T-L(Lr)	ID-MH	*Hr	*IsRise	[ID-T-L(Hr) & *Fall]$_{SEG}$	*Rise	*Fall	ID-T-R(Hr)	ID-T-L(Hr)
c.ML-ML [Lr, hl]-[Lr, hl]						*			**	*!	
☞d.ML-LM [Lr, hl]-[Lr, lh]								*	*	*	

In (31), candidate (c) violates *IsRise because the intersyllabic pitch is rising. Since there is no crucial ranking between *Fall, ID-T-R(Hr) and ID-T-L(Hr), candidate (c) then has one more violation mark than candidate (d) does. Hence, candidate (c) is eliminated and candidate (d) is chosen as the optimal output. The constraint ranking displayed in (31) can account for all the tonal pairs which have the second-syllable tone sandhi. The revised ranking is given in (32).

(32) Temporal ranking 3



4.3.2.2 The first-syllable tone sandhi

As for the first-syllable tone sandhi, it occurs when MLM is followed by a low register tone. The trigger can simply be regarded as *Concave. However, the ranking in (32) encounters some problems in accounting for the mechanism of the first-syllable tone sandhi.

(33) *Shang* MLM-*Yinqu* ML in the temporal ranking 3

MLM-ML → **HM**-ML

[fo tsien] ‘rocket’

MLM-ML [Lr, hlh]-[Lr, hl]	OCP-Hr	*Concave	ID-T-L(Lr)	ID-MH	*Hr	*IsRise	[ID-T-L(Hr) & *Fall]$_{SEG}$	*Rise	*Fall
a.MH-ML [Hr, lh]-[Lr, hl]			*		*!			*	*
☞b.HM-ML [Hr, hl]-[Lr, hl]			*		*?				**
?c.ML-ML [Lr, hl]-[Lr, hl]			*			*			**
?d.LM-ML [Lr, lh]-[Lr, hl]			*					*	*

In dealing with the first-syllable tone sandhi, ID-T-R(Hr) and ID-T-L(Hr) are not influential. In this case, they are not considered in this section. In (33), only four candidates are discussed because other candidates are ruled out by OCP-Hr, ID-T-R(Lr) and *Concave. Candidate (a) is ruled out by *Hr because it contains the high register tone, MH. Candidate (b) should be the optimal output, but it is wrongly ruled out by *Hr. In this case, candidates (c) and (d) are incorrectly predicted as the optimal output forms. The case of candidate (c) is similar to that in (25). However, the solution proposed in (26) does not work here because the input forms are different.

Notice that both candidates (c) and (d) consist of two tones which have same register. To rule out candidates (c) and (d), OCP-Register is a possible solution.

(34) OCP-Register (OCP-Reg):

Assign one violation mark for adjacent tones which have the same register.

Nevertheless, OCP-Reg has to ranked lower than *Rise so that **ML-ML**, the optimal output of HM-MH, will not be eliminated. Due to the low ranking, OCP-Reg is not enough to rule out candidates (c) and (d). A conjoined constraint is posited in (35).

(35) [OCP-Reg & *Rise]$_{ADJ}$:

Assign one violation mark for adjacent tones which violate both OCP-Reg and *Rise (Lin 2011).

The constraint in (35) is from Lin (2011). This constraint is originally used to explain the tone sandhi in Dongshi Hakka. Here it is posited to rule out candidate (d) in (33). It has to be ranked higher than both ID-MH and *Hr. It is ranked higher than *Hr in order to successfully chose candidate (d) as the optimal output and rule out candidate (c) in (29). On the other hand, it ranked higher than ID-MH to ensure that **ML**-**ML**, the optimal output of HM-MH, is not eliminated. The tableau in (36) shows how [OCP-Reg & *Rise]$_{ADJ}$ works.

(36) [OCP-Reg & *Rise]$_{ADJ}$ rules out LM-ML

MLM-ML → **HM**-ML

[fo tsien] 'rocket'

MLM-ML [Lr, hlh]-[Lr, hl]	OCP-Hr	*Concave	ID-T-L(Lr)	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	[ID-T-L(Hr) & *Fall]$_{SEG}$	*Rise	OCP-Reg	*Fall
☞b.HM-ML [Hr, hl]-[Lr, hl]			*			*					**
?c.ML-ML [Lr, hl]-[Lr, hl]			*				*			*	**
d.LM-ML [Lr, lh]-[Lr, hl]			*	*!					*	*	*

In (36), candidate (d) is ruled out by [OCP-Reg & *Rise]$_{ADJ}$ because both LM and ML are low register tones and there is a rising tone in the tonal pair. However, the optimal output still loses to candidate (c). Notice that the differences between the tones in candidates (b) and (c) are the register of HM and ML and the pitch in the intersyllabic position. Since the register of the output falling tones is more marked, the pitch in the intersyllabic position is considered. The pitch in the intersyllabic position of candidate (c) is rising. In order to rule out candidate (c), *IsRise has to dominate *Hr somehow. Whenever the rising pitch in the intersyllabic position is penalized, there is a citation tone in the tonal pair. In other words, *IsRise also applies to the context where there is a citation tone in the tonal pair. The conjoined constraint is posited in (37).

(37) [*IsRise & *T]$_{ADJ}$:

Assign one violation mark for adjacent tones which violate both *IsRise and *T.

*T in (37) follows the concept of anti-faithfulness (Alderete 1999, 2001) and forbids citation tones in the output. If it is not conjoined with *IsRise, it is meaningless to posit this constraint because its ranking is low. It has to be dominated by both *Rise and [ID-T-L(Hr) & *Fall]$_{SEG}$ so that MH-**ML**, the optimal output of MH-HM, will not lose to the candidate, **ML**-**ML**. The low ranked *T cannot solve the problem in (33) and (36) alone; hence, [*IsRise & *T]$_{ADJ}$ is necessary. [*IsRise & *T]$_{ADJ}$ does not only target this tonal pair specifically, but also rules out the candidate, ML-MLM, and makes possible the emergence of **HM**-MLM, the optimal output of MLM-MLM.

In terms of the ranking of [*IsRise & *T]$_{ADJ}$, it has to dominate [OCP-Reg & *Rise]$_{ADJ}$; otherwise, ML-**LM**, the optimal output of ML-HM, will lose to the candidate, ML-**ML**. The residual problem in (36) is solved and demonstrated in (38).

(38) [*IsRise & *T]$_{ADJ}$ rules out ML-ML

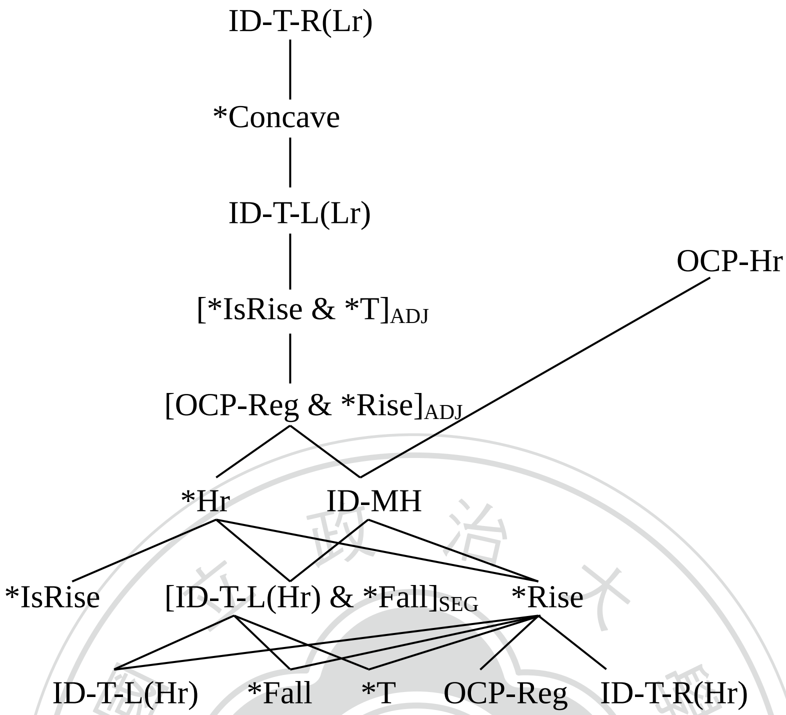
MLM-ML → **HM**-ML

[fo tsien] 'rocket'

MLM-ML [Lr, hlh]-[Lr, hl]	OCP-Hr	*Concave	ID-T-L(Lr)	[*IsRise & *T]$_{ADJ}$	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	[ID-T-L(Hr) & *Fall]$_{SEG}$	*Rise	*T	OCP-Reg	*Fall
☞b.HM-ML [Hr, hl]-[Lr, hl]			*				*				*		**
c.ML-ML [Lr, hl]-[Lr, hl]			*	*!				*			*	*	**

In (38), candidate (c) violates [*IsRise & *T]$_{ADJ}$ because the pitch in the intersyllabic position is rising and ML in the second syllable is a citation tone. In this case, candidate (b) is successfully predicted. The ranking for construction *B* can be revised as follows:

(39) Temporal ranking 4



4.3.2.3 Both-syllable tone sandhi

In terms of the both-syllable tone sandhi, the triggers are the avoidance of two adjacent high register tones, the avoidance of MLM in the non-phrase final position and the requirement of no high tones respectively. In OT, these factors can be captured by OCP-Hr, *Concave and *Hr. Since these three constraints are already discussed, the ranking in (39) could also account for. The tableau in (40) will take HM-HM as an example and illustrate how the tone sandhi of both syllables works.

(40) *Yinping* HM-*Yinping* HM in the temporal ranking 4

HM-HM → **ML-ML**

[fuŋ tʃʰa] ‘windmill’

HM-HM [Hr, hl]-[Hr, hl]	OCP-Hr	*Concave	ID-T-L(Lr)	[*IsRise & *T]$_{ADJ}$	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	[ID-T-L(Hr) & *Fall]$_{SEG}$	*Rise	*T	OCP-Reg	*Fall
a.HM-HM [Hr, hl]-[Hr, hl]	*!			*			**	*			**	*	**
b.MLM-HM [Lr, hlh]-[Hr, hl]		*!		*			*	*			*		*
c.ML-HM [Lr, hl]-[Hr, hl]				*!			*	*	*		*		**
d.ML-LM [Lr, hl]-[Lr, lh]					*!				*	*		*	*
e.HM-ML [Hr, hl]-[Lr, hl]							*!				*		**
☞f. ML-ML [Lr, hl]-[Lr, hl]								*	*			*	**

In (40), candidate (a) consists of two high register tones, so it violates OCP-Hr. Candidate (b) changes the input tone in the first syllable into a concave tone; thus, it is ruled out by *Concave. The second syllable of candidate (c) is preserved from the input. Also, there is a rising pitch across the syllable boundary. This is prevented by [*IsRise & *T]$_{ADJ}$. [OCP-Reg & *Rise]$_{ADJ}$ ruled out candidate (d) because the two tones are in the same register and its second syllable is a rising tone. Candidate (e) contains a high register tone, so it is ruled out by *Hr. In this case, candidate (f) is chosen as the optimal output. On the other hand, the tone sandhi of both syllables can occur in another situation, i.e. where MLM followed by a high register tone. It displays the same violation patterns as in (40).

4.3.2.4 Wrong predictions of [*IsRise & *T]$_{ADJ}$

The ranking so far has successfully accounted for tones which undergo tone sandhi. However, the ranking is too powerful to influence tones which do not undergo tone sandhi. [*IsRise & *T]$_{ADJ}$ would incorrectly rule out the unchanged tonal pairs, LM-HM and ML-MH.

In terms of LM-HM, the LM is preserved by ID-T-L(Lr). As for HM, owing to the rising pitch in the intersyllabic position, it is incorrectly changed. LM-HM, LM-MH, LM-ML and LM-LM are all possible candidates.

(41) *Yangping* LM-*Yinping* HM in the temporal ranking 4

lien LM tau HM 'sickle' → LM-HM

LM-HM [Lr, lh]-[Hr, hl]	OCP-Hr	*Concave	ID-T-L(Lr)	[*IsRise & *T]$_{ADJ}$	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	*Rise	*T
☞a.LM-HM [Lr, lh]-[Hr, hl]				*?			*	*	*	**
?b.LM-MH [Lr, lh]-[Hr, lh]							*		**	*
?c.LM-ML [Lr, lh]-[Lr, hl]					*				*	*
?d.LM-LM [Lr, lh]-[Lr, lh]					*				**	*

Notice that the constraints lower than [*IsRise & *T]$_{ADJ}$ is not influential in this condition except for *Rise and *T. Therefore, in addition to *Rise and *T, they are not discussed in this section. In (41), the tonal pair LM-HM should not undergo tone sandhi; however, the optimal output LM-HM is ruled out by [*IsRise & *T]$_{ADJ}$. To rule out candidates (b) and (d), OCP-Rise is a solution.

(42) OCP-Rise:

Assign one violation mark for adjacent rising tones.

Nevertheless, OCP-Rise has to be ranked lower than *Rise; otherwise, the unchanged tonal pair, MH-LM, will be incorrectly ruled out. If OCP-Rise is ranked this low, it cannot solve the problem in (41). Since there is a high register tone in the input, OCP-Rise is restricted to the context where the input high register tones is retained. To define such a situation, IDENT-High register should be posited.

(43) IDENT-High register (abbr. ID-Hr)

Assign one violation mark for the Hr tone which is not identical to its corresponding output tone.

ID-Hr has to be ranked lower than *Rise in order not to rule out the optimal output of HM-MH. In this case, the conjoined constraint is posited in (44).

(44) [OCP-Rise & ID-Hr]$_{ADJ}$:

Assign one violation mark for adjacent tones which violate both OCP-Rise and ID-Hr.

[OCP-Rise & ID-Hr]$_{ADJ}$ penalizes two adjacent rising tones and these tones are required to be identical to their input high register tones. This constraint needs to dominate [*IsRise & *T]$_{ADJ}$ to solve the problem in (41). The tableau in (45) illustrates how [OCP-Rise & ID-Hr]$_{ADJ}$ works.

(45) [OCP-Rise & ID-Hr]$_{ADJ}$ rules out LM-MH and LM-LM

LM-HM → LM-HM

[lien tau] 'sickle'

LM-HM [Lr, lh]-[Hr, hl]	[OCP-Rise & ID-Hr]$_{ADJ}$	OCP-Hr	*Concave	ID-T-L(Lr)	[*IsRise & *T]$_{ADJ}$	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	*Rise	*T	OCP-Rise	ID-Hr
☞a.LM-HM [Lr, lh]-[Hr, hl]					* ?			*	*	*	**		
b.LM-MH [Lr, lh]-[Hr, lh]	*!							*		**	*	*	*
?c.LM-ML [Lr, lh]-[Lr, hl]						*				*	*		*
d.LM-LM [Lr, lh]-[Lr, lh]	*!					*				**	*	*	*

In (45), candidates (b) and (d) violate [OCP-Rise & ID-Hr]$_{ADJ}$ because they consist of two rising tones and the input HM is not preserved. Therefore, they are eliminated. However, the case of candidate (c) is still unsolved. Notice that the optimal output consists of two tones in different registers whereas candidate (c) consists of two tones in the same register. This difference can be captured by OCP-Reg; however, the low ranking of OCP-Reg in this dialect limits its power. The conjoined constraint in (46) is needed.

(46) [OCP-Reg & OCP-**h**]$_{ADJ}$:

Assign one violation mark for adjacent tones which violate both OCP-Reg and OCP-**h**.

[OCP-Reg & OCP-**h**]$_{ADJ}$ penalizes adjacent tones which have the same register and have the same **h** tone melody in the intersyllabic position. [OCP-Reg & OCP-**h**]$_{ADJ}$ has to be ranked lower than ID-T-L(Lr) in order not to rule out tonal pairs, such as LM-ML. The OCP-**h** restricts the power of OCP-Reg. It has to be ranked at the same level with *Fall so that MH-**ML**, the optimal output of MH-HM will not be ruled out. The tableau in (47) illustrates how [OCP-Reg & OCP-**h**]$_{ADJ}$ rules out candidate (c) in (41) and (45).

(47) [OCP-Reg & OCP-**h**]$_{ADJ}$ rules out LM-ML

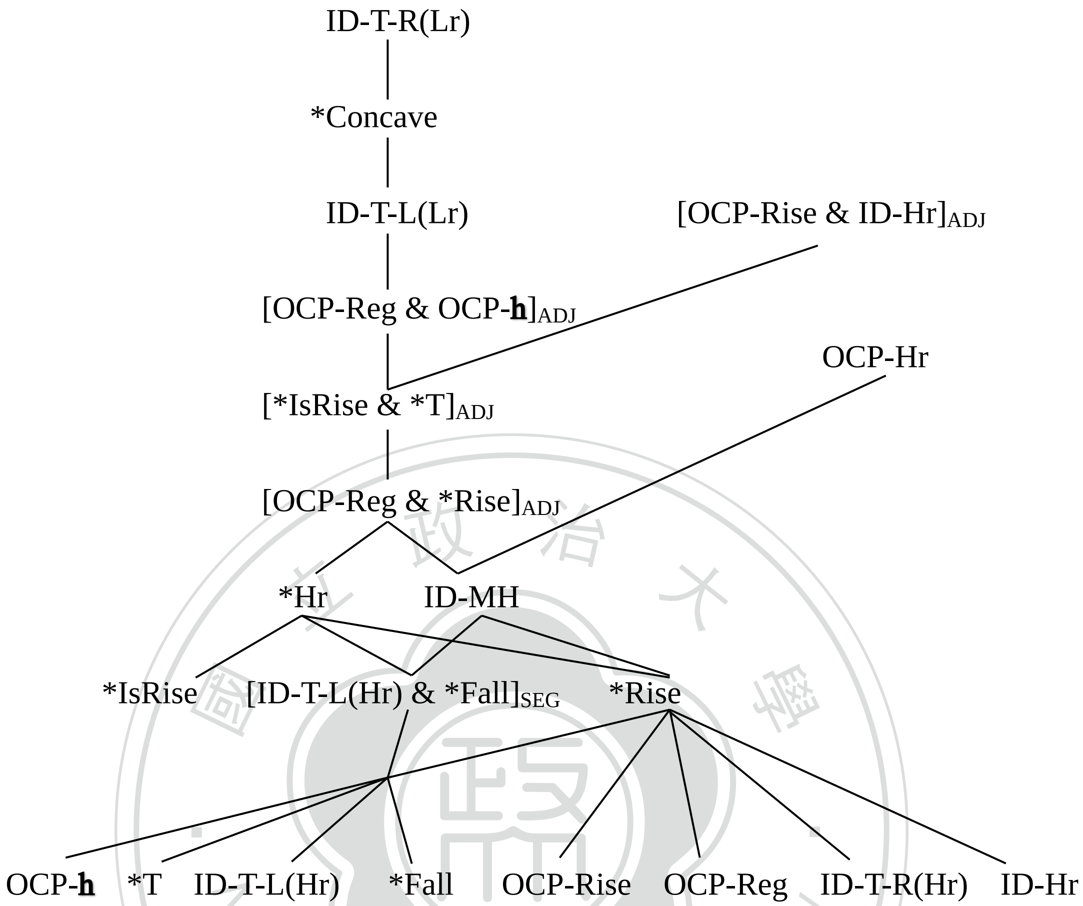
LM-HM → LM-HM

lien tau 'sickle'

LM-HM [Lr, lh]-[Hr, hl]	[OCP-Rise & ID-Hr]$_{ADJ}$	OCP-Hr	*Concave	ID-T-L(Lr)	[OCP-Reg & OCP-**h**]$_{ADJ}$	[*IsRise & *T]$_{ADJ}$	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	*Rise	*T	OCP-**h**	OCP-Rise	ID-Hr	OCP-Reg
☞a.LM-HM [Lr, lh]-[Hr, hl]						*			*	*	*	**				
b.LM-MH [Lr, lh]-[Hr, lh]	*!								*		**	*		*	*	
c.LM-ML [Lr, lh]-[Lr, hl]					*!		*				*	*			*	*
d.LM-LM [Lr, lh]-[Lr, lh]	*!						*				**	*		*	*	*

In (47), [OCP-Reg & OCP-**h**]$_{ADJ}$ successfully rules out LM-ML because LM and ML are in the same register and there are adjacent **h** tone melodies. The ranking is revised and illustrated as follows:

(48) Temporal ranking 5



In addition to LM-HM, ML-MH is the other tonal combination that will be incorrectly ruled out by [*IsRise & *T]$_{ADJ}$ in the temporal ranking. The constraint ranking in (48) still fails to predict ML-MH, as in (49).

(49) *Yinqu* ML-*Yangqu* MH in temporal ranking 5

ML-MH → ML-MH

[kau t^hiau] 'entomb'

ML-MH [Lr,-hl]-[Hr, lh]	[OCP-Rise & ID-Hr]$_{ADJ}$	OCP-Hr	*Concave	ID-T-L(Lr)	[OCP-Reg & OCP-**h**]$_{ADJ}$	[*IsRise & *T]$_{ADJ}$	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	*Rise	*T	OCP-**h**	OCP-Rise	ID-Hr	OCP-Reg
a. ML-HM [Lr, hl]-[Hr, hl]						*!		*	*	*		*			*	
☞b.ML-MH [Lr, hl]-[Hr, lh]						*?			*	*	*	**				
c.ML-ML [Lr, hl]-[Lr, hl]						*!		*		*		*			*	*
?d.ML-LM [Lr, hl]-[Lr, lh]							*	*			*	*			*	*

Candidates (a) and (c) are ruled out by [*IsRise & *T]$_{ADJ}$ because this ML is a citation tone and there is a rising pitch in the intersyllabic position. The optimal output should be candidate (b); however, it is ruled out by [*IsRise & *T]$_{ADJ}$ as well. Candidate (d) is then wrongly selected as the optimal output. In order to rule out ML-LM, OCP-**l** is posited.

(50) OCP-**l**:

Assign one violation mark for adjacent tones which have the same **l** tone melody in the intersyllabic position.

However, this constraint may penalize the optimal output as well. Besides, it has to be dominated by *Rise in order not to rule out the unchanged tonal pair, such as HM-LM. It cannot solve the problem in (49) alone. [OCP-**l** & ID-MH]$_{ADJ}$ is then posited to rule out candidate (c), ML-LM. Its definition is exhibited in (51).

(51) [OCP-**l** & ID-MH]$_{ADJ}$:

Assign one violation mark for adjacent tones which violate both OCP-**l** and ID-MH.

The OCP in (50) targets the **l**-melody instead of the general tone melody in order not to rule out MH-ML, the optimal output of MH-MH. The ranking of [OCP-**l** & ID-MH]$_{ADJ}$ should be higher than [*IsRise & *T]$_{ADJ}$ to preserve the optimal output, ML-MH. Besides, it has to be ranked lower than ID-T-L(Lr) to prevent ML from changing. The tableau in (52) shows how [OCP-**l** & ID-MH]$_{ADJ}$ works.

(52) How [OCP-**l** & ID-MH]$_{ADJ}$ works

ML-MH → ML-MH

[kau t^hiau] ‘entomb’

ML-MH [Lr,-hl]-[Hr, lh]	[OCP-Rise & ID-Hr]$_{ADJ}$	OCP-Hr	*Concave	ID-T-L(Lr)	[OCP-**l** & ID-MH]$_{ADJ}$	[OCP-Reg & OCP-**h**]$_{ADJ}$	[*IsRise & *T]$_{ADJ}$	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	*Rise	*T	OCP-**l**	OCP-**h**	OCP-Rise	ID-Hr	OCP-Reg
a. ML-HM [Lr, hl]-[Hr, hl]							*		*	*!	*		*				*	
☞b.ML-MH [Lr, hl]-[Hr, lh]							*			*	*	* ?	* *	*				
?c.ML-ML [Lr, hl]-[Lr, hl]							*		*		*		*				*	*
d.ML-LM [Lr, hl]-[Lr, lh]					*!			*	*			*	*	*			*	*

In (52), candidate (a) is eliminated because it violates both ID-MH and *Hr. [OCP-**l** & ID-MH]$_{ADJ}$ successfully rules out candidate (d) because there are adjacent **l** tone melody in the intersyllabic position and the input rising tone is not preserved. Nevertheless, the optimal output still loses to candidate (c). Notice that candidate (c) consists of two ML’s. OCP-ML is posited in (53).

(53) OCP-ML:

Assign one violation mark for adjacent ML.

However, the tonal pair, ML-ML, does exist and this constraint cannot rule out the optimal output of tonal pairs, such as HM-MH. Therefore, this constraint has to be dominated by *Rise. Due to the low ranking of OCP-ML, it cannot solve the problem in (52). In this case, the constraint in (54) is needed.

(54) [OCP-ML & *T]$_{ADJ}$:

Assign one violation mark for adjacent tone which violate both OCP-ML and *T.

[OCP-ML & *T]$_{ADJ}$ has to dominate ID-T-L(Lr) so that the unchanged tonal combination, ML-ML, will not be wrongly changed. Besides, it has to dominate *Rise in order to rule out candidate (c) in (52). The OCP in (54) target the ML instead of the general falling tone in order not to eliminate another unchanged tonal combination, HM-ML. Moreover, the OCP that targets a specific tone category is not an idiosyncratic phenomenon in this language. In Mandarin Chinese tone sandhi, there is a requirement avoiding two adjacent low tones. It can be regarded as an OCP effect. The tableau in (55) illustrates how [OCP-ML & *T]$_{ADJ}$ predicts ML-MH as the optimal output.

(55) [OCP-ML & *T]$_{ADJ}$ rules out ML-ML

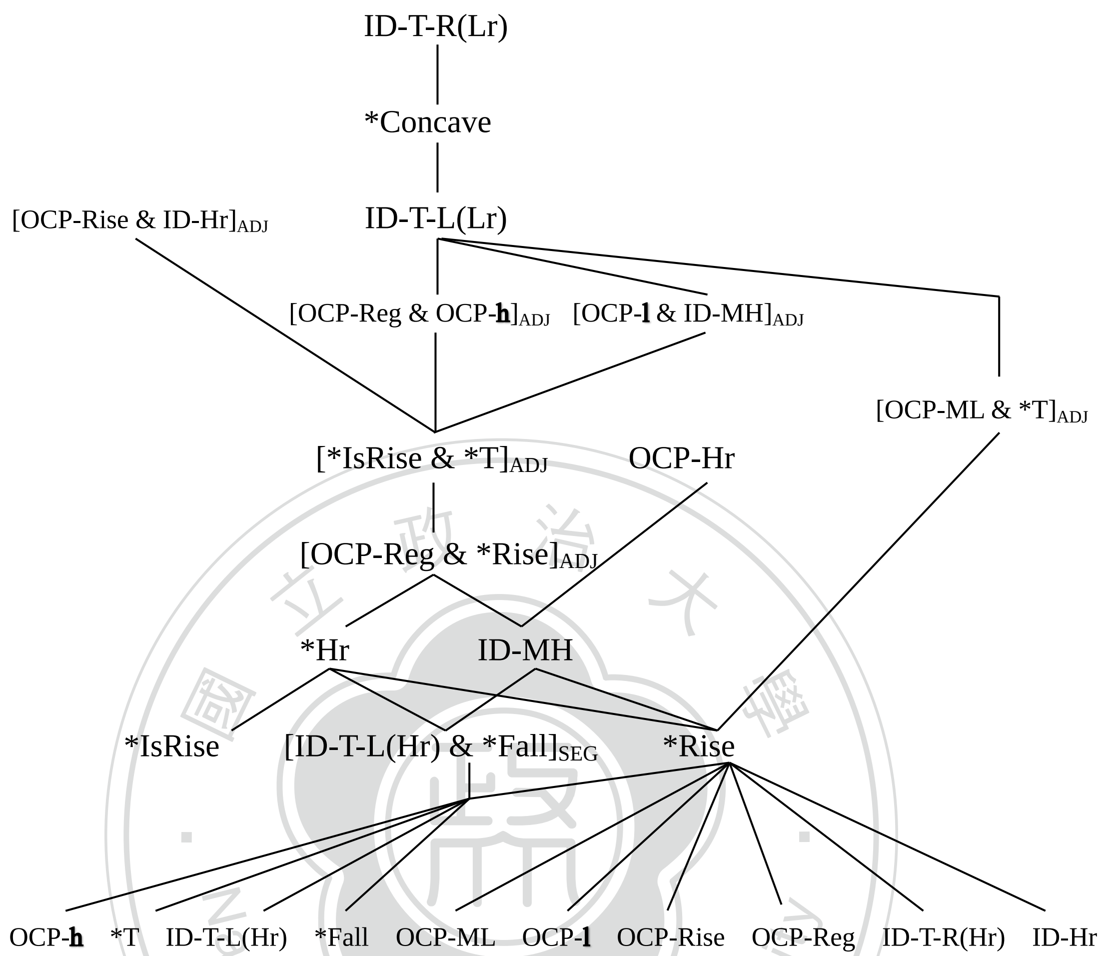
ML-MH → ML-MH

[kau tʰiau] ‘entomb’

ML-MH [Lr,-hl]-[Hr, lh]	[OCP-Rise & ID-Hr]$_{ADJ}$	OCP-Hr	*Concave	ID-T-L(Lr)	[OCP-ML & *T]$_{ADJ}$	[OCP-**l** & ID-MH]$_{ADJ}$	[OCP-Reg & OCP-**h**]$_{ADJ}$	[*IsRise & *T]$_{ADJ}$	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	*Rise	OCP-ML	OCP-**l**	OCP-**h**	OCP-Rise	ID-Hr	*T	OCP-Reg
☞b.ML-MH [Lr, hl]-[Hr, lh]								*			*	*	*		*				**	
c.ML-ML [Lr, hl]-[Lr, hl]					*!			*		*		*		*				*	*	*

Candidate (c) in (55) is ruled out by [OCP-ML & *T]$_{ADJ}$ because there are adjacent ML and the first ML is a citation tone. Therefore, candidate (b) is successfully selected as the optimal output. The constraint ranking illustrated in (48) will be revised in (56).

(56) Temporal ranking 6



The ranking in (56) successfully accounts for the non- *ru* tone sandhi. The *ru* tone sandhi will be discussed in the following section.

4.3.2.5 *Ru* tone sandhi

In terms of *ru* tones, it follows the argument in the last chapter. Owing to different syllable structures, limited tones could be realized in the *ru* tone syllable. Also, the tone sandhi patterns differ from non-*ru* tones. In this dialect, the trigger of the *ru* tone sandhi is contextual. Adjacent high *ru* tones are prohibited. Besides, when *ru* tones are next to non-*ru* tones, the constraints targeting the interaction between syllables still work, such as [*IsRise & *T]$_{ADJ}$ and [OCP-Reg & *Rise]$_{ADJ}$. However, the preservation of *ru* tones is different from the preservation of non-*ru* tones. *Ru* tones tend to stay unchanged, except for the high register *ru* tone in the second syllable. In this case, the ranking of ID-T-L(Hr) may be different in dealing with *ru* tones and non-*ru* tones; otherwise, the example in (57) will be wrongly predicted.

(57) High register *ru* tones in the first syllable

<u>*H*</u>-HM → <u>*H*</u>-**ML**

nat kɔŋ ‘moonlight’

<u>*H*</u>-HM [Hr,-h]-[Hr, hl]	[OCP-Rise & ID-Hr]$_{ADJ}$	OCP-Hr	ID-T-R(Lr)	*Concave	ID-T-L(Lr)	[OCP-ML & *T]$_{ADJ}$	[OCP-**l** & ID-MH]$_{ADJ}$	[OCP-Reg & OCP-**h**]$_{ADJ}$	[*IsRise & *T]$_{ADJ}$	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	[ID-T-L(Hr) & *Fall]$_{SEG}$	*Rise	OCP-ML	OCP-**l**	OCP-**h**	OCP-Rise	ID-Hr	*T	OCP-Reg	*Fall	ID-T-R(Hr)	ID-T-L(Hr)
a. <u>*L*</u>-HM [Lr, l]-[Hr, hl]									*!			*	*								*		*		*
b. <u>*L*</u>-MH [Lr, l]-[Hr, lh]												*!	*		*		*			*				*	*
?c. <u>*L*</u>-ML [Lr, l]-[Lr, hl]													*							*		*	*	*	*
d. <u>*L*</u>-LM [Lr, l]-[Lr, lh]										*!					*		*			*		*		*	*
e. <u>*L*</u>-MLM [Lr, l]-[Lr, hlh]				*!									*							*		*		*	*
f. <u>*H*</u>-HM [Hr, h]-[Hr, hl]		*!						*				**						*			**	*	*		
g. <u>*H*</u>-MH [Hr, h]-[Hr, lh]		*!						*		*		**			*					*	*	*		*	
☞h. <u>*H*</u>-ML [Hr, h]-[Lr, hl]												*?						*		*	*		*	*	
i. <u>*H*</u>-LM [Hr, h]-[Lr, lh]												*!			*					*	*			*	
j. <u>*H*</u>-MLM [Hr, h]-[Lr, hlh]				*!								*						*		*	*			*	

In (57), the optimal output is candidate (h); however, it is ruled out by *Hr because of <u>*H*</u> in the first syllable. Candidate (c), <u>*L*</u>-ML, is wrongly predicted. Since <u>*H*</u>

in the first syllable never changes, the constraint for the preservation for H in the first syllable should be undominated. Therefore, ID-T-L(Hr)$_{ru}$ is posited. The problem in (57) is solved in (58).

(58) ID-T-L(Hr)$_{ru}$ rules out L-LM

H-HM → H-**ML**

nat kɔŋ ‘moonlight’

H-HM [Hr,-h]-[Hr, hl]	ID-T-L(Hr)$_{ru}$	[OCP-Rise & ID-Hr]$_{ADJ}$	OCP-Hr	ID-T-R(Lr)	*Concave	ID-T-L(Lr)	[OCP-ML & *T]$_{ADJ}$	[OCP-**l** & ID-MH]$_{ADJ}$	[OCP-Reg & OCP-**h**]$_{ADJ}$	[*IsRise & *T]$_{ADJ}$	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	[ID-T-L(Hr) & *Fall]$_{SEG}$	*Rise	OCP-ML	OCP-**l**	OCP-**h**	OCP-Rise	ID-Hr	*T	OCP-Reg	*Fall	ID-T-R(Hr)	ID-T-L(Hr)
c. L-ML [Lr, l]-[Lr, hl]	*!													*							*		*	*	*	*
☞h. H-ML [Hr, h]-[Lr, hl]													*						*		*	*		*	*	

In (58), candidate (c) does not preserve the input H in the first syllable so it is ruled out by ID-T-L(Hr)$_{ru}$. H-ML is then selected as the optimal output. This is the case which H is in the first syllable. As for the cases which H is in the second syllable, unchanged tonal pairs, such as LM-H, ML-H and L-H, may be wrongly ruled out by [*IsRise & *T]$_{ADJ}$. The example is given in (59).

(59) High register *ru* tones in the second syllable

<u>L</u>-<u>H</u> → <u>L</u>-<u>H</u>

tsat sat 'tightly weaved (basket)'

<u>L</u>-<u>H</u> [Hr,-h]-[Hr, hl]	ID-T-L(Hr)$_{ru}$	[OCP-Rise & ID-Hr]$_{ADJ}$	OCP-Hr	ID-T-R(Lr)	*Concave	ID-T-L(Lr)	[OCP-ML & *T]$_{ADJ}$	[OCP-**l** & ID-MH]$_{ADJ}$	[OCP-Reg & OCP-**h**]$_{ADJ}$	[*IsRise & *T]$_{ADJ}$	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	[ID-T-L(Hr) & *Fall]$_{SEG}$	*Rise	OCP-ML	OCP-**l**	OCP-**h**	OCP-Rise	ID-Hr	*T	OCP-Reg	*Fall	ID-T-R(Hr)	ID-T-L(Hr)
☞a. <u>L</u>-<u>H</u> [Lr, l]-[Hr, h]										*?			*	*								**				
?b. <u>L</u>-<u>L</u> [Lr, l]-[Lr, l]																		*			*	*	*		*	
c. <u>H</u>-<u>H</u> [Hr, h]-[Hr, h]			*!			*			*				**						*			*	*			
d. <u>H</u>-<u>L</u> [Hr, h]-[Lr, l]						*!					*		*								*				*	

In (59), candidate (c) consists of two high register tones, so it is ruled out by OCP-Hr. Candidate (d) violates ID-T-L(Lr) because the input <u>L</u> in the first syllable is not preserved. Candidate (a) should have been the optimal output. However, it is incorrectly ruled out by [*IsRise & *T]$_{ADJ}$ and candidate (b) is selected as the wrong optimal output. To fix this wrong prediction, the preservation of <u>H</u> in the second syllable is considered. ID-T-R(Hr) is indexed as ID-T-R(Hr)$_{ru}$ which has to be ranked at the same level with [*IsRise & *T]$_{ADJ}$ so that the optimal output of MH-<u>H</u>, ML-<u>H</u>, MLM-<u>H</u> and MH-<u>H</u> will not be wrongly ruled out. Nevertheless, ID-T-R(Hr)$_{ru}$ is not sufficient to account for the problem in (59). The tableau in (60) illustrates the situation which ID-T-R(Hr)$_{ru}$ is not enough.

(60) ID-T-R(Hr)$_{ru}$ is not enough

L-*H* → *L*-*H*

tsat sat 'tightly weaved (basket)'

L-*H* [Hr,-h]-[Hr, hl]	ID-T-L(Hr)$_{ru}$	[OCP-Rise & ID-Hr]$_{ADJ}$	OCP-Hr	ID-T-R(Lr)	*Concave	ID-T-L(Lr)	[OCP-ML & *T]$_{ADJ}$	[OCP-**l** & ID-MH]$_{ADJ}$	[OCP-Reg & OCP-**h**]$_{ADJ}$	ID-T-R(Hr)$_{ru}$	[*IsRise & *T]$_{ADJ}$	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	[ID-T-L(Hr) & *Fall]$_{SEG}$	*Rise	OCP-ML	OCP-**l**	OCP-**h**	OCP-Rise	ID-Hr	*T	OCP-Reg	*Fall	ID-T-R(Hr)	ID-T-L(Hr)
☞a. *L*-*H* [Lr, l]-[Hr, h]											*			*?	*								**				
?b. *L*-*L* [Lr, l]-[Lr, l]										*									*			*	*	*		*	

In (60), ID-T-R(Hr)$_{ru}$ is included. Candidate (b) violates it because the input *H* in the second syllable is not retained. However, it is not enough to prevent candidate (a) from being eliminated. In (60), candidate (a) is still wrongly ruled out by *Hr due to the retention of the *H*. In this case, the conjoined constraint, [OCP-Reg & *T]$_{ADJ}$ is posited.

(61) [OCP-Reg & *T]$_{ADJ}$:

Assign one violation mark for adjacent tone which violate both OCP-Reg and *T.

[OCP-Reg & *T]$_{ADJ}$ has to dominate *Hr to solve the wrong prediction in (60). Besides, it has to be dominated by [*IsRise & *T]$_{ADJ}$ so that ***L*-LM**, the optimal output of L-HM, will not lose to candidates such as ***L*-ML**. The tableau in (62) illustrates how [OCP-Reg & *T]$_{ADJ}$ works.

(62) [OCP-Reg & *T]$_{ADJ}$ rules out *L*-*L*

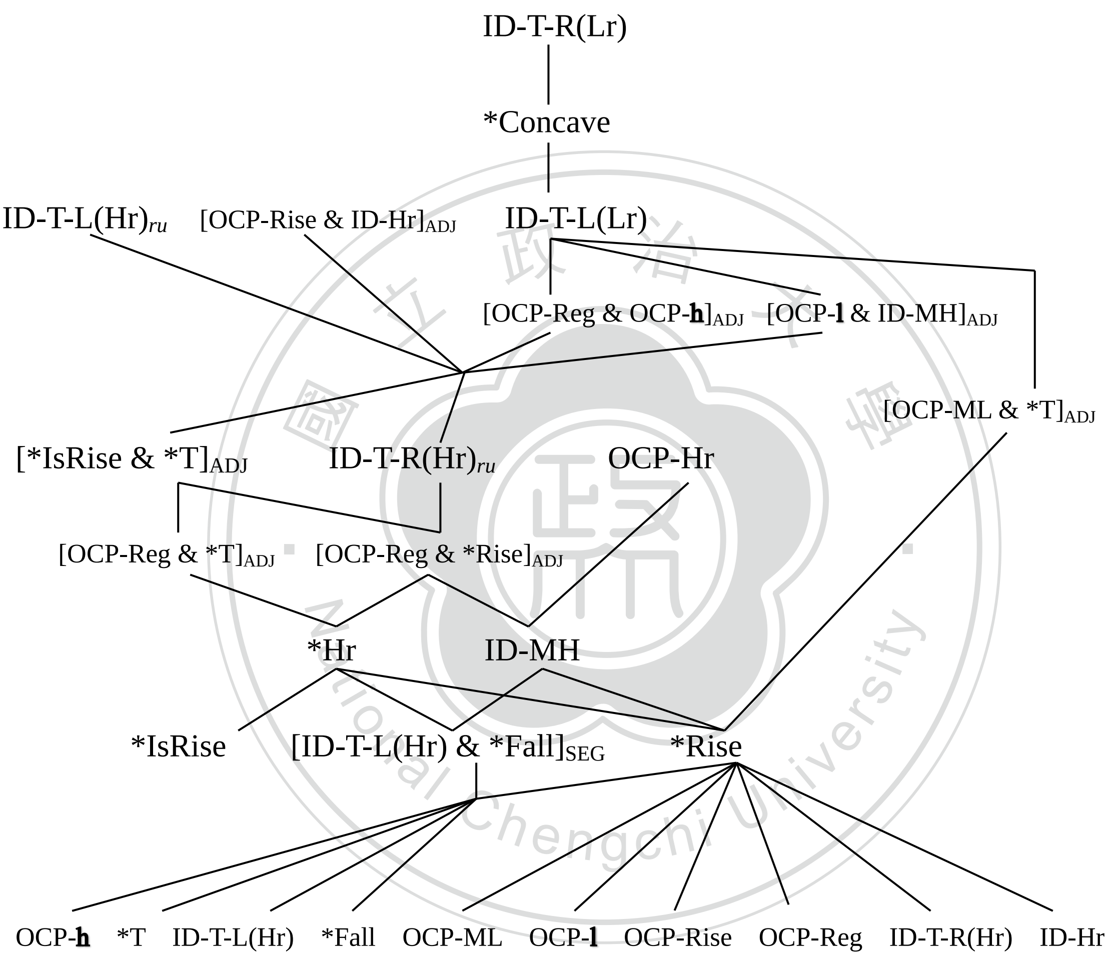
L-*H* → *L*-*H*

tsat sat 'tightly weaved (basket)'

L-*H* [Hr,-h]-[Hr, hl]	ID-T-L(Hr)$_{ru}$	[OCP-Rise & ID-Hr]$_{ADJ}$	OCP-Hr	ID-T-R(Lr)	*Concave	ID-T-L(Lr)	[OCP-ML & *T]$_{ADJ}$	[OCP-**l** & ID-MH]$_{ADJ}$	[OCP-Reg & OCP-**h**]$_{ADJ}$	ID-T-R(Hr)$_{ru}$	[*IsRise & *T]$_{ADJ}$	[OCP-Reg & *T]$_{ADJ}$	[OCP-Reg & *Rise]$_{ADJ}$	ID-MH	*Hr	*IsRise	[ID-T-L(Hr) & *Fall]$_{SEG}$	*Rise	OCP-ML	OCP-**l**	OCP-**h**	OCP-Rise	ID-Hr	*T	OCP-Reg	*Fall	ID-T-R(Hr)	ID-T-L(Hr)
☞a. *L*-*H* [Lr, l]-[Hr, h]											*				*	*								**				
b. *L*-*L* [Lr, l]-[Lr, l]										*		*!								*			*	*	*		*	

In (62), [OCP-Reg & *T]$_{ADJ}$ successfully rules out candidate (b) because both tones in candidate (b) are in the same register and one of them is a citation tone. In this case, the input *L*-*H* is finally preserved. The ranking will be revised and the final constraint ranking of construction $\mathbb{B}$ is illustrated in (63).

(63) The constraint ranking of Construction $\mathbb{B}$



The motivation for tone sandhi in construction $\mathbb{B}$ is not purely positional as that in construction $\mathbb{A}$ and in Liujia Raoping Hakka. The relevant tone sandhi that selects optimal output forms is mainly ontextual. [*IsRise & *T]$_{ADJ}$ and OCP-Hr can be regarded as the contextual triggers while *Concave, *Rise and * Hr can be regarded as positional triggers. Conjoined constraints, [OCP-Rise & ID-Hr]$_{ADJ}$, [OCP-Reg & OCP-**h**]$_{ADJ}$, [OCP-**l** & ID-MH]$_{ADJ}$, [OCP-Reg & *T]$_{ADJ}$ and [OCP-ML & *T]$_{ADJ}$ are posited to solve the problem where unchanged tonal pairs might be wrongly ruled out. [OCP-Reg & *Rise]$_{ADJ}$ and [ID-T-L(Hr) & *Fall]$_{SEG}$ are posited to prevent optimal outputs from losing to other candidates.

4.3.3 OT analysis of Tone sandhi in construction $\mathbb{A}$ and $\mathbb{B}$

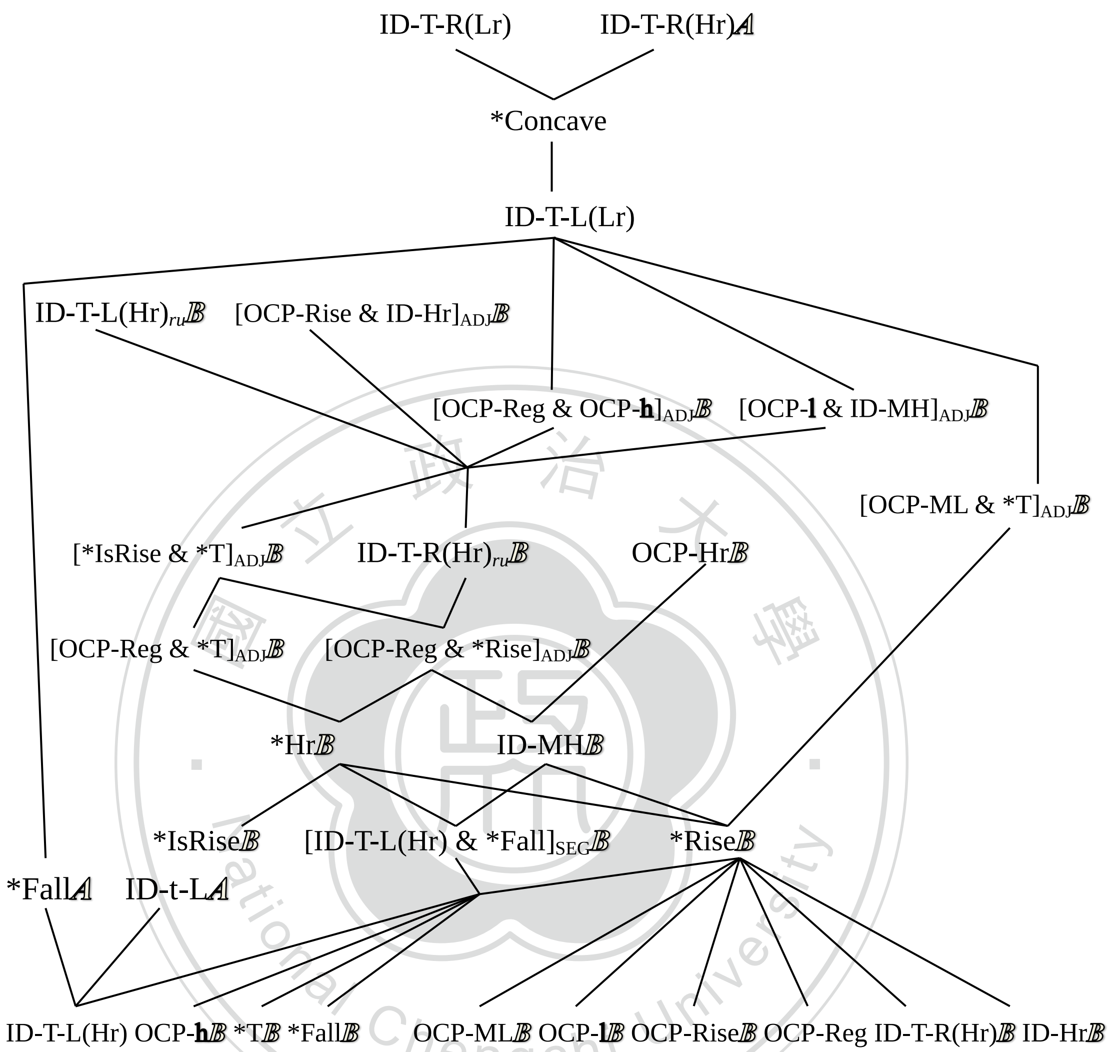
In sections 4.3.1 and 4.3.2, tone sandhi in both construction $\mathbb{A}$ and $\mathbb{B}$ are discussed under the framework of OT. To provide a comprehensive analysis for this language, it is necessary to investigate both tone sandhi mechanisms under the same constraint ranking. To account for different phonological processes resulting from the morphological effects, the and indexed approach is adopted.

In terms of construction $\mathbb{A}$, the tone in the second syllable never changes; therefore, ID-T-R(Hr) and ID-T-R(Lr) are undominated. On the other hand, in construction $\mathbb{B}$, the tone in the second syllable is not always retained. Since ID-T-R(Lr) is undominated in both constructions, it needs no specific index and is undominated in the comprehensive ranking. However, ID-T-R(Hr) has different rankings in the two constructions. It needs to be indexed as ID-T-R(Hr)$\mathbb{A}$ and ID-T-R(Hr)$\mathbb{B}$. ID-T-R(Hr)$\mathbb{A}$ is undominated while ID-T-R(Hr)$\mathbb{B}$ stays as the lowest ranked as in (63). For the first syllable in both constructions, ID-T-L(Lr) is dominated by *Concave while ID-T-L(Hr) is ranked as the lowest ranked. Due to the same ranking of ID-T-L(Hr) and ID-T-L(Lr) in both constructions, they do not need to be indexed.

ID-t-L should be indexed as ID-t-L𝔸 because this preservation occurs in construction 𝔸 only. As for markedness constraints, according to Pater (2007, 2010), they can be indexed. *Concave has the same ranking in both constructions. However, the ranking of *Fall is slightly different in both constructions, i.e. *Fall is ranked higher than ID-T-L(Hr) in construction 𝔸 while it is at the same level with ID-T-L(Hr) in construction 𝔹. Therefore, it is unnecessary to index *Concave but *Fall has to be indexed as Fall𝔸 and *Fall𝔹. As for the rest of the constraints in construction 𝔹, they are all indexed with 𝔹.

The constraint ranking for this language is illustrated in (64).

(64) The complete ranking for Ningdu Tiantou Hakka



4.4 Summary

This chapter analyzes the tone sandhi patterns of Ningdu Tiantou Hakka under the OT framework. Tone sandhi in this dialect is construction sensitive. In construction 𝔸, the tone sandhi is positional. The second syllable never undergoes tone sandhi. The trigger of tone sandhi in this construction follows the universal tone markedness tendency (Yip 2001, 2002). In terms of construction $\mathbb{B}$, the tone sandhi is both positional and contextual. *Concave is regarded as the motivation for the first-syllable tone sandhi. In terms of the second-syllable tone sandhi, OCP-Hr and [*IsRise & *T]$_{ADJ}$ are the triggers. [*IsRise & *T]$_{ADJ}$ triggers the tone sandhi of tonal pairs in which only one of the syllables undergoes tone sandhi and there is a rising pitch in the intersyllabic position. For the tone sandhi of both syllables, the triggers are identical with previous two. Besides, since it is possible that both syllables undergo tone sandhi, the faithfulness constraints may target both position and register. Notice that different situations of tonal preservation are due to different indexes of IDENT which target both position and register. Accordingly, I have argued that the tonal preservation is not because of the stress assignment or the syllable length.

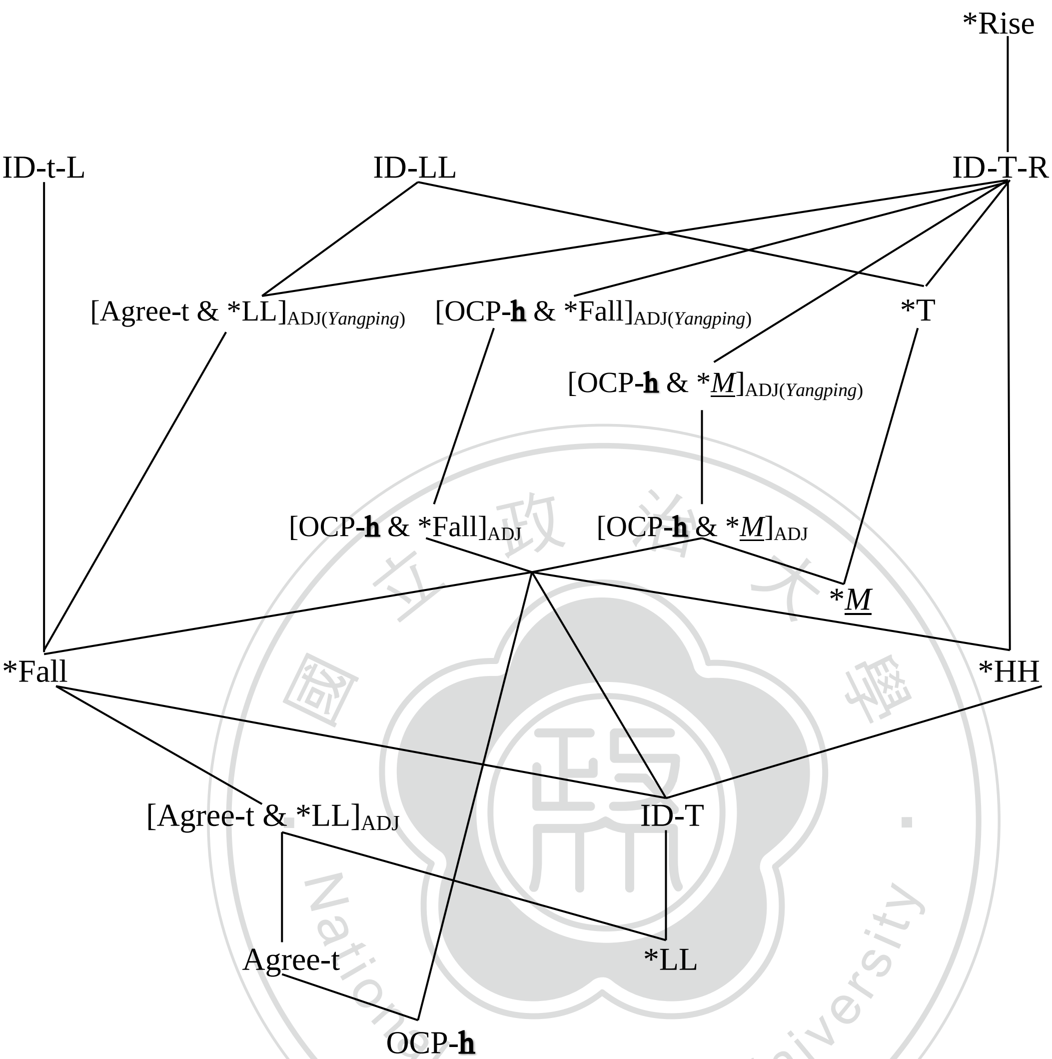
CHAPTER 5

CONCLUSION

5.1 Summary of the thesis

This thesis analyzed the tone sandhi in two Hakka Dialects, namely Liujia Raoping Hakka and Ningdu Tiantou Hakka. The Optimality Theory is applied to account for the mechanisms of tone sandhi in these two Hakka Dialects. In chapter three, a constraint ranking is proposed to predict the tone sandhi patterns in Liujia Raoping Hakka and the morpheme specific phonology (Pater 2007, 2010) is adopted to explain the historical merged tones, as in (1).

(1) Constraint ranking for Liujia Raoping Hakka

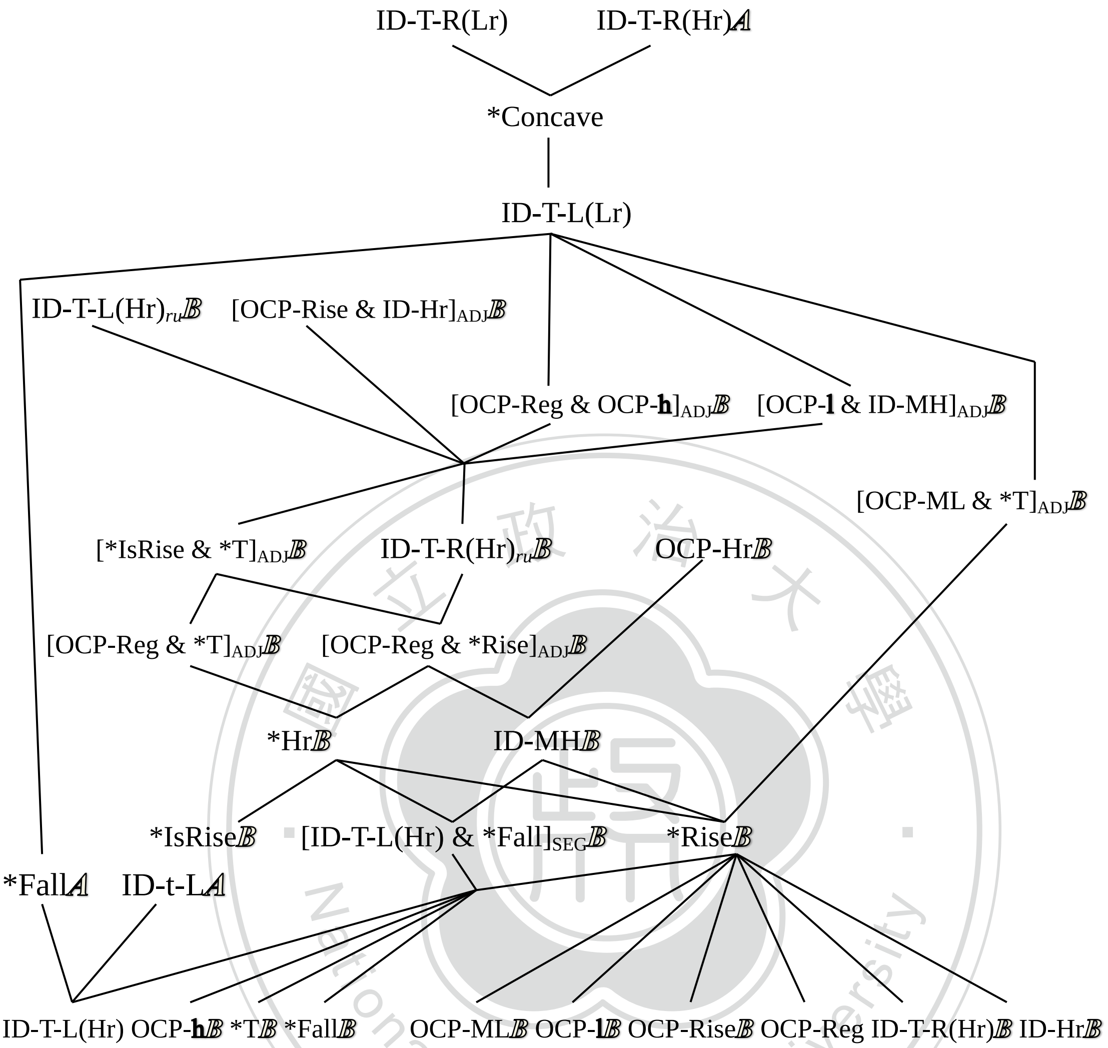


In (1), since the tone sandhi only occurs in the left syllable, ID-T-R is undominated. *Fall and *HH, according to the universal tonal markedness tendency (Yip 2001, 2002), are posited to motivate tone sandhi in Liujia Raoping Hakka. They capture the tone sandhi patterns of *Yinshang* HM and *Yangqu* HH2. ID-t-L is posited to retain the left tone melody of the input tone based on the idea of tonal target (Yip 2001). It prevents the input form from mapping to LL [Lr, l]. As for the *ru* tone sandhi, *T is considered to be the trigger.

In terms of the merged tones, *Yangping* HH1 and *Yangqu* HH2, the morpheme-specific phonology (Pater 2007, 2010) is applied and therefore [Agree-t & *LL]$_{\text{ADJ(}\textit{Yangping}\text{)}}$ is posited. It has to dominate *Fall to map HH1 to HM when it is followed by the low level tone, LL. Moreover, [OCP-h & *Fall]$_{\text{ADJ(}\textit{Yangping}\text{)}}$ is posited and ranked at the same level with [Agree-t & *L]$_{\text{ADJ(}\textit{Yangping}\text{)}}$ to change HH1 into HM when it is followed by HM. Finally, [OCP-h & *$\underline{M}$]$_{\text{ADJ(}\textit{Yangping}\text{)}}$ is posited to predict that HH1 changes to HM when it precedes $\underline{M}$. These three indexed constraints target the specific tone category, *Yangping*. Furthermore, the assimilation and dissimilation in specific contexts are governed by conjunction constraints. The tone sandhi in this language is basically positional. The contextual tone sandhi only occurs when the input is a *Yangping* tone, HH1.

In chapter four, OT is applied to account for the construction sensitive tone sandhi in Ningdu Tiantou Hakka. Tone sandhi in this language shows different patterns in different constructions. The modifier-head construction and conjunction construction show the same tone sandhi pattern while the verb-object construction shows a different tone sandhi pattern. The indexed approach is employed to capture different tone sandhi patterns of different constructions. The complete constraint ranking for this language is shown in (2).

(2) Constraint ranking for Ningdu Tiantou Hakka



In (2), the verb-object construction is named construction 𝔸 while other two are named construction 𝔹. In both constructions, low register tones in the right syllable never undergo tone sandhi; therefore, ID-T-R(L) is always undominated. *Concave dominated by ID-T-R(L) dominates ID-T-L(L), which illustrates that the concave tone only occurs in the right syllable. In terms of construction 𝔸, the motivation for the tone sandhi is similar to the one in Liujia Raoping Hakka, i.e. the universal tonal markedness tendency (Yip 2001, 2002). *Concave and *Fall are regarded as the triggers. Moreover, the constraint preserving the left tone melody, ID-t-L, exists in both construction 𝔸 and in Liujia Raoping Hakka. The tone sandhi in this construction is positional. On the other hand, in terms of the tone sandhi in construction 𝔹, it takes place in both syllables. *Concave is posited to govern the left-syllable tone sandhi while OCP-Hr is posited to govern the second-syllable tone sandhi. Both constraints are the triggers of the both-syllable tone sandhi. Besides, [*IsRise & *T]$_{ADJ}$ is the other trigger for the both-syllable tone sandhi. The constraints posited above can predict the tonal pairs which undergo tone sandhi; nevertheless, they may wrongly rule out tonal pairs which do not undergo tone sandhi. In this case, [OCP-Rise & ID-Hr]$_{ADJ}$, [OCP-Reg & OCP-𝕙]$_{ADJ}$, [OCP-𝕝 & ID-Rise]$_{ADJ}$, [OCP-ML & *T]$_{ADJ}$ and [OCP-Reg & *T]$_{ADJ}$ are posited to ensure that the unchanged tonal pairs will not be wrongly ruled out. Last, the preservation of *ru* tones differs from that of non-*ru* tones in construction 𝔹. Hence, ID-T-L(H)$_{ru}$ and ID-T-R(H)$_{ru}$ are posited and ranked higher than the unidexed ID-T-L(H) and ID-T-R(H). The tone sandhi in construction 𝔹 is both positional and contextual.

According to the tone sandhi in these two dialects, the tonal preservation in the tone sandhi process is regarded as typological differences. The preservation is not based on the stress assignment or the length of the syllable. It is believed that the syllable in the final position of a phonological phrase is relatively longer (Zhang 2001, 2004, 2007) and easier to bear more complicated tones. According to this idea, the tone in the second syllable should be preserved. However, it displays a different case in construction 𝔹 of Ningdu Tiantou Hakka.

5.2 Further issues

In addition to the disyllabic tone sandhi, the trisyllabic tone sandhi and the tone sandhi in the reduplication are issues which can be further studied. Since the tone sandhi patterns in trisyllabic words are different from the patterns in disyllabic words, it would be interesting to investigate different tone sandhi patterns in longer sequence of these two Hakka dialects.

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