

Chris Oakden Writing Sample: “Tone Sandhi in the Nanjing Dialect: A Phonological Analysis”

This writing sample is a revised version of my MA thesis. It was originally submitted to the Department of East Asian Studies at the University of Arizona, and was accepted by the department in December of 2012.

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ABSTRACT

This thesis examines disyllabic tone sandhi phenomena in the Nanjing Dialect, a Lower Yangzi dialect of Mandarin. The tonal model offered by Duanmu (1990, 1994) is adopted as the preferred means of representing the tonal inventory and sandhi patterns of this dialect, despite the theory’s lack of support in contemporary discussions of Chinese phonology. Analysis of disyllabic tone sandhi is conducted through the framework of Optimality Theory (Prince and Smolensky 1993); a combination of OCP-based (Goldsmith 1976, Leben 1973) constraints and Local Conjunction (Green 1993, Smolensky 1993, Moreton and Smolensky 2002) in the analysis underscore the unique typological features of the Nanjing Dialect’s tone system.

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INTRODUCTION

The Nanjing dialect, a variety of Mandarin belonging to the Lower Yangzi or *Jianghuai* subclass, is spoken by roughly seven million people in the city of Nanjing, Jiangsu and its immediate vicinity. While several descriptive accounts of the dialect's tone sandhi system exist (Liu 1995, Fei and Sun 1993), there has been little analytic discussion of sandhi apart from the analysis of disyllabic sandhi offered by Ma (2009). Analysis of this system is underrepresented in Chinese-language literature and nonexistent in English-language literature. This thesis will offer a phonological analysis of disyllabic tone sandhi in the Nanjing dialect. Incorporation of both OCP (Goldsmith 1976, Leben 1973) and Local Conjunction (Green 1993, Smolensky 1993, Moreton and Smolensky 2002) constraints accommodate the dialect's unique system of tone sandhi, which exhibits alternation strategies common to many Mandarin dialects, but with a tonal inventory that is distinct from almost all other subcategories of Mandarin. Furthermore, this analysis will adopt the tonal model of representation offered by Duanmu (1990, 1994), which has fallen out of favor in recent discussions of Chinese phonology, but is thoroughly adequate—in fact preferred—in accounting for the tonal inventory and sandhi processes observed in the dialect. The analysis presented here, then, will be an improvement on Ma's (2009) earlier account, which adopts a comparatively burdensome tonal model.

Section 1 introduces the theoretical framework for the exposition by selecting a representational model and outlining the analytical lens (Optimality Theory) through which the analysis will be conducted. Next follows a brief discussion of syllables and rime structure in the Nanjing dialect, and Section 3 introduces the tonal melodies in the dialect and identifies the cases in which disyllabic tone sandhi occurs. Section 4 examines the model of tonal representation in greater detail as it applies to the Nanjing dialect and motivates this representation using OT, followed by a subsection arguing for specific underlying representations for the tones based on their distribution throughout the language. This necessitates the proposal of several new constraints. Section 5 tests the existing OT analysis against a variety of possible input forms for monosyllables, refining the existing model with new constraints. In Section 6, an OT account for disyllabic tone sandhi is presented, integrating the analysis from earlier sections. Section 7 discusses the implications for the analysis and concludes.

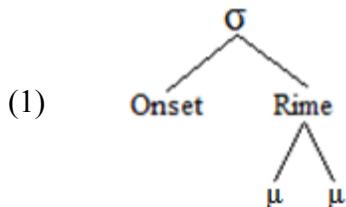
1. THEORETICAL FRAMEWORK

The analysis conducted in this thesis employs two main theoretical constructs: one to conceptualize tonal structure, and another to couch the analysis within a specific analytical configuration. To represent the internal structure of tone based on observed data, we adopt Duanmu's (1990, 1994) tonal model and understand the phonological system of the Nanjing Dialect using this framework. We carry out the analysis of tone sandhi using Optimality Theory, with the assistance of several important theoretical developments within OT.

1.1 Tonal Representation Model in Duanmu (1990, 1994)

Duanmu's (1990, 1994) model of representing tonal structure in Chinese dialects, though having lost favor in recent discussions of Chinese tone, is preferable for our analysis of Nanjing Dialect tone sandhi for reasons that will be made clear as the exposition develops. The discussion here will not be exhaustive; instead, we will identify the key components of Duanmu's theory as they apply to our analysis of Nanjing Dialect tone.

One of the essential claims Duanmu makes about the phonological system of Chinese dialects is that all syllables contain bimoraic rimes (1):¹



He furthermore argues that tones map directly to morae, making the mora the tone-bearing unit of syllables.

Individual tonal elements can be either high [H] or low [L]², and morae map to *exactly* one tonal segment; more specifically, this requires both morae to attach to a segment (no floating tonal segments or morae), and prohibits moraic association with two separate segments simultaneously. Duanmu argues against the notion of tonal units representing contours; he proposes, rather, that contour

¹ This figure is adapted from Bao (1999:36).

² These segments are actually derived from varying values of “V/R” and “pitch” nodes (sisters under the “Laryngeal” node that Duanmu proposes in his discussion of tone and feature geometries. I will not go into detail here about this part of his discussion.

tones are in fact chains of two [H] and [L] segments. Under this interpretation of tonal structure, level and contour tones are represented as follows:

- (2) rising tone falling tone high level tone low level tone



The impetus to adopt this model for our analysis lies in its ability to sufficiently represent the full tonal inventory of the Nanjing dialect and capture all observed sandhi patterns using only three basic components: [H], [L] and morae.

1.2 Optimality Theory

The analysis will motivate the adopted tonal representation model and analyze the system of tone sandhi in the Nanjing dialect within the framework of Optimality Theory (OT), which was first introduced by Prince and Smolensky (1993). This theory proposes that phonological phenomena observed in human language can be understood in terms of the interaction between three main components:

- (3) Generator (GEN)
Constraints (CON)
Evaluator (EVAL)

These components comprise the processing mechanism that produces output forms (surface representations) from inputs (underlying representations). For a given input, GEN produces an infinite number of candidates that could potentially be the output for that form. These candidates are subject to constraints (CON) in the language. Constraints express certain stipulations or restrictions by which the language assesses potential candidates, and are divided into two basic types: faithfulness constraints and markedness constraints.

Faithfulness constraints require that output forms be identical to their corresponding inputs. Markedness constraints, on the other hand, govern the well-formedness of output forms by making certain prohibitions in regard to their structure. If a particular candidate does not conform to the preconditions of the constraint, it is said to violate that constraint. EVAL assesses candidates for a certain form, and selects an optimal candidate (which will be the output form) based on violations of these constraints.

In theory, CON is a finite set of constraints that apply to all languages; cross-linguistic variation arises as the result of different languages ordering constraints in different ways. Within a given language, constraints are ranked in a specific hierarchy, with some constraints being ranked critically above others. Therefore, EVAL selects optimal candidates based on violations of constraints within this hierarchy. An optimal candidate, then, can violate certain low-ranked constraints, provided that it avoids violating high-ranking constraints.

The interaction between GEN, CON and EVAL is represented in tableaux:

(4)

/Input/	Constraint X	Constraint Y	Constraint Z
a. Candidate 1	*!		
b. Candidate 2		*!	
c. → Candidate 3			*

For this given input, we examine three possible output candidates, and three constraints with a language-specific ranking. The solid line that separates Constraints X and Y from Constraint Z signifies that these two constraints are ranked above Constraint Z, while the dotted line between Constraint X and Constraint Y indicates that no critical ranking is motivated between these two constraints. The first two candidates violate Constraint X and Constraint Y, respectively. Presence of an asterisk (*) shows that a candidate has violated a particular constraint. Since Constraints X and Y are ranked above Constraint Z, the first two candidates' violations of these constraints are fatal (*!), and they are rejected as possible optimal candidates. Candidate 3 is selected as the optimal candidate (signified by the arrow) in spite of violating Constraint Z, because that constraint is ranked lower in the hierarchy, and there is no fourth candidate that does not violate any of the constraints.

The model so far displays candidate rejection through fatal violation of *single* constraints. However, while constraints are typically viewed as independent, they have also been found to operate in conjunction, a concept we will exploit later in our analysis. This theory is known formally as Local Constraint Conjunction (Green 1993, Smolensky 1993, Moreton and Smolensky 2002), and allows for the proposal of a constraint that combines two separate constraints that are active within some domain (for example a segment). If a candidate simultaneously violates both of these constraints in that

particular domain, it violates the local conjunction of these constraints. Moreton and Smolensky define the conjunction configuration in general terms (2002:1):

- (5) If C_1 and C_2 are constraints, and D is a representational domain type (e.g. segment, cluster, syllable, stem), then $(C_1 \ & \ C_2)_D$, the *local conjunction of C_1 and C_2 in D* , is a constraint which is violated whenever there is a domain of type D in which both C_1 and C_2 are violated.

For example, we may propose two separate markedness constraints making stipulations about some segment (the domain type), so, for example NOCODA and *[+voi, -son] (Moreton and Smolensky 2002:2). If a candidate simultaneously violates both constraints (i.e. a voiced obstruent coda), it is said to also violate the conjunction of the two constraints.

By ranking this type of constraint above the separate constraints individually, a candidate that violates only one of the constraints can be selected as optimal over another one that violates both.

See the use of Local Conjunction in (6):

- (6)

/Input/	$(C_1 \ & \ C_2)_D$	Constraint X	C_1	C_2
a. Candidate 1	*!		*	*
b. → Candidate 2			*	
c. Candidate 3		*!		

In this case, Candidate 2 wins out over Candidate 1 by violating only one of the lower-ranked individual constraints. By violating both (and therefore fitting the requisite criteria of the higher-ranked local conjunction constraint), Candidate 1 is rejected. Candidate 3 violates none of the separate constraints in the conjunction, but is ruled out by violating another constraint that has the same high ranking as the local conjunction constraint. Therefore, a candidate that violates one of the separate constraints can still be selected as optimal.

The prohibitory scope of markedness constraints extends beyond the individual segment, having the capacity to restrict what can occupy a certain element's immediate vicinity. This includes duplicates of that same element. Formally, this is known as the Obligatory Contour Principle (OCP), which was first discussed by Leben (1973) and Goldsmith (1976) and further developed by McCarthy (1986) and

others (Yip 1988, Suzuki 1998 among others). This principle places a prohibition on adjacent identical ‘elements’, which can refer to features, segments, even entire syllables. Suzuki’s (1998:27) Generalized OCP is restated below as an example markedness constraint:

- (7) *X...X- A sequence of two X’s is prohibited

An OCP-based constraint operates identically to other markedness constraints in a grammar. Candidates containing the prohibited sequence receive a violation, and high ranking in a hierarchy results in fatal violations and candidate rejection:

- (8)

/Input/	*X...X
a. XX	*!
b. → XY	

We will draw upon this concept heavily in our discussion of the Nanjing Dialect tone system and disyllabic tone sandhi, which displays an aversion to certain adjacent identical elements. The benefit of Suzuki’s Generalized OCP becomes more apparent later in the analysis. Specifically, the theory permits constraint proposal across multiple domains; while tone formation strategies exhibit aversion to adjacent tonal elements in the dialect, adjacency proscriptions in sandhi alternations also govern on the syllable level. Markedness constraints are necessary in both domains to offer a unified account.

2. SYLLABLES AND RIME STRUCTURE IN THE NANJING DIALECT

The most comprehensive survey of syllable and rime structure in the Nanjing Dialect is offered by Liu (1995); here, he provides an exhaustive discussion of possible syllables in the language, and offers tables outlining all combinations of onsets and rimes. The examples in this section draw primarily from his discussion.

Like other dialects of Mandarin, the Nanjing Dialect can have at most a single consonant as an onset. Nuclei contain either a single vowel or diphthong, some of which can be optionally preceded by a glide [j] or [w].³

(9)

V	[í] ‘meaning’	[ù] ‘five’	[é] ‘hungry’	[ŷ] ‘rain’	[ɔ̄] ‘rest’
CV	[tí] ‘brother’	[tʰú] ‘spit’	[pʰá] ‘to fear’	[lâ] ‘spicy’	[kʰí] ‘go’
CVV	[bēi] ‘cup’	[xóu] ‘thick’	[lǣi] ‘come’	[tɛ̄ēi] ‘thief’	[sóu] ‘thin’
C[j/w]V	[kwâ] ‘melon’	[tɛ̄jâ] ‘home’	[ɛ̄jɛ̄] ‘shoe’	[tswâ] ‘grab’	[tɛ̄jó] ‘teach’
C[j/w]VV	[ɛ̄jôu] ‘fix’	[twéi] ‘yes’	[kʰwǣi] ‘fast’	[tswɛ̄i] ‘mouth’	[ljóu] ‘six’

The dialect allows the nasal codas [n] and [ŋ], also characteristic of Mandarin.

(10)

V[N]	[ă̄n] ‘peace’	[ĭn] ‘sound’	[é̄n] ‘hard’	[â̄ŋ] ‘dirty’	[ŷn] ‘cloud’
CV[N]	[pʰîn] ‘spell’	[tĕ̄in] ‘gold’	[fán] ‘rice’	[xé̄n] ‘hate’	[lîŋ] ‘zero’
C[j/w]V[N]	[kwè̄n] ‘roll’	[twà̄n] ‘short’	[njâ̄ŋ] ‘mom’	[ljè̄n] ‘face’	[ɛ̄jâ̄ŋ] ‘think’

However, what distinguishes it from the majority of Mandarin dialects is the presence of glottal stop codas; this feature—allowing a non-nasal consonant coda—was prominent in Middle Chinese and survives in other dialect families like Wu and Yue, but is almost completely absent in Mandarin dialects spoken in modern times (see Chen (2000) for more in-depth discussion of this phenomenon).

Syllables that take a glottal stop coda have at most one vowel in their nucleus, optionally preceded by a glide. There are no codas in the language containing both a nasal and a glottal stop. Possible syllable formations are summarized in (11).⁴

(11)

V?	[ጀ?̄] ‘grumpy’	[ጀ?̄] ‘QP’ ⁴	[ጀ?̄] ‘one’		
CV?	[tጀ?̄] ‘virtue’	[fጀ?̄] ‘law’	[zጀ?̄] ‘hot’	[xጀ?̄] ‘live’	[sጀ?̄] ‘kill’
C[j/w]V?	[swጀ?̄] ‘swipe’	[tʰwጀ?̄] ‘pull’	[eyጀ?̄] ‘snow’	[tጀ?̄jɛ̄] ‘iron’	[ɛ̄jጀ?̄] ‘blind’

³ IPA tone diacritics will be used to represent tones in this section to distinguish meaning; the tonal system of the language will be introduced formally in Section 3.

⁴ Entry [ጀ?̄] is an interrogative particle that, when placed pre-verbally, forms a yes-or-no question.

The distinctive nature of the glottal stop coda is also reflected in the tonal system of the Nanjing dialect, in that syllables with this coda comprise their own tonal class. This feature is a relic of the tonal phonology of Middle Chinese; syllables with an obstruent coda (specifically [p,t,k,?]) formed their own tonal category called ‘entering tone’ (or *rusheng* 入声). In the Nanjing dialect, as is true for other dialects with obstruent codas, all syllables with a glottal stop coda have a distinct tonal quality shared by none of the other syllables. The demarcation between syllables without a non-nasal consonant coda and those with—and the resulting tonal effects—is referred to by Chen (2000) as the difference between ‘legato’ and ‘checked’ toned syllables. That is, CV? syllables are referred to as ‘checked’ syllables, and syllables without the glottal stop are termed ‘legato’.

With respect to syllable weight, I will follow the general consensus in discussions of Chinese phonology (Yip 1990, 2002; Bao 1999; Chen 2000) and maintain that all syllables in the Nanjing dialect are bimoraic. The bimoracity of rimes is crucial to our analysis; in the representational model we will adopt in subsequent sections, morae are the tone-bearing units (TBU) of syllables. This will be discussed formally in Section 4. Before discussing formal representation, we will introduce the basic tonal melodies in the language, and identify the environments in which tone sandhi occurs.

3. BASIC TONAL MELODIES AND INSTANCES OF SANDHI

There are five contrastive tonal melodies on syllables in the dialect. Tonal representation of these melodies offered in (12) makes use of Chao's (1930) *tone letter* system, which denotes pitches ranging from 1 (lowest) to 5 (highest):⁵

- | | | | | |
|------|-------|-----------|----|--|
| (12) | [fu] | 'husband' | 41 | falling contour tone |
| | [fu] | 'hold up' | 24 | rising contour tone |
| | [fu] | 'wife' | 44 | high level tone |
| | [fu] | 'rotten' | 11 | low level tone |
| | [fu?] | 'luck' | 5 | high, short tone with glottal stop coda ('checked tone') |

With five tonal patterns on monosyllables, there is a total of 5^*5 , or twenty-five possible combinations of contrastive tonal melodies when two syllables appear adjacently. For the majority of these possible combinations, the tonal melody of each syllable appears identical to that observed in isolation (13):

- | | | | |
|------|-------------------------|---------------------------|----------------------|
| (13) | a. [nan tɕin] 'Nanjing' | b. [lɔ zən] 'the elderly' | c. [tɔ tɕɔ] 'Daoism' |
|------|-------------------------|---------------------------|----------------------|

In Isolation

[nan]	24	'south'	[lɔ]	11	'old'	[tɔ]	44	'the Dao'
[tɕin]	41	'capital'	[zən]	24	'person'	[tɕɔ]	44	'religion'

In Combination

[nan tɕin]	24.41	'Nanjing'	[lɔ zən]	11.24	'the elderly'	[tɔ tɕɔ]	44.44	'Daoism'
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For some combinations, however, the tonal form for a syllable in a specific environment appears different from that observed in isolation and other combinations, a process known as tone sandhi. Below are several observed examples of tone sandhi in the Nanjing dialect:

⁵ These pitch values are given in Liu (1995).

- (14) a. [piŋ ɛjan] ‘refrigerator’ b. [tsə ɛyɛ?] ‘philosophy’ c. [k^hu kwa] ‘bitter melon’

In Isolation

[piŋ]	41	‘ice’	[tsə]	24	‘wisdom’	[k ^h u]	11	‘bitter’
[ɛjan]	41	‘box’	[ɛyɛ?]	5?	‘study’	[kwa]	41	‘melon’

In Combination

[piŋ ɛjan]	44.41	[tsə ɛyɛ?]	11.5?	[k ^h u kwa]	24.41
‘refrigerator’		‘philosophy’		‘bitter melon’	

Of 25 possible disyllabic combinations, six cases of tone sandhi are observed. The table below outlines all potential combinations, with observed sandhi patterns in bold:⁶,⁷

Leftσ \ Rightσ	41	24	44	11	5?
41	44.41	41.24	41.44	41.11	41.5?
24	24.41	24.24	24.44	24.11	11.5?
44	44.41	44.24	44.44	44.11	41.5?
11	24.41	11.24	24.44 ⁶	24.11	11.5?
5?	5?.41	5?.24	5?.44	5?.11	5?.5? ⁷

Table 1: Possible disyllabic tonal combinations in Nanjing dialect with sandhi forms

Two important general observations can be made about tone sandhi in the dialect given the table above. First, when sandhi occurs, variation in the tonal pattern takes place only for the first (leftmost) syllable in a disyllabic combination; the second (rightmost) syllable does not alter in any of the observed patterns. In addition, no new tonal melodies are created through sandhi; the tonal melodies in sandhi forms for all tonal patterns are identical to other melodies in isolation.

⁶ Sandhi pattern 22.44, observed by the author in Nanjing in the summer of 2012, does not appear in Liu (1995) or Ma(2009), but is reported in a recent acoustic analysis of Nanjing dialect tones conducted by Song (2006).

⁷Ma (2009), following Liu (1995), reports that sandhi pattern L?.H? as a sandhi form for 5?.5?, a form which the author finds spurious. Song’s (2006) analysis calls the veracity of this pattern into question, and consultations with native speakers echo this suspicion. Therefore, it will not be included in this analysis.

- (15) a. Sandhi form for falling contour tone [41] = **[44]** (identical to high level tone)
b. Sandhi form for rising contour tone [42] = **[11]** (identical to low level tone)
c. Sandhi form for high level tone [44] = **[41]** (identical to falling contour tone)
d. Sandhi form for low level tone [11] = **[24]** (identical to rising contour tone)

Given this symmetry, and in light of the fact that checked tone syllables [5?] do not undergo sandhi, the tonal melodies described in (12) represent all possible tonal patterns in the language, encompassing syllables in isolation, disyllabic sandhi environments, and non-sandhi combinations.

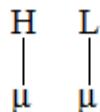
4. TONAL REPRESENTATIONS

As discussed in Chapter 1, we have selected a model for which to represent the tonal system of the Nanjing Dialect. However, analysis of sandhi using this framework is ill-advised without two crucial considerations: theoretical motivation of surface forms and thoughtful consideration of these forms' underlying representations. In this chapter, we conceptualize Nanjing Dialect tones according to Duanmu's model, and employ Optimality Theory to motivate these surface representations and determine underlying forms.

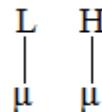
4.1 Duanmu's Tonal Model

For the tonal system of the Nanjing dialect, we adopt a representational model based on that offered by Duanmu (1990, 1994) in which phonemic tones are represented in terms of tonal elements [H] and [L] and morae. This representational configuration is sufficient in representing all surface tones, including sandhi variations. The surface forms of the five tones are represented graphically in terms of [H], [L] and morae in the following way:

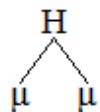
- (16) a. falling contour tone [HL]



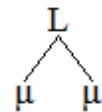
- b. rising contour tone [LH]



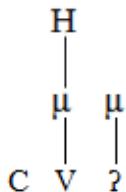
- c. high level tone [H]



- d. low level tone [L]



- e. checked tone [H?]



Throughout the remainder of the exposition, we refer to the surface forms of tones using the bracketed notation in (16); individual segments in a tonal melody will be referred to as ‘H-element’ or ‘L-segment’. Therefore, [H] in (16c) and [L] (16d) refer to the syllable-level tones: two morae that attach to a single H- and L-segment, respectively. (17) organizes the tones with respect to their tonal shapes:

	level	contour	CVC (checked)
(17)	H	HL	H?
	L	HH	

High and low level tones, rising and falling contour tones, and a high, short tone with a glottal stop coda (checked tone) are observed in this dialect. Duanmu’s model adequately accounts for all five tonal contrasts.

4.2 OT Analysis

In terms of OT, ensuring that only the observed surface forms appear requires proposal of a series of constraints that govern the tonal well-formedness of the language. The discussion below introduces and motivates each constraint separately, with relevant tableaux.

Recall that in Section 2 we introduced the notion of all syllables in the Nanjing dialect being bimoraic; to reflect this in the formal language of OT, we introduce a markedness constraint requiring all syllables to have two morae. We will rank this constraint at the top of our hierarchy, and assume that it is a general property of the language.

- (18) BIMORAIC σ - All syllables contain two morae

This constraint will reject any mono- or trimoraic forms.

(19)	/σ/	BIMORAIC σ
a.	σ μ	*!
b.	σ → $\mu \mu$	
c.	σ $\mu \mu \mu$	*!

Another crucial element of our model is not only the presence of morae in syllables, but also their attachment to tonal segments in output forms to yield toned syllables. A markedness constraint governing moraic association to tonal segments will achieve this.

- (20) * μ_T - Assign one violation to a mora that does not associate with a tonal segment

We are confronted with a dilemma here: given our established tonal configuration scheme, checked tone syllables will inevitably violate * μ_T when the second mora attaches to a glottal stop. How will this affect constraint ranking? Keeping in mind that checked tone syllables trigger sandhi but do not undergo the process, in order to yield only the surface form for checked tone syllables described in (16e)—the only form observed in the data—we must introduce other constraints that will favor that configuration, and rank them critically above * μ_T . One constraint will ensure moraic assignment to glottal stop; its ranking above * μ_T permits the optimal candidate [H?] to violate * μ_T once without facing rejection. The other prevents a checked tone syllable from surfacing with a L-element.

- (21) a. [?]to μ - A glottal stop coda takes one mora

- b. *L?- Assign one violation to sequences where a L-segment is followed by a glottal stop [?]

Ranking these constraints at the top of the hierarchy along with BIMORAIC σ —and critically above * μ_T —will only allow the observed checked tone syllable surface form [H?]:

- (22)

/ H C V ? /	[?]to μ	*L?	BIMORAIC σ	* μ_T
a. \rightarrow 				*
b. 		*!		
c. 		*!		*
d. 			*!	*

We expect that these constraints reflect basic properties of the language, and therefore will not discuss them further. In addition, subsequent tableaux will not consider alternative output forms for checked tones.

In legato syllables, $*\mu\text{-T}$ selects optimal candidates for which both morae associate with some tonal segment. (23) illustrates with a high, level tone syllable /H/; any less than two associations guarantees rejection.

(23)

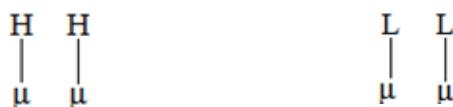
	BIMORAICσ	$*\mu\text{-T}$
a. 		
b. 		$*!$
c. 		$*!*$

Our representations of the two level tones [H] and [L] so far have included two morae attaching to a single tonal segment (as shown in 16c and 16d). Another possible understanding of these tones' structure could be two identical tone segments, with each mora attaching to one segment.

(24)

a. [HH]

b. [LL]



While this configuration represents the same surface form for both tones, we follow Yip's (1990:*vi*) suggestion that level tones contain only one tonal segment, since consecutive identical tonal segments is a violation of the Obligatory Contour Principle. Therefore, we propose a specified OCP constraint that targets the tonal melody of a syllable.⁸

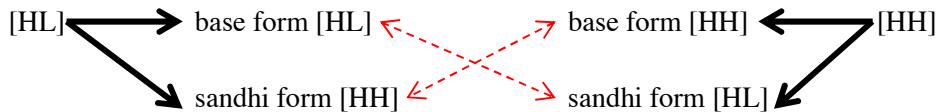
⁸ As is the case with most other dialects of Chinese, this dialect's syllable-to-morpheme ratio is typically 1:1, so this constraint could also take the morpheme as its domain. We choose, however, to limit the discussion to syllables.

- (25) *HH/*LL_[σ]- Assign one violation to sequences of adjacent identical tonal elements within a syllable

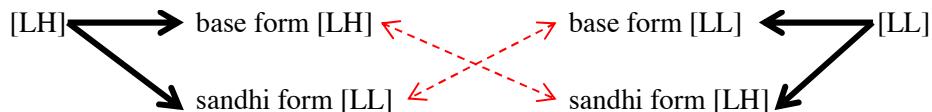
Since this constraint applies to H- and L- elements within a syllable, it rejects candidates like (24a) and (24b) while accepting those represented by (16c) and (16d).

This constraint achieves two primary goals in our model: not only does it encourage the more felicitous representation of level tones in outputs, it also permits exactly the two contours (rising and falling) that appear in the dialect. If a tonal melody contains two tonal segments, the only acceptable possibilities are [HL] (falling contour tone) and [LH] (rising contour tone). This constraint, in conjunction with the binary nature of the H and L model, thus selects the base and sandhi forms for all legato toned syllables, reflecting the symmetry that exists between sandhi and non-sandhi forms across tonal categories (26):

- (26) [HL] and [HH]:



- [LH] and [LL]



Since no impetus to consider an alternative ranking arises, we situate the OCP-based constraint at the top of our hierarchy with the other two markedness constraints. Illustrated in the tableau in (27)⁹, this constraint allows precisely the four legato tones in the Nanjing dialect, and rejects candidates that exhibit the unsuitable representation of level tones.

⁹ Notice also that, in order to select one optimal candidate over otherwise well-formed outputs, inputs must contain at least one tonal segment in the melody underlyingly. Our discussion of richness of the base in the following chapter, accordingly, will only examine this variety of input.

(27)

/ σ /	BIMORAICσ	*μ _T	*HH/LL _[σ]
a. ⌚ H μ μ			
b. ⌚ H L μ μ			
c. ⌚ L H μ μ			
d. ⌚ L μ μ			
e. ⌚ H H μ μ			*!
f. ⌚ L L μ μ			*!

Our constraint ranking, which will select all observed surface forms, is summarized in (28):

(28) BIMORAICσ, *μ_T, *HH/LL_[σ]

4.3 Motivating Underlying Representations

Each of the four legato tones in this dialect has two observed surface forms: (1) the tone observed in isolation and in non-alternating disyllabic combination, and (2) the ‘sandhi’ form. For example, the tone that is a falling contour [HL] in isolation appears as either a falling contour tone [HL] or a high level tone [H], depending on the tones in its immediate vicinity:

(29)

[HL]	[H]
In isolation	Before [HL]
Before/after [LH]	
Before [LL]	
Before/after [H]	
Before/after [H?]	
After [HL]	

Either of these surface forms could be the underlying representation. We will argue that the form observed in isolation (and in the majority of other environments) is the underlying form for all phonemic tones in the dialect, but not without first considering the alternative analysis.

Let us assume /H/ as the underlying representation for the tone in question. To select this form in isolation, some prohibition against the tone surfacing as [H] must exist in the grammar of the language. A potential way to capture this is a wellformedness requirement related to word edges, and could be expressed in the form of a markedness constraint:

- (30) *H#- Assign one violation when a [H] sequence appears at a right word edge

If /H/ is the underlying form, and [HL] is the observed surface form, the surface form will inevitably entail epenthesis of a L-segment.

(31) /H/ and [HL]

A faithfulness constraint prohibiting epenthesis of tonal segments (32) would resist the addition of the L-segment in the example:

- (32) DEP(T)- Output tonal segments are dependent on having an input correspondent (don't epenthesize tonal segments)

Ranking *H# above DEP(T) would accurately select the [HL] form in isolation.

- (33)

/ /	*H#	DEP(T)
a.	*!	
b.		*

In addition, it would select the observed sequence when the tones appear together in a disyllabic combination...

(34)

	*HH#	DEP(T)
	*!	
		*
		**!

...as well as other cases in which the tone occurs at a right word edge, for example when it appears after a rising contour tone [LH]:

(35)

	*H#	DEP(T)
	*!	
		*

This analysis becomes problematic, though, when examining the proposed /H/ in disyllabic forms where it occupies the leftmost syllable position. Note that this tone surfaces as [HL] in the following environments:

(36)

- | | |
|---|--|
| <p>a. <i>jia ting</i> ‘family’
HL LH (before LH)</p> | <p>c. <i>dan wei</i> ‘working unit’
HL H (before H)</p> |
| b. <i>yin ying</i> ‘shadow’
HL L (before L) | d. <i>fang fa?</i> ‘method’
HL H? (before H?) |

This would entail proposing at least two more markedness constraints to select the ‘sandhi’ form for /H/ in these environments, as well. Another complication arises for the markedness constraint that will select the correct form for /H/ in isolation; recall that there is another tonal category in the language that surfaces as [H] in isolation and all other combinations, except when it occurs before [H?], where it appears as [HL]. Assuming this tone is also /H/ underlyingly, the constraint cannot account for why one set of /H/ morphemes appear as [HL] in isolation, and others appear as [H]. If we assume that its observed sandhi form [HL] is basic, another word edge constraint similar to (30) will select the observed [H] in isolation.

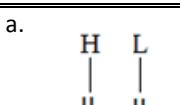
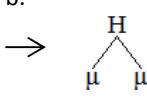
- (37) *HL#- Assign one violation when a [HL] sequence appears at a right word edge

The obvious problem with this constraint is that it clashes with *H# in selecting forms in isolation. If we situate it critically above *HH# in our hierarchy, the ranking yields [H] in isolation, though we must also propose another faithfulness constraint preventing deletion of tonal segments (/HL/ → [H]):

- (38) MAX(T)- Maximize input tonal segments in output forms (don’t delete tonal segments)

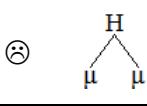
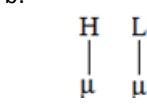
Placing MAX(T) at the bottom of our ranking with DEP(T) would accurately predict [H] from /HL/ in isolation:

(39)

/ H L /	*HL#	*H#	DEP(T)	MAX(T)
a. 	*!			
b. → 		*		*

The unfortunate consequence, though, is the constraint ranking’s inability to accurately select the optimal form [HL] in isolation without reordering constraints.

(40)

/ H /	*HL#	*HH#	DEP(T)	MAX(T)
a. 		*		
b. 	*!		*	

The same is true for the observed rising contour tone [LH] in isolation. Recall that this tone appears in the data as either a rising contour tone [LH] or a low level tone [L], depending on its environment:

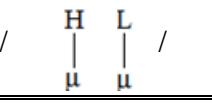
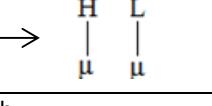
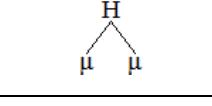
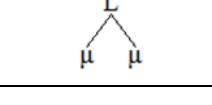
(41)

[LH]	[L]
In isolation	Before [H?]
Before/after [HL]	
Before/after [LH]	
Before/after [L]	
Before/after [H]	
After [H?]	

Assuming /L/ to be basic necessitates the proposal of several new markedness constraints that will select [LH] in those ten environments, and—as was also true of [HL]—the ranking of these constraints will become problematic when trying to select optimal forms consistently throughout the language. Already, the analysis has become quite complex, and we have yet to discuss cases of tone sandhi!

If we take forms observed in isolation as basic, however, it effectively mitigates the need for extra constraints. For example, if we assume /HL/ as underlying for the observed falling contour tone in isolation, it will be selected over [H] (and anything else) simply with our existing faithfulness constraint MAX(T). Candidates that delete either the H- or L- segment are rejected:

(42)

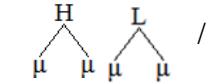
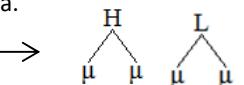
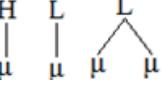
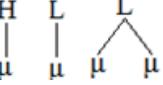
/  /	MAX(T)
a. 	
b. 	*!
c. 	*!

The same holds for [HL] in the other eight possible disyllabic combinations in which it appears as [HL]. To select its sandhi form in the combination /HL.HL/, we will need to propose only one

markedness constraint that applies to that sequence specifically (see Section 6). This is the preferred method of representation, then, because it calls for less constraints, and is readily applicable to the entire tonal system of the language.

Taking /H/ as the basic form for [H] in isolation yields identical results. The optimal candidate is one that incurs no faithfulness violations, though in this case the active constraint is DEP(T). For disyllabic combinations in which [H] is also the observed form, our constraint ranking operates in the same way:

(43)

	MAX(T)	DEP(T)
 a. \rightarrow 		
		*!

Here, the candidate (a) fully-faithful to underlying /H/ is selected over its sandhi form candidate [HL], by virtue of a DEP(T) violation. Similar to the case described above, since /H/ surfaces as [HL] in only one environment—before [H?—a single specified markedness constraint is sufficient in selecting that form.

The same generalizations for [HL] and [H] can also apply to [LH] and [L]. Assuming forms observed in isolation as underlying allows for a simpler and less problematic system of constraints. Tones in isolation and non-sandhi disyllabic combination are accurately selected vis-à-vis faithfulness stipulations MAX(T) and DEP(T), identical to (42) and (43).

Since [H?] does not participate in sandhi, I will assume that its observed surface form is also the underlying form for the same reasons, and that its appearance in the data is similarly constrained by faithfulness as well as the constraints described in 4.2 (see example 21).

For the remainder of the exposition, and especially in the discussion of disyllabic tone sandhi, we will adopt the surface forms observed in isolation as our underlying representations. Having determined the underlying representations, we can reintroduce Table 1, using H and L notation:

Left σ	Right σ	/HL/	/LH/	/H/	/L/	/H?/
/HL/	H.HL	HL.LH	HL.H	HL.L	HL.H?	
/LH/	LH.HL	LH.LH	LH.H	LH.L	L.H?	
/H/	H.HL	H.LH	H.H	H.L	HL.H?	
/L/	LH.HL	L.LH	LH.H	LH.L	L.H?	
/H?/	H?.HL	H?.LH	H?.H	H?.L	H?.H?	

Table 2: 25 possible tonal combinations with sandhi (H and L)

Our ill-fated assumption of ‘sandhi’ forms as basic, though erroneous, does shed light on an important property of the language: tones surface in their sandhi forms through minimal faithfulness violation. Given our adopted model, we understand contour tones /HL/ and /LH/ to surface in their level sandhi equivalents [H] and [L] through a process of deletion, incurring one violation of MAX(T). The inverse is true of level tones /H/ and /L/; selection of contour sandhi forms [HL] and [LH] entails tonal segment epenthesis and violation of DEP(T). Universal violability of constraints and general conflict between faithfulness and markedness in the OT model suggests that Nanjing Dialect sandhi authorizes minimal alteration of underlying forms to avoid violation of some higher-ranked markedness stipulation. Therefore, we can anticipate a critical ranking of some markedness constraint above MAX(T) and DEP(T) to yield sandhi outputs.

The proposed faithfulness constraints do not yet interact directly with the wellformedness constraints BIMORAIC σ , * μ -T, and *HH/LL[σ], and therefore no motivation is present to offer a ranking between the two. However, this will change in the following two sections.

5. RICHNESS OF THE BASE: MONOSYLLABLES

Our constraint hierarchy up to this point has successfully predicted observed surface forms in the dialect in question. However, it has done so assuming inputs identical to optimal output forms. While convenient for analysis, this presumption neglects an essential characteristic of the Lexicon in Optimality Theory: Richness of the Base. As described by Prince and Smolensky (1993), Richness of the Base demands that “*all* inputs are possible in all languages” (209), or, in the words of Kager (1999:19): “no constraints hold at the level of underlying forms.”

In other words, building an analysis with mirror input/output forms is not incorrect, but rather incomplete; it fails to take into consideration the full spectrum of possible inputs. A theoretically viable account, then, gauges the extent to which the existing analytical configuration effectively selects outputs regardless of the quality of the input. Germane to our consideration are fundamental features of Duanmu’s tonal model: all syllables are bimoraic, contain at most two tonal segments H or L (which do not repeat), and both morae associate to a tone. Richness of the Base requires consideration of inputs underpecified or deficient in these areas.

To begin, let us first examine input forms for which tone and morae do not associate. The current constraint hierarchy lacks any markedness constraint addressing this issue, so a new one is necessary:

- (44) *FLOAT- A tone must be associated with a TBU

This constraint, discussed in Yip (2002:83), and based on Goldsmith’s (1976) Wellformedness Conditions, requires that tonal segments in the input associate with a mora in the output. The importance of *FLOAT manifests for inputs composed of one or less associations between tonal segments and morae.

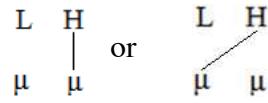
(45)

/ L H / μ μ	BIMORAIC σ	*μ-T	*HH/LL $[\sigma]$	*FLOAT
a. L H μ μ		*!*		**
b. → L H μ μ				
c. 				*!

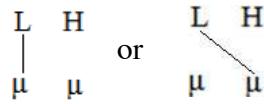
The tableau in (45)¹⁰ evaluates candidates for a bimoraic input with no associations. *FLOAT is necessary to select optimal (b) over the otherwise-wellformed candidate (c), which could also show both morae associating with the H-segment. The rejection of both (a) and (c) motivates ranking this constraint with the other wellformedness conditions.

*FLOAT will also select [LH] from the following inputs that are underspecified for either mora count or tonal segment-to-mora associations (in conjunction with the higher-ranked markedness constraints):¹¹

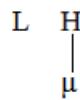
(46) L,H, two morae, one attaches to H:



L,H, two morae, one attaches to L:



L,H, one mora attaches to H:



L,H, one mora attaches to L:



L,H, no morae, no attachments:



¹⁰ Candidates (b) and (c) would invariably violate some faithfulness constraint requiring identical tone-to-mora associations between input and output. Such a constraint is likely inoperative in the language in other contexts, so we do not discuss it further.

¹¹ For syllables in which the leftmost mora associates with the rightmost tonal segment (and vice versa), we assume that outputs conform to the general wellformedness conditions outlined by Goldsmith (1976), especially the condition that association lines do not cross (captured in OT terms via LINEARITY constraints (McCarthy and Prince 1995)).

These generalizations hold true for correspondingly-underspecified inputs with an underlying H- and L-segment yielding falling contour tone [HL]. (47) shows an such input configuration containing neither morae nor associations:

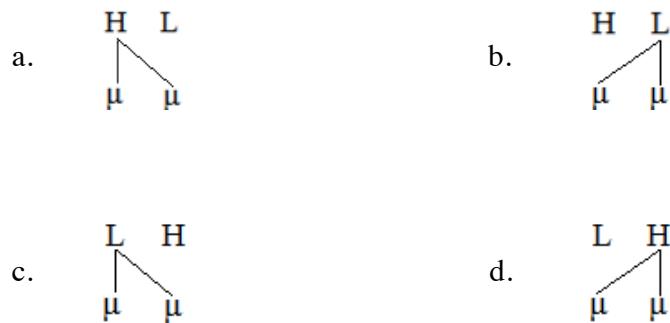
(47)

/ $\begin{array}{cc} \text{H} & \text{L} \end{array} /$ o o	BIMORAIC σ	* μ_T	*HH/LL $_{[\sigma]}$	*FLOAT
a. $\begin{array}{cc} \text{H} & \text{L} \\ \text{o} & \text{o} \end{array}$		*!*		**
b. $\rightarrow \begin{array}{cc} \text{H} & \text{L} \\ \mu & \mu \end{array}$				
c. $\begin{array}{cc} \text{H} & \text{L} \\ \mu & \diagdown \mu \end{array}$				*!
d. $\begin{array}{cc} \text{H} & \text{L} \\ \mu & \diagup \mu \end{array}$				*!
e. $\begin{array}{cc} \text{H} & \text{L} \\ \mu & \diagup \mu \end{array}$		*!		

Fully-faithful (a) is rejected after the first of two BIMORAIC σ violations, which disposes of candidates containing any less than two morae. Both * μ_T and *FLOAT dispose of candidates with either unassociated tones or morae, and (b) is selected as optimal.

Another category of input to consider is one maximally-specified with respect to morae and associations (two morae that both associate), but whose fully-faithful candidate violates *FLOAT. Cases like these would have a structure identical to that of candidates (c) and (d) in (47).

(48)

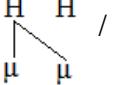
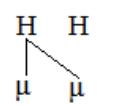
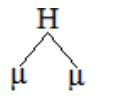


When evaluated by the current constraint hierarchy, all fully-faithful candidates for the inputs in (47) would incur a fatal violation of *FLOAT, and the inevitable optimal candidate would be contour tones in all cases; falling contour tone [HL] for (a) and (b), and rising contour tone [LH] for (c) and (d).

Optimal candidates for level tones are selected through the same process. *FLOAT will render as suboptimal any forms fully-faithful to inputs underspecified for mora-to-tone associations. Similarly, BIMORAIC σ constrains output forms with one or no morae, even if inputs are moraically deficient.

Observation of diverse input sets regarding the melodic tier, however, turns the analysis in a new direction. Recall the proposal of the OCP-based constraint for tonal melodies in Section 4, effectively preventing syllables with [HH] or [LL] tonal melodies. Similar to the interaction with wellformedness constraints shown above, we expect fully-faithful candidates for inputs containing this malformed sequence to be eliminated via *HH/LL. An optimal candidate, for example high level [H], would need to delete the extraneous tonal segment and incur a violation of MAX(T). This partially confirms the suspicions introduced at the end of the preceding chapter, and motivates ranking faithfulness MAX(T) below the markedness constraints:

(49)¹²

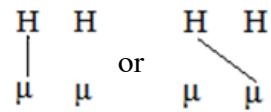
/  /	BIMORAIC σ	*μ _T	*HH/LL _[σ]	*FLOAT	MAX(T)
a. 			*!	*	
b. 					*

Candidate (a) violates both the OCP-based constraint and *FLOAT to remain faithful to the input and is rejected. Given *HH/LL's ranking, a candidate associating the rightmost mora to the rightmost [H] would also be eliminated, in spite of conforming to *FLOAT. Optimal candidate (b), while deleting one H-element and violating MAX(T), successfully avoids the prohibited [HH] melodic tier configuration.

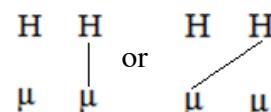
¹² But what about well-formed [HL]? This candidate would incur violations of both MAX(T) and DEP(T) and be eliminated. Here, however, DEP(T)'s appropriate ranking respective to MAX(T) is unclear. The following section will adequately motivate the ranking of DEP(T).

Input forms with adjacent identical tonal segments combined with other underspecified elements (morae and/or associations) are similarly within the purview of the current constraint scheme. (50) provides several examples for [HH] sequences. Keep in mind that the same would apply to equivalent [LL] forms:

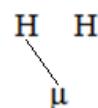
(50) H₁,H₂, two morae, one attaches to H₁



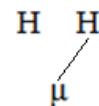
H₁,H₂, two morae, one attaches to H₂



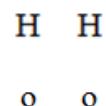
H₁,H₂, one mora attaches to H₁



H₁,H₂, one attaches to H₂



H₁,H₂, no mora, no attachments



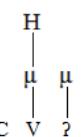
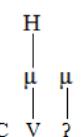
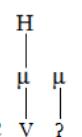
With the introduction of *FLOAT and new critical rankings, the system of constraints effectively takes into account a variety of underspecified input forms. This includes inputs with as little as zero morae or tone-to-mora associations, as well as syllables whose melodies are [HH] and [LL]. In all cases, the constraint ranking will predict surface forms consistent with observed data.

The following Chapter introduces and analyzes disyllabic tone sandhi in the dialect. Of all possible input configurations for monosyllables discussed in this section, our analysis will assume underlying forms that are identical to the observed outputs, a principle known as Lexicon Optimization (Prince and Smolensky 1993: 209):

- (51) **Lexicon Optimization:** Suppose that several different inputs I_1, I_2, \dots, I_n when parsed by a grammar G lead to corresponding outputs O_1, O_2, \dots, O_n , all of which are realized as the same phonetic form Φ – these inputs are all *phonetically equivalent* with respect to G . Now one of these outputs must be the most harmonic, by virtue of incurring the least significant violation marks: suppose this optimal one is labeled O_k . Then the learner should choose, as the underlying form for Φ , the input I_k .

Since observed output forms (Φ) for all tones in the Nanjing dialect incur the least significant violations of our proposed constraints, we will assume that those forms (O_k) are identical to the input configurations (I_k) in our discussion of tone sandhi in disyllabic combinations. (52) illustrates:

- (52)

Φ	O_k	I_k
[HL] 	[HL] 	/HL/ 
[LH] 	[LH] 	/LH/ 
[H] 	[H] 	/H/ 
[L] 	[L] 	/L/ 
[H?] 	[H?] 	/H?/ 

6. DISYLLABIC TONE SANDHI

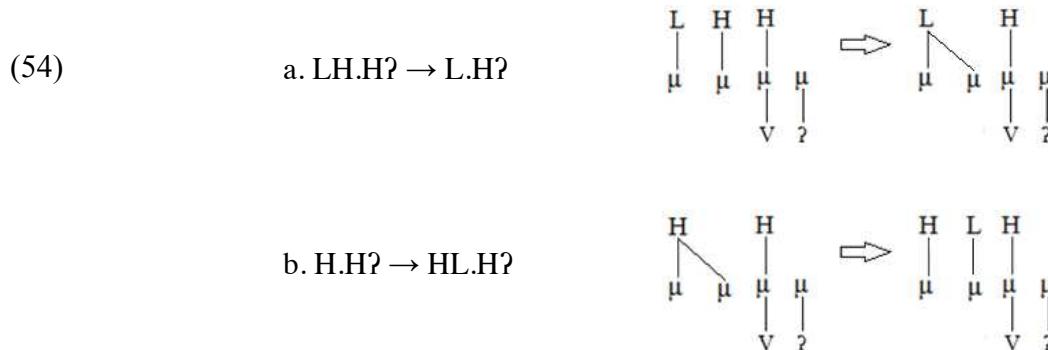
A five-tone system with twenty-five possible disyllabic combinations, the Nanjing Dialect exhibits six cases of tone sandhi. All six alternations entail minimal modification of the leftmost syllable.

(53)	a.	<i>shu xue</i>	'mathematics'	d.	<i>lao shu</i>	'rat'
		H. H?	base form		L. L	base form
		HL. H?	sandhi form		LH. L	sandhi form
	b.	<i>na tie</i>	'latte'	e.	<i>bing xiang</i>	'refrigerator'
		LH. H?	base form		HL. HL	base form
		L. H?	sandhi form		H. HL	sandhi form
	c.	<i>fan kang</i>	'resist'	f.	<i>lao shi</i>	'teacher'
		L. H	base form		L. HL	base form
		LH. H	sandhi form		LH. HL	sandhi form

While structurally similar, these alternations are reflective of either assimilatory or dissimilatory processes, and display sensitivity to different domains within our adopted syllable structure. New constraints are added to the existing OT account to select for observed surface forms. Analysis is organized by tonal category type (6.1) as well as operative domain (6.2 and 6.3)

6.1 Sandhi with Checked Tone Syllables

Checked tone syllables are a unique feature of the language; as discussed earlier, this tonal category is practically extinct in Mandarin, surviving only in Lower Yangzi dialects. They are also robust members of the phonological system. Checked tone syllables trigger sandhi in two environments, but resist modification through sandhi themselves. The two alternations are represented graphically in (54):



These sandhi patterns are dissimilatory in nature; the language prohibits adjacent H-elements in disyllabic combinations when the second H in the melodic tier is part of a checked tone syllable. To

prevent this occurrence, rising tone in (54a) deletes its H-segment, surfacing as [L], while (54b) avoids adjacent H-elements through L-epenthesis.

What triggers this pattern is not simply adjacent H-elements, but rather when the second H-segment is in a *checked tone syllable*. Adjacent inter-syllabic H-segments in tonal melodies elsewhere in the language are perfectly well-formed, and do not undergo sandhi.

$$(55) \quad \mathbf{H.H} \rightarrow \mathbf{H.H}$$

$$\mathbf{LH.H} \rightarrow \mathbf{LH.H}$$

$$\mathbf{H.HL} \rightarrow \mathbf{H.HL}$$

$$\mathbf{LH.HL} \rightarrow \mathbf{LH.HL}$$

A more accurate description of the conditioning environment for this alternation, then, is [H.H?], or a sequence of H-element plus ‘checked’ H-element.

Capturing this prohibition via OT constraint is possible through Local Constraint Conjunction (Green 1993, Smolensky 1993, Moreton and Smolensky 2002).

$$(56) \quad *[\mathbf{HH}, \mathbf{H?}][\mathbf{H}] - \text{Assign one violation to an H-element that occupies both HH and H? melodies}$$

Recall our discussion of Local Conjunction in 1.2; this constraint is the conjunction of C₁ (*HH) and C₂ (*H?) in a domain D (any H-element).

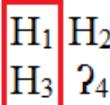
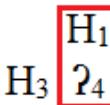
The impetus to adopt Conjunction is in capturing the ill-formed sequence [H.H?], which is composed of several parts: an H-element that is simultaneously preceded by another H-element across a syllable boundary, and followed by a glottal stop. Local Conjunction makes possible the isolation of *precisely* this conditioning environment—differentiating it from environments in (55)—in a constraint that is not exceedingly stipulative, and is preferable to proposing a constraint that simply prohibits the entire sequence, such as *H.H?.

To explain this further, let us examine the possible correspondences between HH and H? (isolating a single H-element that constitutes our domain) that would incur a violation of this constraint. We will use the following notation [H₁H₂] [H₃?₄] for clarity.

The desired melodic correspondence targeted by *[\mathbf{HH}, \mathbf{H?}][\mathbf{H}] is one in which H₂ and H₃ represent the same H-element. (57) dissects the combination [LH.H?] within these terms:

$$(57) \quad [\mathbf{LH.H?}] \quad \begin{array}{c} \mathbf{L} \ \mathbf{H}_1 \boxed{\mathbf{H}_2} \\ \boxed{\mathbf{H}_3} \ ?_4 \end{array}$$

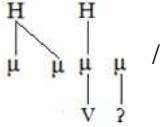
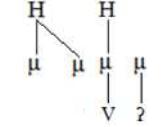
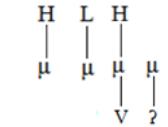
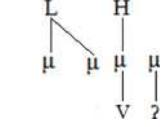
Candidate [LH.H?] conforms to the prohibited sequence addressed by the constraint as we have proposed it, and would incur one violation. Two other potential correspondences exist, however: one in which H₁ is equivalent to H₃, and another in which H₁ is equivalent to ?₄.

(58)	a. H ₁ =H ₃	
	b. H ₁ =? ₄	

Such correspondences, however, are nonviable. The equivalence of H₂ with ?₄ (58a) and H₁ with ?₄ (58b) entail a generally ill-formed assignment of tone to consonant. Therefore, *[HH, H?]_[H] sufficiently targets only the sequence [H.H?].

Situating this constraint among the other high-ranked markedness constraints in the existing hierarchy will reject candidates that contain the melody [H.H?]. Avoidance through tonal epenthesis or deletion seen in surface forms also effectively motivates critical ranking above the faithfulness constraints MAX(T) and DEP(T). See the illustrative tableau for /H.H?/ below:

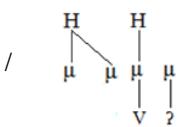
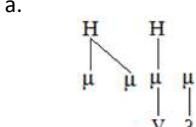
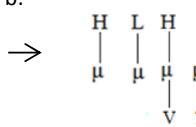
(59)

/ 	BIMORAICσ	*μ _T	*HH/LL [σ]	*[HH, H?]_[H]	*FLOAT	MAX (T)	DEP (T)
a. 				*!			
b. → 							*
c. 						*!	*

The optimal form (b) avoids violating the relevant markedness constraint through L-segment epenthesis, earning it one violation of DEP(T). Note that candidate (c)¹³ also conforms to the Conjunction constraint, but is rejected due to an unacceptable degree of variation from the input form.

An important functional component of Local Conjunction left to address is its simultaneous proposal of three constraints. As proposed in the theory, the conjunction constraint ranks higher in a hierarchy than the separate individuals. Optimal forms can then non-fatally violate one of the constraints. Our proposed Conjunction constraint is joined by separate *HH and *H? constraints lower in the hierarchy. We will tentatively assume that these are ranked along with MAX(T) and DEP(T). The tableau in (59) is thus revisited:

(60)

/ 	BIMORAIC σ	*μ-T	*HH/LL [σ]	*[HH, H?]_I[H]	*FLOAT	MAX(T) DEP(T)	*HH	*H?
a. 				*			*	*
b. → 						*		*

Here, optimal candidate (b) violates DEP(T), as well as *H? by virtue of containing a checked tone, but is selected over fully-faithful (a) by avoiding violation of the conjunction of *HH and *H?.

The case above does not provide explicit evidence motivating a critical ranking between *HH/*H? and MAX(T)/DEP(T). Testing the current hierarchy against disyllabic combinations that do not undergo sandhi, however, reveals that a ranking between the two is necessary. For example, in a combination of two high level tones /H.H/, fully-faithful [H.H] will violate *HH, as it exhibits two adjacent H-segments in its tonal melody. If *HH ranks among general faithfulness constraints, selection between [H.H] and [HL.H] (avoids violating *HH, but incurs a violation of DEP(T)) is impossible.

¹³ The crucial faithfulness violation committed by (58c) is its failure to preserve the input alignment of the tonal melody at the left edge of the syllable (the H-element occupies the left edge in the input but not in the output). A constraint addressing this faithfulness stipulation, L-ANCHT[σ], is introduced in the next section.

(61)

	DEP(T)	MAX(T)	*HH	*H?
/ . H H /				
a. ? . H H μ μ μ μ			*	
b. ? H L H μ μ μ μ	*			

Individual constraints *HH and *H? must rank below MAX(T) and DEP(T) to select fully-faithful output candidates. For such sequences (either monosyllables in isolation or non-sandhi combinations), this ranking reliably selects observed forms; violation of either *HH or *H? is permitted for an optimal candidate, as long as both constraints are not simultaneously violated, thereby triggering the local conjunction constraint. (61) illustrates: situating *HH below DEP(T) renders candidate (a)'s violation non-fatal, while guaranteeing that suboptimal (b) does not surface.

(62)

	DEP(T)	MAX(T)	*HH	*H?
/ . H H /				
a. → . H H μ μ μ μ			*	
b. H L H μ μ μ μ	*!			

Careful ranking of conjunction and corresponding individual constraints, then, imposes restrictions where necessary, but without problematic consequences elsewhere in the language. Moreton and Smolensky (2002) illustrate this concept with the example of German final-obstruent devoicing. Their relevant data is reproduced here (2002:1):

- (63) a. [ʁa:.dəs] [ʁa:t] [ʁɛ:t.çən]
wheel-PL wheel wheel-DIM
- b. [ta:.gəs] [ta:k] [tɛ:k.liç]
day-PL day daily

Two separate markedness constraints conjoin to isolate the proscribed element: any segment (the domain D) that is simultaneously a coda (C1) *and* an obstruent (C2). This stipulation is couched in the formal terminology of Local Conjunction (2002:1).

(64) (NoCODA & *[+voi, -son])segment- voiced obstruent codas are prohibited

(64) results in three separate constraints in the hierarchy: individual NoCODA, individual *[+voi, -son], and their conjunction. The authors then demonstrate the interaction of these constraints with faithfulness conditions. Tableaux (2002:2) for /li:b/ ‘dear, pred.’ and /li:bə/ ‘dear, attr.’ reveal that the hierarchy selects forms exhibiting requisite coda devoicing but not over-applying to include onset devoicing:

(65) a.

/li:b/	NoCODA & *[+voi, -son]	IDENT	*[+voi, -son]	NoCODA
a. [li:b]	*!		*	*
→ b. [li:p]		*		*

b.

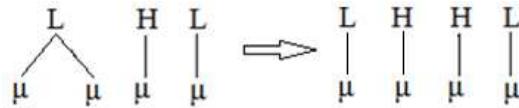
/li:bə/	NoCODA & *[+voi, -son]	IDENT	*[+voi, -son]	NoCODA
→ a. [li:.bə]			*	
b. [li:.pə]		!*!		

The constraints *HH and *H? in our analysis are analogous to NoCODA and *[+voi, -son] in the German example. The conjunction of these constraints works for a specific alternation, while their low individual ranking prevents problems from arising elsewhere. Certainly, both codas and voiced obstruents are well-formed in German; the exception is when the two intersect in a segment. The same is true of *HH and H?. Sequences of HH and H? are widely observed in the dialect. The apposite prohibition, however, is precisely their intersection on a single H-element.

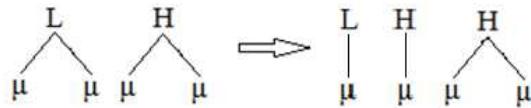
6.2 Sandhi with [L.H]

Sensitivity to adjacent tonal elements in a melody also manifests in two alternations involving the low level tone /L/. When /L/ occurs before H-initial tones (either /H/ or /HL/), it surfaces in its observed sandhi form [LH]. From an articulatory perspective, this pattern can be understood as assimilatory; the low tone raises in anticipation of the following H-element.

(66) a. L.HL → LH.HL



b. L.H → LH.H



Both patterns contain the prohibited melodic sequence [L.H], that is, some L-segment abutting a heterosyllabic H-element. The sandhi form emerges as a result of H-segment epenthesis.

Local Conjunction also succeeds in expressing this conditioning environment. The active constraint differs from that proposed in 6.1 in two ways. First, the domain is not a single segment on the melodic tier but rather two adjacent segments '[TT]'. The constraint furthermore conjoins three separate markedness constraints instead of two.

(67) *[L(σ), $\sigma[H, LH][TT]$] - Assign one violation to adjacent melodic elements that have a syllabic low tone, a syllable-initial [H] element, and a LH sequence

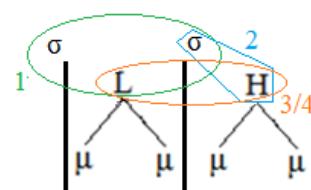
This method of constraint formulation isolates exactly the following adjacent melodic elements [TT]: a L-element occupying its own syllable followed by syllable-initial H-segment.

The formulation of *[L(σ), $\sigma[H, LH][TT]$] narrows its target to the prohibited sequence [L.H]. In the language, disyllabic combinations [L.H] and [L.HL] reflect the prerequisite correspondences for the constraint:

(68) {L(σ)₁} { $\sigma[H$ ₂} L₃H₄

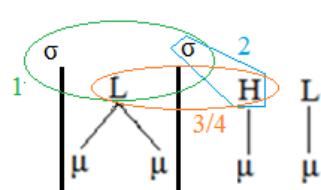
a. [L.H]

{L(σ) ₁ }
{ $\sigma[H$ ₂ }
L ₃ H ₄



b. [L.HL]

{L(σ) ₁ }
{ $\sigma[H$ ₂ }
L ₃ H ₄

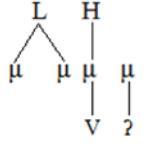
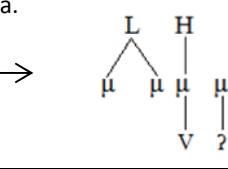
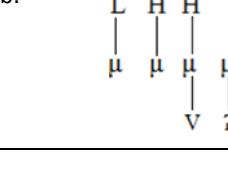


The ranking of $*[L(\sigma), \sigma[H, LH][TT]$ —especially with respect to the other Local Conjunction constraint—warrants further discussion. Specifically, it aims to prevent the realization of candidates containing the [L.H] sequence in their melody. While this sequence triggers sandhi in the environments described above, it is the preferred sequence (and at times the end product of sandhi alternation) in other disyllabic combinations. For example, when the rightmost H-segment belongs to a checked tone syllable, [L.H?] is the observed form when the leftmost syllable is either a low level tone /L/ or a rising contour tone /LH/:

- (69) a. *ran se* ‘dye’
 L. H? base form
 L. H? surface form b. *tu sha* ‘massacre’
 LH. H? base form
 L. H? surface form

To prevent this constraint from blocking optimal candidates in cases like (69), it must be critically ranked below $*[HH, H?][H]$ and above MAX(T) and DEP(T). A tableau for /LL.H?/ illustrates:

(70)

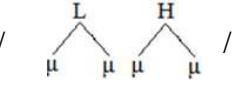
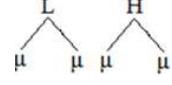
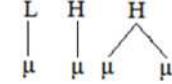
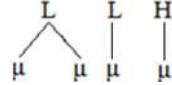
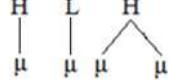
/  /	BIMORAICσ $*\mu_T$ $*HH/LL_{\sigma}$ $*FLOAT$	$*[HH, H?][H]$	$*[L(\sigma), \sigma[H, LH][TT]$	MAX (T)	DEP (T)
a. 			*		
b. 		!			*

Both candidates violate one of the Conjunction constraints. Fully-faithful [L.H?]—the observed surface form—violates $*[L(\sigma), \sigma[H, LH][TT]$ but emerges as optimal, motivating its ranking below the other conjunction constraint.

Before turning to /L.H/ and /L.HL/, it is necessary to address an inadequacy in the current constraint ranking. Recall that the observed sandhi form for /L.H/ is [LH.H]. As described above, this output is the result of an epenthesized H-element in the first syllable. With respect to our current ranking, this candidate would incur a violation of DEP(T). [LH.H] cannot yet be definitively selected,

as GEN produces other candidates which avoid violation of *[L_(σ), σ[H, LH][TT] through minimally violating DEP(T):

(71)

/  /	BIMORAICσ *μ-T *HH/LL _[σ] *FLOAT	*[HH, H?]_[H]	*[L _(σ) , σ[H, LH][TT]	MAX (T)	DEP (T)
a. 			*!		
b. ? 					*
c. ? 					*
d. ? 					*

Candidates (b) through (d) epenthize single tonal segments to successfully evade the prohibited melody. No accurate selection between them is possible in this hierarchy. Note, though, that of the three epenthetic configurations, only (b)'s epenthesis preserves input-output correspondence of leftward-most tonal segments in both syllables. This observation evinces an important generalization about tone sandhi in the Nanjing dialect, not just in these patterns but in the entire system at large: sandhi forms exhibit minimal modification of the *right edge* of a syllable.

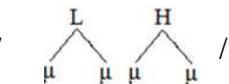
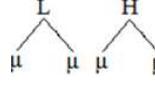
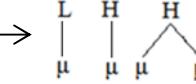
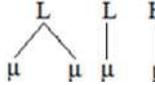
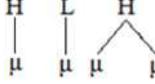
- (72) a. /H.H?/ → [HL.H?]
 b. /LH.H?/ → [L.H?]
 c. /L.H/ → [LH.H]
 d. /L.HL/ → [LH.HL]
 e. /HL.HL/ → [H.HL]
 f. /L.L/ → [LH.L]

Following McCarthy and Prince (1995), we offer an ANCHOR constraint requiring input-output correspondence in this environment:

- (73) L-ANCHT[σ]- Any tonal element at the left edge of a syllable in the input has a correspondent at the left edge of a syllable in the output

Situating the ANCHOR stipulation toward the top of the hierarchy (with the constraints governing tonal well-formedness) reflects its leverage in the language's grammar, as no output forms exhibiting leftmost tonal segment alteration appear in the data. (74) reexamines /L.H/:

- (74)

/  /	BIMORAIC σ * μ_T *HH/L $L_{[\sigma]}$ *FLOAT	L-ANCHT[σ]	*[HH, H?][H]	*[L $_{(\sigma)}$, σ H, LH][TT]	MAX(T)	DEP(T)
a. 				*!		
b. \rightarrow 						*
c. 			*!			*
d. 			*!			*

Candidate (b) circumvents the prohibited tonal melody sequence through epenthesis, but in a way that preserves syllable-left-edge correspondence between input and output. It is therefore selected as optimal.

As individual constraints, * $L_{(\sigma)}$, * σ [H, and *LH rank at the bottom of the hierarchy with the individual markedness constraints for *[HH, H?][H]. Critical ranking below MAX(T) and DEP(T) forestalls rejection of observed output forms in monosyllables and non-alternating disyllabic

combination. Paralleling the German example, violation of these markedness constraints individually or in pairs is pervasive in the language, motivating a low ranking. Several examples are presented below:

- (75) a. /L/ → [L] violates * $L(\sigma)$ c. /HL.L/ → [HL.L] violates * $\sigma[H, *L(\sigma)$
 b. /HL/ → [HL] violates * $\sigma[H$ d. /LH.HL/ → [LH.HL] violates * $LH, *_{\sigma}[H$

In isolation and non-sandhi cases, candidates can incur up to two violations of these constraints. By preserving higher-ranked faithfulness, EVAL selects these forms as surface outputs.

6.3 Syllable-level Sandhi: T₁.T₁

The two remaining sandhi patterns arise from sensitivity not on the melodic tier but at the syllabic level. Sandhi occurs for sequences of adjacent low, level /L/ syllables and falling contour /HL/ syllables. Modification is restricted to the right edge of the leftmost syllable, resulting in tone segment epenthesis (gaining a H-element to become [LH]) or deletion (losing a L-element to become [H]).

- (76) a. L.L → LH.L
-
- b. HL.HL → H.HL
-

Syllable-level dissimilation of this type is widespread in dialects of Mandarin, especially (76a), which is commonly referred to as ‘T3 Sandhi’. This alternation—with identical resulting sandhi form—sees wide geographical distribution throughout the Mandarin area. Relative to Nanjing, it is observed in the nearby province of Anhui (Kong 2008), further south in Hubei (Xiong 1998), and in northern China, where it appears in dialects spoken in Shandong (Wu and Liu 2010), Hebei (Jiang 2001, Li 2005), as well as Tianjin (Tan 1987 among others) and Beijing (Chen 2000 and numerous others cited therein).

In accounting for third-tone sandhi in Beijing Mandarin, Yip (2002:181) posits an OCP constraint specified for low, level tone /L/. We will follow her example, adding an equivalent constraint specified for /HL/:

- (77) a. OCP(L)- Assign one violation to sequences of adjacent low level tones
 b. OCP(HL)- Assign one violation to sequences of adjacent falling contour tones

We provisionally assign OCP(L) and OCP(HL) high ranking in the constraint hierarchy.

In 6.2, the edge-anchoring faithfulness constraint successfully restricted variation to the right edge of the left syllable; for syllable-level sandhi, however, it is insufficient. Compliance with syllabic OCP holds through modification of either the leftmost or rightmost syllable, both of which satisfy L-ANCHT[σ] and minimally violate faithfulness:

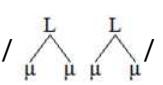
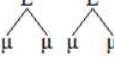
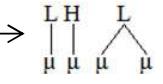
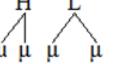
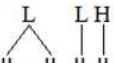
(78)	/L.L/	OCP(L)	DEP(T)
L.L	*!		
?LH.L		*	
?L.LH		*	

Another ANCHOR constraint can remediate this complication with the correct specifications. To prioritize input-output correspondence on the rightmost syllable, the constraint targets toned syllables—as opposed to individual tonal segments—as the basic anchoring unit, and broadens its scope to the entire sandhi domain.

- (79) R-ANCHT σ [SD]- Any toned syllable at the right edge of a sandhi domain in the input has a correspondent at the right edge of a sandhi domain in the output

To reflect consistent preservation of the rightmost syllable as observed in surface outputs, the ANCHOR constraint occupies the higher tier of the constraint hierarchy. (78) illustrates with a tableau for /L.L/:

(80)

/  /	BIMORAIC σ * μ_T *HH/LL $_{[\sigma]}$ *FLOAT R-ANCHT σ [SD]	L-ANCHT[σ] OCP(L) OCP(HL)	*[HH, H?] $_{[H]}$	*[L $_{(\sigma)}$, σ H, LH] $_{[TT]}$	MAX (T)	DEP (T)
a. 			*!			
b. 						*
c. 		*!			*	*
d. 	*!					*

Though the symmetrical candidates (b) and (d) satisfy OCP(L) through one violation of DEP(T), the Anchor constraint disqualifies (d) from output candidacy, preferring (b) instead. The same holds true for /HL.HL/; R-ANCHT σ [SD] determines the final selection between [HL.H] (one violation of MAX(T)) and optimal [H.HL] (also one violation of MAX(T)).

6.4 Summary

A combination of Local Conjunction and OCP constraints encapsulate the markedness conditions that elicit six tone sandhi patterns in the Nanjing Dialect, stemming from adjacency sensitivities in either the melodic tier or at the syllable level. Table 3 summarizes the conditions under which sandhi occurs, the nature of the alternations, and active markedness conditions:

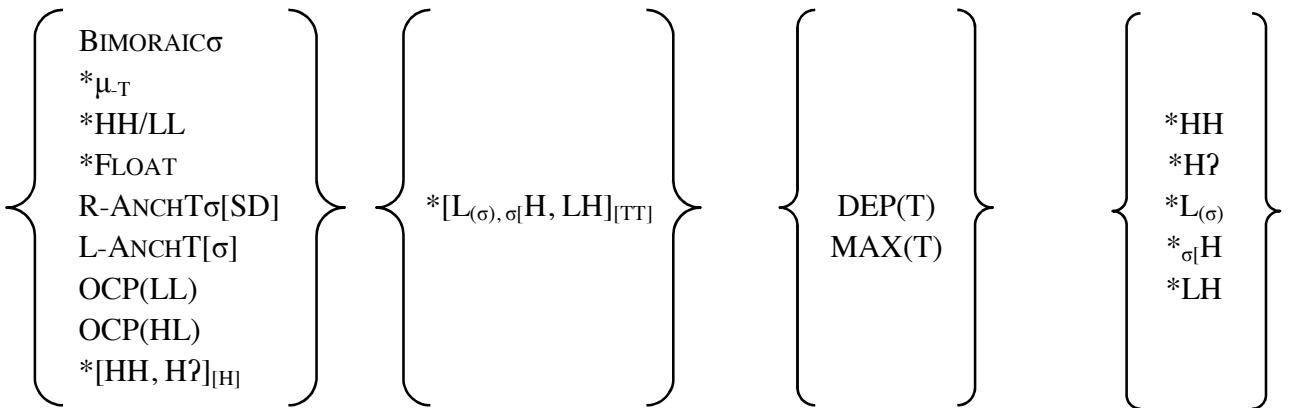
Input form	Output form	Prohibited sequence	Alternation type	Relevant markedness constraint
/LH.H?/	[LL.L?]	[H.H?]	Melodic tier dissimilation	*[HH,H?]_{[H]}
/HH.H?/	[HL.H?]	[H.H?]	Melodic tier dissimilatoin	*[HH,H?]_{[H]}
/LL.HL/	[LH.HL]	[LL.H]	Anticipatory assimilation	*[L _(σ) , _σ H,LH]_{[TT]}
/LL.HH/	[LH.HH]	[LL.H]	Anticipatory assimilation	*[L _(σ) , _σ H,LH]_{[TT]}
/LL.LL/	[LH.LL]	[LL.LL]	Syllable-level dissimilation	OCP(LL)
/HL.HL/	[HH.HL]	[HL.HL]	Syllable-level dissimilation	OCP(HL)

Table 3: Six tone sandhi patterns in the Nanjing Dialect

Anchor constraints confine modification to the right edge of the leftmost syllable in a sandhi domain, and general faithfulness stipulations demand minimal output variation from the input. The interaction of markedness and faithfulness in the hierarchy—by means of critical rankings—selects optimal forms observed in the data.

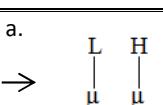
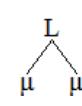
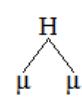
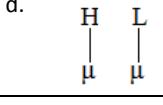
The final constraint ranking (incorporating general wellformedness conditions) for the OT account is presented in (81):

(81)



The proposed final hierarchy accurately predicts outputs for all six cases of disyllabic tone sandhi, and is unproblematic for non-alternating forms in isolation and combination, shown in a tableau for /LH/.

(82)

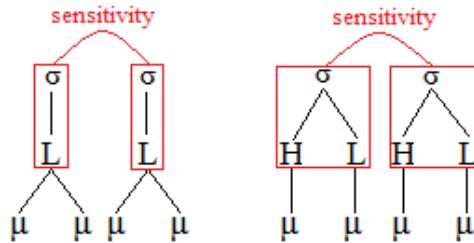
/ L H /	BIMORAIC σ * μ_T *HH/LL $_{[\sigma]}$ *FLOAT R-ANCHT σ [SD] L-ANCHT[σ]	OCP(LL) OCP(HL)	*[HH, H?] $_{[H]}$	*[L $_{(\sigma)}$, $_{\sigma}$ H, LH] $_{[TT]}$	MAX(T) DEP(T)	*HH *H?	*L $_{(\sigma)}$ * $_{\sigma}$ H *LH
a. \rightarrow 							*
b. 					*!		*
c. 	*!				*		*
d. 	*!						*

Markedness constraints relevant to sandhi are inert here, and the same would hold in sandhi-static combinations unless the constraints were violated by candidates already rendered suboptimal via other means. Candidates failing to adhere to anchoring requirements such as (c) and (d) are eliminated, and minimal variation in the tonal melody as in (b)—though permitted in cases of sandhi—is prohibited by MAX(T) and DEP(T). Fully-faithful (a) wins out as the optimal form; violation of individual markedness constraints used in Local Conjunction are non-fatal given the critical ranking below general faithfulness.

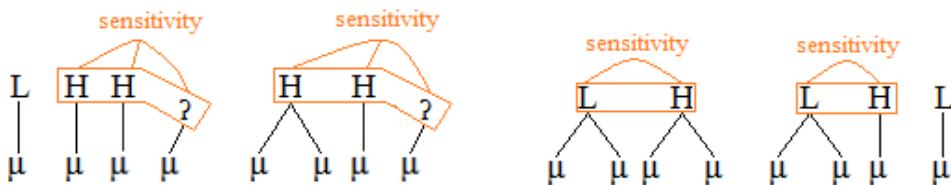
7. DISCUSSION/CONCLUSION

The above account of disyllabic tone sandhi points toward several noteworthy implications. First, the Nanjing Dialect system of tone sandhi can be better understood as the concurrent operation of two systems, or perhaps more accurately as a system reacting to sensitivities spanning two separate domains. Recall that patterns described in 6.3 have analogs in other varieties of Mandarin; the alternation involving adjacent low level tones /L/ occurs in numerous Mandarin dialects—covering a considerable span of that language family’s geographical distribution—with a parallel sandhi form [LH.L]. These patterns exhibit sensitivity to adjacent elements at the syllable level. At the same time, the Nanjing Dialect’s language-specific sandhi patterns (6.1 and 6.2) result from adjacency proscriptions in an entirely separate domain: the melodic tier. Sandhi alternations specific to this dialect are indicative of its tonal system, which is most manifestly distinguished from other Mandarin dialects by the presence of checked tone. The structural ambit of tone sandhi, as a result, is two-tiered:

- (83) a. Sensitivity to syllable-level tone (shared with other Mandarin dialects)



- b. Sensitivity to melodic tier (dialect-specific)



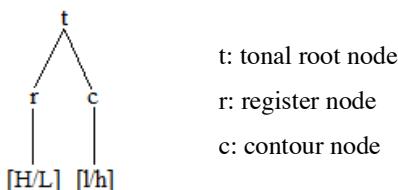
The obvious intersection of these two domains is in how the language manages the unacceptable sequences of adjacent elements: minimal variation of the leftmost syllable. Typologically, this quality—known as right prominence—is characteristic of Mandarin dialects (Hoa 1983; Duanmu 1993, 1995). The varieties of Mandarin mentioned in 6.4 all exhibit variation of this nature in cases of tone sandhi. This is significant in light of the fact that this modification strategy differs noticeably from

those observed in other non-Mandarin families in the general vicinity of Nanjing, most notably Wu. For example, the Shanghai dialect (which also preserves checked tone) is left-prominent, extending the tonal shape of the first syllable rightward over the entire sandhi domain (Jin 1986). Therefore, the Nanjing dialect is unique in that its tonal inventory, given the presence of the checked tone category, perhaps more closely resembles a system of the Wu family, but its sandhi behavior is clearly Mandarin in nature. It reconciles a structurally non-Mandarin tonal system with conventional Mandarin sandhi strategies.

Our analysis of tone sandhi in the dialect reflects these generalizations, specifically in our method of constraint proposal. Different types of constraints accommodate the divergences in domain sensitivity observed in the language's sandhi system. For syllable-level tone sensitivity characteristic of Mandarin dialects, we follow previous accounts and propose OCP constraints. In order to capture the prohibited sequences in tonal melodies unique to the Nanjing dialect, conversely, we utilize Local Conjunction, domain-specified for the tonal melody. The resulting constraint scheme satisfies the grammar's demands across both domains equally.

The account proposed also substantiates the efficacy of our adopted tonal representation model. This is important since, in contemporary discussions of Chinese tone, the model that appears to have triumphed over all others—including Duanmu's model—is that offered by Bao (1990). In fact, it is the standard model utilized in more recent seminal works on tone in Chinese, including Chen (2000) and Yip (2002). The crucial difference between Bao's model and Duanmu's is that Bao's theory of tonal representation incorporates tonal register:

(84)



In his analysis of disyllabic tone sandhi in the Nanjing dialect, Ma (2009:30) also adopts Bao's model, giving the following register values—where [+U] represents upper register and [-U] represents lower register—for the five phonemic tones:

(85)

Phonemic Tone	Value for Register and Contour
Falling contour tone [HL]	[+U, HL]
Rising contour tone [LH]	[+U, LH]
High level tone [H]	[-U, L]
Low level tone [L]	[+U, H]
Checked tone [H?]	[+U, H?]

A benefit of our analysis is its adequate account of tones and tone sandhi in the Nanjing dialect without appealing to register. We have shown that Duanmu's comparatively lean formal model is capable of producing a unified account of this dialect's tonal system; [H], [L] and morae are sufficient in capturing tonal contrasts and sandhi patterns in the Nanjing dialect. Our analysis, then, is an improvement on Ma (2009), since it accounts for the same data alternations using a more economical representational scheme with less theoretical burdens to justify.

Another advantage of the leaner model is a less cumbersome OT analysis. Apart from the general well-formedness constraints ranked at the top of our hierarchy, surface tones in isolation can be selected chiefly through MAX(T) and DEP(T). Assuming that all syllables are bimoraic and contain two mora-to-tone associations, the only other possible variation is adding or deleting tonal segments in the melodic tier. Introducing register into the discussion necessitates the proposal of more constraints, both faithfulness and markedness, that address register. In his account of Nanjing dialect tone sandhi, Ma (2009:31) introduces constraints apropos to register, two of which are presented below:

- (86) a. *r/-U: 不允许出现低调域 (low register is not allowed to surface [my translation])
- b. IDENT-IO(r): 输出调的调域必须与入调的调域相一致 (register in output tones must be identical to input register tones [my translation])

One of the strengths of our analysis, and specifically our implementation of Duanmu's model, is that it mitigates the need for extra constraints addressing register. Our proposed hierarchy is therefore more efficient because it selects forms from the same set of data using fewer constraints.

The analysis presented here, through the proposal of OCP and Local Conjunction constraints, accounts for and reflects the Nanjing dialect's unique system of disyllabic tone sandhi, underlying its exhibition of both Mandarin and non-Mandarin-like characteristics. Furthermore, by adopting Duanmu's (1990, 1994) formally-economical model of tonal representation, we demonstrate the model's effectiveness in describing the tonal systems of Chinese dialects, in spite of its virtual exclusion from contemporary discussions of tone in Chinese languages.

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