CHINESE TONE SANDHI AND PROSODY

by

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THESIS

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Table of Contents

Preface

This thesis examines the problem that tone sandhi in Chinese dialects presents for phonological analysis. Synchronic analyses that have been proposed, including some commonly accepted proposals, will be shown to have considerable shortcomings. Both derivational and optimality theoretic approaches will be examined, from which it will be seen that purely synchronic, phonological accounts are unsatisfying.

Some of the more significant insights come from historical phonology, where evidence suggests that sandhi forms could be, among other things, remnants of earlier tonal values. I posit that sandhi could have been conditioned by changes since the yin-yang register split of Old Mandarin, especially tone shifting, register reversal, and other realignments or changes in tonal systems across the dialects. Sandhi could be better analyzed as a mechanism of preserving earlier tonal values and contrasts in the synchronic grammar, most likely as a separate tonal morpheme that surfaces and imposes itself in tonal combinations.

I will consider other, possibly more promising, avenues to analyzing sandhi, namely in diachronic and morphological aspects as alternatives to the standard treatments which rely solely on synchronic phonology. I will argue that historical and morphophonological approaches seem more promising and should be researched further. I will also show that an optimality theoretic analysis can work for sandhi if morphology is taken into account. Thus, I will try to show that synchronic morphophonological accounts or historical phonological accounts of sandhi will be preferable to the standard accounts already put forth.

Chapter one examines the basic properties and historical background of Chinese tonality, and the basic problems posed by sandhi. Previous synchronic accounts, both derivational and optimality theoretic, of Mandarin, Cantonese, and Tianjin will be examined in chapter two. Chapter three examines the types of domains over which sandhi and other related tonal phenomena apply; the relationship between morphosyntactic domains, phonological domains, and sandhi domains; and the prosodic structure of sandhi domains. Chapter four examines and evaluates possible diachronic explanations for sandhi, such as tonal merger, chain shifts, flip-flop, and register reversal. Chapter five explores tonal morphophonology, the plausibility of morphophonological explanations for sandhi, and how a morphophonological approach would work in an optimality analysis of Tianjin and other sandhi systems[1]. Chapter six addresses the more global issues of sandhi, prominence, and prosody, and wraps up with final discussion of theoretical implications, conclusions, and topics for future exploration.

Ultimately, I hope to show that sandhi more than anything else is a key component of the prosodic system. Throughout this thesis I will try to present a case for sandhi as a means of marking prosodic prominence. Sandhi systems evolved historically out of the older Chinese tonal system to enhance the tonal system with a mechanism for prosodic prominence, much like reduction in unstressed syllables in a stress system as in English. Synchronically, it marks prominence and non-prominence by featural faithfulness and unfaithfulness, respectively. Thus, a sandhi system is more closely akin to other tone, pitch accent, and stress systems than previously thought. Although sandhi is sometimes sensitive to syntactic domains, morphological contexts, and tonal categories, its behavior is primarily prosodic, and in light of its characteristics, it is best regarded as a component of the morphophonological level of the grammar.

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[1] In this thesis, especially in chapter 5, I may occasionally use procedural metaphors, e.g., speaking of a sandhi "process" that "applies" in a given way. This denotes no concessions to derivational phonology; rather, such terms are used merely for the sake of convenience and familiarity.

While this paper brings morphophonology and morphological contexts to bear on phonological analysis, I intend this without reference to particular morphological OT approaches proposed by Robert Kirchner or others; rather, this is purely my own attempt to extend and further develop standard OT morphophonology as developed in the standard works of Prince and McCarthy.

Chapter 1

General Characteristics of Chinese Tone

Introduction.

The phenomenon of tone sandhi in Chinese dialects has presented long-standing difficulties to phonologists and East Asian linguists. The sandhi patterns are complicated, often seemingly unpredictable, can be left or right-aligned (anticipatory or regressive), can be seemingly assimilatory or dissimilatory or neither, vary widely among the dialects, and have defied attempts at phonological analysis. The most famous example occurs in Mandarin, where the third tone (T_3), a falling-rising tone with the value [213], undergoes sandhi in a doublet, i.e., a $T_3 + T_3$ pair, and the first changes to a rising tone: [213][213] ÷ [35][213]. This change represents leftward sandhi, as the right element remains and the leftward elements undergo sandhi. This occurrence is commonly explained as tonal dissimilation, but as we shall see, these explanations run into difficulties.

Before launching directly into the sandhi problem, preliminary background information on Chinese tone, sandhi patterns, and a sketch of its historical background will be presented.

Tonal features.

Three systems of tonal representation are used here: the traditional Chao tone numerals, tonal features according to the Yip system, and historical tonal categories. In the Chao (/t”àʊ/) numeral system, 5 is highest and 1 is lowest; e.g., 35 is a high rising tone, 213 or 214 is low falling-rising. For level tones, two digits indicate a single tone of regular length, i.e., in an open syllable (which I will assume to be bimoraic); e.g., 55 denotes a high level tone, and 11 denotes a low level tone. Conversely, single digits indicate level tone short syllables ending with a stop (which I will assume to be monomoraic nuclei), i.e., checked syllables, e.g., the high level checked tone 5, or the mid level 3. However, the Chao system has two major drawbacks: it is not grounded in phonological or phonetic features, but is merely a relative scale; and it is sometimes imprecise or ambiguous. A high falling-rising tone could be transcribed as 514, 424, 423, etc.; a 33 could be high register, low pitch tone, or a low register, high pitch tone, depending on patterning and features of the 33 and the other tones in the given dialect. Nonetheless, I will use Chao letters for most data, due to its convenience, easy use, and the fact that almost all data is transcribed in the Chao system.

Referring to historical, etymological tonal categories is essential for historical analysis of Chinese tone and for comparing tones across dialects. These are based on the four tone categories of Old Chinese: *pingsheng* (even tone), *shangsheng* (rising tone), *qusheng* ("departing" or falling tone), *rusheng* ("entering" or checked syllable tone); these later split into *yin* (high register) and *yang* (low register) tones. These tonal categories refer to those present since the yin-yang register split; please note that these are *historical* tone categories, and the actual modern-day tone values can be quite different from their original values.[2] Tonal categories (hereafter, TC) are generally transcribed in Roman numerals, with *a* for *yin* and *b* for *yang*; thus, II is shangsheng, IIa is yinshang. Sometimes designations like T_1 are used to denote what speakers consider the "first tone", "second tone" etc. in their language, but this is a convention that does not refer to historical tonal categories.

(1)	designation	Ch. name	description	Mandarin counterparts	
	Ia	y§npíng	high level	T_1 = 55	[2]
	Ib	yángpíng	low level	T_2 = 35	[3]
	IIa	y§nsh|ng	high rising		
	IIb	yángsh|ng	low rising	TC IIA T_3 = 213	[7]
	IIIa	y§nqù	high falling		
	IIIb	yángqù	low falling	TC IIIA T_4 = 53	[4]
	IVa	y§nrù	high short	---	

[2]The phonetic values of these Chinese terms, in IPA, is as follows: *ping* /pʰí0/, *shang* /"|0/, *qu* /²ʰ&/, *ru* /£ù/, *sheng* /"ɋ0/, *yin* /§n/, *yang* /já0/. In compounds, *sheng* "tone" is customarily omitted.

IVb	yángrù	low short	---

If the categorical names are indeed accurate reflections of the original tone values at some time in the past, then obviously the actual tonal values have undergone historical changes. In Mandarin, Ib has changed from a true low level tonal value to a high rising tone, IIa and IIb have merged, IIIa and IIIb have merged, and IVa/b have disappeared altogether in Mandarin. Examination of tonal data throughout the dialects likewise shows a great deal of change, if not more so. For example, Ib has the following values in other dialects: Wuxi [213], Changzhou [13], Wenzhou [31], Luoyang [43], Pingyang [21], Xianyou [24], Chaoyang [55] (Ballard 1988).

As in the literature, I shall refer to the TC system in discussing tone from a morphological or diachronic viewpoint, and for reporting dialect data, for tonal categories provide a convenient means of describing tones in different dialects. This is because of the "linguistic reality" of tonal categories across Chinese dialects, that is, the regular cross-dialectal correspondence of lexical items and tonal categories. Since Ib in Mandarin has the value of [35], a regular correspondence will obtain between words across dialects, such that Mandarin words with [35] will correspond regularly to Wuxi [213] words, Changzhou [13] words, Wenzhou [31] words, etc., and they will correspond tonologically to each other for most words, since those lexical items carry a tone of category Ib throughout the various dialects. For Chinese speakers learning new dialects, this tone category correspondence is reported to be a psycholinguistic reality that enables them to acquire the pronunciation of new dialects.

Synchronic phonological analysis of tone requires a formal system of tonal features, such as the Yip system. Yip (1995) proposes high and low register features [H, L] which are subdivided into the pitch values high and low [h, l], which together define a given tone or toneme. If we apply these tone features to Mandarin, for example, T_1 is [55] or [H, h]; T_2 is [35] or [H, lh]; T_3 is [213] or [L, hlh]; and T_4 is [53] or [H, hl]. The older Wang (1967) tone feature system will not be considered here, because it overgenerates tones and lacks precision. It invokes the binary features [contour], [high], [central], [mid], [rising], [falling], [convex] for tone, many of which seem suspect as atomic tonal features, especially for complex tones. The Yip system seems to be the most suitable and accurate for representation and analysis of tone. I shall use it when it is necessary for analysis of phonological tonal features.

Yin-yang register split.

The Ancient Chinese tonal system consisted of four tonal categories, which at some point in Middle Chinese underwent a register split into upper register [H] and lower register [L] tones. The split is believed to have been caused by the depressor effect of initial voiced consonants, especially obstruents, and raising effect of voiceless initial consonants. Register distinction before the loss of voice/voiceless contrast was allotonic, but after loss of voice distinction, the register split became phonemic. This yielded an eight tone system, which does not obtain in all the dialects; whether the split did not occur for all tonal categories in all the dialects, or whether it did but was later undone by merger, is a matter of some debate. Also, TC 4 tends to merge with other categories, especially in Mandarin dialects[3]. Comparative evidence for this tonogenesis comes from Wu dialects, which still retain voiced consonants and in which high register tones pattern with voiceless onsets and low register tones with voiced onsets, e.g., Suzhou dialect (see Ye 1979). The timing for the phonemicization of the split is uncertain, but since the four-level system was apparently still in effect in the seventh century *Qièyùn* rhyme tables, and reported evidence of a phonemic split comes from a ninth century source, the split possibly happened between those times (see Norman 1988), and must have taken place by the time of the fourteenth-century rhyme book *ZhÇngyuán Y§nylin* (see Hsueh 1975) . For discussion of the aforementioned points, debates, proposals, and reconstructions, see Baxter (1992), including discussion of proposals set forth by Karlgren, Haudricourt, and Pulleyblank.

Tonogenesis by [±voice] consonants can be explained by appealing to glottal features which subsume both voicing and tonal features. Constricted glottis [cg] characterizes [+voice] and [L], and slack glottis [sg] characterizes [-voice] and [H]; see Yip (1995); Ladefoged and Maddieson (1996) use the features stiff voice for [cg] and slack voice for [sg]. Evidence for such a relationship comes from historical phonology of Southeast Asian tonal systems (see Baxter

[3]The term ‘Mandarin’ is used in Chinese linguistics in two different ways: (1) the official standard language, or *pßtÇnghuà*; (2) a dialect grouping which includes the dialects of the northern provinces, Beijing, and the southwestern provinces. The major dialect divisions of Chinese are Mandarin, M©n, Wú, Xi|ng, Gàn, Yuè (Cantonese), Jìn, and Hakka (Kèji~).

1992) and from acoustic evidence, as in Pierre-Hombert *et al.* (1979).

While loss of the initial voicing distinction is believed to have led to tonogenesis in Chinese, Vietnamese, and Mon-Khmer, it has been argued that the same loss of contrast led to changes in vowel quality on the following vowel, a “vowel register”, so to speak. Vowels after formerly voiceless onsets became associated with features and coarticulations like tense, open, on-glided, whereas vowels after voiced onsets became associated with breathy, lax, close, centering, and diphthongized. See Duanmu (1990) and Baxter (1992) for discussion. Likewise, in some Chinese dialects, vowels in IV tone words are glottalized or creaky voiced. Chapter 4 will sketch out an OT based account of tonogenesis in Chinese.

Sandhi patterns.

Most linguists outside of Chinese phonology are primarily familiar with one well-known case of Chinese tone sandhi: the Mandarin T_3 rule, whereby the first T_3 (falling-rising tone) in a T_3 couplet changes to a rising tone, identical to Mandarin T_2. This sandhi can apply over larger stretches, whether over a compound word, a morphosyntactic phrase (XP), or even over an entire intonational phrase (S or IP), depending on speech rate and the speaker’s contrastive stress. Below are examples of my own:

(2)	compound	wß-wß-wß-wß	÷ wú-wú-wú-wß	*5,555*
	XP	m|i h|o b0	÷ mái háo b0	*buy good pens*
	IP/S	n0 zh0 m|i h|o b0	÷ ní zhí mái háo b0	*you only buy good pens*

Notice that the final syllable retains its underlying value, while the other syllables before it in the sandhi phrase undergo sandhi. Thus, sandhi here is described as right-headed, as is the case in a majority of Chinese dialects. In some dialects, sandhi is left-headed: the initial syllable remains unchanged, while the following syllables of the sandhi phrase undergo sandhi. Left-headedness mainly occurs in Wu dialects such as H|iyán and SãzhÇu.

The Mandarin example is very simple compared to sandhi patterns in other dialects. Typically in the dialects, more than one tone is affected and a multiplicity of sandhi changes occur;

in some dialects, almost all of the tones undergo sandhi. Just 70km from Beijing, where the simple T_3 sandhi takes place, is the Tianjin dialect with four different sandhi patterns. Even greater complexity in sandhi patterns is common, as shown in the case of Shaoxing (Wu dialect, Zhejiang province; Ballard 1988). Citation tones for Shaoxing are shown in (3), and the sandhi patterns in (4), with citation values in brackets.

(3) Shaoxing citation tones

	I	II	III	IV
a	51	335[4]	33	45§
b	231	113	11	12§

(4) Shaoxing two-syllable sandhi chart

F_1 \ F_2	Ia/Ib [51, 231]	IIa/IIb, IIIa/b [335, 113, 33, 11]	IVa/IVb [45, 12]
Ia [51]	33-51	33-55	33-5
Ib [231]	11-51	11-55	11-5
IIa [335]	335-51	335-51	335-54
IIb [113]	115-51	115-51	115-54
IIIa [33]	33-33	33-33	33-3
IIIb [11]	11-11	11-11	11-3
IVa [45]	3-51	3-55	3-5
IVb [12]	1-51	1-55	1-5

Notice that the same tone values surface, whether F_2 is of a-categories or b-categories, i.e., the a-category and b-category merge in sandhi. Also note that categories II and III merge together with respect to F_2. The data here cannot be explained easily by phonological or phonetic assimilation or dissimilation, according to the standard treatment. For example, Ib, a low rising-

[4] I consider transcriptions like 335 and 113 to be an aberration of the Chao system in some of the data, perhaps due to acoustic or phonetic factors, and I will take these to actually be 35 and 13, respectively.

falling tone, before another Ib becomes a high rising tone. But its behavior is exactly the same before Ia, a high falling tone. This and many other sandhi tone values throughout the dialects cannot be captured well by the standard theory. In fact, in the case of Shaoxing, tonal categories seem more important than phonetic / phonological factors.

A curious feature of sandhi is that in some dialects, sandhi is context-free: a given citation tone corresponds to only one sandhi tone value, regardless of the neighboring tones. Yet in other dialects, sandhi is context-sensitive — a citation tone correspond to two or three different sandhi tone values, depending on the neighboring tones. Another common feature of sandhi is that tonal values surface in sandhi forms which do not exist in the underlying citation values for those tones. A typical example is Changting (Hakka dialect, NW Fujian province; Ballard 1988), which has the citation tones Ia [33], Ib [24], II [42], IIIa [54], and IIIb [21]. Sandhi forms are given in (5), with citation values in brackets.

(5) Hakka: Changting dialect bisyllabic sandhi chart

F_1 \ F_2	Ia [33]	Ib [24]	II [42]	IIIa [54]	IIIb [21]
Ia, IIIb [33, 21]	33-33	21-24	33-42	33-54	21-21
Ib [24]	44-33	24-24	24-42	24-54	24-42
II [42]	213-33	21-24	33-42	42-54	213-42
IIIa [54]	54-33	54-24	55-42	55-55	54-21

This data shows new tonal values cropping up in the surface forms: [213, 55, 44]. As I will show in the following chapter, one would be hard-pressed here to try to account for the facts by appealing to assimilation or dissimilation. The sandhi processes in Changting, Shaoxing, and many other dialects are too complicated for such a simple account. The next chapter will examine this standard account in detail, and point out its flaws, theoretically and in the data.

Chapter 2

Previous Accounts of Sandhi

In this chapter I will examine previous accounts of tone sandhi in the literature, in particular the so-called standard account of sandhi in Mandarin and other dialects. This standard account, as set forth by C. Cheng (1968), Yip (1980), Chen (1995) and others, treats sandhi as a phonological dissimilation or assimilation between certain tones and tone registers. I will first examine the standard analysis of Mandarin sandhi as tonal dissimilation and will find it wanting. I will recast the standard account into an OT framework to show that it would likewise encounter problems. Next I will examine a Cantonese sandhi rule to show it suffers similar shortcomings. Then I will examine Tianjin, another sandhi system that is also prominent in the literature and more complicated, in terms of a derivational analysis and of a more recent attempt at an OT analysis. Both approaches fail to account satisfyingly for this case. I will conclude from all this that so far purely synchronic phonological analyses fail to account adequately for sandhi in Chinese languages.

Mandarin tone sandhi.

The most intuitive approach to explaining the development of tone sandhi is by invoking tonophonetic factors like tonal assimilation and dissimilation, and phonetic influences from glottal features of initial consonants. Since glottal features do not seem to play a role outside the Wu dialects in modern Chinese, I will begin with the most intuitive, the tonophonetic approach, and show that it can only explain very few cases of tonal change.

The simple four-tone system of Mandarin with its very simple tone sandhi phenomenon ([213][213] ÷ [35][213]) tends to support a phonological explanation. The derivational sandhi rule for T_3 doublets is typically stated essentially as below[5]:

(2) [214] ÷ [53] / __ [214] or: T_3 ÷ T_2 / __ T_3

Cheng (1973) points out that Mandarin T_3 is phonologically low, whereas the other tones are high, and argues for low tone dissimilation. Phonetic evidence for its lowness comes from code switching of English words in Chinese, as reported in C. Cheng (1968), and from the lower F_0 of T_3 compared to F_0 of the other tones, as described in Shen (1989). Similarly, Yip (1980) ascribes the low register feature [L] to T_3 and [H] to the others, and likewise argues for [L] dissimilation by means of OCP (obligatory contour principle). However, this approach encounters difficulties. OCP or L-dissimilation do not account for the particular sandhi value of [35] as opposed to any other high tone — why not [55], [53], or even possibly (ex nihilo) [33]? The standard derivational account actually fails to predict the exact outcome, for any of the three would be a possible outcome of an OCP effect, and it fails to explain what would condition any given outcome. (While derivational phonology generally did not concern itself so much with the reasons for a particular output, in a constraint-based framework one would seriously ask such questions — e.g., why does OCP prefer any one given output over another here?)

This standard treatment of sandhi via register dissimilation translates well into an OT version, which allows us to test this theory further. But even an optimality theoretic account does not help much here. An OT account would most likely posit a constraint for L-dissimilation, let us call it OCP-[L], and constraints on faithfulness between input and output of tonal features, let us call them Max-IO[T] and Dep-IO[T]. OCP-[L] would be ranked above the Max-IO and Dep-IO faithfulness constraints. There would also be a right-alignment constraint to account for directionality of sandhi, depending on the prosodic or morphosyntactic domain in question. An evaluation of possible candidates (in the Yip featural system) would appear as in (3) below. For the input [L, hlh] [L, hlh], the candidate that should be selected by the constraint evaluation should

[5] I use the term *doublet* or *couplet* to signify a pair of adjacent syllables with identical lexical tones, e.g., Tianjin *guan*^{21}-*xin*^{21} 'to be concerned' , with the sandhi [21][21] ÷ [213][21].

be output candidate #a in (3), since this is the actual output in Mandarin. However, the evaluation according to the dissimilation account would just as well select another candidate, and more optimally select yet another.

(3)

. [L, hlh] [L, hlh]	OCP-L	Align-R	Max-IO	Dep-IO
a. [H, lh] [L, hlh]			L, h	H
b. [H, lh] [L, hlh]			L	H
c. [H, hlh] [L, hlh]			L, h	H

Candidate a is the actual output, but b should do just as well, as both fare equally on the faithfulness constraints and OCP-L. However, c should be the most optimal candidate, since it follows OCP-L and incurs the fewest violations of Max-IO. This shows that a purely phonological OT account appealing to dissimilation does not explain Mandarin sandhi very well, nor does any equivalent derivational account as those by Yip and Cheng. On the other hand, one might propose an OCP [complex contour] constraint to mitigate against outputs like c. But this still would not decisively choose between a and b, nor would it successively account for cases of sandhi in other dialects, which often do not involve complex contours.

Convincing examples of tonal changes via phonological or phonetic processes are rare when one surveys the dialect data. One case of tonal assimilation in Mandarin fast speech is reported in Mei (1991), in which a [55-35-55] phrase becomes [55-55-53] and [53-53-55] becomes [55-55-55]. Another is Gao'an (Gan dialect, Jiangxi province; Bao 1990:113) with tonal pitch assimilation in which the [55] or [H, h] tone becomes [53] or [H, hl] before [33], [11], [3], and [1] tones. But such cases are rare, and their paucity fails to support assimilation based accounts. Thus, the standard treatments appealing to tonal assimilation and dissimilation actually do not work well for many of those cases in the literature, as these proposals can only account for very few instances of tone change in Chinese dialects.

A much more plausible case for sandhi by assimilation comes from outside of East Asian linguistics: from Comalpatec Chinantec, a Uto-Aztecan language in Mexico. This language has a tonal system with sandhi phenomena showing assimilatory effects, such as LH ÷ MH (Silverman 1997).

Cantonese sandhi.

Cantonese is a group of dialects in Guangdong province, Guangxi province, and Hong Kong that belong to the Yue dialect region. The Yue dialects typically preserve all the historical tonal categories well, as in the case of Cantonese, which has the following tonal system as reported in Wong (1982), with tonal features as assigned by Yip (1995). The last three short tones occur only in checked syllables and are considered variants of their full length counterparts in open syllables.

(4)

historical category		tonal value	description	features
yinping	Ia	55 / 53	high level	[H, h]
yangping	Ib	21	low falling	[L, hl]
yinshang	IIa	35	high rising	[H, lh]
yangshang	IIb	23	low rising	[L, lh]
yinqu	IIIa	33	mid level	[H, l]
yangqu	IIIb	22	low level	[L, l]
upper yinru	IVa	5	high level	[H, h]
lower yinru	IVc	3	mid level	[H, l]
yangru	IVb	2	low level	[L, l]

The [53] tone occurs in some varieties of Cantonese and contrasts with [55] as a result of a phonemic split. In these dialectal varieties, this [53] tone undergoes sandhi before [55], [5], and [53]. This is considered an example of sandhi by tonal assimilation, and commonly is expressed by a derivational rule as in Wong (1982):

(5) 53 ÷ 55 / __ {55, 5, 53}

Such a rule simply defines the environment of this sandhi in terms of the particular tonal values which must follow the sandhied syllable, which amounts to an arbitrary stipulation of unrelated items necessary to trigger the process. This rule is featurally ill-defined, for it fails to pick out the feature(s) most relevant to the process. It is not formulated in terms of phonological features or morphological categories, and so fails to make any generalization or to identify what is driving the sandhi. But then, one must ask if it is even possible to do so. It is claimed that this is a case of tonal assimilation; if so, then assimilation to what? Is it assimilation to the register feature [H]? Clearly not, since all the tones on both sides of the equation obviously are [H] tones. If [H] is the conditioning environment for the operand, then why is [53] the only tone to undergo this change, and not also others like [3]? Likewise, why does [33] not condition this change? Since the [55/5] and [53] tones consist of the pitch features [h] and [hl], respectively, is this sandhi an assimilation to the pitch feature [h]? While that would be the most intuitive solution, that presents problems. No other tones consisting of a [l] feature undergo this change. If both [H] and [l] are both requisites for this process, then again other tones like [33] would be affected, since it is [H, l]. If it is assimilation to preceding and following [h] (or [5]), then one must question why only [53] undergoes this change, while the other tones with the low pitch feature [21], [2], [23], or [22] do not undergo similar changes in the appropriate environments.

Attempting an optimality theoretic analysis would encounter similar difficulties as above. Yet a derivational rule fails to be very satisfactory, as no rule can be formulated that captures a generalization about what is happening featurally or categorically. It is difficult to single out a particular phonological process, feature, or constraint that could be identified as the force driving sandhi here. While tonal assimilation is claimed here, upon closer examination this claim runs into difficulties.

Tianjin sandhi.

Though only 120km from Beijing, the Tianjin tonal system is quite different and has much more complicated sandhi patterns. The derivational rules and examples are shown in (6) and (7), respectively, from Chen (1987).

(6)

	derivational rule	tonal category	description
	a. 21 ÷ 213 / __ 21	1a ÷ 2	$T_1 T_1$ ÷ $T_2 T_1$
	b. 213 ÷ 45 / __ 213	2 ÷ 1b	$T_3 T_3$ ÷ $T_2 T_3$
	c. 53 ÷ 21 / __ 53	3 ÷ 1a	$T_4 T_4$ ÷ $T_1 T_4$
	d. 53 ÷ 45 / __ 21	3 ÷ 1b	$T_4 T_1$ ÷ $T_2 T_1$

(7)

	base form		sandhi form	example	gloss
	a. 21-21	÷	213-21	gao shan	*high mountain*
	b. 213-213	÷	45-213	xi lian	*wash face*
	c. 53-53	÷	21-53	jing zhong	*net weight*
	d. 53-21	÷	55-21	kan shu	*read book*

Application of sandhi in compounds and phrases presents complications of directionality. For trisyllabic words, sandhi operates over the entire word, regardless of internal prosodic hierarchy. For some tonal patterns, sandhi seems to apply rightward (8a, b) below, but leftward in all others. The following is from Chen (1995), showing phrasal and compound sandhi. The bracketing is apparently meant to show that sandhi patterns and their respective directionality operate over the entire compound, regardless of internal prosodic word structure; thus, [[*si-ji*]$_{\text{PWd}}$]-*qing*]$_{\text{PWd}}$ and [*zuo*-[*dian-che*]$_{\text{PWd}}$]$_{\text{PWd}}$ in (7a) undergo sandhi in the same manner and directionality, just as a phrase would.

A curious feature of Chen's 1995 paper is the different tonal transcription. Here, T_1 is "L", [11]; T_2 is "H", [55]; T_3 is "R" ("rising"), [24]; T_4 is "F" ("falling"), [53]. He does not explain whether this is a simplified transcription or a different subdialect than in previous papers. Aside from when citing Chen (1995), I will use the transcription common in the literature, as in Chen (1987) and others.

(8)

	input	output	[xx]x	x[xx]
	a. FFL	LHL	[si-ji]-qing	zuo-[dian-che]
			evergreen	*take a train*

b. RRR	HHR	[li-fa]-suo	mu-[lao-hu]
		barber shop	*tigress*
c. FFF	HLF	[su-liao]-bu	ya-[re-dai]
		plastic cloth	*sub-tropical*
d. LLL	LRL	[tuo-la]-ji	kai-[fei-ji]
		tractor	*pilot a plane*
e. RLL	HRL	[bao-wen]-bei	da-[guan-qiang]
		thermos cup	*speak in a bureaucratic tone*
f. LFF	RLF	[wen-du]-ji	tong-[dian-hua]
		thermometer	*make a phone call*
g. FLL	FRL	[lu-yin]-ji	shang-[fei-ji]
		tape recorder	*board a plane*

Patterns a and b show rightward application of sandhi, whereas c-g show leftward application. This is shown in (9) in procedural, derivational terms, as reported in the literature, based on Chen's (1995) data; parentheses indicate applications of sandhi in the derivation. Some examples such as #a appear to have a two-step process, in which sandhi applies to the two leftmost syllables in a sandhi domain, then applies again to the last two syllables. Others like #f appear to have a two-step process in which sandhi first applies to the two rightmost syllables, then to the two leftmost — opposite in direction compared to #a-b. Some seem to have a simple one-step application of sandhi, as in #d and #g. We have here an apparent problem of cyclicity and dual directionality.

(9)	<u>input</u>						<u>output</u>
a)	53-53-21	÷	(21-53)-21	÷	21-(45-21)	÷	21-45-21
b)	213-213-213	÷	(45-213)-213	÷	45-(45-213)	÷	45-45-213
c)	53-53-53	÷	53-(21-53)	÷	(45-21)-53	÷	45-21-53
d)	21-21-21	÷	21-(213-21)			÷	21-213-21
e)	213-21-21	÷	213-(213-21)	÷	(45-213)-21	÷	45-213-21
f)	21-53-53	÷	21-(21-53)	÷	(213-21)-53	÷	213-21-53
g)	53-21-21	÷	21-(213-21)			÷	21-213-21

If directionality applies incorrectly, i.e., if leftward in (a, b), or rightward in (c-g), we obtain false outputs as shown below.

(10)	<u>input</u>				<u>false output</u>
a)	53-53-21	÷ 53-(45-21)		÷	*53-45-21
b)	213-213-213	÷ 213-(45-213)		÷	*213-45-213
c)	53-53-53	÷ (21-53)-53	÷ 21-(21-53)	÷	*21-21-53
d)	21-21-21	÷ (213-21)-21	÷ 213-(213-21)	÷	*213-213-21
e)	213-21-21	÷ (213-213)-21		÷	*213-213-21
f)	21-53-53	÷ 21-(21-53)		÷	*21-21-53
g)	53-21-21	÷ (45-21)-21	÷ 45-(213-21)	÷	*45-213-21

Chen's first attempt in 1986 to account for Tianjin sandhi and bidirectionality by derivational means yielded limited positive results. He writes,

> "In Chen (1986b) I reached the unhappy and inelegant conclusion that no conceivable mode of rule application seemed to be compatible with Li-Liu's (1985) data. I demonstrated that neither cyclic application (obeying Strict Cyclicity Condition), nor simultaneous or iterative application in any direction (L to R, or R to L) is capable of generating the attested sandhi patterns." (Chen 1987, citing Chen 1986).

Tan (1987) and Zhang (1987) also attempt derivational analyses to account for the sandhi patterns, but run into serious difficulties with bidirectionality, as Chen (1987) points out. Tan proposes four separate, ordered sandhi rules, with the stipulations that two of the rules apply right to left, and one rule applies left to right. The various tone sandhi rules initially apply in lexical units and NP's, and then two of the sandhi rules apply cyclically at higher levels. Chen cites weaknesses in Tan's analysis, namely that directionality is a rule-specific feature, requiring no explanation, and it ignores the relevance of morphosyntax for sandhi. Zhang's proposal consists of two rules applying right to left, one rule applying left to right, partial rule ordering, and the stipulation that tone sandhi does not apply cyclically on morphosyntactic structures. According to Chen, this analysis likewise ignores the importance of morphosyntax, and cannot account for the opaque left-right direction of one rule. Hung (1987) likewise attempts to account for the Tianjin data derivationally by positing a phonotactic constraint against adjacent low tones to account for the unexpected right-to-left sandhi, and by appealing to prosodic structure. He argues for a so-called unified analysis, in which rules apply in the same fashion for all sandhi patterns, in a minimally ordered and non-cyclic fashion. However, Chen (1987) points out that his analysis overgenerates and yields incorrect surface forms; his sandhi rules could produce some strings that would violate his phonotactic constraint, and nothing in his theory would prevent sandhi rules from further applying to repair the damage. Thus, counterfactual derivations cannot be ruled out under this proposal.

Chen (1995) proposes an optimality theoretic account of Tianjin sandhi and bidirectionality. His analysis proposes a two-tiered optimality analysis of Tianjin sandhi that is wrought with serious technical and theoretical shortcomings. He offers two OCP principles and a generalization, and proposes the following constraints and constraint ranking:

(11a) OCP bars a sequence of adjacent like tones (except HH)

OCP' (partial OCP) bans adjacent partially identically tones; bars the sequence FL (=HL.L)

(11b) "Generalization: By default, rules apply from left to right--unless such a mode of application produces an ill-formed output, in which case reverse the direction of operation."

(11c) Dissimilation: enforces OCP

Tonal Absorption: enforces OCP'

Temporal: Apply rules left to right

WFC: Output must obey OCP and OCP'

Preempt: Dissimilation precedes Tonal Absorption

NoBT: Do not backtrack

(11d) WFC, Preempt, NoBT o Temporal

For the data in (8), he offers a constraint grid showing a two-level constraint application and argues for cyclic application of sandhi rules, which is reproduced in full in the appendix of this thesis. By way of illustration, parts of the grid for patterns in (8a) and (8c) are given below.

(12)

					WFC	Preempt	Temporal
#1 (8a)	L	a	¸	FFL ÷ LFL ÷ LHL			
	*	b	¹	FFL ÷ FHL			*
#3 (8c)	L	a	¹	FFF ÷ FLF ÷ HLF			*
	*	b	¸	FFF ÷ LFF ÷ LLF	*		

For pattern 1, candidate a is selected as the output, since rightward application of sandhi yields an output satisfying Temporal, and it satisfies other higher constraints. Candidate b fails since leftward application of sandhi yields an output that violates Temporal. For pattern 3, candidate a is selected; although its leftward application of sandhi yields an output in violation of Temporal, it satisfies the higher constraints. Candidate b is rejected, since its rightward sandhi application yields an output that violates WFC.

However, Chen’s analysis contains some serious problems, foremost among them being methodological. The analysis is inherently procedural and derivational, and the constraints are not proper OT constraints, but are rather processes or procedures. Temporal says, “apply rules left to right”, Preempt says, “dissimilation precedes tonal absorption”, and NoBT says, “do not backtrack”. However, OT is a non-derivational, non-procedural theory of constraint interaction, whose constraints are constraints on features, domains, and alignment, not constraints on processes or procedures. See McCarthy and Prince (1993a, b, c) for discussion. Chen’s proposed constraints are inconsistent with proper optimality theory. Furthermore, some of Chen’s so-called constraints lack cross-linguistic motivation, such as the prohibition on HL.L, the prohibition on a sequence of adjacent like tones *except HH*, or “enforces OCP’”.

The WFC constraint requires outputs to obey OCP and OCP!, which requires the constraint to possess clairvoyant powers, able to see ahead to the outputs. But constraints are constraints on possible candidates and do not select outputs. Selection of outputs is the domain of the Eval function (Evaluator). Thus, WFC is logically circular. Chen’s generalization that “...rules apply from left to right — unless such a mode of application produces an ill-formed output, in which case reverse the direction of operation" suffers from similar logical circularity.

Chen's two-level optimality is contrary to the spirit of orthodox OT, and is not entirely necessary for explaining sandhi; I hope to show later that a monostratal approach can account for Tianjin sandhi, including its apparent cyclical application of sandhi in phrases and trisyllabic compounds. Furthermore, Chen dismisses the possibility of using alignment theory for Tianjin sandhi without explanation or discussion; however, I hope to show how alignment theory can be used successfully in explaining this sandhi problem.

Chen's formulation of OCP and OCP! are ill-defined. Chen's OCP bars sequences of adjacent like tones except HH, and OCP! (or partial OCP) bars the sequence FL (or HH.L). "Adjacent like tones" is not defined specifically or featurally, and excepting HH is an ad hoc device. The ban on FL is also an ad hoc device lacking specific or featural definition. In actuality, Tianjin sandhi shows no consistent pattern of OCP; no uniform dissimilation of pitch or register features obtains. The sandhi patterns are restated in (13) in featural representation to demonstrate the lack of consistent dissimilation; underlined portions indicate the features involved in the change.

(13)	a. [L, $\underline{\text{hl}}$] [L, hl]	÷	[L, $\underline{\text{hlh}}$] [L, hl]
	b. [$\underline{\text{L}}$, $\underline{\text{hlh}}$] [L, hlh]	÷	[$\underline{\text{H}}$, $\underline{\text{lh}}$] [L, hlh]
	c. [$\underline{\text{H}}$, hl] [H, hl]	÷	[$\underline{\text{L}}$, hl] [H, hl]
	d. [H, $\underline{\text{hl}}$] [L, hl]	÷	[H, $\underline{\text{lh}}$] [L, hl]

(13a, d) would seem to show hl-hl dissimilation, but such does not obtain in (c); (b) would seem to show L dissimilation, but (a) does not; (c) would seem to show H dissimilation, but (d) does not; also, Tianjin T_2, which is [45] or [H, lh], shows no sandhi whatsoever, either in doublets or in combinations with other tones. No uniform pattern of dissimilating atomic tone units as a whole obtains, i.e., no rule of the form $T_x\, T_x \div T_y T_x$ can generate the sandhi forms. T_2 does not dissimilate from itself in T_2 doublets, and Chen's dissimilation rule would fail to generate (d).

Another strategy might be appealing to dissimilation or neutralization of tonal categories, but this also fails to explain the enigma. The Tianjin sandhi is restated below in terms of tonal categories and the resulting neutralizations (Ia=yinping, Ib=yangping, II=shangsheng, III=qusheng).

(12)	a. Ia - Ia	÷	II - Ia	*or*	Ia ÷ II
	b. II- II	÷	Ib - II		II ÷ Ib
	c. III - III	÷	Ia - III		III ÷ Ia
	d. III - Ia	÷	Ib - Ia		III ÷ Ib

Few consistent patterns of morphological leveling or phonological neutralization of tonal categories emerge, nor do a significant number of any patterns of tonal assimilation or dissimilation obtain when one surveys the dialect data[6]. Chen's review (1987) of the Tianjin data and of attempts at derivational and autosegmental analyses by Hung (1987), Tan (1987), and Zhang (1987) concludes that no derivational or autosegmental analysis can account for Tianjin tone sandhi. Chen's (1995) mixed OT/derivational analysis also fails. Given the irregularity, unpredictability, and phonological unanalyzeability of tone sandhi, we must conclude that sandhi is not a purely phonological process, and that something beyond the phonology is involved (even if the triggers are merely phonological). The unpredictability points to sandhi as a morphophonological process which exists as historical residue. We shall see how historical evidence can shed some light and point us toward a morphophonological analysis of sandhi.

Sandhi in other dialects.

If one recalls sandhi data presented in the previous chapter, one can see the difficulty of applying the standard account to complex sandhi phenomena in much of the dialect data. We can see this, for example, in recalling the Shaoxing data, partially reproduced in (13) below, with citation values in brackets.

(13) Shaoxing bisyllabic sandhi chart (partial)

$F_1 \setminus F_2$	Ia/Ib [51/ 231]	IIa/IIb, IIIa/b [335/113/33/11]	IVa/IVb [45/12]
Ia [51]	33-51	33-55	33-5

[6] For a compact survey of the cross-dialectal tonal data, please refer to the appendix.

F_1 \ F_2	Ia/Ib [51/ 231]	IIa/IIb, IIIa/b [335/113/33/11]	IVa/IVb [45/12]
Ib [231]	11-51	11-55	11-5
IVa [45]	3-51	3-55	3-5
IVb [12]	1-51	1-55	1-5

An underlying Ia [51] becomes [33] before another tone, regardless of the value of F_2, whether F_2 is high or low register, and regardless of other phonological or phonetic features. The same holds true for other tones. These surface tone values cannot be explained as assimilation or dissimilation. In fact, the tonal categories themselves seem to be the key players in the sandhi here, not phonetic or phonological phenomena.

Again recall the data from the Hakka dialect of Changting, reproduced in (14) below, with citation values in brackets.

(14) Changting bisyllabic sandhi chart

F_1 \ F_2	Ia [33]	Ib [24]	II [42]	IIIa [54]	IIIb [21]
Ia, IIIb [33, 21]	33-33	21-24	33-42	33-54	21-21
Ib [24]	44-33	24-24	24-42	24-54	24-42
II [42]	213-33	21-24	33-42	42-54	213-42
IIIa [54]	54-33	54-24	55-42	55-55	54-21

New tonal values [213, 24, 55, 44] appear in surface forms, which do not exist in the underlying citation forms. Appealing to assimilation or dissimilation cannot explain the creation of new tonal values, the fact that [24-24] does not change, or the occurrence of high register tones [54, 55, 42, 44] and low register tones [21, 24, 213] in surface combinations like HH [55-42], LL [21-21], HL [54-21], or a possible LH [33-54][7]. The sandhi processes in Changting, as well as in many

[7] [33] could either be low [L, h] or high [H, l], depending on its patterning with other tones. This is due to the inherent ambiguity of the Chao system (and likewise, other numeric systems such as the Pike system often

other dialects, are far too complicated for such a simple account.

Conclusion.

We have just seen that the standard accounts of Mandarin and Cantonese sandhi fail to adequately explain what is happening, contrary to what has often been accepted. The standard explanations are unable to specifically predict the surface tone, whether in derivational or constraint-based frameworks. Nor are they able to explain what is actually driving sandhi; assimilation and dissimilation do not satisfyingly explain the tone changes. The Tianjin data is even more problematic for phonological analysis, whether the derivational attempts, or the one constraint-based attack thus far, are considered. Moreover, the majority of dialect data disconfirm the standard hypothesis that phonetic or phonological features drive sandhi. However, one should not have the impression that no analysis is possible, nor should one draw the conclusion that optimality theory has been falsified here. In fact, later I hope to show that OT can be more useful than derivational theories in explaining sandhi phenomena. But more than just OT is required; other factors need to be taken into account as well. The problems discussed here lead us to conclude that the standard approaches in the literature seem unsatisfactory and unable to handle the theoretical problems posed by tone sandhi. One needs to look elsewhere for further insight. The more helpful insights probably come from diachronic and morphological avenues, and I will try to make a case for these as directions that should be explored further, as pursuits that could possibly be more promising than those so far attempted.

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used in African and American tone languages), which does not consider the component features such as pitch and register, but rather just serves as a numeric description of relative pitch levels . A mid-level tone in a tone language may belong to either the high tone register or the low tone register. In the case of ambiguity posed by a mid-level tone, its register may best be determined by its patterning with other tones, if data permit such a determination (David Odden, personal communication, 8 April 1996). Since the Chanting [33] patterns with IIIb [21], it is more likely a low register tone [L] in this dialect. Also, [55-42] would be HH, because the tones can be resolved into their component features [H, h]-[H, hl].

Chapter 3

Prosodic Domains of Sandhi

This chapter will examine the types of domains over which sandhi applies, directionality of sandhi, and headedness. We will refer to sandhi domains, the domains or phrases over which sandhi phenomena occur. Sandhi domains correspond to some level of morphosyntactic or prosodic structure. Some dialects show a greater propensity for sandhi domains to correspond to morphosyntactic domains like compound words, syntactic phrases (VP, noun + classifier phrases, NP), and entire phrases (S). Other dialects show a greater propensity for sandhi domains to correspond to lexical items, i.e., phonological words (PWd, which includes both monomorphemic and compound words), prosodic phrases (e.g., subject + verb sequences, or other phrases cutting across syntactic boundaries), and intonational phrases (IP). A majority of dialects exhibit right-headed sandhi, where sandhi proceeds leftward from the head of the phrase (speaking in derivational metaphor), whereas others exhibit left-headed sandhi, where sandhi is rightward. This section will not deal with these issues exhaustively; the reader is referred to Shih (1986), Jin (1986), Selkirk & Shen (1990), Chen (1991), Yip (1996), and others for discussion. The general prosodic features of sandhi will be treated here within an optimality theoretic framework, and Yip's (1996) analysis of headedness will be discussed, which I will extend from mere tone spreading to more general sandhi patterns. To provide a satisfactory overview of the general prosodic scope of sandhi cross-dialectically, I will focus on contrasting and comparing Mandarin, Min, and Wu.

Minnan and Mandarin.

Xiàmén is a southern Min dialect of Fujian province with right-headed sandhi, so that the final syllable of a phrase retains its citation form, while all other preceding syllables undergo sandhi. Xiamen (also called Amoy) and other Min dialects are notorious in the phonological literature for the Min tone sandhi circle. While the tone circle will not be dealt with here, the Xiamen pattern from Shih (1986) is given for the sake of reference in (3).

(3) Xiamen tone circle

[35, 55]	**6**	[33]
8		**9**
[53]	**7**	[11]

Xiamen sandhi domains align themselves with syntactic domains, as described in Chen (1985) and Chen (1991). His findings show that tonal domains align themselves with XP's, whether NP, VP, AP, etc., so long as the XP is not an adjunct phrase (an adjunct phrase does not form a separate tonal domain, but is subsumed under the larger XP tonal domain). Basically, his rule formulation stipulates:

(4a) Mark the right edge of every XP with # (a tonal domain boundary) except where XP is an adjunct c-commanding its head.

(4b) XP is an adjunct of Y, if XP (a) appears in $[...XP...]_{YP}$, and (b) is not a strictly subcategorized argument of Y. (Chen 1991:126)

A few examples appear below in (5) as given or cited in Chen (1991). Tonal values are not given in Chen's data, but tonal domains are demarcated with pound signs (#); the rightmost syllable immediately before the domain boundary retains its original tone, and all others before it have sandhi tone values.

(5) a. ts'ong-bing # k'un-lat # e hak-sing
smart *hard-working* PAR *student* = *a smart and hard-working student*

b. mua-a # tua # e sio-piah
sesame-seed *big* PAR *bun* = *buns with big sesame seeds*

c. gua kai-tsai # tse tsit pan-ki

I *fortunately take this flight* = *Fortunately, I am taking this flight.*

d. lao tsim-a-po # m siong-sin ying-ko # e kong-we

old lady *not believe* *parrot* PAR *talk*

= *The old lady doesn't believe that parrots can talk.*

Chen's data include examples in which sandhi domains do not strictly follow syntactic constituents. For example, in 5d the NP and VP of the complement clause are bisected and the NP groups with the preceding main clause VP in the formation of tonal domains; this is contrary to the tonal domain boundary that one would expect to coincide with the syntactic boundary at "# *not believe* [*parrot* # PAR *talk*". Chen explains this problem by claiming that sandhi domains are functionally, not categorically, determined. Nonetheless, this suggests that his XP approach does not report the full story, and that his proposal requires some modification. Perhaps another constraint, e.g., a prosodic alignment constraint, is dominating the XP alignment constraint here. Thus, contrary to what was previously thought, the sandhi in this dialect could be prosodically determined, although it may often take syntactic boundaries into account.

While Xiamen tends to align sandhi with XP's (nothing is said of wider-scope alignments or contrastive stress in Chen's account), the northern dialects tend to align sandhi with prosodic phrases and may be less sensitive to syntactic boundaries. In fact, depending on the context, different alignments are possible, and tonal domains may or may not coincide with XP's. Consider the following famous and oft-quoted example from C. Cheng (1968), with vertical bars added to show sandhi domains[8]:

(6) UR: L|o L0 m|i h|o jiß = *Old Mr. Li buys good wine.*

a. 5 4 | 4 | 5 4

b. 5 5 4 | 5 4

c. 5 4 | 5 5 4

d. 5 5 5 5 4

Cheng identifies these different outputs as conditioned by different speech rates:

[8] The accent mark [5] abbreviates for the high-rising T_2, and [4] abbreviates for the falling-rising T_3.

6a=adagio, 6b=moderato, 6c=allegro, 6d=presto. A syntactically based account will fail to explain the different possible outputs, since different divisions are possible irrespective of syntactic phrasing. 6a inserts a prosodic juncture inside a VP, 6b prosodically groups a subject NP with the main verb, and 6d lumps everything in the intonational phrase together into one tonal phrase. Yet syntax does count for something, since an output like **L|o | L0 | m|i| háo jiß* would be ungrammatical — an NP cannot be chopped in half. Another factor is contrastive stress, which affects prosodic groupings in addition to speech rate. The output in 6a would be possible in faster speech if contrastive stress is placed on the verb *m|i* to mean “Old Li *buys* good wine, not sells (*mài*) it”. Thus the Mandarin data are best explained if cast in terms of prosodic phrases (PP), not syntactic phrases, yet the latter do play an indirect role, in that in some environments the sandhi prosody does take syntactic information into account.

Also important as sandhi domains are compound words, which define tonal domains and into which junctural boundaries are not inserted. Consider the following examples:

(7)	b| yßs|n d|pò le	÷	bá yús|n	d|pò le	PREP *umbrella break* PAR
		÷	*bá yß|s|n d|pò le	= *broke an umbrella*
	d|s|o x0	÷	dás|o	x0	*sweep and wash*
		÷	dásáo x0	
		÷	*d||sáo x0	
	h.n b|osh4u	÷	hén báosh4u	*very conservative*
		÷	h.n	báosh4u	
		÷	*hén b|o|sh4u	

Thus, compound words form tonal domains which are inviolable. Tonal domains may consist of a compound word, or may envelop the compound along with a larger phrase, but tonal domains may not cut across word boundaries even to form larger prosodic domains. This indicates that the alignment constraint with the prosodic word ranks higher than alignment with prosodic phrases.

A notable difference obtains between Mandarin and Min in the interaction between tonal domains and focus stress. Focus stress can freely force new domains in Mandarin, as in 6a of the

Lao Li example above ("*old* Li"), and as R. Cheng (1968) notes, focus stress on words can also force new tonal domains in Taiwanese. However, these data apply to whole words, and these works of Cheng (1968) and Chen (1991) have not examined the possibility of focus stress on individual morphemes in a compound. Having looked into this, I have found that focus stress in Taiwanese cannot force a word-internal break and realignment in the tonal domains; evidence comes from my own data of trisyllabic compounds[9]:

(8) lig^{33}-tao^{33}-thq0^{55} ÷ lig^{21}-tao^{21}-thq0^{55} *sweet green bean soup*

g]^{24}-lgi^{23}-ru^{24} ÷ g]^{33}-lgi^{21}-ru^{24} (personal name)

÷ g]^{33}-lgi^{214}-ru^{24} (name, with focus on *lgi*; = '*lei*', not something else)

For example, a trisyllabic compound such as *lig-tao-t^{h}q0* ('sweet green bean soup') cannot have word-internal focus stress which forces a break in tonal domains to create separate tonal domains inside the word. Thus, [lig-tao-t^{h}q0] is the only possible output; an output with more than one tonal domain due to focus stress, such as *[lig-tao]# [t^{h}q0] ("green *bean* soup"), is not possible. Likewise, a personal name as above (a full name) cannot have focus stress which forces a new sandhi domain. While focus stress may force new tonal domains word externally, leading to tonal domains that may differ from morphosyntactic domains, it cannot enter into word internal domains. Thus for the Taiwanese constraint ranking (and perhaps for Min in general), the integrity of the morphological word dominates focus stress. Curiously, the personal name example above shows a prejunctural lengthening of the tone which receives focus stress. Word-internal focus stress is sometimes possible in Mandarin, e.g., "*x0* sh4u" = '*wash* one's hands'.

Evidence for foot structure exists in tonal domains, which shows up in longer compounds. One piece of evidence in Mandarin comes in compound numbers with multiple third tones, e.g., in phone numbers, which may be parsed variously depending on speech rate and contrastive stress. Several possible outputs reflect a tendency toward formation of binary feet, or sometimes ternary feet to avoid forming degenerate feet. The usual possible outputs in (8) show sandhi domains

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[9] The following are data I collected from an interview of a Taiwanese speaker from Taipei, who is from a Taiwanese L_1 home environment in which both parents speak Taiwanese.

marked by vertical bars.

(9) jiß-jiß-jiß-jiß-jiß-jiß-jiß = *999-9999*

÷ 99 | 99 | 999 |

999 | 99 | 99 |

999 | 9999|

9999999 |

One may refer to Yip (1996) and Duanmu (1995) for discussion of prosodic feet across Chinese dialects.

These facts being the case for Mandarin and Xiamen, we can postulate the following alignment constraints for the sandhi domain (SD) operative in the grammars of these dialects, as shown in (10):

(10) Align-R (SD, PP): right-align sandhi domain with the prosodic phrase

Align-R (SD, Ft): right-align sandhi domain with prosodic foot

Align-R (SD, IP): right-align sandhi domain with intonational phrase

Align-R (SD, PWd): right-align sandhi domain with the prosodic word

Align-R (SD, XP): right-align sandhi domain with XP

For XP, we will assume a non-adjunct XP as defined by Chen. Alignment constraints for PP and PWd will be ranked high enough to be robust in Mandarin, but ranked low enough in Min to have little or no surface effect; likewise, XP alignment will be highly ranked and robust in Min but low ranked and weaker in Mandarin[10]. For the two dialects, the following rankings are proposed:

(11a) Mandarin:

Align-R (SD, PWd) o Align-R (SD, PP) o Align-R (SD, XP)

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[10] The constraint Align-R (SD, XP) may need to be further defined, or (in OT terms) "exploded" into specific constraints, e.g., to align with PP, VP, NP, etc., but for the dialects under consideration here, exploding does not seem warranted.

OT claims that all constraints are universal, but if a given constraint never has any discernable effects upon surface forms in a language, then for that language the constraint is ranked very low, and below all other constraints with which it might come in conflict with. How or why tonal alignment constraints could exist at all, albeit buried deep in the constraint hierarchy of non-tonal languages (or for that matter, any constraint irrelevant to a given language), would be an interesting question for optimality theoreticians to address.

(11b) Xiamen:

Align-R (SD, XP) o Align-R (SD, PP), Align-R (SD, PWd)

The relative ranking of alignment constraints for IP, PP, PWd, and Ft with respect to one another in Mandarin, besides the above ranking, will vary according to speech rate and speakers' contrastive stress. The above ranking, though, accounts well for the Mandarin data. Clear preferences exist for aligning tonal domains with prosodic phrases, but not at the expense of alignment with prosodic words (compounds), as well as a tendency for foot based domains. Alignment with prosodic domains outranks syntactic alignment, allowing groupings such as NP V | PRED in 6b. Yet syntactic alignment, though lower ranked, can still prevent XP's from being chopped up, as in **Lao| Li*. The Xiamen ranking allows for the predominant XP-SD alignment over alignment with prosodic domains. A more detailed ranking of Xiamen would depend on further investigation into wider scope domains and the relevance of prosody in Min tonal domains.

For speech rate phenomena, the logical tendency is for wider scope alignment with faster speech, thus, the faster the speech, the wider the domains. I propose the following markedness hierarchies to formalize this tendency:

(12) Align(IP) > Align(PP) > Align(PWd) > Align(Ft) > Align(F)

Align(S) > Align(XP) > Align(YP) > Align(X^0)

if XP=non-adjunct phrase, and if YP=adjunct phrase, and if X^0=lexical word

Hopefully, further research could be done into the validity of Align-R (SD, Ft) for these dialects. Mei also cites philological evidence for 16^{th} century standard Mandarin having the same bisyllabic limitation. Apparently Mandarin has experienced a diachronic reranking of alignment constraints since that time.

Headedness.

I will begin with Yip's (1996) treatment of tone deletion and spreading in Wu, and with discussion of headedness in tonal domains. Tone deletion and spreading are phenomena in some Chinese dialects, especially in Wu, whereby the head syllable retains its full tonal features, while syllables in the rest of the tonal domain undergo partial or total loss of their tonal features. Then some or all of the tonal features from the head tone spread onto the syllables of the tonal domain, and/or default low tones are inserted on tones undergoing full reduction. An example from Selkirk and Shen (1990) with the authors' tonal transcriptions is given in (11) below from Shanghai. Shanghai is a left-headed dialect in which tone sandhi, deletion, and spreading operate rightward; an example of full tonal reduction and spreading of head tones is shown in the traditional derivational notation (the final L is a phrase-final low tone inserted as a default tone; one may refer to the authors' article for details).

(13) MH - HL - LH ÷ M - H - ~~H L L H~~ 6 M - H - L
sou-foN-dziN
hand-wind-organ = accordion

Partial tone loss occurs in Suzhou, another left-headed Wu dialect. Non-head tones lose their pitch features [h/l] but medial syllables retain their register features [H/L], as the head tone spreads its pitch features onto the non-head tones. (14) shows a few of Yip's (1996) examples[11].

(14) <u>underlying tones</u> <u>surface tones</u> <u>example</u> <u>gloss</u>

[11] For those unfamiliar with these data and their interpretation, the tonal patterns are restated featurally to show more clearly the pitch neutralization and register domains:

a. 52-13-44 = [H, hl] [L, lh] [H, h] ÷ 52-33-21 = [H, hl] [L, h] [L, hl] *or* h [H, l] [L] [L, l]
b. 13-13-13 = [L, lh] [L, lh] [L, lh] ÷ 13-33-21 = [L, lh] [L, h] [L, hl] *or* h [L, l] [L] [L, l]
c. 13-52-31 = [L, lh] [H, hl] [L, hl] ÷ 13-44-21 = [L, lh] [H, h] [L, hl] *or* h [L, l] [H] [L, l]

Thus, [h] has scope over the entire tonal domain. The final [1] is apparently a sentence-final phonetic lowering effect which surfaces in the six possible sandhi patterns reported. This lowering within a [h] domain can be accounted for with the OT constraint Non-Finality, which causes a phrase-final element to fail to express a domain feature. Non-Finality (as defined and treated by Prince and McCarthy in their various works) handles effects previously termed extratonality, extrametricality, etc.

a.	52-13-44	52-33-21	tsæ ñi kæ	*date paste cake*
b.	13-13-13	13-33-21	nø mcn ¯ iæ	*south gate bridge*
c.	13-52-31	13-44-21	suã tɡ bin	*jaundice*

Using an optimality theoretic framework, Yip handily accounts for these phenomena which have posed considerable difficulties to previous researchers in Chinese phonology (see Chen 1991). Yip draws from and expands on recent research in the OT literature which shows that head syllables exhibit a featural faithfulness stronger than and different from that of non-head syllables, or foot syllables[12]. For faithfulness in regular syllables she appeals to the faithfulness constraint Max(T), or Max for tonal features. For head tones, she appeals to other constraints of the Head-Max family, that is, featural faithfulness in head syllables: Head-Max(T) for tonal features. For non-head tones, she formulates the constraint Foot-Max(T). Finally, she enlists so-called markedness constraints (such as *Contour, a prohibition on contour tones; *T, a prohibition on surface tones; or *Rising, a prohibition on rising tones) to drive the process of tonal reduction and deletion. Then the ranking of Head-Max over markedness constraints, and the ranking of different markedness constraints with respect to Foot-Max, produce the described tonal phenomena. If markedness constraints are all ranked below Foot-Max, no reduction or deletion occurs. If one or more markedness constraints rank above Foot-Max, then reduction or deletion occurs, and the superordinate ranking of Head-Max for tonal features causes tonal features from the head to spread to the entire foot. A brief example is given in (15), showing how non-head syllables lose their tones, and the tone of a head syllable is realized over the whole domain. In this ranking, Head-Max[T] dominates *T, which in turn dominates Max[T]. Tones are deleted to satisfy *T in violation of Max[T], but head tones remain to satisfy Head-Max[T]. Candidate *a* is the selected output since it satisfies Head-Max[T]; parentheses indicate tonal domains.

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[12] For this, Yip cites relevant research by the following:

Alderete, John. 1995. Faithfulness to Prosodic Heads. Rutgers Optimality Archive #94.
Beckman, Jill. 1996. Positional Faithfulness and the distribution of phonological features. MS, UMass, Amherst.
Dresher, Bezalel Elan and Harry van der Hulst. 1995. Head-dependent asymmetries in prosodic phonology. University of Toronto and University of Leiden.

			Head-Max[T]	*T	Max[T]
(15)	input:	$(F_1)t_1$ - $(F_2)t_2$ - $(F_3)t_3$			
	a. L	$(F_1$ - F_2 - $F_3)t_1$		**	**
	b.	$(F_1)t_1$ - $(F_2)t_2$ - $(F_3)t_3$	*!	**	**

Candidate *a* is maximally faithful to head tones, and minimally faithful to non-head tones. As a result, non-head tones are deleted, and the head tone spreads over the whole domain. Thus, the candidate with tonal deletion and spreading satisfies the constraint ranking.

Given that head syllables are cross-linguistically more featurally faithful and prosodically stronger, Yip proposes that ranking of Head-Max constraints over Foot-Max constraints is an undominated ranking of the universal grammar, so in every language, informally stated, Head-Max(F) o Foot-Max(F). Yip does not discuss this further, but this seems intuitively correct. By virtue of definition of headedness, head elements must be more featurally distinctive than non-heads. The cross-dialectal tonal data would seem to confirm this. A few apparent exceptions exist, which I will treat later; these data may or may not disconfirm Yip's hypothesis, depending on their interpretation (or at least show a universal tendency for this ranking). Tonal heads are not subject or less subject to tone sandhi, spreading, deletion, or reduction than non-head elements throughout Chinese. Yip gives this universal constraint in formal terms for the UG:

(16) UG: HEADPCAT$_A$-MAX(T) oHEADPCAT$_B$-MAX(T) iff PCAT$_A$ < PCAT$_B$.

Incidentally, Yip's analysis invokes markedness constraints such as *Rising, a prohibition against rising tones, and *Contour, a prohibition against contour tones. In place of these various, individual markedness constraints, I would like to propose a tonal markedness hierarchy. This concept is grounded in the fact that level tones are least marked due to their phonetic simplicity, while contour tones are phonetically more complex and therefore more marked, and complex contours are most complex and most marked. This is also grounded in the statistical frequency of tones reported in Chen (1991), in which tonal data for 737 Chinese dialects are compared for frequency of tone types. Simple contours (falling tones and rising tones) are found to be much more common than complex contours (rising-falling and falling-rising), rising tones are more common than falling tones, and concave tones (falling-rising) are more common than convex tones (rising-falling). This work finds falling tones to be slightly more common than level tones, but it remains to be seen whether this tendency holds true for tonal systems world-wide[13]. Based on these data, I put forth the following markedness hierarchies:

(17) NoTone > Level > Contour > Complex-Contour

Concave > Convex

Falling > Rising

NoTone mitigates insertion of any tonal material, similar to Yip's *T (*Tone), and *Structure in other OT works. This hypothesis awaits empirical verification.

Headedness in sandhi.

Yip's research is insightful for my investigation, because the same principles can be applied to headedness in sandhi domains. As seen above, both right-alignment and left-alignment patterns obtain in tone sandhi. For tonal heads, the Head-Max constraint stipulates that the head tone will surface with its underlying tonal values intact, while the non-head tones may undergo deletion, reduction, and spreading of features from the head tone. Applying Yip's insights to sandhi, we would logically conclude that head tones will remain unchanged, while non-head tones will change due to sandhi. Of course, this would intuitively seem correct, since head tones bear prosodic prominence. However, this is not always so, although it is most often the case, as in most of the dialects discussed so far — Mandarin, Tianjin, Xiamen, Changting, Suzhou, etc. Whether sandhi is right-prominent or left-prominent, the head tones in these dialects remain unchanged while non-head tones change. Yet we have that one complication to deal with: in some dialects, the head tones themselves undergo sandhi in addition to non-head tones. Shaoxing provides a good example of this pattern. Shaoxing has a left-prominent alignment, yet even tones in left-heads show change in addition to tones following in the tonal domain. The data for both two-syllable and three-syllable sandhi patterns from Ballard (1988) is given in (18) below.

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[13] Perhaps this is related to the cross-linguistic tendency for declarative sentences to have falling intonational contours (British English being a noticeable exception),

(18) Shaoxing bisyllabic and trisyllabic sandhi:

F_1 \ F_2	I [51, 231]	II/III [335, 113, 33, 11]	IV [45, 12]	F_2 + F_3
Ia [51]	33-51	33-55	33-5	33-55-51
Ib [231]	11-51	11-55	11-5	11-55-51
IIa [335]	335-51	335-51	335-54	335-55-51
IIb [113]	115-51	115-51	115-54	113-55-51
IIIa [33]	33-33	33-33	33-3	33-33-55
IIIb [11]	11-11	11-11	11-3	11-11-33
IVa [45]	3-51	3-55	3-5	3-55-51
IVb [12]	1-51	1-55	1-5	1-55-51

The table shows that Ia, Ib, IVa, and IVb consistently undergo sandhi in head position, and IIb does so in bisyllabic domains; on the other hand, IIa, IIIa, IIIb in heads, and IIb in heads of trisyllabic domains retain underlying forms. In trisyllabic domains, for a given head tone T_x , the melody of the tonal phrase is the same regardless of the following non-head tones. This melody is similar to the sandhi melody for the bisyllabic pattern F_2 = Ia/b, except for F_1 = IIIa.

Clearly the patterns for Ia, Ib, IIb (FF), IVa, and IVb violate the Head-Max constraint, but perhaps no less than the non-head tones violate Foot-Max and Max(T). Whether Yip's proposed universal constraint ranking is violated here depends on what is driving the sandhi in Shaoxing. If it is a prosodic or phonological constraint driving sandhi here (e.g., those used in Yip's paper — Foot-Max, Max[T], markedness constraints, etc.), then this would suggest that Yip's universal constraint is not an undominated constraint of the UG, but is a normal, violable constraint. In this case, the constraint could be reformulated as a universal markedness hierarchy constraint for head faithfulness. If it is not these constraints violating Head-Max, but rather a morphophonological constraint, i.e., a morphophonologically specified tone sandhi process (as discussed in the following chapter) that violates Head-Max here, then the proposal stands. In a subsequent chapter I will attempt to show that some cases of sandhi could be morphological, or at least morphophonological, processes. This being so, sandhi could be specified as morphophonological constraints which interact with other constraints in the grammar, in a manner similar to morphophonological constraint interaction in the OT literature, e.g., McCarthy & Prince (1995). This would lead to the proposed constraint ranking: TS (tone sandhi) o Head-Max(T). Yet this ranking does not seem to obtain for the Shaoxing patterns for IIa, IIb (FFF), IIIa, and IIIb, where head tones show no sandhi. Two possible ways out of this difficulty would be: (1) Stipulate that for the latter set, a second, perhaps differently ranked, sandhi constraint is involved; or (2) Stipulate different morphological constraints for the different patterns. The latter would require constraint parametrization, that is, constraints specified for specific morphophonological paradigms or tonal categories. Parametrization would seem preferable, especially when faced with other complex patterns. For example, in the Wu dialect Chomgming, depending on the tonal environment, the citation tone IIa [435] in head position can surface as [42] or [33] (Ballard 1988). These complexities and difficulties of sandhi heads will be dealt with further after discussion of tonal morphology in a following chapter.

Prosody.

What follows logically from applying headedness to sandhi can help us to consider the overall purpose of sandhi in the grammar of a tone language. We have seen that heads are most faithful to tonal features, while non-heads are considerably less faithful to tonal features. This situation is very similar to stress systems in languages such as English. Syllables with phrasal stress or lexical stress are very faithfully, if not maximally faithful, to segmental featural information. On the other hand, syllables with no lexical or phrasal stress undergo reduction, especially in vowel quality — the underlying vowels often surface as reduced forms [c] or [ɪ]. Reduction serves to downgrade these syllables and enhance the prominence of stressed syllables or lexical items. Sandhi operates in a very similar way: it downgrades non-head syllables by neutralizing and/or reducing their tonal featural information, and thereby enhances the prominence of head syllables. Hence, sandhi operates as a tonal analog of prominence and reduction in stress systems, and is thus a key component of the prosodic system. Sandhi, then, is a prosodic phenomenon, operating as a mechanism of prosodic prominence and reduction. It marks head tones as prominent by virtue of their featural faithfulness, and marks non-head tones as non-prominent by virtue of their unfaithfulness.

Because sandhi exists as a prosodic system, it follows that it can mark focus stress domains, and that it would align with content words or domains headed by content words (PWd, feet, XP), with syllables, with phrasal domains, or even with intonational phrases, depending on the language-specific constraint ranking. It also follows that its alignment, behavior, and scope of domains would vary across dialects and languages, just as stress systems vary across languages. And that in a given language it could correspond to different kinds of prosodic and/or morphosyntactic domains, though regardless of the different types of domains or types of information that it may be sensitive to, in any dialect it is nonetheless prosodic. So while southern Min sandhi often corresponds to syntactic domains (as Chen gives many examples where sandhi does seem to correspond to syntactic domains), a 1:1 sandhi-syntax correspondence does not always obtain. Other constraints will force it to sometimes violate tone-syntax alignment constraints, and even where syntactic and tonal domains do correspond to each other, the sandhi is still primarily prosodic. In the cases of sandhi-syntax correspondence in Min, it is possible that prosodic and/or phonological domains are aligning with syntactic domains, and then tonal domains are aligning with these prosodic / phonological domains.

Conclusion.

In this chapter I have tried to define briefly the types of domains over which sandhi operates, and to formulate some basic constraints to capture the more important patterns found in the literature. However, the literature does seem wanting in terms of comprehensive data on tonal domains of dialects outside of Mandarin and southern Min. More data would be beneficial, as would more synchronic research focusing on spontaneous speech data rather than on elicited data.

This chapter serves as a framework for treatment of further questions in subsequent chapters of this thesis. In particular, chapter six will further discuss prosody and sandhi. Drawing from this framework and other evidence, I will try to put forth some hypotheses or suggestions about the fundamental nature and function of sandhi in Chinese.

Chapter 4

Sandhi in historical perspective

This chapter will provide general historical background on Chinese tonal systems, and will examine possible historical factors in the origin and development of tonal values and tone sandhi. First, I will provide an overview of what we know of the origins of the tonal system — its development from loss of final consonants in archaic Chinese, and the great register split in Middle Chinese. For further details, the reader is referred to the diachronic research of Haudricourt, Maspero, Karlgren, Pulleyblank[14] , Baxter (1992), Mei (1991, 1977), etc. What is not understood is how the sandhi system came about. Here I will look at the possible hypotheses that might explain this problem. I will examine some of the dialectal tone data and patterns, and their bearing on these hypotheses. I will conclude by evaluating the possible explanations and will suggest possible avenues for further research.

Ancient origins of the tone system.

Going far back in time, we want to account for the existence of the four tonal categories and their origin. The commonly held view among Chinese historical linguists is that the tones initially arose in an ancient stage of Chinese due to the disappearance of final consonants; this

[14] For sources not directly referred to in this thesis, see for example:

Haudricourt, André. 1954. "De l'origine des tons en viêtnamien". *Journal Asiatique* (242:68-82).
Haudricourt, André. 1954. "Comment reconstruire le chinois archaïque". *Word* (10:351-64).
Karlgren, Bernhard. 1915-26. *Etudes sur la phonologie chinoise. Archives d'études orientales*, vol. 15 (in 4 parts). Leiden: E.J. Brill; Upsalla: K.W. Appelberg.
Maspero, H. 1916. "Etudes sur la phonétique historique de la langue annamite: les initiales". *BEFEO* (12:102).
Pulleyblank, E.G. 1978. "The nature of the Middle Chinese tones and their development." *JCL* (6:173-203).

theory comes mostly from the works of Haudricourt and Pulleyblank (see, for example, Pulleyblank (1973)). Historical tone I (pingsheng or "even") arose from loss of final voiced obstruents; tone II (shangsheng or "rising") arose from the loss of final glottal stops; tone III (qusheng or "departing") arose from loss of final *-h* deriving from earlier *-s*; and tone IV (rusheng or "entering") from final voiceless stops, which were lost in some dialects and retained in others to this day (§ and/or *p, t, k*)[15]. Historical phonologists in Chinese and Southeast Asian linguistics (namely, those in the above references and footnote) find evidence for this in tonogenesis from lost final consonants in Vietnamese and other southeast Asian languages; Sino-Vietnamese loanwords; loanwords into old Chinese; phonetic properties of how such final consonants influence preceding vowels; corresponding final consonants in Classical Tibetan, such as a final *-s* suffix; and final § co-occurring with shangsheng tones (category II) in a few dialects of the southeast coast (Mei 1970, Yue-Hashimoto 1986). Incidentally, Mei (1970) argues that the so-called rising tone or shangsheng was actually a high level tone, at least in Middle Chinese of 7th-9th centuries. Evidence for this comes from phonetic descriptions of the tones in Chinese Buddhist writings of this period.

The ancient Chinese tonal system consisted of four tonal categories, which at some point in Middle Chinese underwent a register split into upper register [H] and lower register [L] tones. The split is believed to have been caused by the depressor effect of initial voiced consonants, especially obstruents, and raising effect of voiceless initial consonants. Register distinction before the loss of voice/voiceless contrast was allotonic, but after loss of voice distinction, the register split became phonemic. This yielded an eight tone system, which does not obtain in all the dialects; whether the split did not occur for all tonal categories in all the dialects, or whether it did but was later undone by merger, is a matter of some debate. Also, tone category IV tends to merge with other categories, especially in Mandarin dialects. Comparative evidence for this tonogenesis comes from Wu dialects, which still retain voiced consonants and in which high register tones pattern with voiceless onsets and low register tones with voiced onsets, e.g., Suzhou

[15] Tone IV glottal stops were derived historically from *p, t, k.* In some dialects, these consonants merged into *-k* or -§, and in some dialects the final disappeared altogether. In some dialects, some tone IV words have glottalization effects like creaky voice on the vowel preceding the final -§ or Ø consonant. See Ting (1983) and references therein.

dialect (see Ye 1979). The timing for the phonemicization of the split is uncertain, but since the four-level system was apparently still in effect in the seventh century *Qièyùn* rhyme tables, and reported evidence of a phonemic split comes from a ninth century source, the split possibly happened between those times (see Norman 1988), and must have taken place by the time of the fourteenth-century rhyme book *ZhÇngyuán Y§nyùn* (see Hsueh 1975).

For discussion of the aforementioned points, debates, proposals, and reconstructions, see Baxter (1992), including discussion of proposals set forth by Karlgren, Haudricourt, and Pulleyblank. Tonogenesis by [±voice] consonants can be explained by appealing to glottal features which subsume both voicing and tonal features. Constricted glottis [cg] characterizes [+voice] and [L], and slack glottis [sg] characterizes [-voice] and [H]; see Yip (1995); Ladefoged and Maddieson (1996) use the features stiff voice for [cg] and slack voice for [sg]. Evidence for such a relationship comes from the historical phonology of Southeast Asian tonal systems (see Baxter 1992) and from acoustic evidence, as in Pierre-Hombert *et al.* (1979). Also, for phonetic explanations of how loss of final consonants can induce tonogenesis, see Pierre-Homert *et al.* (1979), Silverman (1997), and references within those works.

The diachronic correlates of the tonal categories are summarized below:

(1)	TC	final correlate	initial glottal correlate
	Ia	[obstr], [+vc]	[sg], [+vc]
	Ib	[obstr], [+vc]	[cg], [-vc]
	IIa	-§	[sg], [+vc]
	IIb	-§	[cg], [-vc]
	IIIa	-h	[sg], [+vc]
	IIIb	-h	[cg], [-vc]
	IVa	[stop], [-vc]	[sg], [+vc]
	IVb	[stop], [-vc]	[cg], [-vc]

This tonogenesis can be explained in terms of alignment constraints. The initial consonant serves as the sponsor for [cg] and [sg], which for most languages would be in a basic alignment featural domain. For MC and Southeast Asian languages, the glottal features (GF, abbreviating for two separate featural domain constraints for [cg] and [sg]) form a wide-scope, left-aligned domain over the syllable, which induces allotonic features onto the vowels. Before the split, we have the following constraint ranking:

(2) Align-L (GF, F), Express o BA (GF), Dep-IO-T

The left-aligned wide-scope domain constraint and Express dominate basic alignment (BA-GF) and a constraint against insertion of tonal structure. As voicing is lost, glottal features are preserved because the faithfulness constraint (Ident-IO-GF) requiring glottal features to be parsed outranks the constraints driving loss of distinctive voice. But the sponsor for GF is lost, so the vowel is reanalyzed as the sponsor for GF. This is made possible in part by reranking BA over wide-scope alignment, so that the latter becomes inactive. Now BA dominates, and we see the new constraint ranking that generates syllables with distinctive register:

(3) BA (GF), Ident-IO-R o Align-L[16]

Owing to diachronic changes in particular tonal values across the dialects since the register split, modern tonal values differ widely when compared with each other and when compared to their putative values before the register split. Yet we might still expect words of the historical yin categories to have higher tones than words in the corresponding yang categories. But in fact, it is easy to find particular instances of counter-examples to this tendency. In some dialects the Ia tone has a lower tonal value than the Ib tone, and likewise for other tonal categories in the various dialects. However, there still remains a strong tendency for yin tones to be phonetically higher than the corresponding yang tones. Cheng (1991) reports his statistical survey in which this holds true for I, II, and III tones, though not so for IV tones, as IVb is slightly higher than IVa (which could be due to the phonetic rising influence of final voiceless stops). His results are summarized in (4) below, in which Cheng statistically averages the numeric values (in the five-point Chao

[16]Wide-scope alignment becomes inactive in that the WSA constraint is reranked below all relevant faithfulness constraints so that it no longer has any effect in the language.

scale) for all cross-dialectal tone values of a given tone category. First, the two registers for a given pre-split category are averaged together from all dialects on the Chao scale, e.g., all Ia/b tone values from all dialects averaged together. Then all particular categories for all dialects are averaged together, e.g., Ia for all dialects, Ib for all dialects, etc. This shows that despite all the historical changes in tonal values, Xa tones still have a strong tendency to be higher than their Xb counterparts.

(4)	TC	Xa/b together	yin (Xa)	yang (Xb)
	I	2.53	3.47	2.83[17]
	II	3.25	3.98	2.75
	III	2.91	3.13	2.46
	IV	3.03	3.19	3.29

Now having briefly seen that phonological theory in addition to historical and comparative evidence can insightfully account for the MC register split, we will examine various possible explanations for tone sandhi in Chinese dialects.

Tonal merger.

One possible explanation for sandhi comes from appealing to tonal merger or neutralization, whereby sandhi is a neutralization process from the merger of historical tonal categories. Mandarin sandhi, for instance, could possibly be explained as neutralization of T_2 and T_3 in favor of T_2. A good candidate for historical merger in sandhi is Haiyan (Wu dialect, Zhejiang province; Ballard 1988). The citation forms are shown in (5) and the sandhi forms in (6), showing that the sandhi occurring in the second of two syllables realizes a neutralization of tonal categories.

[17] These figures for Ia/b and Ib seem aberrant, as the Ia/b value should fall between the Ia and Ib values; perhaps they have been accidentally transposed in Cheng's work.

(5)	TC:	<u>Ia</u>	<u>Ib</u>	<u>IIa</u>	<u>IIb</u>	<u>IIIa</u>	<u>IIIb</u>	<u>IVa</u>	<u>IVb</u>
		54	31	434	242	25	213	5	2

(6)[18]	F_1	F_2: <u>Ia/b</u>	<u>IIa/b, IIIa/b</u>	<u>IVa/b</u>
	Ia	54-31	54-31	54-31
	Ib	31-434	31-434	31-434
	IIa	434-434	434-434	434-5
	IIb	242-31	24-213	242-21
	IIIa	25-42	25-42	25-42
	IIIb	23-21	23-21	213-5
	IVa	5-434	5-25	5-5
	IVb	2-213	2-213	2-213

For TC Ia + Ia/b, both 54-54 or 54-31 surface alike as 54-31, so that Ia and Ib are neutralized in favor of Ib in F_2. In fact, for Ia + {Ib, IIa/b, IIIa/b, IVa/b}, every possible combination of Ia + F_2 will realize the same [31] on every F_2. Similar wide-scale neutralization occurs for F_1 = Ib, IIIa, IVb, and to lesser degrees for the other tonal categories: Ib + F_2 ÷ Ib + [434], IIIa + F_2 ÷ IIIa + [42], etc. For F_1 = IIb, the F_1 outputs are slightly different, hence apparently a slightly more complicated neutralization pattern emerges. IIb + {Ia/b, IVa/b} have similar outputs, if we treat [21] and [31] as notational variants, but IIb + {IIa/b, IIa/b} has a slightly different F_1 value. No phonological or phonetic explanations such as assimilation or dissimilation consistently hold for Haiyan. Rather, the sandhi of this dialect reveals some complicated patterns of neutralizations from historical mergers of tonal categories. Here sandhi serves as a historically innovative device for reducing the tonal inventory in prosodically and metrically less prominent syllables.

Shaoxing dialect also shows mergers of historical tone categories, in addition to other tonal changes. In sandhi, Ia and Ib are merged together; IIa, IIb, IIIa, IIIb are merged together; and

[18] The tone values 242-*31*, 242-*213*, 242-*21*; and 434-*434*, 434-*5*; and 23-*21*, 213-*5*; and 5-*434*, 5-*25* are not typographical errors, but are exactly as reported in Ballard (1988); however, [21] and [31] are probably notational variants of one another — an aberration of the five-level Chao scale.

IVa, IVb are merged together. The neutralization patterns are similar to Hiayan above. Other representative dialects with mergers in sandhi are: Danyang II c III; Yongkang IIa c IVa and IIb c IVb; Ningbo Ib c IIb, etc. (Ballard 1988). Other dialects show partial mergers in the sandhi paradigms, e.g., two or more tonal categories merge, but not in all combinations. For example, in the Wu dialect of Zhenhai, the sandhi paradigm here shows many partial neutralization patterns such as Ia + {Ia, Ib, IIa, IIb, IIIa, IIIb} ÷ [33-41], but Ia + {IVa, IVb} ÷ [33-4]; Ib + {Ia, Ib, IIa, IIb, IIIa, IIIb} ÷ [11-41], but Ib + {Iva, IVb} ÷ [11-4]. (Ballard 1988)

Conversely, a very small number of dialects show the opposite pattern: the base tone system merges tonal categories together, which are differentiated in their sandhi values. That is, for a given pair of categories Xa/b, on the surface both have the same tone value and show no distinction, but in sandhi the Xb surfaces with a distinctively different tone value. Xiuning (Mandarin, Anhui province; Ballard 1988) shows sandhi mergers in that Ia, IIa, IIb, IIIa surface as [13], and IVa and IVb both as [35]. However, while Ia and Ib have the same citation tone [33], Ib has the sandhi form [55]; likewise, IIIa and IIIb both have the citation tone [55], the latter of which becomes [33] in sandhi. This is summarized below, with non-distinctive Xb base tones in parentheses:

(7)	Xiuning:	TC	I	II	III	IV
		a	33 ÷ 13	31 ÷ 13	55 ÷ 13	212 ÷ 35
		b	(33) ÷55	13	(55) ÷ 33	35

Incidentally, mergers occur not only synchronically in sandhi tones as above, but also diachronically in the tone categories themselves, in that one category merges with another and disappears altogether from the dialect. IIb and IIIb merged in many Chinese dialects, most notably in northern dialects. Taishan (Yue dialect, Guangdong province; Wong 1982) not only merged IIb and IIIb, but also merged IIIa with Ia. However, the Tiashan IV split into three categories: IVa [55], IVa_2 [33], and IVb [21]. The related dialect of Cantonese also splits IV into IVa [5], IVa_2 [3], and IVb [2] (plus the distinct Ia, Ib, IIa, IIb, IIIa, IIIb categories). In the cases of the historical mergers, the tonal value of one category gave way in favor of another, as the former was lost. One question for future research would be whether some instances of sandhi came about as a means of preserving tones lost in such a manner.

In the cases above, sandhi participates in phonological neutralization and/or neutralization of tone categories by merging categories together in sandhi syllables to reduce the surface inventory of possible tonal combinations. However, many of the cases of sandhi as neutralization are restricted to the Wu dialects, which exhibit most of the more complicated patterns. The complexity of the Anhui Xiuning pattern is attributed to the fact that Xiuning lies very close to the Wu dialect area, in southern Anhui near the boundary with Zhejiang. While neutralization is operative in Wu and plays some prosodic or morphophonological role in these dialects (which I will speculate on further in a subsequent chapter), it is not sufficient to account for the development of sandhi generally in all of Chinese. Its restrictions to some dialects, especially Wu, and its restriction to certain tonal categories in some of the affected dialects, make it implausible that neutralization serves as the driving force behind sandhi, let alone as its origin.

Other historical origins of sandhi.

While attempted analyses of sandhi in purely synchronic phonological approaches or neutralization do not satisfyingly account for this phenomenon, attempts to account for it diachronically seem more promising. Sadly, little work has been done in this area. Ballard suggests historical origins behind sandhi, and Mei and Yue-Hashimoto have made some significant undertakings here. But too little work has been done for the reasons that (1) relatively few ancient texts with adequate phonetic or phonological information about the tones and tonal system exist to work from, so diachronic work and reconstruction is thereby hindered; and (2) the great amount of data to work with for macrocomparison from hundreds or thousands of local dialects, and reconstruction of proto-tones and tonal development, present a daunting task, especially given how much tonal values and patterns can vary within a given dialect area.

Within a purely diachronic framework, the following three most plausible options are available:

1) Sandhi is innovative, i.e., it serves as a means of creating new tonal values, while base tones preserve older values.

2a) Sandhi is preservatory, i.e., after the MC register split, further innovations have occurred in the base tone values, and sandhi preserves the earlier post-split values.

2b) Sandhi and/or base tones are preservatory in a more archaic fashion, i.e., they retain tonal features from before the MC register split; possibly, sandhi originated before the split.

I will base my discussion on the first two possibilities. While the third is plausible, discussion of this in the literature is very scant, we have little evidence for or against this, and the timing of sandhi is presently indeterminate. Also, (2b) would make it more difficult to account for the origin of sandhi, if it is not post-split occurrences that brought about sandhi phenomena. This leaves the possibilities that sandhi arose as a preservatory or innovative device after the yin/yang split. I will examine these possibilities by first examining one similar theory suggested in the literature.

Sandhi, reversal, and stress.

Yue-Hashimoto (1986) proposes a more complex theory of register reversal, tonal flip-flop, and derivation of new base forms from prejunctural stress. In this theory, sandhi values preserve historically older tone values and citation forms are more recent innovations. She examines tonal data from 997 dialects and notes 340 particular cases (instances, not dialects) in some dialects of register flip-flop or reversal. What she terms "flip-flop" is a case in which an yin tone, which would historically be high register, is a low register tone, and the corresponding yang tone is high register. Furthermore, in sandhi the situation is reversed and the two tones show an exact switch in sandhi values — to what one would normally expect for yin/yang categories. While flip-flop is an exact switch of tonal values between yin and yang categories, register reversal has a less strict sense. The yin tone is low register and the yang tone higher, which is reversed in sandhi, but the tone values do not correspond exactly. She finds that each Min dialect has at least one case of register reversal for at least one pair of tonal categories. She also notes some cases of neutralization in sandhi of reversed or flip-flopped tones. Some examples are shown below: flip-flop in (8a), reversal in (8b), and neutralization in (8c); arrows indicate sandhi values.

(8)	dialect	TC	base T > sandhi T	TC	base T > sandhi T[19]
a)	Fuzhou	Ia	44 > 52	Ib	52 > 44; 32
	Tainan	IIIa	33 > 21	IIIb	21 > 33
	Longdu	Ib	33 > 42	IIIb	42 > 33
	Xianyou	IVa	32 > 54	IVb	54 > 32
	Chaozhou	IVa	21 > 4; 3	IVb	4 > 21
b)	Zhangping	IIIa	21 > 33; 55	IIIb	53 > 21
	Dongshan Is.	IIIa	21 > 42	IIIb	33 > 21
c)	Longxi	Ia	24 > 33	Ib	313 > 33
	Chaoyang	Ia	33 > 11	Ib	55 > 11

According to her analysis, at some time after the yin/yang split, flip-flop or reversal occurred with some tones in the affected dialects, but the earlier tonal values from before flip-flop or reversal were preserved in the sandhi values. The sandhi tones, then, are diachronically older, and flip-flop and reversal came via changes in the base tones. She also notes that Wu dialects, which preserve the pre-split situation, have sandhi (and tone spreading), but no register reversal or flip-flop. So far her analysis seems logical and supported by the data.

However, her hypothesis for how flip-flop and reversal came about seems less plausible. She points out that these changes occurred in dialects with right-headed stress alignment, but not in Wu dialects which exhibit left-headedness in stress. In her view, the modern citation (underlying) values arose from tones in prejunctural stress environments, where stress juncture caused high tones to lower and low tones to rise, leading to flip-flop or register reversal. However, she does not spell out specific details of the process, nor does she give examples of how this might work out in a historical example from the dialect data. Nor does she address potential problems of this proposal. For example, if a new citation value arises in a prejunctural environment, how does it become generalized to all citations forms in all environments? While it is not impossible, how this might happen requires explanation. More significantly, what prosodic or morphosyntactic levels are involved in prejunctural stress tone change? Also, for Wu dialects,

[19] Different sandhi forms such as 54 > 44; 32 and 21 > 33; 55 are environmentally conditioned.

the significant player may be headedness and tonal domains, rather than stress. As Duanmu (1995) discusses, tonal domains constitute metrical domains, and apparently stress is less prominent in Chinese and possibly less significant not only in metrical systems synchronically, but in inducing diachronic changes in metrical systems.

One might expect that prejunctural stress could cause pitch lowering on a preceding tone. And going beyond Yue-Hashimoto's theory, it is quite possible that the lowering of a tone in prejunctural position could be lexicalized so that the tone category undergoes diachronic change in its tonal value. But it is highly implausible that prejunctural stress would both lower high tones *and* raise low tones. Prejunctural stress would often phonetically lower the preceding tone pitch, but then it would do so for all tones in all environments. Prejunctural stress and phrasal boundaries in most languages of the world are generally signalled by a falling pitch; this is documented for English and many other languages (see Beckman 1996 and references therein). Of course, rising intonation is also common in questions, anticipatory environments (anticipating a following phrase), and in focus stress. Final lowering is also confirmed for Mandarin in experimentation and F_0 measurements by Shen (1989). Phrase-final portions, especially phrase-final syllables, show a measurable drop in frequency, but tonal shapes remain intact and recognizable. Prejunctural focus stress can cause prejunctural lengthening in Taiwanese; recall the personal name example from chapter three: g]^{24}-lɡi^{23}-ru^{24} (base forms) ÷ g]^{33}-lɡi^{21}-ru^{24} (sandhi form) ÷ g]^{33}-lɡi^{214}-ru^{24} (focus form). The focus form shows a prejunctural lengthening of [21] to [214], a type of prejunctural drawl or lengthening. Nevertheless, prejunctural stress would consistently have a lowering effect on all tones in declarative, focus-stressed, and non-anticipatory statements, and would consistently have a raising effect in question and anticipatory statements. Thus, it is rather unlikely for prejunctural stress to lower high tones and to raise low tones as Yue-Hashimoto proposes.

The most important consideration is that prejunctural effects would have the same effect — either raising or lowering, but not both — on any given tone or tone system. Therefore, this part of Yue-Hashimoto's theory lacks phonetic plausibility. Also, Yue-Hashimoto fails to explore other possible candidates for tone change, e.g., tonal assimilation, dissimilation, rapid speech phenomena, moraicity, etc.

Nonetheless, Yue-Hashimoto brings to light an interesting and unique sandhi phenomenon, which raises further questions and avenues of research. How did these flip-flops and reversals occur? Why were some tones neutralized, but not others? Did these changes occur by direct exchanges between tonal categories, or were intermediate stages involved? Could final lowering have caused high tones to lower, inducing low tones to undergo compensatory raising? Finally, Yue-Hashimoto's observations cover only some or a few cases of sandhi. However, her works does suggest larger avenues for exploration in the diachronic phonology of tone. Her work and the tonal data at large require larger and more powerful mechanisms of generating tonal changes and sandhi, something much more complex than mere register reversals. As a possible candidate I turn to the possibility of chain shifting.

Tone chain shifts.

For many sandhi paradigms, the bewildering complexity of the tonal changes, their lack of identifiable, logical patterns, and their great variation cross-dialectically suggests historical occurrences in the tonal systems of much greater complexity. A suitable candidate capable of generating such chaotic patterns, I propose, would be tonal chain shifting. I will try to present some evidence, mostly from northern dialects, to show that such a theory is at least plausible and deserving of further research. I will examine how this might be the case for northern dialects such as Guiyang, Sichuan, Lanzhou, Xining, Xi'an, Dunhuang, and Luoyang, all being Mandarin dialects except for the Jin dialect of Xi'an, and posit scenarios for how chain shifting processes might have occurred. In much of Guiyang and Sichuan (SW Mandarin, Guizhou and Sichuan provinces; Tu 1989), the II tone has the value [42], and III has the value [13], similar to other related dialects. When compared with other Mandarin dialects and the assumed historical values of the Middle Chinese tonal categories, this would seem to indicate a flip-flop between these categories. Something more like a chain shift is seen when we bring in Lanzhou dialect (Gansu province; Gao 1980), as shown in (9). The provinces of Sichuan, Guizhou, and Gansu lie in the western and southwestern parts of the Mandarin dialect area.

(9)

TC	Guiyang / Sichuan	S. Guiyang	Lanzhou
Ia	55	33	31
Ib	21	31	53
II	42	35	33
III	13	13	24

In this chain shift, Lanzhou tones apparently moved in the following manner: Ia > II, II > III, III > Ib, Ib > Ia; that is, Ia shifted its tonal value to II, II shifted its value to III, III shifted its value to Ib, Ib shifted its value to Ia (though not necessarily in that order). Comparison of these three dialects indicates that Ia has undergone lowering, as Guiyang Ia is [33]; if Lanzhou also lowered from an earlier *[55] to *[33], this might have triggered the chain shifting in Lanzhou (refer to diagram below). If that scenario is the case, the historically rising II of ancient Chinese must have been a low rising tone in proto-SW-Mandarin. Such a hypothetical scenario as above is sketched out in (10) below, and the Lanzhou scenario is sketched out in the acoustic space in (11); values are based on comparison with other Mandarin dialects (keeping in mind that these three are closely related to each other); hypothetical proto-values are given in italics.[20]

(10)

	GY / SCh	S. GY	LZh
Ia	55	**55* ÷ 33	**55* ÷ *33* ú 31
Ib	21	31	**31* ü 53
II	**24* ÷ *13* ú 42	35	**24* ú 33
III	**42* ü 13	**53* ÷ 13	**53* ü 24

(11) Lanzhou shifts

53_{III}		55_{Ia}	53_{Ib}
9		9	8
24_{III}	24_{II} 6 33_{II}	33_{Ia} 6 31_{Ia}	31_{Ib}

[20] Tone numerals 24 and 35 are notational variants of each other, as are [42]/[53], [21]/[31], and [13]/[24]. IIb and IIIb as distinct categories do not exist in most Mandarin dialects.

So according to the proposed scenario, we would have a push chain here to avoid tonal merger, whereas other dialects have allowed tonal mergers. One could construct similar scenarios for the other dialects. Whether such shifts involve disappearance of a tonal value from one tone category and re-emergence in another tonal category, or a more direct interchange, is a challenge for future investigation.

The simple tonal systems of other northern dialects also show some evidence of tonal shifts in the lexical tones. The following dialect data are from Coblin (1994), Sun (1961), Zhang (1980), and Mei (1991), with available sandhi values in boldface.

(10)

	<u>Xining</u>	<u>Dunhuang</u>	<u>Xi'an</u>	<u>Luoyang</u>
Ia	44	Ia-b merger	21 > **24**	33
Ib	24 > **21**	A 24	24 > **21**	31
II	53	42	42/53 > **21** A merger	53 > **31** A merger
III	213 > **53, 21**	44	45	412 > **41**

In Xining, the Ib tone has become rising, II has become high falling, and III has become a complex contour; how to account historically for the origin of complex contours is not so clear. III has both leftward and rightward sandhi, each with different values. In leftward sandhi it becomes [53] (213 ÷ 53 / 35, 213__) and [21] in rightward sandhi (213 ÷ 21 / __ œ TC). This [53] could be explained as a fossil of an earlier IIIa tonal value, which shifted to II and was also preserved in the III sandhi form after the [21] value of Ib shifted to III. The [21] value of III sandhi in Xining and Luoyang could be phonetically induced by phrase finality, especially in rightward Xinging sandhi patterns. Dunhuang has experienced a phonemic merger between 1a and 1b, with the single I tone becoming a rising tone; II has become falling; and III has acquired an even tone value. Xi'an shows a tonal flip-flop between Ia and Ib, which shows up in the sandhi forms. Tone value [21] apparently fell on Ib at one time, then traded position with Ia. II and III seem also to have flip-flopped with one another in their lexical tone values, but without sandhi processes as traces. In Loyang, the [31] tone value (corresponding to historical IIIb) apparently shifted to II, then later shifted to Ib and left behind its vestige in the sandhi, as II took on a falling value from III. One could speculate that III then became a complex contour [412], taking on a final rise or [h] to preserve the distinction between II and III, and left behind a trace of its earlier [hl] value in its sandhi form.

Penghu, a Southern Min dialect of the Penghu Islands of Taiwan, shows the following lexical and sandhi tone values (Kubler 1986):

(12)	TC	Ia	Ib	II	IIIa	IIIb	IVa	IVb
	lexical tone	44	24	42	11	22	21	4
	sandhi tone	22	11	24	42	11	42 /__§ 4 /__p,t,k	1

Here we see possible evidence for complex chain shifts in Min, which could explain the Min tone circle mystery, in which every tone not in phrase-final position surfaces in sandhi form and surfaces with its underlying form only in phrase-final position. Ib shifted from low even to rising, leaving its earlier trace in the sandhi [11]; IIIa shifted to low even, leaving its trace in the sandhi [42]; IVa left its earlier trace in its sandhi [4], with § possibly contributing to development of the other sandhi [42]; IVb shows its earlier trace in sandhi [1]. However, this scenario assumes that sandhi forms are diachronically older; for this hypothesis to work, we would then say that Ia was originally high even, shifted to low even, and then shifted back to high even, leaving [22] as its sandhi trace; and we would also say that II was originally rising, became falling, then rising again as it left its falling fossil in the sandhi. However, if we assume that the sandhi tones are the source of diachronic innovation, at least in this case, then it seems that sandhi introduces chain shifting to the system, and the base tones of (for example) Ia/b are consistent with the historical tone categories, and sandhi reverses the Ia/b registers as part of the chain shift.

Other historical examples.

Comparison of tonal values for Tianjin, Lianyungang (northern Jiangsu province) and Jinan (Shandong province) shows similarities and more possible evidence for chain shifting. Tianjin is apparently related to the other dialects 300-1000 km away, since Tianjin was settled historically via population movement from Anhui. Base tones and sandhi tones (after the arrows) are shown below:

(11)

	Tianjin	Lianyungang	Jinan
Ia	21 > 213	214 > 21	213 > 23
Ib	45	35 > 55	42 > 55
II	213 > 45	41 > 55	55 > 42
III	53 > 45, 21		21 > 23
IVa		55 > 22, 214	
IVb		24> 22, 55	

These data suggest some interesting possibilities. First, Ia and Ib seem to have undergone register reversal. Ia has become a trimoraic low concave tone, (a complex contour tone)[21] and Tianjin II has become a complex contour just as its Beijing counterpart II is [214]. Is the low falling or low falling-rising tone in Ia the historically earlier form? Was this tone at one time [hlh] and shortened to [hl], or was a [hl] lengthened to [hlh]? Was the lengthening or truncation due to phrasal phenomena, especially phrase-final phenomena such as stress or pitch downgrade? Jinan and Lianyungang have high tones in II, while Tianjin has a similar value in the sandhi form but [213] for the II base tone, similar to Beijing. Since population movements were involved in settling Tianjin, could a dialect substratum, borrowing, or areal influence have been at work in changing the Tianjin II base tone from [45] to [213], the earlier tone being preserved in sandhi? That is, could neighboring dialects like Beijing, or a dialect substratum, have caused this change and this sandhi value? The [45] tone in Tianjin Ib, II, and III base and sandhi tones could indicate some chain shifting; the [55] in Lianyungang and Jinan Ib and II could be evidence for the same shift, assuming [45] or [55] to be reflexes of the same high tone.

Ting's (1983) work on diachronic tonal innovations also sheds some light on the matter. Although his work deals with isolated tonal changes, rather than chain shifts or flip-flops, his findings show us how tones might have changed during such processes. First, he compares two closely related local Minnan dialects to show that the sandhi forms are diachronically older and

[21] [213] and [214] are notational variants.

closer to the proto-tones of the earlier language, while the base tones are innovations. He also focuses on tone category IV in checked syllables. IV tones were historically derived from checked syllables ending in *-p, -t, -k*, which in some dialects merged into *-k* or -§, and in some dialects the final consonants disappeared altogether. In these cases, the short IV tones tended to become long tones. He examines various Yunnan dialects (SW Mandarin) to argue that these IV tones became long and tonally similar or identical to other tones (tonal assimilation), in which case a merger would have taken place. Conversely, from an Wu dialect in Jiangsu province, he argues for the possibility of tonal dissimilation under similar circumstances. From comparative evidence in various Yunnan and related dialects, he also argues that falling-rising tones (e.g., [213]) were derived historically from rising tones, which took on an initial falling contour.

We have yet to consider what mechanisms could have induced the more complicated tone changes in the first place. Here I can only sketch out a few possible scenarios for the beginnings of flip-flops and chain shifts. Ting's paper raises the interesting possibilities that IV tone lengthening could have led to mergers via tonal assimilation, or to tonal dissimilation, and these changes could have set the more complicated changes like flip-flop or chain shifting in motion. Likewise, an initial falling contour on a rising tone as Ting proposes could have set the further changes in motion, but how a falling contour on a rising tone might come about to begin with is unclear, as Ting does not explain how this might happen. Moreover, phrase-final effects or other factors could have induced reversals and chain shifts via lowering or raising of tones. Such lowering or raising effects could then set off a chain shift in that another tone category would change its value to compensate for the lost tone value, or would change to differentiate itself from a new tone (polarization); these could then cause other tone categories to change in tone value. Once such changes are introduced by lexicalization of prejuncturally changed values or by chain shifting, sandhi in less prominent or otherwise unaffected positions could set in, thereby preserving the older tonal values.

But this begs an important question: While final lowering does exist in Chinese, is it sufficient, over time, to induce a pitch lowering significant and noticeable enough to actually cause changes in the tonal values? Is it strong enough to actually alter tonal values? Could stress itself, or other phrasal effects, be responsible? Or could segmental features have contributed to tonal changes, such as aspiration of initial consonants, consonant sonority, glottalization that still occurs in IV tones with final §, or voiceless stops in IV syllables?

Or most significantly, the MC register split could have introduced such complexity to the system, that reversals and chain shifts could have been touched off as a result. The system may have been overrich tonally, with phonetically similar tones. The pressure of tones so close together in the acoustic space could have forced mergers and/or chain shifts — probably push chains rather than pull chains (see Hock (1991) for further discussion of chain shifts). For example, let us suppose a hypothetical case to illustrate how chain shifting due to this and/or other factors might have occurred. For a hypothetical dialect, let us assume the following putative pre-split and post-split tonal values as given in (12). Before the split, a given category X has two allotonic values, which become phonemic after the split; IV are tones on syllables with a final stop consonant (C).

(12)	pre-split			post-split			
	I	55~33	,	Ia	55	Ib	33
	II	35~13		IIa	35	IIb	13
	III	53~31		IIIa	53	IIIb	31
	IV	5C~3C		IVa	5C	IVb	3C

Let us then suppose that Ib raises to a [35], and IIa changes to [33] to fill the gap and to remain distinct from Ib. IIIb becomes [313], and IIb becomes [33] to differentiate from [313] (polarization), and then merges with IIa. IVb becomes [31C] to fill the gap left by the change in IIIb, and to differentiate from the other [33] tone. As these various changes occurred in the base tones, the earlier historical values became fossilized in non-head positions as sandhi tones, hence a sandhi system develops.

Many such hypothetical scenarios could be imagined; which are more plausible ultimately depends on what factors are responsible for diachronic changes in tonal values. These conditioning factors, investigation of diachronic chain shifts, as well as synchronic chain shifts, all strongly merit further research.

Finally, one last question remains unaddressed. Were base tones the source of tonal innovations, or sandhi tones, or both? This may depend on which mechanism or mechanisms are responsible for inducing tone change. If it is a phrase-final effect such as final lowering, that would suggest a possible solution. Wu dialects are often left-headed, with base tones appearing in the heads, and sandhi tones in non-head position, including phrase-final position. Most other dialects, e.g., in the Mandarin and Min groups, are right-headed, with base tones in final head position and sandhi tones in syllables preceding non-head syllables. If phrase-final effects occur in left-headed dialects, then the innovations will be introduced through non-head tones. Base tones will tend to preserve older tonal values, and sandhi will be innovative. If phrase-final effects occur in right-headed dialects, then innovations will be introduced into the base tones, and non-head tones will preserve older values. Here sandhi tones will be preservatory and base tones innovative.

Historical domains.

One last area of historical interest is the development of tonal domains, which has been given very scant attention in the literature. Chen (1991) distinguishes between so-called *s-tone* and *w-tone* languages, that is, dialects in which tone sandhi domains correspond to two-syllable units (s-tone), and dialects in which tone sandhi domains correspond to larger units, such as polysyllabic compounds, and finally, to complete phrases. He describes this in terms of a cross-linguistic developmental tendency from s-tone languages such as Mandarin, to w-tone languages such as Suzhou and other Wu dialects in which tonal domains correspond to polysyllabic compounds. At the far end of the continuum stands Shanghai, which has developed from an s-tone language to a full-blown w-tone language in which all non-head tones are obliterated as head tones spread over an entire polysyllabic compound or phrase.

Mei (1991) describes the modern northern dialects of Luoyang and Xi'an, in which sandhi domains are limited to two syllables. This indicates that prosodic feet correspond to sandhi domains, and suggests a high ranking of Align-R (SD, Ft) for these dialects. Mei also cites philological evidence for 16th century standard Mandarin having the same bisyllabic restriction. Apparently, Mandarin has experienced a diachronic reranking of alignment constraints. Mei

(1991:462) provides the following general sketch of a developmental tonal typology:

(13) Stage 1: No tone sandhi which changes tone categories;
Example: Cantonese.

Stage 2: Tone sandhi limited to bisyllabic units;
Examples: Luoyang, Xi'an, 16th century Mandarin.

Stage 3: Tone sandhi applies obligatorily to bisyllabic units, and optionally to longer sequences; Example: modern Mandarin.

Stage 4: Tone sandhi applies to multi-syllabic words or phrases;
Example: Shanghai.

As Chen discusses, a transition to a w-tone stage (especially with accompanying neutralization) is advantageous in that it reduces the number of possible tone outputs from the many that are statistically possible to a smaller, more manageable number. In OT terms, it also satisfies the desire for articulator stability, that is, for the vocal organs to have to meet fewer articulatory targets in a given utterance. Thus, the alignment constraints will tend to rerank themselves in the direction of preferring alignment with successively larger domains over smaller domains — e.g., from an initial point where Align(SD, Ft) dominates to a point larger scope alignment constraints are dominant. The precise nature of historical progressions in tonal domains and rerankings of all the relevant alignment constraints merit further investigation.

These transitions raise a deeper question: What is driving the developmental tendency toward larger tonal domains? Is articulator stability really sufficient enough of a cause to be identified as the driving force behind these diachronic changes? To answer this question, I come back to prominence and prosody. Since sandhi seems to exist as a prosodic phenomenon, its prosodic nature would seem to be the driving force behind these diachronic realignments. For whatever reasons, albeit poorly understood, that first gave rise to sandhi in earlier stages of Chinese, it has since been taken over by the prosody, incorporated into the prosodic system, and developed as a means of marking prominence and demarcating prosodic boundaries. While it started out operating over smaller domains, it has shown a tendency to align with larger domains.

This is advantageous not only because it leads to a reduction in output forms and satisfies the principle of articulator stability, but also because sandhi then is used to mark larger and prosodically more significant domains. It is generally more desirable for a prosodic feature like tone or stress to mark a prosodically more important and larger unit such as a prosodic phrase or intonational phrase rather than a smaller unit such as a PWd or foot.

Therefore, the prosodic nature of sandhi can successfully account for its scope and its developmental tendencies since its inception. Its tendency to evolve from the so-called s-tone stage to w-tone stage corresponds fairly well to application of the OT articulator stability principle to sandhi systems, but its developmental tendencies follow ultimately from its prosodic nature. If this hypothesis about the prosodic nature of sandhi is correct, then we can expect to find that further historical research will turn up consistent patterns of development similar to those described above.

Conclusion.

Comparison of tonal values and tonal categories across the dialects lends credence to the view that tone reversals and chain shifts have taken place, where sandhi sometimes preserves diachronically older tonal values. While prejunctural phenomena may be part of the explanation, it cannot account for tonal changes in the way that it has been proposed. More complex forces such as chain shifting and regional inter-dialect influences, need to be investigated in much greater depth to explain historical tone changes and the development of sandhi. Much further diachronic investigation of Chinese tonal systems is required, especially of historical prosodic factors that might have triggered tone changes and tone sandhi. One kind of research that we seriously need is field work and analysis of tone systems in the dialects at various points in time to chart the evolution of tone systems and the nature of tone changes from empirical evidence. We have data of dialects from decades or many decades ago; many such places could be revisited, and as data is collected from multiple field works efforts over time, the diachronic data could provide insights into how tones and tone systems actually change over time. Such data could also yield insights about the developmental tendencies of tone, and perhaps confirm the above hypothesis which claims that sandhi tends to change in that it follows a historical progression from smaller to larger domains, and that this progression follows from the prosodic characteristics of sandhi.

More work in comparison and historical reconstruction of tonal systems is seriously needed, as is work in understanding how historical tonal relics might be encoded into the synchronic grammar; I will look at this problem and related issues in the next chapter.

Chapter 5
Tone and morphophonology

As shown, the standard approach runs into difficulties due to the lack of consistent phonetic or phonological patterns. Some cases point to tone sandhi as a historically innovative process in introducing neutralization of tonal categories in sandhi environments, and some cases hint at sandhi as an innovative process of assimilation. But while the problems of sandhi require fresh insights, new approaches, further synchronic investigation, and much further diachronic investigation, we must also reconsider the synchronic situation and characteristics of sandhi from a theoretical standpoint. Obviously, an average speaker of Chinese does not have an inventory of diachronic changes or previous historical stages of the language encoded in her/his brain, which s/he could draw from to produce sentences with tonal sandhi. We must ask what form of a synchronic reality sandhi takes on in the mind of the Chinese speaker — in the grammar of the Chinese L_1 speaker, and in the synchronic grammar of the various dialects. In other words, how is sandhi, especially the particular sandhi tonal values, encoded into the synchronic grammar? What kind of specific rules or constraints can explain the particular tone values in a given sandhi system?

I propose that morphophonology would be the best vehicle and optimal candidate for encoding this information into the grammar. This would at least seem plausible at first, given the apparent unpredictability of most sandhi values. Since no general cross-dialectal principle can be found to account for the particular tonal values, we can most likely discount phonology, phonetics, and certainly syntax as the grammatical domains responsible. We do not want to simply use morphophonology as the “dumping ground” for such kinds of unresolvable problems; rather, this seems to be the most logical level to consign a prosodic system with such unpredictability in its tonal values. Since sandhi is a prosodic system that is sensitive to various kinds of information and environments — morphological, lexical, syntactic — and interacts with the phonology, it would best be classified as morphophonological.

If morphophonology is the domain in which tonal values are set, then the scenario for the relationship between the synchronic grammar and diachronic grammar would be like this: Prosodic factors (as discussed in chapter four) bring about changes in the tonal values of words in particular tonal categories. The conditioning factors create new tones, and the new tonal values become encoded in the lexical information of the base tone words and hence become the new base tones. The older tone values are realized as sandhi tones that are inserted by morphophonological constraints. In this case, sandhi is preservatory. Or under different headedness conditions and/or conditioning prosodic factors, the conditioning factors impose new tonal values on the words. These new tonal values are encoded as morphophonological alignment constraints that impose innovative tonal values onto base tones. In this latter case, sandhi is an innovative process.

Beyond simple argument by default, outlined briefly above, I will present evidence that I believe points to morphophonology as the proper means of encoding sandhi into the grammar. I will present evidence from Chinese dialects for the morphophonological character and behavior of sandhi, first from tonal changes in derivational morphology, secondly, from sandhi in morphosyntactic patterns, and thirdly, from the existence of tonal categories. Based on this evidence, I theorize that sandhi patterns are morphophonologically stipulated.

Derivational tonal morphology.

I begin with tone in derivational morphology, a process documented in the literature on historical Chinese linguistics. The best documented examples of derivational tonal morphology are found in Yue dialects. Him (1977) shows that Cantonese has a number of pairs of words related in meaning and identical segmentally, but distinguished by different tones. Most often these are two words of different word classes with similar or identical meanings, with a tone change deriving nouns from verbs, verbs from nouns, adverbs from verbs, specialized meanings, and antonyms. These are relics of an earlier time in the language when derivation of new words by tonal change was a productive process. Some examples from Him (1977) and Chen (1991) are cited below; (1a) shows derivation of nouns from verbs, (1b) derivation of verbs from nouns, (1c) derivation of adverbs from verbs, (1d) derivation of specialized meanings, and (1e) derivation of antonyms.

(1)	a)	<u>segment</u>	<u>tone</u>	<u>gloss</u>	<u>tone</u>	<u>gloss</u>
		s]	[53]	*to comb*	[55]	*comb*
		tin	[33]	*to cushion*	[35]	*cushion*
		p]0	[22]	*to weigh*	[35]	*scale*
		jau	[11]	*to paint*	[35]	*oil, paint*
	b)	tsu0	[53]	*middle*	[44]	*to hit the target*
		ti:m	[35]	*a point, spot*	[35]	*to touch a point*
	c)	sa:m	[53]	*three*	[44]	*thrice*
	d)	hou	[35]	*good*	[44]	*to be fond of*
	e)	mai	[33]	*to sell*	[44]	*to buy*

The derived form in these words shows a higher tone, apparently either a [H, h] or a [H, lh] tone added to the end of the syllable. The derivation of the noun *jau*^{35} from *jau*^{11} requires the feature [H]. This works just like affixation of segmental morphemes, as Chen points out. At the stage of the language when this process was productive, the synchronic scenario would have looked like this: The derivational tonal morpheme imposes itself over the existing tonal structure, violating faithfulness to the underlying lexical tonal features. Thus, the derivational morphological rule might look like (2a), and the ranking like (2b):

(2) a) Align-R ([H, lh]$_m$, PWord)

b) Align-R ([H, lh]$_m$, PWord) o Max-IO[T], Dep-IO[T]

Later, the morphophonological constraints would have disappeared (or reranked so low in the grammar as to be inoperative) as the information became lexically encoded in the individual lexical items, and the process ceased to be productive. Similar derivational processes occurred in Mandarin, though modern day relics are fewer than in Cantonese. Some common Mandarin examples include are shown in (3). Mei (1991) also cites word pairs showing the same phenomenon in Thai derivational morphology[22], as in (4):

(3) Mandarin

zhong	[213]	*seed*	[53]	*to plant*
fen	[55]	*to divide*	[53]	*to share*
jia	[55]	*family, home*	[53]	*to marry a husband*
hao	[213]	*good*	[53]	*to be fond of*
jin	[55]	*eyes*	[53]	*lens*

(4) Thai

k~n	*to hold, carry (in the hand)*	kàn	*heft of a tool*
kháa	*to trade*	khàa	*price, value*
l~am	*to widen out, expand*	làam	*interpreter*

Wong (1982) provides further examples of derivational tone change in Cantonese verbal reduplication and diminutives. Verbs may be reduplicated to convey a sense of casualness, brevity, or limited action, with meanings of "to X a little, to X a while, to X once"; Li and Thompson (1981) refer to this as delimitative verbal aspect. In Cantonese, verbs may be reduplicated directly in X ÷ XX pattern, as shown in (5). In this case, the first morpheme changes to a high register rising tone [35] and the second syllable remains unchanged. However, if the verb already has a high register tone [55], [35], or [5], it remains unchanged, as shown in (6). Alternatively, verbs may be reduplicated by insertion of the morpheme *jat*^{5} "one", or the morpheme *a*^{55} (a particle with no meaning). In these cases, no tone changes occur, also shown in (5).

(5)

si^{33}	*to try*	÷	si^{35}-si^{33}	si^{33}-jat^{5}-si^{33}	si^{35}-a^{5}-si^{33}
lai^{21}	*to come*	÷	lai^{35}-lai^{21}	lai^{21}-jat^{5}-lai^{21}	lai^{21}-a^{5}-lai^{21}

[22] Mei (1991), citing Manomaivibool, Prapin. 1980. "Tonal derivation in Tai". *Computational Analyses of Asian and African languages* 13.165-172.

	sæ0^{23}	*to go up*	÷	sæ0^{35}-sæ0^{23}	sæ0^{23}-jat^{5}-sæ0^{23}	sæ0^{23}-a^{55}-sæ0^{23}
	gam^{22}	*to press*	÷	gam^{35}-gam^{22}	gam^{22}-jat^{5}-gam^{22}	gam^{22}-a^{55}-gam^{22}
	tsip^{3}	*to fold*	÷	tsip^{35}-tsip^{3}	tsip^{3}-jat^{5}-tsip^{3}	tsip^{3}-a^{55}-tsip^{3}
	kwat^{2}	*to dig*	÷	kwat^{35}-kwat^{2}	kwat^{2}-jat^{5}-kwat^{2}	kwat^{2}-a^{55}-kwat^{2}

(6)	t^{h}ɡ0^{55}	*to listen*	÷	t^{h}ɡ0^{55}-t^{h}ɡ0^{55}	t^{h}ɡ0^{55}-jat^{5}-t^{h}ɡ0^{55}	t^{h}ɡ0^{55}-a^{55}-t^{h}ɡ0^{55}
	sɪk^{5}	*to turn off*	÷	sɪk^{5}-sɪk^{5}	sɪk^{5}-jat^{5}-sɪk^{5}	sɪk^{5}-a^{55}-sɪk^{5}
	t^{h}ai^{35}	*to look*	÷	t^{h}ai^{35}-t^{h}ai^{35}	t^{h}ai^{35}-jat^{5}-t^{h}ai^{35}	t^{h}ai^{35}-a^{55}-t^{h}ai^{35}

Wong explains the inserted [35] as a tone derived from deletion of *jat*^{5}, which strands its tone upon deletion, causing the tone to attach itself to the preceding syllable. If the preceding syllable is already high, no tone change occurs, as it would be redundant. As further evidence for tone change from deletion of segmental material, she cites classifier reduplication, adjectival reduplication, and verb affixation. Noun classifiers can reduplicate with the pattern *jat*^{5}-CLASS-*jat*^{5}-CLASS, meaning "one by one". This construction can reduce to *jat*^{5}-CLASS-CLASS, with the stranded high tone from the second *jat*^{5} attaching to the preceding classifier. No tone change occurs if the classifier is already a high tone. Adjectives can reduplicate to derive an intensive meaning, either with the with the form ADJ-*jat*^{5}-ADJ, or with the direct ADJ-ADJ reduplication form. For the latter, a changed tone shows up on the first syllable, due to tone stranding after deleting *jat*^{5}.

Wong also presents two additional cases of tonal affixation on verbs. The perfective aspect suffix *ts]*^{35} and the preposition *hai*^{35} "at, on, in" coalesce with the verb by deleting their segmental material imposing their tonal material on the verb as a tonal affixes. A few examples appear in (7) and (8)[23]. As before, this tonal affix does not override existing high register tones.

(7)	høy^{33} ts]^{35} lak^{3}	~	høy^{35} lak^{3}	*has gone*
	lai^{21} ts]^{35} lak^{3}	~	lai^{35} lak^{3}	*has come*
	tsai^{55} ts]^{35} lak^{3}	~	tsai^{55} lak^{3}	*has put*

[23] The morpheme *lak*^{5} is a sentence final particle for changes of state; *sy*^{33} means 'here'.

(8)	fan^{33} hai^{35} sy^{33}	~	fan^{35} sy^{33}	*sleep here*
	ma:i^{21} hai^{35} sy^{33}	~	ma:i^{35} sy^{33}	*bury here*
	tsɪk^{5} hai^{35} sy^{33}	~	tsɪk^{5} sy^{33}	*accumulate here*

A possible constraint ranking for the above reduplication and affixation paradigms might be:

(9) Max/Dep-IO[H] o Align ([H, lh]$_{m}$, PWord) o Max/Dep-IO[T]

such that faithfulness to the high register feature dominates the morphological constraint for aligning the tonal morpheme with the adjacent word, which in turn dominates faithfulness to the general tonal features of the lexical item. This ranking obtains as a result of the need to retain morphological information while deleting the inserted morpheme. This retention of information is accomplished by deleting the morpheme's segmental material, retaining the tonal material as an affix, and imposing it on the adjacent word.

While the above data show synchronic derivation of tonal change, Wong (1982) describes other cases of derivational tone change brought about diachronically. The Yue dialect in Bobai (Guangxi province) has two subdialects, one of which preserves older features of relevance here, the other showing morphological innovation. The "older" dialect contains a diminutive suffix /-...in^{25}/, a cognate of the Mandarin diminutive /-•^{35}/. In the "newer" dialect, this suffix is absent, and the diminutive noun instead has a changed tone from losing its own tone and taking on the diminutive tone. (10a) shows old Bobai, with the noun stem undergoing further sandhi after affixation of the diminutive; (10b) shows the innovative forms

(10a) <u>"old" Bobai</u>

kae^{44}	*chicken*	kae^{32} ...in^{25}	*chick*
ia0^{23}	*sheep*	ia0^{21} ...in^{25}	*little sheep*

(10b) <u>"new" Bobai</u>

meo^{44}	*cat*	meo^{25}	*kitten*
0ao^{23}	*cow*	0ao^{25}	*calf*

In Cantonese, nouns may similarly take on a [35] tone, which serves as a diminutive suffix that totally replaces the lexical tone. This derives historically from the same diminutive suffix, which was originally /-jin^{55}/; it is very rare in modern Cantonese, and its diminutive function has been replaced by the derived tonal suffix. Other nouns are formed with the derivational suffix /-tsi^{35}/, used to form bisyllabic nouns from monosyllabic morphemes. Some nouns delete the suffix and affix the tone over the tone of the noun stem. The two suffixes are shown in (11) and (12), respectively.

(11)	kao^{33}	*dog*	÷	kao^{35}	*puppy*
	jat^{5} jan^{22}	*a while*	÷	jat^{5} jan^{35}	*a little while*
(12)	mui^{21} tsi^{35}		~	mui^{35}	*plum*
	jat^{2} tsi^{35}		~	jat^{35}	*day, special day*

In similar fashion, Taishan dialect (Yue dialect, Guangdong province) adds [5] as a tonal morpheme to lexical tones [22], [21], [33] (but not to [55], perhaps due to an OCP constraint). This tonal suffix performs morphological derivations such as deriving nouns from verbs. Wong (1982) discusses these and similar examples of derivational tones in Yue dialects. The Yue dialect of Rongxian also has diminutives in the [35] tone (Ballard 1988).

The above examples from Cantonese, Bobai, other Yue dialects, and Thai all show that tonal changes can result from diachronic and synchronic changes which leave tonal material behind, and that these tones can function as morphemes that induce tone changes. The directionality of these tonal changes, i.e., whether by prefixation or suffixation, and whether to the preceding or following syllable, is also morphologically conditioned. Given all these facts, the next logical step would be to extend the concept of tonal morphology to broader areas and roles. Next I will look at tonality in the morphosyntax.

Tonal morphosyntax.

Good evidence for sandhi being a morphological process exists across the Chinese dialects, in derivational morphology and in different sandhi patterns for different syntactic and morphological paradigms. In some dialects, different tonal patterns obtain for different morphosyntactic categories or constructions, i.e., sandhi patterns are morphosyntactically conditioned. The best examples come from Wu dialects, and others from Min.

Changzhi shows morphologically conditioned sandhi. Below in (13) is the Chángzhì tonal system (Jin dialect, Shanxi province) and sandhi patterns for tonal categories I, II, III in (14) from Hou (1983) and Duanmu (1994), with sandhi values in boldface.

(11)	TC:	Ia	Ib	II	IIIa	IIIb	IVa	IVb
		213	24	535	44	53	4	54

(12)	F_1	F_2:	213	24	535	44	53
	213		213-**53**	213-24	**35-53**	213-**53**	213-53
	24		24**-53**	24-24	**35-53**	24-**53**	24-53
	535		535-213	535-24	**35-53**	535-**53**	535-53
	44		44-213	44-24	**35-53**	**53**-44	**53-**53
	53		53-213	53-24	**35-53**	53-44	53-53

Curiously, however, in reduplication a different set of sandhi patterns emerges:

(13)			
	213 + 213	÷	213-**35**
	24 + 24	÷	24-**53**
	535 + 535	÷	535-**35**
	44 + 44	÷	**21-53**
	53 + 53	÷	**35**-53

Of course, no consistent phonological pattern obtains, except for neutralization in II general sandhi, and certainly none that would account for differing general and reduplicative sandhi. Thus, general sandhi and reduplicative sandhi have differing tonal values that cannot be determined by straightforward phonetic or phonological principles, yet their occurrence is conditioned by the morphological context. This would point to morphophonological specification for Changzhi sandhi. This being the case, then historical investigation would probably turn up different prosodic environments in general and reduplicative contexts that led to different tonal developments and different sandhi patterns.

Some dialects such as Wuyi (Wu dialect, Zhejiang province) has different sets of sandhi patterns for verb plus object phrases than for other types of phrases (V + Obj. phrase forms a single prosodic phrase and domain). Lexical tones are given in (14) and sandhi patterns in (15).

(14)	TC:	Ia	Ib	IIa	IIb	IIIa	IIIb	IVa	IVb
		24	213	55	13	53	31	5	212

(15)	TC	general	verb + obj.
	Ia + Ia	24-53	55-24
	Ib + Ia	213-53	55-24
	Ia + Ib	24-53	55-213
	Ib + Ib	213-31	55-213
	Ia + IIIa	24-53	55-53
	Ib + IIIa	213-53	55-53
	Ia + IIIb	24-53	55-31
	Ib + IIIb	213-31	55-31

The distribution of sandhi according to morphosyntactic categories in Changzhi and Wuyi points to sandhi being a morphological phenomenon first, and secondarily phonological. For sandhi to have different morphological and syntactic paradigms requires sandhi to be a morphological process, albeit poorly understood as of yet.

Chongming (Wu dialect, Shanghai province) shows a similar differentiation between sandhi in general phrases and verb plus complement phrases, and yet a third slightly different sandhi pattern for number plus noun classifier phrases. Danyang (Wu; Zhejiang) shows a general sandhi pattern, and different and complex sandhi patterns for numerals and numeral plus classifier phrases; also, phrases with a monomorphemic adverb plus a verb or adjective may or may not undergo sandhi. Shaoxing also has different sandhi patterns for numerals, numeral phrases, noun classifiers, reduplicated classifiers, and reduplicated verb phrases, besides the general sandhi pattern. Yongkang (Wu; Zhejiang) has sandhi patterns for diminutives different from the general sandhi patterns. Zhoushan (Wu; Ballard 1988) has irregular sandhi patterns in certain modifier + noun combinations. Wenzhou (Wu; Ballard 1988) has special sandhi forms for exhortatives and vocatives, and another special pattern for diminutives.

The Mandarin dialect of Xiuning (Ballard 1988) shows a different sandhi pattern for diminutives besides the general sandhi paradigm. The Minbei dialect of Xianyou has a different tone sandhi paradigm for adjective reduplication, and Putian (Minbei) has separate sandhi patterns for reduplicated and triplicated adjectives (Ballard 1988).

The Minnan dialect of Chaoyang (Ballard 1988) shows a most curious pattern of both rightward and leftward sandhi patterns. The sandhi patterns and their directionality is syntactically conditioned. Resultative verbal complements and numeral phrases exhibit leftward sandhi, while noun phrases, verb phrases, pronouns, and certain noun classifiers show rightward sandhi. Such a system would require morphological specification of sandhi tones and directionality.

Special sandhi patterns for certain high frequency words in Mandarin also supports the idea that sandhi is morphologically determined. For example, the negative particle bu^{53} ‘not’ normally surfaces with [53], but before another syllable with a [53] tone, it becomes [35]. The numeral yi^{55} ‘one’ only surfaces with [55] in counting; it becomes [35] before [53] and the neutral tone, and [53] before other tones. Since only a few isolated function words are involved, rather than any entire grammatical categories, and since numerals with even tones do not behave in such a manner, these cases of sandhi and their irregular tonal values would be best considered lexically specified.

Finally, one last possible piece of evidence for sandhi as a morphological entity comes from my Taiwanese data from chapter three. While focus stress can create new tonal domains in the phrasal phonology, as Cheng (1968) notes, in Min, or at least in Taiwanese, it cannot force a word-internal break and realignment in the tonal domains. Thus, a trisyllabic compound such as *lig-tao-t*^{h}*qO* (‘sweet green bean soup’) cannot have word-internal focus stress forcing a break in tonal domains, so that [lig-tao-t^{h}qO] is the only possible phrasing, not *[lig-tao]# [t^{h}qO].

The irregularity and unpredictability of sandhi in the evidence presented in this section points to morphological specification, as does the parameterization of sandhi patterns to morphological and syntactic categories. This morphological and syntactic parameterization requires much further historical investigation into its causes. Explanations lie most likely in differing prosodic environments of different types of morphosyntactic and prosodic phrases and domains which induced varying tone changes and sandhi processes. Thus, historical prosody as a possible causal factor should be looked into for future research.

Tonal morphophonology.

The above examples show sandhi values conditioned by differing morphosyntactic environments. Some sandhi values appear in general sandhi, while other values appear in particular kinds of words or phrases. Yet in all cases, the sandhi values cannot be generated by a particular phonetic factor, phonological rule, or even a syntactic rule; the sandhi values are not predictable. To posit a syntactic rule imposing new tonal material would be implausible and certainly unprecedented, and syntactic rules would fail to account for the effects of sandhi in different types of prosodic and morphosyntactic domains. The apparent irregularity and unpredictability of sandhi values in many of the above examples, and the different environments that condition sandhi values, point more strongly to morphophonological specification of sandhi values. To this I would also add a few more considerations.

First, each tonal category in a given Chinese dialect has its own paradigm of base and sandhi tone values. Tonal categories would best be viewed as lexical categories. Mandarin words like • 'disgusting', *wß* 'five', *d|* 'to beat', *w4* 'I', *zh0* 'paper' etc. bear no grammatical or semantic relation to one another, but are grouped into the Ia tonal category because they all have the same falling-rising tone, and they all undergo the same sandhi change in non-head position. Since an entire lexical category is affected by the same tone change rule, it seems that morphophonology would be the best part of the grammar to assign the specification of tonal values. Likewise in Bantu, words for 'woman', 'house', 'iguana' etc. have few or no inherent semantic or grammatical differences for which they would be placed into different noun classes (besides some human/ animate/ inanimate distinctions, which do not always apply consistently), but are distinguished by the segmental morphemes assigned to these words and their corresponding adjectives. Just as morphology or morphophonology assigns segmental morphemes to Bantu noun classes (and sometimes different tonal behavior), so does morphophonology assign tonal material to Chinese lexical classes in certain combinations and environments.

Another probable argument for tonal morphophonology in sandhi is the problem of directionality. Some dialects have right-aligned sandhi, some have left-aligned sandhi, and a few have both (mixed directionality). The first two types are generated by a predominance of left-headed and right-headed alignment constraints, respectively, in the constraint hierarchy. In the case of mixed alignment, sandhi domains may correspond to morphosyntactic phrases, as in Wuyi, or to strictly prosodic phrases, as in Tianjin. Tianjin sandhi is generally right-headed, i.e., applies leftward in traditional terminology. However, in trisyllabic or larger domains, e.g., in trisyllabic compounds, some tonal combinations realize a rightward application of sandhi, while other combinations realize a leftward application. Since previous attempts at accounting for Tianjin trisyllabic sandhi and bidirectionality have not been very successful (see chapter two), and since the patterns do not submit to clear, predictable rules, I find it best to resolve this problem by appealing to morphophonological constraints that impose and align different sandhi values upon base syllables, each with its own specific tonal material and specified alignment. Later in this chapter, I will sketch out how this might work for Tianjin.

My proposal, then, consists of morphophonological constraints not much unlike those already put forth in the OT literature for reduplication, infixation, and similar prosodic phenomena. In the various works of McCarthy and Prince, these are captured by morphophonological constraints that prescribe the scope of a reduplicant (e.g., RED=F, RED= : :), alignment of infixes and reduplicants, and the segmental material of infix morphemes. If we extend the concepts to Chinese tone sandhi, we end up with morphophonological constraints that define the sandhi tonal material that is imposed upon a syllable, its prosodic or morphosyntactic alignment (hence, directionality), and the tonal category that it aligns with. From this it follows that these constraints are parameterized to specific tones or tonal categories, just as other constraints proposed in the OT literature which are parameterized to specific morphological paradigms. Alignment and parameterization of these constraints, and their predominance in the grammar, are conditioned by historical prosodic and tonal changes. Appealing to morphophonology would seem to be the most optimal way to account for the historical origins of sandhi (whatever they may be) and how such a historically derived paradigm (particularly the particular tonal values of the sandhi system in a given dialect) could be encoded into the synchronic grammar of a language. This would all be handled in a correspondence theoretic approach, which raises the question of whether deletion of lexical tones in favor of sandhi tones is always deletion and replacement in toto, or if partial deletion and replacement occurs. Since a dialect could have multiple morphophonological sandhi constraints, each possibly in a different relative ranking to the faithfulness constraints, this theory would predict a multiplicity of patterns in the grammars of real languages. This is what in fact seems to obtain in the Chinese dialects — dialects with sandhi affecting only one tone or tonal category, or with sandhi affecting all or almost all tones, or a given tone undergoing sandhi in all non-head positions, or a given tone changing only in certain combinations, and even some head tones undergoing sandhi. The following abbreviatory constraints and ranking would generate a system in which all non-head tones undergo sandhi. The alignment constraint here abbreviates for all the sandhi constraints in the grammar, which align the tone sandhi (TS) values with their respective domains.

(17) HeadMax[T] o Align(TS, domain) o Max-IO[T], Dep-IO[T]

The above constraints and ranking stipulates a sandhi morpheme and alignment of the tone sandhi morpheme (TS) with the relevant domain, be it syllable, phonological word, prosodic phrase, or syntactic phrase. These dominate constraints on faithfulness to underlying tonal material, i.e., lexical tones or base tones. Head tones are preserved and non-head tones change. Such a schema would generate full deletion and substitution by sandhi tonomorphemes.

In the next section I will show how the hypotheses that I have presented here might work out in an optimality theoretic analysis of the Tianjin sandhi system, a dialect whose tonal system has previously eluded attempts at purely synchronic phonological analyses.

Tianjin revisited.

Tianjin sandhi defies satisfactory analysis due to the problems of cyclicity and dual directionality in trisyllabic sandhi, as discussed in chapter two. To accomplish this in a monostratal optimality analysis, I turn to a recent proposal by Odden (1996) for output-output correspondence[24]. This output-output (O/O) correspondence theory relates an output that is

[24]This proposal does requires more explication and theoretical elaboration, especially as it would apply to tonality. Nonetheless, Odden's output-output correspondence differs from other O/O approaches in that Odden's approach and the approach here represent a monostratal, noncyclical approach within the original spirit of OT, as

dependent on another output for faithfulness and identity. Both outputs can be generated and evaluated together in parallel, rather than generating and evaluating the first output and feeding the results into the second input to produce the second output. The second output stands in a dependency relation with the first, not in a procedural relation. Both outputs are evaluated according to their correspondence with one another, i.e., the elements of the second output are evaluated according to how faithfully they correspond to the elements of the first output, on which they depend. This evaluation is by an Identity constraint from Prince & McCarthy (1995); in addition, there are Max and Dep constraints for output-output correspondence. Predictably, these are ranked low in Tianjin. The first output, the base, is the bisyllabic sandhi pattern. The second output, the dependent, is the trisyllabic or phrasal sandhi pattern. The grammar evaluates the possible outputs for the dependent by comparing it to its base and evaluating both together in parallel.

Thus, we have the following O/O constraints in Tianjin for the base (first output, a bisyllabic sandhi phrase) and dependent (second output, a trisyllabic sandhi phrase):

(18) Ident-OO[T]: tone between base and dependent are identical.
Max-OO[T]: parse base tone features into dependent.
Dep-OO[T]: do not insert tone features into dependent.
Head-Max[T]: heads are faithful to tonal material.

We also must appeal to alignment constraints for syllables, and for directionality in phrasal sandhi. As in Mandarin, we would have constraints to align sandhi domains with feet and larger units, we will see below how this works in Tianjin. Since specific constraints are parameterized, the particular sandhi tone values depend on the particular context — the particular syllables which sandhi is connecting. We have the following general alignment constraint patterns in (19) and constraint rankings in (20), with the specific constraints to be presented shortly. Basic alignment (BA) handles local sandhi by aligning tones with syllables, and wider scope alignment constraints are responsible for larger domains like compounds and phrases.

(19) BA: Align (TS, F): basic alignment of tone sandhi value(s) with syllable

opposed to the O/O proposals of Kenstowicz, Chen, and others, which use a cyclical, bistratal OT.

Align-L/R (TS, PWord): left/right alignment of sandhi value(s) with phonological word

Align-L/R (TS, PP): left/right alignment of sandhi value(s) with prosodic phrase

(20) Head-Max[T] o Align (TS, PP), Align (TS, PWord) o B-Align (TS, F), Ident-OO[T], Max-OO[T], Dep-OO[T] o Max-IO[T], Dep-IO[T]

Head-Max dominates sandhi constraints (the morphophonological "process" of inserting sandhi tones), so no head tones undergo sandhi. Head-Max[T] is undominated in Tianjin, as in most or all northern dialects, so it will be omitted from most OT tables here for the sake of convenience from some of the OT tables below. For Wu dialects with some head tones undergoing sandhi, the relative ranking of Head-Max[T] would be more significant. For bisyllabic sandhi, the evaluation is straightforward as for Mandarin. Chao numerals will be used for convenience. Relevant constraints are shown below for Tianjin, in which candidate #a is selected as the optimal candidate and therefore as the output, for best satisfying the constraint hierarchy.

(21)

. 21-21	Head-Max[T]	B-Align (TS)	Max-IO[T]	Dep-IO[T]
L a. 213-21			*	*
b. 21-21		*!		
c. 21-213	*!		*	*
d. 213-213	*!		**	**

Candidate #a wins for application of sandhi and alignment, at the expense of faithfulness constraints; #b satisfies faithfulness constraints, but fails for failing to apply sandhi; #c and #d both fail for violation of Head-Max[T]. Let us now consider why this form surfaces as [213-21], rather than [45-21] or [53-21]. Since particular sandhi values correspond to particular tonal categories, we invoke parameterized alignment constraints. For this sandhi pattern, the basic alignment constraint would be as (22), which aligns the sandhi value with the [21] tone, i.e., tonal category Ia. In its evaluation in (23), #a is selected as the optimal output for satisfying the parameterized morphophonological constraints.

(22) Align (TS_{Ia} , F): basic alignment of [213] with syllable of category Ia (in Ia + Ia sequence)

(23)

. 21-21	Head-Max[T]	Align (TS_{Ia})	Max-IO[T]	Dep-IO[T]
L a. 213-21			*	*
b. 45-21		*!	*	*
c. 53-21	*!		*	*
d. 213-213	*!		*	*

Candidate #a wins for satisfying both Head-Max[T] and the proper alignment constraint for the given tonal category. Candidates #b and #c fail to satisfy the sandhi constraint for this tonal category and for this particular combination — the wrong kind of sandhi surfaces, i.e., incorrect sandhi tone values surface. The last one, #d, fails again for crucial violation of Head-Max[T], as Head-Max is ranked above all the sandhi alignment constraints. Thus, the high ranking of Head-Max in this grammar prevents all head tones from changing, even though they belong to the sandhi domain: $(213\text{-}21)_{TS}$ cf. $*(213\text{-}213)_{TS}$.

Some of the above constraints will be called upon for trisyllabic and phrasal sandhi. By way of illustration, the evaluation for sandhi pattern #1 for trisyllabic compounds in chapter two (example 8a: FFL ÷ LHL, or [53-53-21] ÷ [21-45-21]) is shown below. The pair of candidates in #a, the bisyllabic and trisyllabic output forms, turn out as the winners in the candidate evaluation. The trisyllabic forms is termed the dependent, because its form and evaluation depends on its output-output faithfulness to its bisyllabic counterpart; it is evaluated according to how well it corresponds to the alignment constraints, as well as according to how well it corresponds to the bisyllabic form.

(24)

▪ 53-53 ▪ 53-53-21	Align-L (TS, PWord)	Ident-O/O	Max-O/O	Dep-O/O	B-Align (TS)	Max-IO	Dep-IO
L a) 21-53 L 21-45-21		 *	 *	 *	 *	* **	* **
b) 45-21 53-45-21	 *!	 *	 *	 *	 *	* *	* *
c) 21-53 21-53-21	 *!				 *	* *	* *
d) 53-53 53-53-21	 **!				* **		

The dependent in #a is the optimal output, because both have their respective sandhi tones, and the dependent is properly aligned, though O/O faithfulness constraints are violated. With correct L-alignment of sandhi with the phonological word (PWord), the correct directionality obtains: 53-53-21 ÷ (21-53)-21 ÷ 21-(45-21) ÷ 21-45-21. That is, the first leftmost syllable undergoes sandhi from [53] to [21] due to the higher ranking L-alignment constraint, then the middle syllable undergoes sandhi from [53] to [45] due to B-alignment in the context of [53-21]. In #b, incorrect alignment is followed, leading to a false output in the dependent: 53-53-21 ÷ 53-(45-21) ÷ *53-45-21. In #c, the dependent identifies faithfully with its base, but fails to show its own sandhi, thus crucially violating alignment constraints. In #d, both fail for lack of any sandhi.

Thus, we end up with directionality determined by wide-scope alignment constraints and their dominance over basic alignment constraints. These wide-scope alignments extend the initial or final sandhi pattern (depending on the particular sandhi environment) over the entire phrase or compound, thus dominating the other basic aligned sandhi domains which also occur in the phrase or compound. We also end up with overlapping sandhi domains. Here the compound level domain extends over the adjacent basic aligned domain:

(25) · 21 $[45\text{-}21]_{TS\text{-}F}$ $_{TS\text{-}PWord}$ ·

This would violate a putative constraint against overlapping domains, the likes of which has been invoked in previous OT domains research such as in Cassimjee (1994).

For the leftward sandhi pattern in Tianjin, sandhi pattern 3 of chapter two, the same ranking and evaluation applies, but with the Align-R morphological constraint below. Thus, the form with apparent leftward directionality is selected as the favorite candidate — candidate #a.

(26)

· 53-53 · 53-53-53	Align-R (TS, PWord)	Ident-O/O	Max-O/O	Dep-O/O	B-Align (TS)	Max-IO	Dep-IO
L a) 21-53 L 45-21-53		 *	 *	 *	 *	* **	* **
b) 21-53 21-21-53	 *!				 *	* *	* *

Those in #a are optimal as outputs because both undergo their respective sandhi, and the dependent follows the correct morphologically specified sandhi alignment: 53-53-53 ÷ 53-(21-53) ÷ (45-21)-53 ÷ 45-21-53. This happens at the expense of O/O faithfulness between dependent and base. Those in #b are rejected because of misalignment, hence, incorrect directionality: 53-53-53 ÷ (21-53)-53 ÷ 21-(21-53) ÷ *21-21-53.

Also, we want to briefly see how Align (TS, PP) works in Tianjin. This constraint will confine sandhi to its sandhi domain and thus keep sandhi from applying outside the prosodic phrase, and it will extend sandhi to the whole phrasal domain, just as in Mandarin or any other language where it enjoys equivalent status in the constraint hierarchy. A brief example of this constraint applied to Tianjin data from Hung (1989) shows that it dominates the Sandhi morphological constraint.

(27)	a. [Wo chi] [ji dan]	*input*: “I eat eggs.”	
	213 - 21 - 21- 53		
	b. [213-21] [21-53]	**T** Align (TS, PP),	*Sandhi
	c. *[213-213] [21-53]	*Align (TS, PP),	**T** Sandhi
	d. *[45-213] [21-53]	**Align (TS, PP),	**T** Sandhi

(27b) is the correct output, because sandhi cannot go across prosodic phrase boundaries. (27c) fails because sandhi reaches across a boundary, and (27d) fails for reaching across a boundary twice.

In Tianjin and many other dialects, Head-Max[T] dominates Sandhi. However, in some Wu dialects as mentioned previously, some head tones do undergo sandhi, while some do not. This suggests that for such a dialect, more than one sandhi tonomorphological constraint is at work, with one more ranked above Head-Max[T] to generate those instances of head tones undergoing sandhi, and the other morphological constraints ranked below Head-Max[T] for the majority of cases where head tones do not change. While such cases require further analysis, such a constraint ranking might look something like this:

(28) Sandhi_1 o Head-Max[T] o Sandhi_2 , Sandhi_3 ...

I have shown that a two-level cyclic analysis is unnecessary, since an output-output and base-dependent identity version of correspondence theory (and violation of O/O constraints) can account for apparent multiple, cyclic application of sandhi in phrasal or multisyllabic sandhi. The above analysis successfully accounts for the problematic cases of sandhi in Tianjin. This account does so without resorting to multi-tier optimality theory or derivational phonology, but rather by incorporating insights from alignment theory and tonal morphology. This allows an accounting for sandhi that is more powerful, more satisfactory, and simpler than previously available.

Chapter 6

Prosody and Final Considerations

In the course of this work, I have presented evidence suggesting fresh approaches to the tone sandhi problem, and I have put forth some new ideas involving prosody, morphology, and output-output correspondence. I have also shown how a tonal morphological approach and O/O correspondence might work in an optimality theoretic analysis of Tianjin. In this chapter I would like to show that grammaticalization would seem to be more fruitful an approach for some cases, especially the Minnan tone circle. Then I will push the concept of prosody further in my analysis of sandhi for a more explanatory account of sandhi and tonality. I will also discuss broader theoretical issues raised by the approach taken in this paper, such as the implications for constraint based phonology, the ultimate purpose of sandhi in the grammar, the mechanisms behind it, and areas for future investigation.

Prosody.

In this thesis, I have tried to deduce the mechanisms operative behind sandhi among Chinese dialects in general. While much of the research in Chinese tone and sandhi has largely been purely descriptive, some have tried to uncover, albeit not so successfully, the mechanisms behind it. However, one issue that has gone egregiously unaddressed in the literature is the broader question of what ultimately is the function of sandhi in the grammar, i.e., what is the purpose behind sandhi. To my knowledge, no linguists have tried to address or even ask this ultimate question. For example, Silverman's (1997) work on tone sandhi in Comalpetec Chinantec (a Uto-Aztecan language in Mexico) provides an insightful and compelling analysis of how sandhi in this language results from phonetic factors and economy of effort competing with pattern coherence and contrast maintenance of phonological targets can account for sandhi. His points are well-taken, but deeper questions remain to be asked, namely: Why do these competing forces result in sandhi in this particular language, but not so in others? Why does this particular form of sandhi result, and not other possible sandhi patterns? And most importantly, why does sandhi exist in this language? What ultimate purpose does it serve in the grammar? I will consider a few hypothetical possibilities for some of these questions, and put forth my own suggestions.

We can discount assimilation and dissimilation, for only a small subset of the tonal data lends itself to this type of analysis. One might suggest phonological and/or morphological reduction or preservation of tonal categories, but again, this only accounts for a small number of cases. Another hypothesis could be that sandhi arose by means of phonetic factors and spread from word-internal to word-external domains by means of analogical spread, akin to how segmental sandhi of voicing features spread in Slavic (see Hock 1991). Similarly, sandhi could have originated phonetically and became grammaticalized into the structure of Chinese. However, both explanations are of little help here. While such hypotheses are true for some cases, and some dialects lend themselves well to such explanations, they cannot provide a general, comprehensive explanation for sandhi and its real purpose in the grammar. I believe that these are valid, but are only the mechanisms of a greater linguistic force at work in the grammar.

One might also claim that since sandhi is highly variable across the dialects, its function could also be varied, having different purposes in different dialects (a language-specific multi-function theory). This might seem intuitively plausible at first, and certainly theoretically possible, but I find this unsatisfactory. Tone sandhi is a regional phenomenon common to Chinese and East Asian languages, but apparently rare outside this sphere. It would be preferable to find one general unified explanation that can account for all sandhi phenomena and relate sandhi to other forms of prosody. Also, such a claim of language-specific multi-functionality would ignore important similarities among the different tonal systems, and the fact that the differences can now be accounted for by the different constraints and constraint rankings in OT.

To answer the ultimate question of sandhi, I believe we must first look at the purpose of tonal systems in East Asian languages. Duanmu (1995a) argues that tonal domains are metrical domains, just as stress systems. It follows from this that tonal systems are metrical systems just like stress systems in other languages. While there is disagreement about the existence and nature of stress in Chinese, stress is apparently much less prominent in Chinese. I posit that tonal systems perform essentially the same role as stress systems, i.e., marking prominent elements, phrasal boundaries, and providing a rhythm to the speech stream. Stress can be rightward or leftward, trochaic or iambic; likewise, tone can be rightward or leftward, trochaic or iambic, depending on the dialect. Tone and stress mark prosodically prominent elements, focused elements, and both consist of head and non-head structures. The function and behavior of tone and stress is similar, though more empirical research is needed to prove that they have identical functions and behaviors in tone languages and stress languages.

Tonal prominence in sandhi seems to work much like stress prominence in stress based systems such as English and other stress languages. Lexical stress exists alongside phrasal stress such that the phrasal stress is the most prominent in the phrase, while other syllables with lexical stress carry less prominence acoustically. Unstressed syllables are greatly downgraded through vowel reduction and other means. Thus, the phrasal stress is made prosodically dominant (either by acoustically downgrading the lexical stress, or by upgrading the phrasal stress). Yet phrasal or lexical stress can be overridden by focus stress, so focus stress dominates other types of stress. Likewise in sandhi systems, non-head tones are dominated by the head tones, i.e., the head tones are realized with maximal prosodic prominence by being fully faithful to underlying tonal features. Non-head tones are realized as prosodically weak by being unfaithful to tonal features, as lexical tones are overridden by sandhi tones in non-prominent position for the sake of phrasal prosody. And some dialects subordinate phrase head prominence to focus stress in that focus stress forces new tonal domains. Hence, sandhi is the tonal analog of reduction in stress systems.

Since sandhi involves downgrading as an analog of syllable reduction in stress systems, this suggests that dominance of phrasal stress over lexical stress could involve downgrading of lexical stress rather than upgrading of phrasal stress, but this requires further investigation. At least this suggests that downgrading would be the preferred or less marked pattern for achieving prominence.

Another parallel between tone sandhi systems and stress systems can be seen in clitics.

Clitics in stress based languages like English undergo maximum reduction in terms of stress and segmental features that are allowed in a given language, and also often attach themselves to a preceding morphological or phonological word. Likewise in Chinese, clitics undergo the maximum reduction allowed for a given dialect. In some dialects such as Mandarin, this full reduction is accomplished by tonelessness. The common clitics of Mandarin have no tone whatsoever — the nominal suffix *-zi;* the nominal suffix *-tou* in some varieties; the verbal aspect markers *-zhe, -le, -guo, -yi-;* the proclitic conjunction *yi-;* the sentence final particles *ma, le, la, ne, ba, a;* and most reduplicant suffixes as in *ji•-jie* "older sister". Just as we can distinguish different levels of prosodic strength in stress systems — phrasal stress, lexical stress; full prominence (primary stress), secondary stress, reduced, and maximally reduced (clitics) — we can also distinguish different levels of prosodic strength in tonal systems — head tones and non-head tones; full prominence (tonal faithfulness), reduced (sandhi tones), and maximally reduced (clitics).

From all this it follows that sandhi functions as a part of the metrical system. Tonal domains generally correspond to sandhi domains, especially in dialects with complex sandhi systems. Tonal domains are marked by a head with unchanged tones, and non-head syllables in sandhi tones. At places in non-head positions where no sandhi occurs (e.g., in a dialect with few sandhi patterns like Mandarin), tonal domains then align with foot structures or morphosyntactic boundaries. Like tonal systems in general, sandhi can be rightward or leftward. Thus, sandhi distinguishes prominent and non-prominent syllables, heads and non-heads, much like a stress system. Prominence or non-prominence is cued by the tone appearing in base or sandhi forms. Sandhi is often the means by which the tonal system divides up phonological or morphosyntactic phrases, marks phrasal boundaries, and realizes focus stress. Yip (1996) describes the workings of tone spreading in Shanghai, with the point that head syllables are most faithful to their underlying tonal material, while non-head syllables are least faithful. Tone spreading and regular sandhi systems, then, work in the same way, so that tone spreading, sandhi, and Chinese tone systems in general work as metrical systems just as stress systems.

Since sandhi functions as a prosodic system, its domains of operation are primarily prosodic. In some dialects it may be more or less sensitive to lexical, syntactic, or morphological information, given the possible various constraint rankings. In Minnan, for example, sandhi domains are often sensitive to syntactic information, but Min sandhi is nonetheless prosodic, and Min sandhi domains are primarily prosodic. Although some of the alignment constraints involve alignment with syntactic or morphosyntactic domains, the dominant alignment constraints are morphophonological. Since this morphophonological level of the grammar ultimately serves prosodic purposes, sandhi then is a part of the prosody and metrical structure. To my knowledge, no language or dialect exists in which tone is purely conditioned by syntax or morphology, and if this generalization is indeed the case, it would follow from the prosodic and metrical purpose behind sandhi.

Yip (1996) proposes a stress-to-tone principle (STP), which stipulates that heads must bear tones. This proposal is based on the weight-to-stress principle (WSP) in OT, which constrains syllable weight to stress prominence. If we appeal to WTP to allow for tonal reduction, this might explain why a trimoraic tone like the Mandarin [213] reduces in non-head position, especially before another [213]. While such cases are rare, it would serve as one example of reduction via sandhi to bring about non-head non-prominence. For other dialects, the interplay of faithfulness, head faithfulness, alignment, and other constraints with tonomorphological constraints can account for sandhi. The upshot of all this is the need to motivate the historical factors responsible for tonal changes and sandhi, and their preservation in the tonal morphology, in light of the metrical role of sandhi and tonality.

From these insights we can formulate a prosodic continuum of metrical systems that can effectively capture the similarities and differences among the various metrical types (as shown below): tone systems, sandhi tonal systems, pitch accent systems, and stress systems. Realization of prominence and non-prominence is a function of all these systems, but what differs is the particular phonological or phonetic expression of prominence and reduction in these systems.

(2)	STRESS systems:	marked by duration, amplitude, pitch; lexically specified stress interacting with phrasal and focus stress
	PITCH-ACCENT systems:	marked by pitch; lexically and/or phrasally determined
	SIMPLE TONE systems:	marked by tones; lexically and/or phrasally determined;

	prosodic strength and weakness marked by tone spreading and/or deletion
TONE SANDHI systems:	marked by tones; lexically determined; prominence marked by Lex-T faithfulness; prosodic weakness marked by Lex-T unfaithfulness

In the simple continuum sketched out above, the STRESS category covers languages like English with a pure stress system in which stress is realized by some form of vocal prominence. The PITCH-ACCENT categories covers languages like Japanese in which accentual stress is marked by pitch prominence, and the accent may be lexically and/or phrasally determined, or an interaction thereof. Pitch accent systems have characteristics of both stress and tone systems. The SIMPLE TONE category covers languages like Shanghai Chinese, which does not have true tone sandhi in the sense of tonal change, but rather deletion of non-prominent tones and spreading of tones from the head position onto non-prominent positions. Another example would be Huichol, a Uto-Aztecan language of west central Mexico in Grimes (1959). In this tone language, lexical tones are deleted in favor of phrase final intonational effects. Finally, the TONE SANDHI category characterizes most Chinese dialects. While Mandarin possesses a weak tone sandhi system with relatively few sandhi phenomena and therefore closer to the simple tone system, many dialects, especially southern dialects, possess richer and much more developed sandhi systems. This spectrum provides a convenient typology for characterizing the various metrical systems found in the world's languages. It may also be convenient to typologize metrical systems according to size and type of metrical domains found cross-linguistically: prosodic feet, morphological or phonological words (as in some African tonal languages), XP's, compounds, larger prosodic phrases, or S-level phrases.

Final considerations and theoretical issues.

I have appealed to optimality theory to the exclusion of derivational phonology. I believe that an OT approach can better capture the insights from prosodic and morphosyntactic approaches put forth in this paper. OT can provide more comprehensive and general insights into the forces that participate in and motivate not only sandhi, but metricality in general. OT also provides more powerful tools for analyzing tonal phenomena, all the complexities involved, and the interface among the different levels of the grammar involved in sandhi and metricality. Of course, these constraints and interactions have many details yet to be worked out. In taking the type of approach espoused here and demonstrated above, we can then combine insights from different levels of the grammar: constraint based phonology, tonal morphophonology, and morphosyntax. This is a logical extension of steps currently being taken in optimality theory. OT allows mixing prosodic morphology and phonology in the constraint interaction, as described in various works of McCarthy and Prince (1993, 1995). Other OT practitioners have gone further in detailing phonological plus morphological constraint interactions, and phonological plus syntactic constraint interactions (e.g., Yip 1995b). The mixing of levels that I practice here provides the more powerful analytical mechanism needed to adequately account for sandhi in a constraint based grammar.

Moreover, sandhi could be one means of verifying or falsifying optimality theory; since it is a very complex phenomenon, it would serve as a good test for the theory. If we ultimately cannot account for sandhi, even after applying all the tools at our disposal in OT, even the mixed level approach advocated here, then we could question whether OT needs an overhaul or reconsideration. If we can ultimately account for sandhi well using this approach, we will have found convincing empirical validation for OT. One should keep in mind, however, that I don't claim that we can explain away everything by magically invoking morphophonology, and then go home. The complexities of tonomorphological, alignment, prosodic, phonetic, tonophonetic, and syntactic constraint interactions still need to be fleshed out in detail.

As regards specific tone values, the reasons for their precise phonetic values underlyingly and their synchronically and diachronically changed forms still remain somewhat intractable and still do not submit well to accurate analysis and predictability, but my hope is that this work and subsequent work into tone based on the findings in this paper can bring some answers to bear upon the difficulties of accounting for tonal values. One other consideration to keep in mind concerns constraint parameterization. While OT is based on universal constraints which should exist in the grammar of every language, no matter how lowly ranked, we must question whether language-specific parameterization poses problems for the OT theorem of universal constraints. Some of my proposed analyses have appealed to constraint parameterization, just as other works in OT (such as Cassimjee 1994) have appealed to constrain parameterization to account for effects specific to morphological paradigms.

Finally, the patterning seen in the Minnan tonal circle raises another issue for theoretical phonology. Cross-linguistically, we see different patternings among particular groups of lexical, phonological, morphological, and other features. We see Chinese dialects with patternings between particular tones or tonal categories (which are apparently lexical categories). In Korean, we see the patterning between so-called light vowels and dark vowels; some have tried to account for this with language-specific rules or constraint rankings involving segmentals, albeit with difficulty. Also, in Germanic languages, we find vowel patterns in the verbal ablaut system. What might be beneficial would be a unified explanation that can satisfyingly account for all these cross-linguistic patterning phenomena within the rubric of OT, so that we could arrive at a more universal account of phenomena that pattern grammatical or phonological categories together in seemingly arbitrary ways. We should at least ascertain whether the fact that such different and varied patternings are merely by coincidence — an epiphenomenon of different constraint rankings, with the constraints involved in one language being unrelated to those involved in another language — or whether they are to be accounted for by a universal set of principles, constraints, or constrain rankings. Can OT, or a particular application of OT principles, account not only for grammaticalization, but also for these patterning phenomena, in a unified, consistent way?

Lastly, we have seen that sandhi is probably prosodically driven, though it may be sensitive to different kinds of information — morphological contexts, syntax, particular lexical items (such as the irregular numerals and negatives in Mandarin). The unifying factor that brings all these forces together is prosody, the driving force behind sandhi and the factor that primarily determines tonal domains.

Conclusion.

In this work I have shown the inadequacy of traditional approaches to tone sandhi, namely, the limitations of appealing to purely synchronic phonetic or phonological factors in accounting for sandhi, and the limitations of neutralization as a productive factor. I have sketched out the domains over which sandhi can apply to set up my subsequent analysis. I have presented evidence which I believe points to the importance of historical and comparative work in discovering the processes behind sandhi and its historical development. I have then tried to make the jump from its diachronic origins to its synchronic reality and its working in the synchronic grammar through tonal morphology. I have presented evidence for morphophonological behavior and morphosyntactic roles of sandhi in the grammar, and from the data, I have argued for a morphophonological explanation behind sandhi in the grammar. I have shown how this works out in my monostratal analysis of Tianjin, bringing insights from this thesis and recent work in optimality theory to bear on my analysis. Finally, I have asked the basic questions of why sandhi exists and what ultimately motivates it. Very few have tried to ask such questions, unfortunately, but at least I have tried to raise them and sketch out the beginnings of an answer to these issues.

In light of these data and proposals, much more research remains, and new issues require exploration. The ideas put forth here also require validation and working out in much greater detail. The metrical functions of sandhi awaits empirical verification, especially psycholinguistically. In the past, few have tried to reconstruct historical tonal values and developments, though Ballard (1988) did put forth his reconstruction of proto-Wu tones. Most have dismissed the task as too daunting and hopeless. However, today more powerful tools lie at our disposal for historical reconstructive work, from optimality theory, and from a combined approach of mixing morphosyntax, tonomorphology, phonetics, and phonology, which OT allows us. We can begin applying these tools to the task of tonal reconstruction.

As mentioned previously, further research into the details of constraint interactions for various dialects is required, as is more investigation into the nature and exact terms of the tonal morphological constraints, and how exactly the particular historical processes correspond to the morphological constraints and constraint rankings of the synchronic grammar. From this it should be possible to verify or falsify the approach suggested and argued for in this thesis.

Finally, a unified account of tone remains as the next task. African tonal systems and East Asian tonal systems have been traditionally regarded as totally different, and beyond explanation within a single, unified theoretical rubric. Not only is a unified theoretical account of Chinese tonality necessary, but one of East Asian tonal languages. Also, the historical and synchronic instantiation of African tonal systems and their nature requires deeper understanding, with the goal of comparing their morphological and phonological natures with those of East Asian tonal systems (and of other tone languages in the world). Then hopefully a unified, comprehensive account of tonal systems can be arrived at.

In this work, I have tried to present new and original ideas on the problems of tone sandhi. It is my hope that these ideas will provide viable alternatives to previous accounts. Most of all, it is my hope that this work will spark new discussion and research of tone systems on a deeper level of analysis.

Appendix:

Tonal Values Across Chinese Dialects

The following is a list of tonal values for various Chinese dialects. The data are organized according to major dialect groups and tonal categories. Base tone values are given, and where available, sandhi values are also given, but without conditioning tonal contexts. The arrow ">" indicates sandhi values. For some dialects the data are incomplete, such as those marked by asterisks. Many dialects have only one tone in a given tonal category X (instead of Xa and Xb), in which case by default it is placed in Xa rather than in Xb, unless it is reported as Xb in the data. Parentheses indicate tones that are on the surface identical with that of another tonal category, but is differentiated in sandhi, usually of the pattern Xa > t_a, (Xb) > t_b. Slashes indicated phonetic or subdialectal variants. Data for sandhi tonal values in Wu have been simplified or omitted below, due to the great complexity of sandhi patterns in many of these dialects.

Sources for the data are: **Mandarin:** Ballard 1988, Chen 1987, Coblin 1994, Gao 1980, He 1984, Mei 1991, Sun 1961, Tu 1989, Yue-Hashimoto 1986, Zhang 1980. **Jin:** Hou 1980, Hou 1983. **Gan:** Ballard 1988, Yang. **Xiang:** Ballard 1988. **Hakka:** Ballard 1988, Huang 1989, Yue-Hashimoto 1986. **Yue:** Ballard 1988, Wong 1982. **Minbei (Northern Min):** Ballard 1988. **Minnan (Southern Min):** Ballard 1988, Kubler 1986, Sung 1996, Yan 1996, Yue-Hashimoto 1986. **Wu:** Ballard 1988, Shen.

Mandarin

	Mandarin/ Beijing	Tianjin	Lanzhou	Xining	Dunhuang	Xi'an	Sichuan/ Guiyang
Ia	55	21 > 213	31	44		21 > 24	55
Ib	35	45	53	24 > 21	24	24 > 21	21
IIa	213	213 > 45	33	53	42	42/53 > 21	42
IIb							
IIIa	53	53 > 45, 21	24	213 > 53, 21	44	45	13
IIIb							

Man-darin	southern Guiyang	Loyang	Shandong Anqiu	Henan Lingbao*	Hubei Daye*	Hubei Macheng*	Jiangsu Lianyungang
Ia	33	33	24 > 31	31 > 35	31 > 35	313 > 11, 33	214 > 21
Ib	31	31	53 > 24	35	313 > 11	42	35 > 55
IIa	35	53 > 31	55				41 > 55
IIb							
IIIa	13	412 > 41	31				
IIIb							
IVa							55 > 22, 214
IVb							24 > 22, 55

Man-darin	Shiqiao	Donggongqi	Jinan	Anhui Xiuning
Ia	312 > 24, 21	213 > 24, 21	213 > 23	33 > 13
Ib	55 > 41	55 > 41	42 > 55	(33) > 55
IIa	35/44 > 55, 41	35 > 41, 55	55 > 42	31 > 13
IIb				13
IIIa			21 > 23	55 > 13
IIIb	41 > 21	41 > 21		(55) > 33
IVa	24 > 21	24 > 21		212 > 35
IVb				35

Jin

	Pingyao	Changzhi
Ia	13 > 31	213
Ib	(13) > 31, 35	24
IIa	53 > 35	535
IIb		
IIIa	35 > 13, 35, 31	44
IIIb	(35) > 35	53
IVa	13 > 31, 35	4
IVb	53 > 35	54

Hakka

	Changting	Minxi (Chengguan)	Chong-qiantang	Meixian	Xingning	Da
Ia	33 > 21	33	23	55	44	55
Ib	24 > 44	24	11	11	11	11
IIa	42 > 21, 213	42	32	31	31	31
IIb						
IIIa	54 > 55	54	53	53	53	31
IIIb	21 > 42, 33	21				
IVa			3	1	1	1
IVb			5	5	5	5

Hakka	Jiao	Pingyuan	Feng	Huiyang	Jin	Yongding	Luzhou
Ia	55	35	55	44	45	44	55
Ib	11	11	13	11	11	11	213
IIa	31	31	53	31	31	53	21
IIb							
IIIa	53	55	31	53	55	33	51
IIIb							
IVa	1	1	1	1	1	1	1
IVb	5	5	5	5	5	5	5

Hakka	Hexian	Youxian	Taoyuan	Hailu Taoyuoan*	Miaoli*	?	Meinong	Raoping*
Ia	35	35	24	53 > 4		45	24	21
Ib	13	12	11	55 > 21, 33		13	11	33 > 5
IIa	31	21	31			31	42	
IIb								
IIIa	53	53	54			53	55	
IIIb								
IVa	3	1	2		2 > 3, 5	2	32	31 > 45
IVb	5	5	5		5 > 2	5	5	45 > 31

Gan

	Hunan Leiyang	Xinyu	Taixin	Yushan	Lianzhou	Guixi	Nankang	Qiannan
Ia	55	44	42	33	42	22	35	33
Ib	35 > 55	31	13	535	24	24	11	31
IIa	41	13	35	55	35	35	42	53
IIb								
IIIa	213 > 21, 55	53	53	51	53	53	53	55
IIIb		24	11	22	11	51	24	22
IVa		23	55	55	32	55	32	32
IVb		55	22	23	55	23	55	55

Gan	Nanchang	Xinjian	Xiushui	Jing'an	Tonggu	Douchang	Yugan	Nancheng
Ia	31	31	44	33	33	33	33	31
Ib	24	35	313	11	44	55	31	55
IIa	313	13	53	313	35	53	53	42
IIb								
IIIa	35	24	55	35	55	35	24	22
IIIb	11	22	33	22	42	11	13	35
IVa	55	44	33	23	32	55	55	55
IVb								

Gan	Nanfeng	Xingguo	Dayu	Ningdou	Huichang	Longnan	Xunwu	Dingnan
Ia	42	44	42	42	24	44	24	24
Ib	33	31	31	24	53	31	42	31
IIa	53	13	13	535	11	53	31	42
IIb								
IIIa	55	11	11	313	31	33	55	53
IIIb	13	24	24	32				
IVa	55	11	11	55	32	21	11	22
IVb					55	23	34	55

Gan	Anyuan	Poyang	Yudou	Gao'an	Shangyou	Guangfeng	Shicheng	Yichun
Ia	24	33	31	24	44	44	53	35
Ib	13	35	44	13	31	33	13	33
IIa	11	31	35	53	53	55	42	31
IIb								
IIIa	31	24	13	42	13	11		13
IIIb	55	11	42	22	22		22	
IVa	23	55	55	55	55	55	32	32
IVb						23	44	

Gan	Yifeng	Wanzai	Ruijin	Chongyi	Wan'an	Ganxian	Xinfeng
Ia	42	33	24	24	24	33	33
Ib	35	42	11	22	313	31	13
IIa	22	313	31	53	42	53	53
IIb							
IIIa	51	53	53	11	53	313	24
IIIb							
IVa	44	55	55	55	55	55	55
IVb							

Gan	Shangrao	Laijiang	Yongxin	Hukou	Pingxiang	Leping
Ia	42	33	24	31	33	42
Ib	22	55	313	33	55	55
IIa	53	42	53	42	35	24
IIb						
IIIa	35	51	55	55	11	
IIIb		13	33	24		13
IVa	55					
IVb						

Xiang

Only a brief description of one Xiang dialect is available. In Dongkou, a Xiang dialect in which "'all second syllables in disyllabic combinations bear a low falling tone,' with the first syllable showing no change." Ballard (1988:196), citing Yue-Hashimoto (1987:455) [25]

Minbei

	Pucheng	Shaowu	Taishun	Shunchang
Ia	35 > 53	21	35 > 44	44
Ib	24 > 31	22	33	11 > 35
IIa	55	55 > 52	55	31
IIb	54	213		43 > 31
IIIa	12		21 > 55	35 > 44
IIIb	11	35	31	53 > 35
IVa	43	52	5	
IVb			5	5

[25] Yue-Hashimoto. 1987. "Tone sandhi across Chinese dialects." In *Wang Li Memorial Volumes*, the Chinese Language Society of Hong Kong. ec. pp. 445-474.

Minbei	Fuzhou	Xianyou	Putian
Ia	55 > 33, 42	55 > 33, 24	53 > 13, 11, 33
Ib	51 > 11, 33, 55	24 > 33, 55, 41	13 > 11, 33, 55, 42
IIa	33 > 24, 45	33 > 24	453 > 11, 13, 35
IIb			
IIIa	11 > 55, 33, 42	41 > 33	42 > 55
IIIb	242 > 55, 33, 42	21 > 33, 55, 41	11 > 13, 55, 42
IVa	13 > 55, 33, 42, 24, 45	32 > 54	21 > 4
IVb	45 > 11, 33	54 > 312	35 > 11, 13, 42 (col.) 4 > 21, 4, 42 (lit.)

In Fuzhou, glottal stops disappear in sandhi tones. Putian IV base tones and sandhi tones differ in the colloquial and literary varieties.

Minnan

	Xiamen (Amoy)	Jinjiang	Longxi	Chaoyang	Jieyang
Ia	44 > 33	44	42 > 33	33 > 11	44 > 33
Ib	24 > 44	24 > 11	313 > 33	55 > 11	55 > 11
IIa	53 > 55	55 > 35	53 > 35	42 > 31	42 > 35
IIb		33 > 11		313 > 33, 11	13 > 11
IIIa	11 > 51	31 > 55	31 > 41	31 > 55	313 > 51
IIIb	33 > 11	31 > 11	33 > 11	11 > 33	33 > 11
IVa	32 > 4, 53	53 > 5, 53	32 > 4, 53	11 > 55	31 > 4
IVb	4 > 1	35 > 1	13 > 1	55 > 11	4 > 11

Minnan	Chao'an	Zhangping	Zhangpu	Zhangzhou #1	Zhangzhou #2
Ia	33	24 > 35, 55	55 >33	24 > 33	55 > 33
Ib	55 > 213	22 > 33, 55	213 > 33	313 > 33	213 > 33
IIa	53 > 21, 24	31 > 21	53 > 55	53 > 35	53 > 55
IIb	35 > 21				
IIIa	213 > 42, 53	21 > 33, 55	21 > 53	41 > 31	21 > 53
IIIb	11 > 12	53 > 21	33 > 21	33 > 11	33 > 21
IVa	21 > 3/4	55 > 33	32 > 4, 53	21 > 44	32 > 4/53
IVb	4 > 21	53 > 21	13 > 11	11 > 23	13 > 11

Min-nan	Anxi	Taiwanese	TW Penghu	Taibei*	TW Yilan*	TW Taizhong*
Ia	44 > 33	55 > 33	44 > 22			
Ib	35 > 11	24 > 21/33	24 > 11			
IIa	53 > 35, 55	53 > 55	42 > 24			
IIb						
IIIa	11 > 21, 53	21 > 53	11 > 42	11 > 51	21 > 43/44	21 > 42
IIIb	33 > 11	33 > 21	22 > 11	33 > 11	33 > 21	33 > 21, 45
IVa	53	21 > 53	21 > 42, 4	32 > 4, 53	22 > 55/43	21 > 42
IVb	35 > 21	53 > 21	4 > 1	4 > 11	55 > 21/23	3 > 21, 45

Wu

	Yongkang	Wenzhou	Qingyan	Luoyang	Tintai	Pingyang
Ia	44	33	35	313	22	44
Ib	22	31	52	41	212	21
IIa	35	35	33	54	325	54
IIb	13	24	22	31	214	35
IIIa	52	42	12	24	55	32
IIIb	241/ 24	11	41	33	23	22
IVa		313	5	5	5	24
IVb		212	3	32	23	213

Wu	Chongming	Shanghai*	Suzhou	Wuxi
Ia	55 > 33, 3, 53	53	44 > 21, 35	52 > 313
Ib	24 > 33, 3, 53		23 > 331, 21, 24	213 > 131
IIa	24		52 > 41, 513, 35	313 > 34
IIb	435 > 42, 33, 3			131 > 313
IIIa	241 > 31, 24, 241, 3, 33	35	412 > 44, 513, 21	34 > 452
IIIb	213 > 31, 24, 22, 2	13	31 > 24, 21, 331, 412	213
IVa	55 > 24, 31	55	44 > 4, 21	53 > 313, 452, 213
IVb	23 > 55	13	23 > 21	13 > 313, 213

*Some dialects such as Shanghai do not have true sandhi in the sense of changed tones, but rather have tone spreading.

Wu	Haiyan	Hangzhou	Shaoxing†	Zhenhai	Ningbo	Zhoushan	Wuyi
Ia	54	334	51	441	53	53	24
Ib	31	23	231	241	35	22	213
IIa	434	53	335	324	424	34	55
IIb	242		113	213	313	23	13
IIIa	25	45	33	441	33	44	53
IIIb	213	113	11	213	213	13	31
IVa	5	5	45	5	55	5	5
IVb	2	23	12	24	34	12	212

†For sandhi values in Shaoxing, refer to the charts in chapters one and two.

Wu	Changzhou	Wujiang Songling	Wujiang Wenling	Danyang
Ia	44 > 33, 55, 22, 23	33	33	33 > 42, 55, 11
Ib	13 > 11, 33, 22, 55	13	31 > 51	24 > 42, 55, 11
IIa	55 > 53, 35, 32, 22	51	42	55 > 3, 2/42, 55, 11
IIb		31	(42) > 31	24 > 1, 11, 55, 24
IIIa	523 > 55, 32, 22, 42	412	55	24 > 3, 2/42, 55, 11
IIIb	24 > 32, 35, 442	212	13	11 > 1, 55, 24
IVa	55 > 33, 23, 22	55	55	3 > 3, 2/42, 5, 24
IVb	23 > 33, 22, 55	22	11	4 > 1, 11, 5, 24

Yue

	Zhengcheng	Rongxian	Cantonese (Guangodng	Taishan
Ia	55 > 45	55 > 33	53 > 55	33
Ib	11 > 51, 45	31	21	22 > 225
IIa	35 > 51	33	35	55
IIb	13 > 51	13	23	21
IIIa	33 > 35	22/ 32	33	33 > 335
IIIb	22 > 35	11	22	52 > 325
IVa	5 >45	5	5	55
IVa2	3 > 35	3	3	33
IVb	2 > 35	1	2	53
IVb2				31 > 315

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abbreviations:

BIHP	Bulletin of the Institute of History and Philology
BSOAS	Bulletin of the School of Oriental and African Studies
FY	Fangyan
JCL	Journal of Chinese Linguistics.

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