THE PROSODY-SYNTAX INTERACTION IN THE "YI-BU-QI-BA" RULE:

A MORPHOLOGICALLY CONDITIONED TONE CHANGE IN MANDARIN CHINESE

C.-M. Bonnie Wang

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Approved by:

Katya Pertsova

Jennifer L. Smith

Randall Hendrick

ABSTRACT

C.-M. Bonnie Wang: The Prosody-Syntax Interaction in
the "yi-bu-qi-ba" Rule: A Morpheme Specific
Tone Change in Mandarin Chinese
(Under the direction of Katya Pertsova)

This thesis investigates the prosody-syntax interaction in morpheme specific tone change, presents a systematic comparison between tone Sandhi and tone change, and proposes a new rule-based analysis for the Mandarin "*yi-bu-qi-ba*" rule.

The empirical data is the comparison between Mandarin 3rd Tone Sandhi (3TS) of numeral morpheme *wu* ('five') and *yi* ('one') tone change (YTC). Data shows that syntax and prosody do not function the same way in predicting 3TS and YTC. The basic domain of 3TS is a foot whereas the domain of YTC is a phonological word (pword).

This thesis also contributes a new analysis for the "*yi-bu-qi-ba*" rule, with three major claims:

(1) YTC only applies when *yi* is the first element of a pword except in the string of digits.

(2) BTC only applies when *bu* is the first element of a pword.

(3) No tone change rule applies to *qi* and *ba* any more.

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TABLE OF CONTENTS

LIST OF TABLES …….ix

LIST OF FIGURES ……....x

LIST OF ABBREVIATIONS…….xi

CHAPTER 1 MOPHOLOGICALLY CONDITIONED TONE CHANGE…….. 1

Introduction……..1

Section 1.1 Tone Change vs. Tone Sandhi……...1

Section 1.2 The Mandarin *yi-bu-qi-ba* Rule…….2

1.2.1 *Yi* -Overview……...2

1.2.2 *Bu* -Overview……..4

1.2.3 *Qi* & *Ba*……...6

CHAPTER 2 3TS (3^{RD} TONE SANDHI) VS. YTC (*YI* TONE CHANGE) ……..7

Introduction……..7

Section 2.1 Mandarin 3^{rd} Tone Sandhi…….7

Section 2.2 Comparison between 3TS and YTC……10

2.2.1 Systematic Comparison……...…..……...10

Similarities……...…..……10

Differences……...…..……11

2.2.2 The Data: *yi* vs. *wu*……14

CHAPTER 3 PROSODY AND SYNTAX IN MANDARIN CHINESE …….19

Introduction……....19

Section 3.1 The Prosodic Hierarchy……...19

Section 3.2 The Prosodic and Syntactic Structures in Mandarin Chinese…….20

3.2.1 The Syllable……..20

3.2.2 The Foot and Foot Formation Rule……...21

3.2.2.1 The Minimal and Maximal Foot……21

3.2.2.2 The Foot Formation Rule (FFR)……....22

3.2.3 The Phonological Word (PW) and PW Formation Rule……..23

3.2.3.1 The ALIGN Constraints and Cliticization ……24

3.2.3.2 The PW Formation Rule.....26

3.2.4 The Prosody-syntax Mapping…….....27

CHAPTER 4 PAST ANALYSIS ……..30

Introduction……...…30

Section 4.1 Chang's (1992) Analysis……..…30

Section 4.2 Limitations……...32

CHAPTER 5 NEW ANALYSIS ……..34

Introduction……....34

Section 5.1 General Claims and the Hypotheses……...34

Section 5.2 The New Analysis: A Rule-based Approach……..34

5.2.1 YTC Rule Application.....36

5.2.2 BTC Rule Application.....45

CHAPTER 6 CONCLUSION ……..47

Section 6.1 Summary of *yi* and *bu*…….47

Section 6.2 The Historical Change of *qi* and *ba*……47

APPENDIX: DATA IN CHINESE……...49

REFERENCES……..51

LIST OF TABLES

Table

1.1 Mandarin Tone Inventory.....2

1.2 The Tone Alternation of *yi*.....3

1.3 The Tone Alternation of *bu*.....5

2.1 3TS- Sensitivity to Syntactic Bracketing.....9

2.2 Similarity between 3TS and YTC in Morpho-syntax.....10

2.3 The Role of Syntactic Bracketing in 3TS and YTC.....12

2.4 3TS and YTC between Two Syntactic Binary Branches.....13

2.5 Differences between 3TS and YTC.....14

2.6 Comparison between *yi* and *wu*.....16

2.7 Comparison between *yi* and *wu* Cont'd 17

LIST OF FIGURES

Figure 3.1 The Prosodic Hierarchy.....20

Figure 3.2 Foot Structure in MC.....21

Figure 3.3 PW Formation based on $ALIGN_2$.....25

Figure 4.1 Chang's (1992, p.169) data of the "*yi-bu-qi-ba*" rule.....31

Figure 4.2 Chang's (1992, p.170) analysis of "*yi-bu-qi-ba*" tonal alternations.....32

LIST OF ABBREVIATIONS

3TS	3rd Tone Sandhi in Mandarin Chinese
YTC	*yi* Tone Change in Mandarin Chinese
NumP	Numeral Phrase
CL	Classifier
OD	Ordinal Marker
MC	Mandarin Chinese
Pword	Phonological word or prosodic word
PhP	Phonological phrase
ComplexNum	A type of pword with the structure of complex numeral expression
Num-CL	A type of pword with the structure “Numeral-Classifier”
OD-Num-CL	A type of pword with the structure “Ordinal prefix-Numeral-Classifier”

CHAPTER 1: MOPHOLOGICALLY CONDITIONED TONE CHANGE

Introduction

In this Chapter, I will start by introducing the key term of my thesis project: morphologically conditioned tone change. In Mandarin Chinese there is one specific phenomenon, known as the "*yi-bu-qi*-ba" rule, in which four morphemes undergo a series of peculiar tone changes that are different from typical Mandarin tone Sandhi. I will briefly explain the tone change rules of these four morphemes and explain how *yi* is the most complicated case, thus making it the focus of this project.

1.1 Tone Sandhi vs. Tone Change

In tonal systems, tone Sandhi refers to a type of tonal modification triggered by phonological conditions. Tone modification can also be affected by morphological conditions. Chen (2000) defined the term "tone change" as "morphologically conditioned tonal modification," to distinguish it from tone Sandhi. The case discussed in this thesis, the Mandarin "*yi-bu-qi-ba*" rule, is a tone-changing process driven by morphological conditions, namely, lexically specific tone change rules. Multiple studies have found that prosody and morpho-syntax are significant factors in the analyses of tone Sandhi (Yip, 1980; Beattie, 1985; L. Cheng, 1987; Chang, 1992; Chen, 2000; Duanmu, 1999, 2000). However, little research has been done on how morpho-syntax and prosody influence the morphologically conditioned tone change. The empirical data presented in Chapter 2 is the comparison between this lexically specific tone change and tone Sandhi.

1.2 The Mandarin *"yi-bu-qi-ba"* Rule

In Mandarin, there is a morpheme specific tone change rule named "*yi-bu-qi-ba*" rule (Chao, 1968). According to this rule, there are four morphemes that are subject to tone change rules that are completely different from tone Sandhi. I will illustrate the "*yi-bu-qi-ba*" rule morpheme by morpheme since each of them has distinctive characteristics.

There are many ways of representing a tone, all of which illustrate the pitch level and contour. In Table 1.1, I have listed four ways of how tones are classified in Mandarin: IPA scale based on 2005, *Pinyin* (Chinese Romanized spelling system), Chao's letters, as well as Yip's (1980) H/L term.

Table 1.1. Mandarin Tone Inventory

Name	T1	T2	T3	T4
IPA Scale (IPA chart 2005)	□ (high-level)	□□ (mid-rising)	□□□ (mid-dipping)	□□ (high-falling)
Chinese *Pinyin* System	*yī*	*yí*	*yi*□	*yì*
Chao's (1930, 1968) Tonal Values	55	35	214	51
Yip's (1980) H/L Term	H	LH	L	HL

A combination of the last two methods will be used throughout my thesis. I will mark Chao's letter as the superscripts of *Pinyin*, but will refer to Yip's H/L system when tone itself is analyzed. For example, **yi**^{55} refers to the morpheme *yi* that carries a H tone with a 55 tonal value.

1.2.1 *Yi* -Overview

Consider the tone of the Mandarin morpheme *yi* (meaning "the number one" or "a") in some morphological environments presented in Table 1.2, shown below.

Yi has the citation high tone (marked as 55 in Chao's letter) and its tone will usually change to either a rising tone (marked as 35, see example ***c***) or a high falling tone (marked as 51, see example ***b***) depending on the tone carried by the syllable that follows it.

Two tone change rules[1] applying to *yi* are generalized as follows:

Rule#1: H → LH /_HL **Rule#2**: H → HL /_{L, LH, H}

However, there are two situations in which *yi* does not change its tone. One of them is presented in (a) in Table 1.2, when *yi* is in a string of digits. The other case is shown in (e), when there is an ordinal marker *di* preceding *yi*, forming an ordinal expression *di-yi-* 'the first sth.'

Table 1.2. The Tone Alternation of *yi*

Morpho-syntactic Environment	Identification	Examples	Underlying Tone / Surface Tone	Rules Applied
YI as numeral in a non-unit word (no CL follows *yi*)	Digital-YI (string of digits)	(a) **yi**^{55}-jiu^{214}-liu-ling 1- 9- 6- 0	H L HL LH **H** L HL LH	N/A
	Numeral-YI in complex numbers	(b) **yi**^{51}-qian^{55}-ling- jiu one-thousand-zero-nine 'number 1009'	H H LH L **HL** H LH L	Rule#2
YI as numeral in a unit word (CL is not obligatory in ordinal expressions.)	Classifier-YI <*yi*,CL,Noun>	(c) **yi**^{35}-ge^{51}-ren 'one person'	H HL LH **LH** HL LH	Rule#1
		(d) **yi**^{51}-zhang^{55}- zhi 'one-piece-paper'	H H L **HL** H L	Rule#2
	Ordinal-YI <*di-yi-*>	(e) di-**yi**^{55}-zhang^{55} 'the first piece'	HL H H HL **H** H	N/A
YI as nominal in a noun phrase	Generic-YI	(f) **yi**^{51}-xie^{55}-ren 'some people'	H H LH **HL** H LH	Rule#2
	Existential-YI	(g) **yi**^{35}-xian^{51}-xiwang 'a piece of hope'	H HL H HL **LH** HL H HL	Rule#1
	Maximal-YI	(h) **yi**^{51}-shen^{55}-shui 'whole body of water'	H H L **HL** H L	Rule#2

[1] These two tone change rules, along with Rule#3 of *bu* are also listed in *Xiandai Hanyu Cidian* (the 5th edition, 2005)

In this table and henceforth, “CL” stands for the “classifier,” also named the “measure word,” that “denotes some salient perceived or imputed characteristic of the entity to which the associated noun refers” (Allan, 1977, p. 285). Mandarin Chinese is one of the “numeral classifier languages” in which the classifiers are obligatorily with a number and/or a demonstrative, or certain quantifiers before a noun’’ (Li & Thompson, 1981, p. 104). The classifiers “carry out a quantifying role by providing additional semantic information” (H. Zhang, 2007, p. 57).

The paradigm combination in the Mandarin numeral classifier structure is:

Quantifier + Classifier + Noun.

In Table 1.2, *ge* in (c) and *zhang* in (d, e) are both classifiers.

In (b), *qian* (‘thousand’) is not a CL but *yi* in this case functions as a quantifier. Some (N. Zhang, 2013) believes that morphemes following quantifiers such as *xie, xian, shen* in (f, g, h) are “CL-like” elements sharing the similar syntactic feature with CL.

All the examples in this chart can be divided in two groups referring to the rule application. In (b, c, d, f, g, h), tone change rules always apply. In (a) and (e), tone change rules do not apply.

Some implications can be also concluded. First of all, the tone change of *yi* cannot be predicted by the phonological environment (i.e. the tone carried by the following syllable) or the morpho-syntactic structure only. For example, in (c) and (e), both instances of *yi* are numeral and can precede a classifier in a noun phrase. (c) has tone change rule #1 applied but (e) does not have any tone changing process.

1.2.2 *Bu* -Overview

Among the four morphemes in the “*yi-bu-qi-ba*” rule, *bu* (‘not’) is different in both semantic concept and syntactic feature from the other three morphemes, *yi* (‘one’), *qi* (‘seven’), and *ba*

('eight'), all of which are numerals. *Bu* can serve as (i) a question marker in the "A-not-A" questions, which includes three types: "VP-not-VP" "V-not-VP" and "VP-not-V" (Zhu, 1991; Huang, 1988, 1991; Huang, Li, & Li, 2009), (ii) a potential/resultative infix inserted between the two elements of Resultative Compound Verb (RCV) structure (V1-not-V2), or (iii) a negative marker (prefix) in the negation structure ("not-Adjective/Verb Phrase").

In the A-not-A and RCV structures, *bu* is usually considered to be toneless (marked by "-" in Table 1.3) therefore does not follow the tone change rule.

Only one tone change rule applies to *bu* when it functions as a negative prefix:

Rule#3: HL → LH /_HL

Table 1.3. The Tone Alternation of *bu*

Morphological Environment	Syntactic Structure	Examples	Underlying Form / Surface Form	Rules Applied
Question Infix	A-*not*-A Question	**(i)** yao^{51} **-bu** -yao^{51} 'want or not'	HL - HL HL - HL	N/A
Potential/Resultative Infix	RCV Structure	**(j)** zuo^{51} **-bu** -wan^{35} 'cannot finish'	HL - LH HL - LH	N/A
Negative Prefix	*Not*-Adjective/ Verb Phrase	**(k) bu**^{35}-yao^{51} 'not want'	HL HL **LH** HL	Rule#3
		(l) bu^{51}-kai^{55} 'not open'	HL H **HL** H	N/A
		(m) bu^{51}-xing^{35} 'not okay'	HL LH **HL** LH	
		(n) bu^{51}-hao^{213} 'not good'	HL L **HL** L	

The only factor triggering the tone change of *bu* is the tone carried by the following syllable except it is an infix. This is similar but more predictable than *yi* case. The only tone changing process of *bu,* as shown in (k), has altered the first tonal value of the adjacent HL cluster. This can be interpreted as a result of Obligatory Contour Principle (Leben, 1973; McCarthy, 1986), which prohibits adjacent identical elements. Obligatory Contour Principle (OCP) is a common

factor triggering tonal process, such as the Mandarin 3rd tone Sandhi, which will be introduced in the next chapter.

1.2.3 *Qi* & *Ba*

The morphemes *qi* (‘seven’) and *ba* (‘eight’) have not been following general morphological tone change in the recent years. These two morphemes used to undergo Rule #1 of *yi* case. Whereas both now always remain in their citation H tone in all circumstances. This historical change has never been discussed in literature before. In Chapter 6, I will explain the reason, which might be due to the less frequent use of these two morphemes.

CHAPTER 2: Mandarin 3TS (3RD TONE SANDHI) VS. YTC (*YI* TONE CHANGE)

Introduction

This chapter systematically illustrates the comparison between Mandarin 3TS (3rd tone Sandhi) and YTC (*yi* tone change) along with supportive data. I will first introduce the phonological tone modification process known as tone Sandhi. 3rd tone Sandhi (3TS) encountered in Mandarin Chinese will be used as an example of tone Sandhi as a whole. Since there is a great deal of literature written on the subject of 3TS, I will only cover some of the basic ideas that are central to my thesis. The numeral morpheme *wu* ('five') is chosen as an example of 3TS and compared to *yi* ('one'), which is affected by the unique tone change rules. Relevant examples are provided to present the differences in surface patterns between 3TS and YTC. This section is the central part of my thesis and leads into my main claims in Chapter 5.

2.1 The Mandarin 3rd Tone Sandhi (3TS)

In Mandarin Chinese, there is a phonological tone Sandhi rule named 3rd Tone Sandhi (3TS), not allowing two adjacent mid-dipping tones ("3rd Tone") to occur within a foot. When it happens, the first dipping tone is realized as a rising tone. This tone Sandhi can be explained by the general phonological condition Obligatory Contour Principle (OCP).

Many approaches have attempted to explain the nature of 3TS. I here refer to the general claims shared by three major analyses of this tone phenomenon (as cited in Duanmu, 2000, p. 240-242): "tree-only" approach (C. Cheng, 1973; Shen, 1994), "stressless-foot" approach (Shih, 1986, 1997; Chen, 1996), and "nonhead stress" approach (Duanmu, 1999, 2000).

In summary, 3TS can be presented as: **L → LH/_L**

This rule is obligatory to the head syllable (typically the left syllable) within the foot domain and optional across the foot boundary. Moreover, 3TS applies to cyclically starting with the innermost minimal foot, proceeding outwards as long as the conditions for the rule are met.

Based on the rule, the Sandhi process in a disyllabic foot will be like: /L. L/ → [LH. L]

Due to the cyclic and optional properties, it can be predicted that in a trisyllabic maximal foot with all the elements carrying the L tone, there will be two surface patterns:

/L. L. L/ → [L. LH. L] or [LH. LH. L]

Although the second syllable is not the head of this trisyllabic foot, it has obligatorily changed from L to LH. To explain the reason, the process of 3TS application is demonstrated step by step in the outward order of the foot structure.

Maximal foot 1:

UR: ((L. L) L)
(**LH**. L) L 3TS applies to the head of the minimal foot
((LH. **LH**) L) L must change before L
SR: (LH. LH. L)

Maximal foot 2:

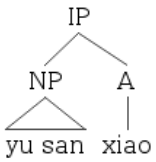
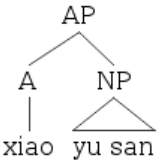
UR: (L. (L. L)
(L. (**LH**. L)) 3TS applies to the head of the minimal foot
(L. (LH. L)) L optionally change before LH that came from L
SR: (LH. LH. L) or (L. LH. L)

The prosodic variation is influenced by the syntactic bracketing. Shih (1986) used two expressions *yu-san xiao* (‘umbrella is small’) and *xiao yu-san* (‘little umbrella’) to show the different outcomes based on different syntactic bracketing, listed in Table 2.1. These two

expressions contain same morphemes but in different orders, resulting different syntactic structures. All the three morphemes have citation L tones. The different minimal feet are caused by the foot formation rule (i) with respect to morpho-syntax.

As shown below, different syntactic bracketing affects the 3TS application. In the left-branching structure, 3TS here is obligatory to both the first and the second syllables. The right-branching structure can have more than one surface pattern.

Table 2.1. 3TS -Sensitivity to Syntactic Bracketing (Shih, 1986)

	Left-branching Structure	Right-branching Structure
Examples	"umbrella is small" *yu - san* *xiao* umbrella small	"small umbrella" *xiao* *yu - san* small umbrella
Syntactic Structure	 [[*yu-san*] *xiao*]	 [*xiao* [*yu-san*]]
Foot Formation	((*yu. san*) *xiao*)	(*xiao* (*yu. san*))
Underlying Tone	((L. L) L)	(L (L. L))
Surface Tone	((**LH. LH**) L)	(L (**LH.** L)) *or* (**LH** (**LH.** L))

Until now, I have briefly introduced this tone Sandhi phenomenon and showed how syntactic bracketing influences the restructuring of prosody. Sandhi rule typically applies to the left syllable of a disyllabic foot that is called "syllable head." 3TS applies cyclically and optionally in certain conditions. Both prosodic structure and morpho-syntax matter in guiding the application of tone Sandhi rules. When turning back to the *yi* problem, will the prosody and

morpho-syntax function the same way in this morpheme specific tone change? If not, what will be the prosody-syntax interaction in YTC? The first question will be clearly answered in the next section. The nature of YTC, however, needs more detailed analyses, which will be presented in the next two chapters.

2.2 Comparison between 3TS and YTC

2.2.1 Systematic Comparison

In this comparison, most of the properties of 3TS are concluded from previous analyses (Kaisse, 1985; Z. Zhang, 1988) based on Duanmu's summary (2000, p. 238-239). In order to compare 3TS and YTC in a systematic way, I will present the features of YTC based on the data in this present paper.

Similarities

Table 2.2. Similarity between 3TS and YTC in Morpho-syntax

	3TS	YTC[2]
Word	*lao*^{LH} *hu*^{L} 'tiger'	*yi*^{LH} *ding*^{HL} 'for sure'
Compound	*mi*^{LH} *jiu*^{L} 'rice wine'	*yi*^{LH} *dan*^{HL} 'once, in case'
Phrase	*mai*^{LH} *jiu*^{L} 'buy wine'	*yi*^{HL} *qi*^{L} *qu*^{H} 'to go together'
Phrase (Idioms)	*ni*^{LH} *hao*^{L} 'Hello!'	*yi*^{LH} *hui-r*^{HL} *jian*^{HL} 'See you later!'

[2] In word *yi-ding* 'for sure,' *yi* does not mean 'one,' but a bound root.

In compound *yi-dan* 'once' literally means 'one day,' where *dan* is not a classifier, but is from traditional Chinese meaning 'day'.

First, both of them can apply in any syntactic structure (a word, a compound, or a phrase). In Table 2.2, some examples are listed to show this similarity. Only surface tones are indicated in the table. All the morphemes in 3TS examples have citation L tones.

Second, both 3TS and YTC are sensitive to syntax since the prosodic domain (either foot or pword) is determined by syntax. The role of syntax in 3TS and YTC, however, are largely distinguishing. The differences will be demonstrated in Table 2.3 and 2.4.

Differences

Following from above, the first difference between 3TS and YTC is the role of syntax.

The sensitivity to syntax of 3TS can be seen in two examples:

(1) The role of syntactic bracketing: 3TS can have more than one surface pattern in right-branching syntactic structure but not in left-branching structure. See Table 2.3.

(2) The optionality of 3TS in some certain syntactic structures: one famous condition is "between two binary branches of a syntactic tree" (Kaisse, 1985; Duanmu, 2000). I will show this property in Table 2.4.

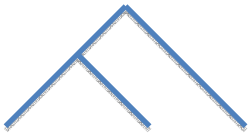
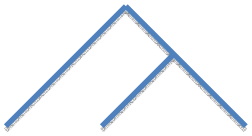
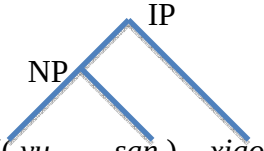
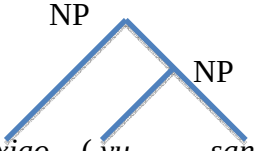
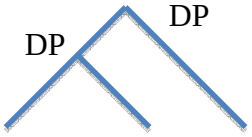
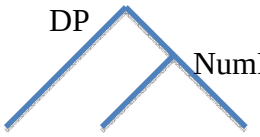
On the other hand, YTC is also sensitive to the syntax because the domain of the rule application depends on morpho-syntactic structure. But there is no alternative pattern in YTC case. The relevant examples I deliberate for YTC are also presented in the following tables.

To see the role of syntactic bracketing in 3TS and YTC, I here take the examples in Table 2.1. In the basic structure illustration of left-branching and right-branching structures, the tree shape shows the syntactic bracketing while the brackets are the foot boundaries.

The 3TS and YTC rules applications are presented in details in Table 2.3. The framed tones are the ones undergoing tone Sandhi or tone change. In the right-branching structure, although 3TS and YTC both apply to the designated morpheme, 3TS shows alternative surface forms.

The DP syntactic trees of ordinal expressions *di yi ben* ('the first CL'), *di yi bai* ('the 100th'), and *di yi ben shu* ('the first book') in these two tables are explicitly explained on p.15 of this thesis.

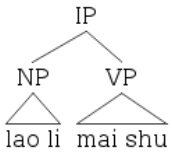
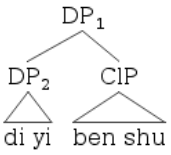
Table 2.3. The Role of Syntactic Bracketing in 3TS and YTC

	Left-branching Structure	Right-branching Structure
Basic Structures: Syntax & Foot Formation	 **[[σ σ] σ]** **((σ. σ) σ)**	 **[σ [σ σ]]** **(σ (σ. σ))**
3TS (Shih, 1986)	 ((*yu* *san*) *xiao*) umbrella small UR ((L. L) L) SR ((**LH.** **LH**) L)	 (*xiao* (*yu* *san*)) small umbrella UR (L (L. L)) SR_1 (L (**LH.** L)) SR_2 (**LH** (**LH.** L))
YTC	 ((*di* *yi*) *ben*) OD one CL UR ((HL. H) L) SR ((HL. H) L)	 (*di* (*yi* *bai*)) OD one hundred UR (HL (H. L)) SR (HL (**HL.** L))

The syntactic trees of YTC in this chapter are not considering the influence from the functional morphemes (clitics). In the two disyllabic feet (*di. yi*) and (*yi. bai*), the left edges of the feet happens to coincide with the equivalent pword boundaries. The tone change in these cases should not be interpreted as the rule application in the foot domain.

Table 2.4 shows 3TS is optionally applied to the nominal morpheme *Li* ('person's last name') that is between two binary syntactic branches. However, in YTC example, *yi* between the two binary branches does not change its tone.

Table 2.4. 3TS and YTC between Two Syntactic Binary Branches

	3TS (Duanmu, 2000, p. 250)	YTC
Syntactic Structure	 Old Li buy book	 OD one CL book
Foot Formation	(*lao. li*) (*mai. shu*)	(*di. yi*) (*ben. shu*)
Underlying	(L. L) (L. H)	(HL. H) (L. H)
Surface Tone	(**LH**. L) (L. H) *or* (**LH**. **LH**) (L. H)	(HL. H) (L. H)

Besides the role of syntax, there are five major differences between 3TS and YTC, which are listed in Table 2.5. The examples related to these differences will be explained in Section 2.2.2.

Table 2.5. Differences between 3TS and YTC

	3TS	YTC
Obligatoriness	3TS is not always obligatory. It can give alternative surface patterns.	YTC rules are obligatory. There is no alternative surface pattern.
Cyclicity	3TS applies cyclically.	No cyclical application in *yi*
String of Digits (eg. phone digits) Structure	3TS applies to the first element of a disyllabic foot or the first two elements of a trisyllabic foot when phonological condition allows.	YTC rules do not apply when *yi* is in a string of digits.
Other Factors	Emphasis and speech speed can affect 3TS.	No effect from emphasis or speech speed is found.

In addition to the differences compared to 3TS above, YTC has its arbitrary nature that can be investigated in three perspectives:

(1) This phenomenon is morpheme-specific as a whole.

(2) The tone changing rules seem phonetically arbitrary.

(3) Obligation of the YTC application is arbitrary. There is no alternation of the surface patterns allowed.

From all the differences illustrated above, the fundamental reason 3TS and YTC distinguish from each other is the distinct domains of rule application. The domain of 3TS is a foot, whereas the domain of YTC is a phonological word. This statement will be addressed in Section 2.2.2 and supported by the examples throughout Chapter 5.

2.2.2 The Data: *yi* vs. *wu*

To demonstrate whether the syntactic and prosodic structures function in the same way in tone change and tone Sandhi, the numeral morpheme *wu* (‘five’) that carries a citation dipping

tone is selected to compare with *yi*. If syntax/prosody functions the same way in these two processes, YTC and 3TS will happen in the same phonological and morpho-syntactic environment.

On the other hand, if phonological and morpho-syntactic environment are same, but only one of the two rules takes place but not the other, the role that prosodic and syntactic factors are playing in the two tonal processes ought to be different.

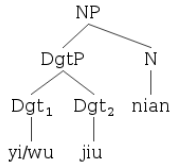
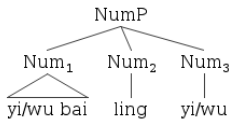
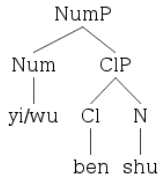
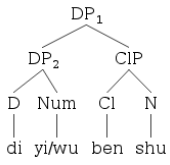
Since *wu* does not have the non-numeral use (eg. generic use) as *yi* has, the morpho-syntactic conditions for both *wu* and *yi* include only four cases: the string of digits, the complex number, the numeral classifier phrase, and the ordinal word. Tone Sandhi rule of *wu* is the Mandarin 3TS: L → LH/_L. To ensure that the two morphemes have similar phonological environment (with a L tone followed), I choose one of the tone-changing rules "H → HL/_L, H, LH" instead of the other one "H → LH/_HL" and narrowed the rule to a specific condition: H → HL/_L. Therefore the phonological environment of these two morphemes looks alike: the following tone of *yi* and *wu* will be all L tones. When *yi* and *wu* change their tones based on the rule, it will be realized as **yì**$^{\mathbf{HL}}$ and **wú**$^{\mathbf{LH}}$.

Table 2.6 illustrates in detail how YTC (*yi*) and 3TS (*wu*) apply, and the comparison between them. The two morphemes are in bold and only the surface form of their tones is shown in the table.

While it is still controversial how the syntactic construction of numeral classifier phrases operates, it has been agreed that the numeral morpheme heads one structure (namely Numeral Phrase, or Quantifier Phrase, or Unit Phrase in different analyses) and the classifier is the head of a Classifier Phrase or a DP c-commanding the noun (Wu & Bodomo, 2009; L. Cheng & Sybesma, 2012; X. Li, 2013; N. Zhang, 2013). In an ordinal expression, *di* serves as a determiner

forming a DP (Tsai, 2011). I will not discuss in detail that how these theories differ from each other here. Instead of choosing one term, I will illustrate the simplest syntactic construction and name each of the branches after their heads, to be convenient for my analysis. For example, I will name the structure [*classifier noun*] a ClP for "Classifier Phrase" following Wu and Bodomo's (2009) claim, although it has been proposed to be a DP in L. Cheng and Sybesma's (2012) recent work. More tree representations are available in Chapter 5.

Table 2.6. Comparison between *yi* and *wu*

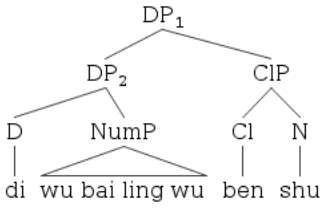
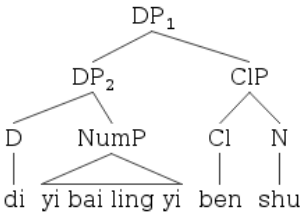
Conditions	WU-Tone Sandhi (Rule: L → LH/_L) $wu^{L} \rightarrow wu^{LH} / \_\ \sigma^{L}$	YI-Tone Change (Rule: H → HL/_L) $yi^{H} \rightarrow yi^{HL} / \_\ \sigma^{L}$	Syntactic Structure	Comparison
(A) String of Digits	***wu***^{LH} *jiu*^{L} *nian* 5 9 year 'the year of (19)59'	***yi***^{H} *jiu*^{L} *nian* 1 9 year 'the year of (20)19'		TC ***yi*** -No TS ***wu*** -Yes
(B) Complex Numeral Structure	***wu***^{LH} *bai*^{L} *ling* ***wu***^{L} five hundred zero five 'the number of 505'	***yi***^{HL} *bai*^{L} *ling* ***yi***^{H} one hundred zero one 'the number of 101'		TC ***yi*** -Yes TS ***wu*** -Yes
(C) Numeral Classifier Structure	***wu***^{LH} *ben*^{L} *shu* five-CL-book 'five books'	**[*yi***^{HL} *ben*^{L} *shu* one-CL-book 'one book'		TC ***yi*** -Yes TS ***wu*** -Yes
(D) Ordinal Structure	*di* ***wu***^{35} *ben*^{L} *shu* 'the fifth book'	*di* ***yi***^{H} *ben*^{L} *shu* 'the first book'		TC ***yi*** -No TS ***wu***- Optional

As shown in the "comparison" column, tone change of *yi* and tone Sandhi of *wu* do not always happen in the same phonological and morpho-syntactic conditions. For example, when *wu* changes its tone in the ordinal phrase *di* ***wu***^{LH} *ben*^{L} *shu* ('the fifth book'), *yi* remains its citation high tone in the compared ordinal phrase *di* ***yi***^{H} *ben*^{L} *shu* ('the first book').

The prosodic parsing of the entire example above should be the same for *yi* and *wu*. There will be a tri-syllabic unit as one prosodic unit in (A) and (C), and two disyllabic feet in (B) and (D). However, the results show that these prosodic structures cannot explain the different application of the tone Sandhi or tone change rules.

The difference between YTC and 3TS in the string of digits has been seen in Table 2.6. Another important difference is the cyclic property of the rule application. Examples in Table 2.7 is established from Table 2.6, forming two new ordinal phrases with complex numbers and classifiers inserted -'the 101st book' and 'the 505th book.' The reason of analyzing 'the 101st book' instead of the original 'the 1st book' is to detect a cyclic process of rule application at different pword levels. I have discussed the cyclic property of 3TS rule application in Section 2.1. However, in YTC, this cyclic feature is not observed.

Table 2.7. Difference in *yi* and *wu* Cont'd

	WU-Tone Sandhi (Rule: L → LH/_L) wu^{214} → wu^{35} /_ $[]^{214}$	YI-Tone Change (Rule: H → HL/_L) yi^{55} → yi^{51} /_ $[]^{214}$
Syntactic Structure		
Foot Structure	(*di* **(*wu*^{L}**.*bai*^{L})) (*ling*.***wu***^{L})(*ben*^{L}.*shu*□)	(*di* **(*yi*^{H}**.*bai*^{L})) (*ling*.***yi***^{H}) (*ben*^{L}.*shu*)
Underlying Tone	*di* ***wu***^{L} *bai*^{L} *ling* ***wu***^{L} *ben*^{L} *shu* OD five hundred zero five CL book 'the 505th book'	*di* ***yi***^{H} *bai*^{L} *ling* ***yi***^{H} *ben*^{L} *shu* OD one hundred zero one CL book 'the 101st book'
Surface Tone	*di* ***wu***^{LH} *bai*^{L} *ling* ***wu***^{LH} *ben*^{L} *shu* OD five hundred zero five CL book 'the 505th book'	*di* ***yi***^{HL} *bai*^{L} *ling* ***yi***^{H} *ben*^{L} *shu* OD one hundred zero one CL book 'the 101st book'
Note	3TS in the second ***wu***^{L} is optional.	

In these examples presented in the Table 2.6 and 2.7, the phonological and syntactic environments of *yi* and *wu* are all same, that is to say, no matter how the prosodic domain and syntactic structure is defined in an expression involving *wu*, it will be the same prosodic parsing in *yi*. The fact YTC is prohibited in some morpho-syntactic conditions is the strong evidence proving that syntax and prosody do not function the same way in predicting YTC and 3TS. This observation was never paid attention in literature as far as I am aware.

CHAPTER 3: PROSODY AND SYNTAX IN MANDARIN CHINESE

Introduction

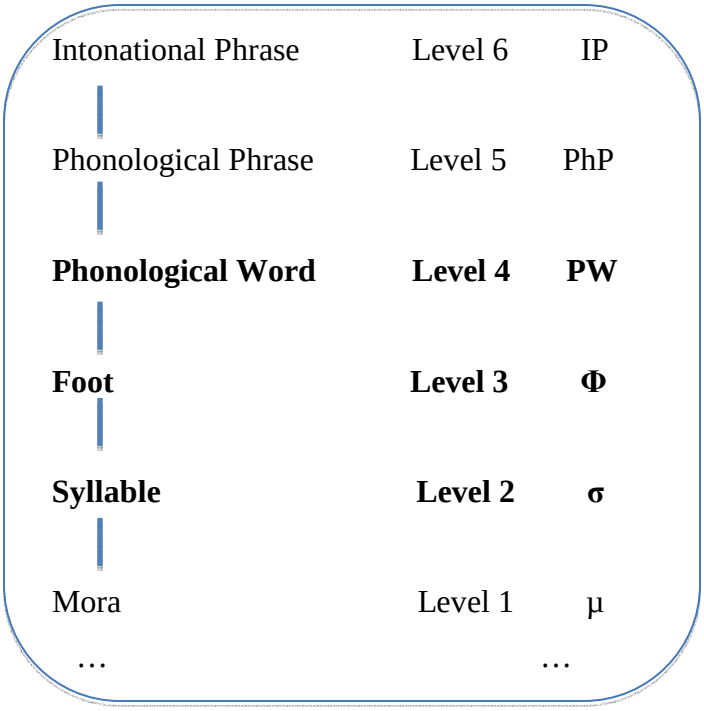
To help the readers understand the nature of the "*yi-bu-qi-ba*" rule, the general patterns of prosodic and syntactic structures are introduced in this chapter. Particular prosodic patterns in Mandarin Chinese are discussed with respect to Universal Prosodic Hierarchy (Selkirk, 1978, 1984), Prosodic Morphology Theory (McCarthy & Prince, 1986, 1993a), as well as some other claims by Shih (1986), Chen (1979, 1980), L. Cheng (1987), Duanmu (1990, 1999, 2000) and Feng (2002). These claims are important for analyzing both tone Sandhi and tone change. My proposal in Chapter 5 is based on what I will present here.

3.1 The Prosodic Hierarchy

Figure 3.1 illustrates a universal prosodic hierarchy that was first proposed by Selkirk (1978) and then gradually modified by others (Selkirk, 1984; Nespor & Vogel, 1986; Beckman & Pierrehumbert, 1986; Pierrehumbert & Beckman, 1988; Hayes, 1989; McCarthy & Prince, 1986, 1993a).

This hierarchy model covers from the smallest units to the largest categories in an utterance. From the "phonological word" level above, the structure is defined according to syntactic structure.

Figure 3.1. The Prosodic Hierarchy



In this thesis, I will mostly focus on Level 4 (phonological word) downwards to Level 2 (syllable). They are important to investigate rather than other levels because the tone is carried by the syllable and tone Sandhi or tone change rules apply at the foot level. Besides these three levels, phonological phrase level will be referred to frequently as well, since it is the prosodic domain of phonological rules at the phrasal level.

3.2 The Prosodic and Syntactic Structures in Mandarin Chinese

3.2.1 The Syllable

Each syllable corresponds to a morpheme in Chinese (Duanmu, 1990). They can be either stressed (full syllables) or unstressed (weak syllables). Stressed syllables carry lexical tones, namely tone-bearing units (Chen, 1979; Bao, 1999; Duanmu, 2008).

Unstressed syllables are toneless. They are usually functional morphemes such as aspectual marker *le* and sentential final marker *ma*. Additionally, the second syllable in a disyllabic

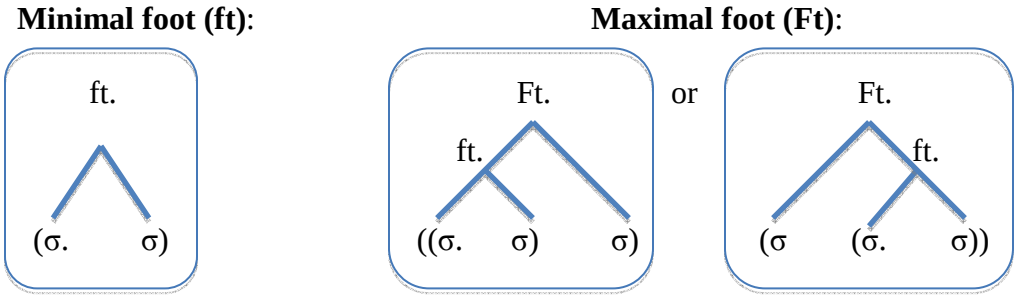
compound or a reduplicative compound is often unstressed. The unstressed conditions in this paper are presented in Table 1.3 (i) and (j), infix *bu* in the A-not-A question and RCV structure. Except the functional *bu*, all other examples in this paper have been selected deliberately without unstressed syllables.

3.2.2 The Foot and Foot Formation Rule

3.2.2.1 The Minimal and Maximal Foot

A foot is the suprasyllalbic unit that has been proposed to vary in size in Mandarin. It could consist of one, two, or three syllables (Feng, 1998; Duanmu, 1999; Chen, 2000). Taken from the claims made by Chen (1979, 1980) and Feng (2002), the "minimal foot" must be disyllabic, while the trisyllabic "maximal foot" is possible in Mandarin. This "maximal foot" phenomenon has also been observed in Japanese prosodic structure (Ito & Mester, 2010).

Figure 3.2. Foot Structure in MC



The process of foot formation is based on the Relative Prominence Principle (Liberman & Prince, 1977) and Foot Binarity Principle (McCarthy & Prince, 1986, 1993a).

3.2.2.2 The Foot Formation Rule (FFR)

Foot structure in Mandarin plays a prominent role in conditioning tone Sandhi. This foot formation process (i-iii) is adopted from previous analyses on 3TS by Chen (1996), Shih (1997), and Duanmu (2000). I added more details to (iii) making it more explicit.

(i) **Lowest Footing**: Form disyllabic feet when there is a disyllabic morphological word or compound, or a disyllabic XP. These disyllabic morpho-syntactic constituents will be the minimal feet in this step.

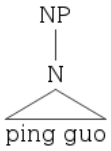
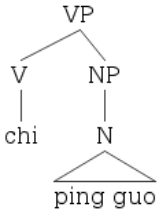
(ii) **Left-to-right Footing**: From left to right, form disyllabic feet when there are adjacent syllables which are not footed at step (i).

(iii) **Left-to-right Joining**: If there are any remaining syllables that are not footed at steps (i) and (ii), from left to right, form a trisyllabic "maximal foot" by joining the adjacent monosyllable and disyllabic foot together. There could be two situations. If there is remaining unfooted syllable at the leftmost position, join this syllable to the following disyllabic foot. If there is no disyllabic foot preceding the first unfooted monosyllable, join the monosyllable to the preceding foot.

Only (i) needs the morpho-syntactic information. (ii) and (iii) are following the foot binary preference in (b). The notion of a foot was not identified in Shih's work. I have listed all the possible syntactic constituents that can form a minimal foot: disyllabic morphological words, compound words, and XPs. Mandarin XPs have the disyllabic preference. Trisyllabic XPs are also possible. Where there is a disyllabic XP, step (i) is easy to achieve. When a trisyllabic XP

(or even longer than 3 syllables) appears, (i) will not affect the foot forming. The trisyllabic XP will break into the monosyllabic structure in the next steps and feet are formed by (ii) and (iii).

For example, a disyllabic NP *ping-guo* (‘apple’) and a trisyllabic VP *chi-ping-guo* (‘to eat apple’) will follow the steps (i) – (iii) as the illustration below.

Foot Formation		**Morpho-syntactic Structure**
‘apple’	*ping-guo*	
(i) Lowest Footing	(ping.guo)	
(ii) Left-to-right Footing	N/A	*ping guo*
(iii) Left-to-right Joining	N/A	‘apple’
“to eat apple”	*chi-ping-guo*	
(i) Lowest Footing	chi. (ping.guo)	
(ii) Left-to-right Footing	N/A	
(iii) Left-to-right Joining	(chi. (ping. guo))	*chi* *ping guo* ‘to eat’ ‘apple’

3.2.3 The Phonological Word (“*pword*”) and PW Formation Rule

A phonological word (henceforth “pword”) is a “word-size entity” defined phonologically, functioning as the domain of phonological rules (Hall, 1999; Packard, 2000), phonotactic generalizations (Nespor & Vogel, 1986), or minimality constraints (Dixon, 1977a, 1977b; McCarthy & Prince, 1986, 1990).

Pword usually contains at least one disyllabic foot but could be one syllable long only when the whole utterance is monosyllabic. In this special case, all of the intonational phrase, phonological phrase, and foot levels coincide to be this particular syllable.

The pword does not need to coincide with a grammatical word (Matthews, 2007). For example, in English *I'm* is considered to be one single pword but two separate grammatical words (*I* and *am*). However, pword boundaries directly correspond the ones of morpho-syntactic structures. Therefore, the concept of a phonological or prosodic word represents the interaction between phonology and morphology (Julien, 2002).

3.2.3.1 The ALIGN Constraints and Cliticization

Formulated from Prosodic Morphology theory (McCarthy & Prince, 1986, 1993a) and edge-based theory (Chen, 1987; Selkirk, 1986; among others), Feng (2002) proposed a series of alignment constraints and rules that predict pword in Chinese morphology. I summarize his main ideas and examples in (I) - (III) below:

(I) $\mathbf{ALIGN_1 : [\ ]_{Comp} = [\ ]_{PW}}$

For lexical idioms such as compounds, the left and right edges of the compound must coincide with the left and right edges of a pword.

(II) $\mathbf{ALIGN_2 : [\ ]_{Foot} = [_M \cdots {}_M]}$

For non-compounds, first identify the foot structure based on $ALIGN_2$: the left and right edge of a morpheme must coincide with the left and right edge of a foot. In other words, a foot must both begin and end with a morpheme.

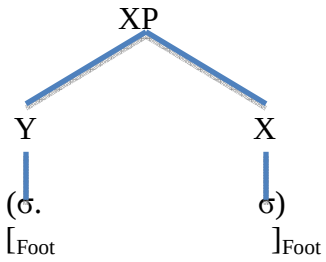
Then assign the foot based on FAR (Foot Assignment Rule): a foot must be assigned to the syntactic tree from right to left, regardless of whether the tree is left-headed or right-headed. The illustration is presented in Figure 3.3.

(III) ALIGN$_3$-L : [$_{PW}$ = [$_{PW}$

When one pword is formed on top of another, the left edge of a pword must coincide with left edge of another pword.

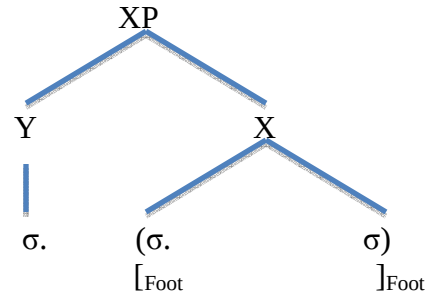
These Alignment constraints make the connection between the morpho-syntactic categories ("morpheme M") and prosodic categories ("syllable σ" and "Foot") to determine a pword.

Figure 3.3. PW Formation based on ALIGN$_2$



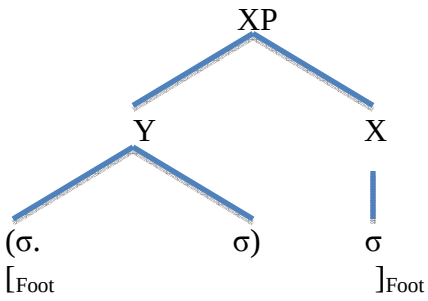
1) When XP is a disyllabic structure, each node contains a monosyllabic word.

→This pword contains one disyllabic foot.



2) When X is a disyllabic structure while Y is monosyllabic.

→This pword contains one disyllabic foot.



3) When Y is a disyllabic structure while X is monosyllabic.

→This pword contains a trisyllabic foot.

However, Feng's analysis does not take functional morphemes into account. When there are functional morphemes (i.e. "clitics") appears, the surface structure need to be "rebracketed" through cliticization process (Chen, 2000).

Clitics are bound morphemes and lack prosodic independence. They must attach to a neighboring "lexical host" to form a phonological constituent (Chen, 2000 p. 398). There are three types of clitics: (i) bare roots that must combine with an affix or another root morpheme in order to form a "free-standing word" (eg. when numeral root meets classifier affix). (ii) Bound word-level affixes (eg. the ordinal number prefix *di-*, progressive suffix *–zhe*, potential/resultative infix *–bu-*), and (iii) a "tertium quid" between words and affixes (eg. prepositions). When forming a pword, the bare roots will combine with the related morphemes. Bound prefixes must attach to the following "phonological host" and suffixes should attach to the preceding host obligatorily. Infix will combine the preceding and following syllables together in order to form a pword. Common clitics in Chinese include prepositions, classifiers or measure words, and object pronouns (Chen, 2000, p. 400-403).

3.2.3.2 The PW Formation Rule

To capture the pwords in a structure consisting of both content and functional morphemes, I combine Feng and Chen's proposals and finalize new PW Formation Rule.

PW Formation Rule:

(A) If all morphemes are content morpheme, form pwords based on the ALIGN constraints.

($ALIGN_1$: $[\ ]_{Comp} = [\ ]_{PW}$, $ALIGN_2$: $[\ ]_{Foot} = [_M \dots _M]$, $ALIGN_3$-L : $[_{PW} = [_{PW}$).

(B) If there is clitics,

i) Cliticization: rebracketing the surface structure by grouping one clitic to the preceding host, the (host-clitic) then becomes a pword

ii) Foot Formation: forming new foot structures based on the new syntactic bracketing after cliticization;

iii) PW Formation: form pwords based on the ALIGN constraints.

These PW Formation Rules are operated right after Foot Formation Rules (i-iii). Different ALIGN constraints will be selected depending on the certain cases. I will demonstrate these rules step by step with sufficient examples to support my hypothesis in Chapter 5.

3.2.4 The Prosody-Syntax Mapping

From the rules I addressed above, it is obvious that neither prosody nor syntax could independently predict the footing at pword domain. There is a close relation between prosodic parsing and morpho-syntactic structure. Has been proposed by Selkirk (1972, 1974, 1978) and confirmed in some Romance languages by Nespor and Vogel (1979, 1982), among others, prosodic structure is projected from syntactic structure but they are not isomorphic. Morpho-syntactic influence has been previously discussed with respect to tone Sandhi (Shih, 1986; Chen, 1992, 2000). In this project, I am presenting the domain of YTC is also constructed depending on morpho-syntax.

The foot and pword formation of *yi-chang-yu* (‘one-CL-rain’) is illustrated below. Syllables in bold are the ones undergoing the tone Sandhi or tone change process.

Level 2 -Syllable σ

Individual morphemes *yī*^{H}(‘one’), *chǎng*^{L} (‘classifier for situation’), *yǔ*^{L} (‘rain’)

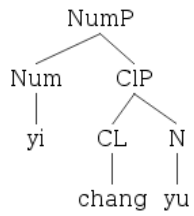
Level 3 -Foot Φ

Foot Formation **Morpho-syntactic Structure**

(i) Lowest Footing *yi.* (*chang. yu*)

(ii) Left-to-right Footing N/A

(iii) Left-to-right Joining (*yi* (*chang. yu*))



Level 4 -Pword

! Classifier *chang* is a clitic

(iv) Cliticization [*yi-chang*] *yu* Attaching clitic to the host

(v) Foot Formation ((*yi.-chang*) *yu*)

(vi) $ALIGN_2$ $[_{Foot}$ $]_{Foot}$

$ALIGN_3$ $[_{PW}[_{PW}$ Forming two PWs

PW Formation $_{PW2}\{$ $_{PW1}\{(yi^{H}\ chang^{L})\}_{PW1}$ $yu^{L}\}_{PW2}$

Rule Application $_{PW2}\{$ $_{PW1}\{((\ \boldsymbol{yi^{HL}}\ \boldsymbol{chang^{LH}}\ )\}_{PW1}$ $yu^{L})\}_{PW2}$

Foot domain: 3TS rule applies in the maximal foot

PW domain: YTC rule applies in the pword

Surface Tones $\boldsymbol{yi^{HL}}\boldsymbol{.}\ \boldsymbol{chang^{LH}}.\ yu^{L}$

In the phrase *yi chang yu* (‘one-CL-rain’), where both tone change and tone Sandhi take place, prosodic structure depends on both the Foot Binarity Principle and word-level syntactic structure.

At the syllable level, there are three tone-bearing units, all of which carry the citation tones, *yi*^{H}, *chang*^{L} and *yu*^{L}.

At the foot level, three syllables form a maximal foot containing a minimal foot. The foot formation relies on the syntactic structure. However, since classifier *chang* is a clitic, which should attach to the preceding numeral *yi*. During the cliticization step, *yi-chang* forms one pword, thus changing the syntactic bracketing. In the maximal foot, *chang*^{L}→*chang*^{LH} is the consequence of 3TS rule. YTC applies earlier in the minimal pword domain *yi-chang*, altering the H tone to a high falling HL.

In this example, all numeral, classifier, and nominal morphemes are monosyllabic. Between the two pwords, *yi-chang* is formed by re-bracketing based on syntactic cliticization, the bigger pword *yi-chang-yu* is determined by Foot Assignment Rule. Both syntax and prosody operate in predicting the rule application.

CHAPTER 4: PAST ANALYSIS

Introduction

In this chapter, I will introduce an earlier analysis of the "*yi-bu-qi-ba*" rule by Chang (1992) that focused on discussing the stress pattern in the foot domain. However, this analysis lacks reference to syntax. In order to truly understand the nature of the "*yi-bu-qi-ba*" rule, far more has to be considered on the prosodic word level. Pointing out the limitations is helpful for establishing a new proposal in the next chapter.

In Chapter 5, I will state my general claims and present my own analysis of the *yi* tone change, which mainly focuses on the prosody-syntax interaction and how it plays an important role in *yi* tone change.

4.1 Chang's (1992) Analysis

Chang (1992) has simply discussed the *yi-bu-qi-ba* rule and gave an analysis regarding *yi* and *bu* tone change. Some questions have been answered, but the whole problem has not been systematically understood. The examples and analysis are taken from her work. I then formulated the tone-marking format to be consistent with the rest of my paper.

Figure 4.1. Chang's (1992) data of the "*yi-bu-qi-ba*" rule (p. 169)

yī[55]	*bù*[51]
[yì[51] -zhāng[55]] 'one sheet (of paper)'	[bù[51] -tōng[55]] 'unworkable'
[HL H]	**[HL H]**
[yì[51] -rén[35]] 'one person'	[bù[51] -xíng[35]] 'not allowed'
[HL LH]	**[HL LH]**
[yì[51] -dǎ[214]] 'one dozen'	[bù[51] -hǎo[214]] 'not good'
[HL L]	**[HL L]**
[yí[35] -yàng[51]] 'the same'	[bú[35] -qù[51]] 'wont go'
[LH HL]	**[LH HL]**

A simplest observation that she proposed is that tone change rule in *bu* seems to be "adopted" by *yi.* Based on this hypothesis, she discussed two main questions regarding the *yi* and *bu* tone change:

(Q1) In *bu,* the tone change seems to be a dissimilation process, however "the cause is not explained."

(Q2) Both *yi* and *bu* are high frequency morphemes. It is not clear why *yi* does not retain the underlying tone following by H, LH, and L.

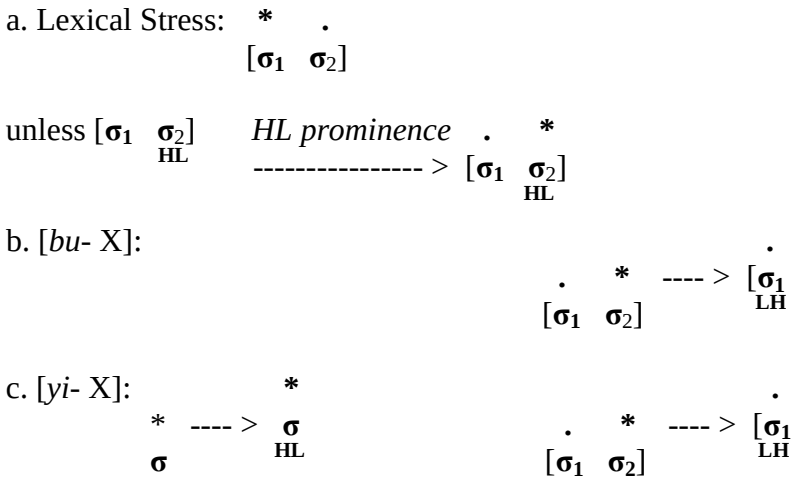
Chang claimed that the tonal alternations seen in these examples involve two things: "a preferred stress pattern for a disyllabic prosodic foot in Beijing Mandarin", and "a special status of HL in determining stress prominence" (p. 169-170). She gave the answers to the previous questions and I generalize them as below:

(A1) Since HL on the second syllable has more metrical prominence (high falling tone HL, was proposed to be the "strongest tone on the stressability hierarchy"), the preceding syllable with a lesser degree of stress would tend to undergo tonal change.

(A2) Furthermore, the alternation of yi preceding H, LH, and L may reflect the preference

of a trochaic foot (cf. lexical stress pattern [Strong. Weak]) in Mandarin.

Figure 4.2. Chang's (1992) analysis of "yi-bu-qi-ba" tonal alternations (p. 170)



In Chang's analysis, stress pattern has been considered crucially in the prominence shifting of the high falling tone HL. When the prominent HL appears on the second syllable of a foot structure, the lexical stress pattern [Strong. Weak] ([***** **.**]) will change into [W. S] ([**.** *****]), where the weakened syllable will not carrying HL anymore. Instead, the weakened syllable on the left side of a foot will have a LH.

4.2 Limitations

First of all, Chang only investigated the tone changing but not tone preserving of *yi.* As I introduced before (refer to Table 1.2), *yi* remains its underlying tone when it is in a string of digits or in an ordinal word. Chang did not take these conditions into account. All the examples she took are the numeral-classifier cases.

In addition, Chang compared *yi* and *bu* together since both of them shared some tone modification processes. However, the tone change processes in *yi* and *bu* are completely

different. The tone change of *bu* relies on the following tone except when it is a toneless infix, whereas *yi* does not have to consider the phonological environment in some cases (such as a string of digits).

Finally, the reason why LH is taking over when the stress shifting appears has not been answered clearly. This has to be analyzed through a series of phonological constraints.

To be concluded, Chang has contributed to answering some questions about tone change by investigating the role of stress pattern. However her analysis failed in treating the morpheme specific tone change problem as a gestalt. No syntactic structure has been accounted in her analysis either. I will introduce my main claims in the next section, in which the interaction between prosody and syntax plays a crucial role in explaining *yi* case.

CHAPTER 5: NEW ANALYSIS

5.1 General Claims and The Hypotheses

Based on the discussion in previous sections, I put forth two general claims:

Claim 1: Within the "*yi-bu-qi-ba*" rule, the tone change of *yi* and *bu* should be treated separately since they have different requirements for phonological environment.

Claim 2: From the comparison in Chapter 3, it is obvious that YTC and 3TS have different natures, and thus, YTC needs a new analysis.

One observation about YTC is the generalized rules do not apply in the string of digits structure, for unknown reason. With this restriction, the hypotheses I propose for YTC rules are:

(H1) YTC only apply when the morpheme *yi* appears as the initial element of a pword except in the string of digits.

(H2) This pword domain could be applicable to *bu*: BTC (*bu* tone change) rule applies when the morpheme *bu* appears at the initial element of a pword.

5.2 The New Analysis: A Rule-based Approach

The new analysis is a rule-based analysis. Combine the Foot Formation Rule (i)- (iii) presented in Section 3.2.2.2 (p. 20) and the PW Formation Rule in Section 3.2.3.2 (p. 24). The whole process is shown below.

(i) **Lowest Footing**: Form disyllabic feet when there is a disyllabic morphological word or compound, or a disyllabic XP. These disyllabic morpho-syntactic constituents will be the minimal feet in this step.

(ii) **Left-to-right Footing**: From left to right, form disyllabic feet when there are adjacent syllables which are not footed at step (i).

(iii) **Left-to-right Joining**: If there are any remaining syllables that are not footed at step (i) and (ii), from left to right, form a trisyllabic "maximal foot" by joining the adjacent monosyllable and disyllabic foot together. There could be two situations. if there is remaining unfooted syllable at the leftmost position, join this syllable to the following disyllabic foot. If there is no disyllabic foot preceding the first unfooted monosyllable, join the monosyllable to the preceding foot.

(iv) **PW Forming:**

(iv-a) If all morphemes are content morpheme, form pwords based on the selected ALIGN constraints and FAR (Foot Assignment Rule).

($ALIGN_1$: $[\ ]_{Comp} = [\ ]_{PW}$, $ALIGN_2$: $[\ ]_{Foot} = [_M \dots _M]$, $ALIGN_3$-L : $[_{PW} = [_{PW}$)

(iv-b) If there is clitics,

1) Cliticization: rebracketing the surface structure by grouping one clitic to the preceding host, the (host-clitic) then becomes a pword;

2) Foot Formation: forming new foot structures based on the new syntactic bracketing after cliticization;

3) PW Formation: form pwords based on the ALIGN constraints.

(v) **TC Rule Applying**: YTC/BTC rules apply when the morpheme *yi/bu* is the first syllable in a pword. (YTC/BTC rules will not apply anywhere else.)

5.2.1 YTC Rule Application

All of the examples are divided into four groups based on their syntactic structures. This classification also corresponds to Table 3.3. Group A is the string of digits condition that has been observed as the exceptional condition. Group B, C, and D altogether are predicted by (H1). The tone-changed morphemes are marked by the rectangular frame, eg. ***yi***^{HL}.

Group A: String of Digits

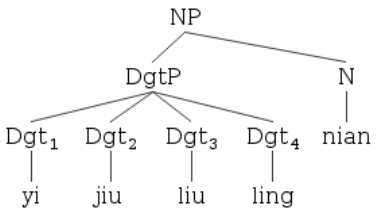
Unlike 3TS, YTC does not apply in the string of digits. In (Eg.1), *yi* remains in its citation H tone, even though there is a L tone syllable following after. If the digits along with the year/month/date are altogether treated as one pword, or string of digits as a whole pword, (H1) does not apply to the first morpheme *yi* in either case. I currently do not have any convincing argument to explain the reason. Therefore I place this group into an exceptional condition.

(Eg. 1) 'the year of 1960'

yi^{H} *jiu*^{L} *liu ling nian*

1 9 6 0 year 'the year of 1960'

Syntactic Structure



Group B: Complex Number Structure

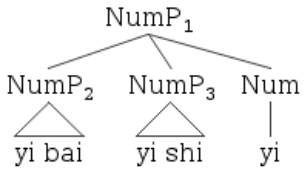
Chinese numerals are content morphemes and usually considered as bound roots that need to combine with a classifier. When numerals are in the specialized context of serial counting, they could be treated as "free" morphemes (Packard, 2000, p. 75). In the latter sense, complex numeral expressions are formed naturally as a morphological word.

Chinese complex cardinals are multiplicatives and can be formed by the process of compounding. The syntactic structure of a complex number looks like a compound word, see the tree structure in (Eg. 2). $ALIGN_3$ predicts that the complex cardinal number itself is a pword no matter how many feet it contains like a lexical idioms. As the complex number being expanded, the pword is extended as well.

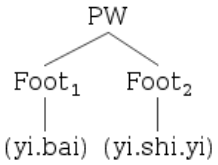
(Eg. 2) '111'

yi	*bai*	***yi***	*shi*	***yi***
one	hundred	one	ten	one

Syntactic Structure



Prosodic Structure



(ii) Left-to-right Footing (*yi. bai*) (*yi. shi*) *yi*

(iii) Left-to-right Joining (*yi. bai*) ((*yi. shi*) *yi*)

(iv) PW Forming $_{PW}\{$(*yi. bai*) ((*yi. shi*) *yi*)$\}_{PW}$ ← $ALIGN_1$: [ ]$_{Comp}$ = [ ]$_{PW}$

Underlying Tone {(***yi***^{H}. *bai*^{L}) ((***yi***^{H}. *shi*^{LH}) ***yi***^{H})}

(v) YTC Applying {(***yi***^{HL}. *bai*^{L}) ((***yi***^{H}. *shi*^{LH}) ***yi***^{H})}

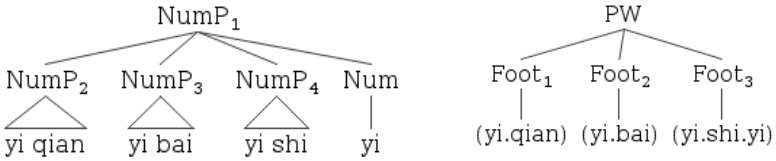
Surface Tone ***yi***^{HL}. *bai*^{L}. ***yi***^{H}. *shi*^{LH}. ***yi***^{H}

(Eg. 3) '1111'

yi *qian* ***yi*** *bai* ***yi*** *shi* ***yi***

one thousand one hundred one ten one

Syntactic Structure Prosodic Structure



(ii) Left-to-right Footing (*yi. qian*) (*yi. bai*) (*yi. shi*) *yi*

(iii) Left-to-right Joining (*yi. qian*) (*yi. bai*) ((*yi. shi*) *yi*)

(iv) PW Forming $_{PW}${(*yi. qian*) (*yi. bai*) ((*yi. shi*) *yi*)}$_{PW}$ ← ALIGN$_1$

Underlying Tone {(***yi***^{H}. *qian*^{H}) (***yi***^{H}. *bai*^{L}) ((***yi***^{H}. *shi*^{LH}) ***yi***^{H})}

(v) YTC Applying {(***yi***^{HL}. *qian*^{H}) (***yi***^{H}. *bai*^{L}) ((***yi***^{H}. *shi*^{LH}) ***yi***^{H})}

Surface Tone ***yi***^{HL}. *qian*^{H}**.** ***yi***^{H}. *bai*^{L}. ***yi***^{H}. *shi*^{LH}. ***yi***^{H}

The complex number can be expanded as long as possible "11…111," but the outcome will be the same: only the initial *yi* changes its tone. Compare the different tone of *yi* in the same word ***yi***-*bai* ('one hundred'), but located in different position of a complex number. In (Eg. 2), the surface tone is ***yi***^{HL}-*bai*^{L}, but the citation tone is realized as in ***yi***^{H}-*bai*^{L} of the example (3). Instead of the foot, the pword is clearly the prosodic domain of YTC.

(Eg. 4) '111 books' vs. '1 book'

{ ***yi***^{HL} *bai*^{L} ***yi***^{H} *shi*^{LH} ***yi***^{H} *ben*^{L} *shu*^{H} **}**

one hundred one ten one CL book '111 books'

cf. **{** ***yi***^{HL} *ben*^{L} *shu*^{H} **}**

one CL book '1 book'

As introduced in Section 3.2.3.1, numerals and classifiers are bound roots thus they always need to be combined to form a pword. This explains that in (Eg. 4), each of the expression is a pword.

Yi-ben-shu (‘one CL book’) has the same PW formation process as *yi-chang-yu* (‘one CL rain’) discussed in Section 3.2.4 on p. 25-26. The reason that *yi-bai-yi-shi-yi-ben-shu* (‘111 books’) is also a pword because of the cliticization, *ben* is attached to the complex numeral expression, foot assignment rule determines the pword has the same right edge as the last element. $ALIGN_3$ requires the left edge of the pword corresponds to the smaller pword.

yi-*bai*-***yi***-*shi*-***yi*** *ben* *shu*

Cliticization: Num-CL Pword

{*yi*-*bai*-*yi*-*shi*-*yi*-*ben*} shu

Rebracketing: **[[*yi*-*bai*-*yi*-*shi*-*yi*-*ben*]** shu]

Re-applying FFR:

(i)Lowest Footing (*yi.bai*) (*yi.shi*) *yi.ben.shu*

(ii) Left-to-right Footing (*yi.bai*) (*yi.shi*) (*yi.ben*) *shu*

(iii) Left-to-right Joining: (*yi.bai*) (*yi.shi*) ((*yi.ben*) *shu*)

PW Formation:

FAR $[_{Foot}$ $]_{Foot}$

$ALIGN_3$ $[_{PW}[_{PW}$

PW Spelling out: $_{PW2}$ **{** $_{PW1}${***yi***-*bai*-***yi***-*shi*-***yi***-*ben*} $_{PW1}$ *shu*} $_{PW2}$

Underlying Tone **{{** ***yi***^{H} *bai*^{L} ***yi***^{H} *shi*^{LH} ***yi***^{H} *ben*^{L} } *shu*^{H} }

YTC Applying {{ ***yi***^{HH} *bai*^{L} ***yi***^{H} *shi*^{LH} ***yi***^{H} *ben*^{L} } *shu*^{H} }

Surface Tone {{ ***yi***^{HL} *bai*^{L} ***yi***^{H} *shi*^{LH} ***yi***^{H} *ben*^{L} } *shu*^{H} }

Again, this supports (H1) that YTC only applies to the first element of a pword (the first *yi* in ‘111 books’) but not in other positions (the second and third *yi* in ‘111 books’).

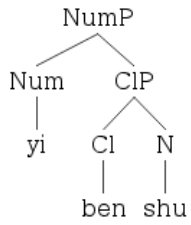
More evidence supporting the hypothesis has been provided in Group C and D –Numeral Classifier phrase, and Ordinal Numeral phrase. In these groups, all of the examples have clitics (ordinal prefix *di-*, numerals, classifiers) therefore cliticization re-bracket the syntactic surface structure. I will no longer discuss the original syntactic trees for simplification. The FFR and PW Formation presented in (Eg. 5 -9) below are as explicit as possible. The prosodic structure only shows the largest pword of the given syntactic expression, even though there are smaller pwords contained within.

Group C: Numeral Classifier Phrase "*yi* + CL + Noun"

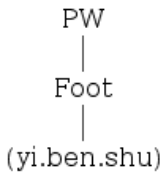
(Eg. 5) 'one book'

yi *ben* *shu*
one CL book

Original Syntactic Structure



Prosodic Structure



Cliticization: **{*yi*-*ben*}** shu Num-CL Pword

Rebracketing: **[[*yi*-*ben*]** shu]

Re-applying FFR:

(i) Lowest Footing (*yi.ben*) *shu*

(iii) Left-to-right Joining: ((*yi.ben*) *shu*)

PW Formation:

FAR $[_{Foot}$ $]_{Foot}$

$ALIGN_3$ $[_{PW}[_{PW}$ $ALIGN_3$ refers to smaller pword

PW Spelling out: $_{PW2}$ **{** $_{PW1}${ ***yi*-*ben***} $_{PW1}$ *shu*} $_{PW2}$

Underlying Tone　　{ { ***yi***^{H} *ben*^{L} } *shu*^{H} }

YTC Applying　　{ { ***yi***^{HL} *ben*^{L} } *shu*^{H} }

Surface Tone　　{ { ***yi***^{HL} *ben*^{L} } *shu*^{H} }

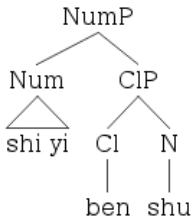
Since classifiers are clitics, therefore need to be attached to the neighboring lexical host leftwards to form pword. However, the classifier and the noun are within the same foot based on syntactic constituent. Pword should contain at least one foot and its boundary shall correspond with the morpho-syntactic boundary.

(Eg. 6) '11 books'

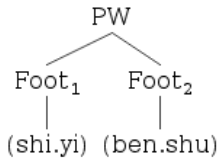
shi　*yi*　*ben*　*shu*

ten　one　CL　book

Original Syntactic Structure



Prosodic Structure



Cliticization:　　**{***shi-**yi**-ben***}** shu　　Num-CL Pword

Rebracketing:　　**[[***shi-**yi**-ben***]** shu]

Re-applying FFR:

(i) Lowest Footing　　(*shi*. *yi*) *ben shu*

(iii) Left-to-right Footing　　(*shi*. *yi*) (*ben*. *shu*)

PW Formation:

FAR　　[$_{Foot}$　　]$_{Foot}$

ALIGN$_3$　　[$_{PW}$[$_{PW}$　　ALIGN$_3$ refers to smaller pword

PW Spelling out:　　$_{PW2}$ **{** $_{PW1}${ *shi-**yi**-ben*} $_{PW1}$ *shu*} $_{PW2}$

Underlying Tone **{{** *shi*^{LH} ***yi***$^{\boldsymbol{H}}$ *ben*^{L} } *shu*^{H} }

YTC Applying **N/A** *yi* is not the first element of any pword

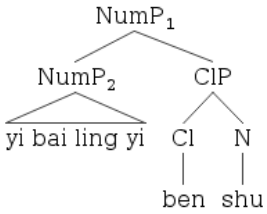
Surface Tone **{{** *shi*^{LH} ***yi***$^{\boldsymbol{H}}$ *ben*^{L} } *shu*^{H} }

(Eg. 7) '101 books'

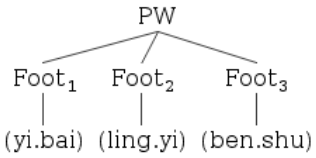
yi *bai* *ling* *yi* *ben* *shu*

one hundred zero one CL book

Original Syntactic Structure



Prosodic Structure



Cliticization: {**{*yi*-*bai*-*ling*-*yi*}***ben*} shu Complex-Num Pword

Num-CL Pword

Rebracketing: **[[[*yi*-*bai*-*ling*-*yi*]***ben***] shu]

Re-applying FFR:

(i)Lowest Footing (*yi.bai*) *ling. yi. ben.shu*

(ii) Left-to-right Footing (*yi.bai*) (*ling.yi*) (*ben.shu*)

PW Formation:

FAR $[_{Foot}$ $]_{Foot}$

ALIGN$_3$ $[_{PW}[_{PW}$ ALIGN$_3$ refers to smaller pwords

PW Spelling out: $_{PW2}$ **{** $_{PW1}${***yi***-*bai*-*ling*-***yi***-*ben*} $_{PW1}$ *shu*} $_{PW2}$

Underlying Tone { { { ***yi***$^{\boldsymbol{H}}$ *bai*^{L} *ling*^{LH} ***yi***$^{\boldsymbol{H}}$ }*ben*^{L} } *shu*^{H} }

YTC Applying { { { ***yi***$^{\boldsymbol{HL}}$ *bai*^{L} *ling*^{LH} ***yi***$^{\boldsymbol{H}}$}*ben*^{L} } *shu*^{H} }

Surface Tone { { { ***yi***$^{\boldsymbol{HL}}$ *bai*^{L} *ling*^{LH} ***yi***$^{\boldsymbol{H}}$} *ben*^{L} } *shu*^{H} }

All numeral classifier expressions in Group C present supportive evidence for the hypothesis that YTC only applies to *yi* when it is the first element of a pword. Sometimes the

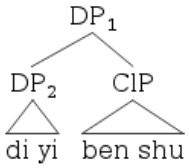
pword is “numeral-classifier” structure, sometimes there is a bigger pword “numeral-classifier-noun (monosyllabic)”.

Group D: Ordinal Phrase ‘*di-*’

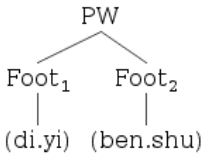
(Eg. 8) ‘the 1st book’

di	*yi*	*ben*	*shu*
Ordinal	one	CL	book

Original Syntactic Structure



Prosodic Structure



Underlying Tone {(*di*. ***yi***^{H}) (*ben*^{L}. *shu*)}

(v) YTC Applying N/A

Surface Tone *di*. ***yi***^{H} . *ben*^{L}. *shu*

Cliticization: **{***di-**yi**-ben***}** shu

Rebracketing: **[[***di-**yi**-ben***]** shu]

Re-applying FFR:

(ii) Left-to-right Footing (*di*. *yi*) *ben shu*

(iii) Left-to-right Joining (*di*. *yi*) (*ben*. *shu*)

PW Formation:

FAR $[_{Foot}$ $]_{Foot}$

ALIGN$_3$ $[_{PW}[_{PW}$

PW Spelling out: $_{PW}$ **{** *di-**yi**-ben* - *shu***}** $_{PW}$

OD-Num-CL Pword

ALIGN$_3$ refers to smaller pword

Only one PW allowed based on the two constraints

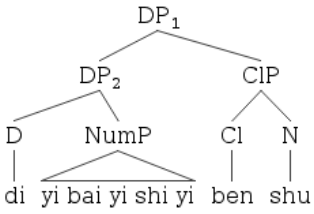
Underlying Tone	{ di^{HL} $\boldsymbol{yi^{H}}$ ben^{L} shu^{H} }	
YTC Applying	**N/A**	*yi* is not the first element of any pword
Surface Tone	{ di^{HL} $\boldsymbol{yi^{H}}$ ben^{L} shu^{H} }	

In an "ordinal-numeral-classifier" expression, all three elements are clitics. None of them can freely stand by itself. Ordinal prefix *di-* needs to attach to the following numeral root. Num-CL is one clitic group. These clitics behaviors will result a new pword "OD-Num-CL."

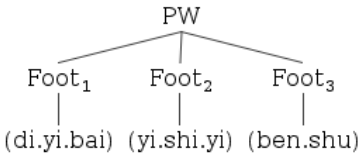
(Eg. 9) 'the 111st book'

di	*yi*	*bai*	*yi*	*shi*	*yi*	*ben*	*shu*
OD	one	hundred	one	ten	one	CL	book

Original Syntactic Structure



Prosodic Structure



Cliticization:	{*di*-**{*yi*-*bai*-*yi*-*shi*-*yi*}**-*ben*} shu	Complex-Num Pword OD-Num-CL Pword
Rebracketing:	[*di*-[***yi***-*bai*-***yi***-*shi*-***yi***]-*ben*] shu]	
Re-applying FFR:		
(i) Lowest Footing	*di* (*yi.bai*) (*yi.shi*) *yi. ben.shu*	
(ii) Left-to-right Footing	*di* (*yi.bai*) (*yi.shi*) (*yi.ben*) *shu*	
(iii) Left-to-right Joining	(*di* (*yi.bai*)) (*yi.shi*) ((*yi.ben*) *shu*)	
PW Formation:		
FAR	$[_{Foot}$ $]_{Foot}$	
$ALIGN_3$	$[_{PW}[_{PW}$	$ALIGN_3$ refers to smaller pwords
PW Spelling out:	$_{PW3}\{_{PW2}$ **{** *di* $_{PW1}$**{*yi*.*bai*.*yi*.*shi*.*yi*}** $_{PW1}$ *ben*$\}_{PW2}$ *shu*$\}_{PW3}$	

Underlying Tone	{{*di* {***yi***^{H}. *bai*^{L} ***yi***^{H}. *shi*^{LH} ***yi***^{H}} *ben*^{L}} *shu*}
YTC Applying	{***yi***^{HL}. *bai*^{L} ***yi***^{H}. *shi*^{LH} ***yi***^{H}} →only at smallest PW
Surface Tone	*di*. ***yi***^{HL}. *bai*^{L}. ***yi***^{H}. *shi*^{LH}. ***yi***^{H}. *ben*^{L}. *shu*

Suggested by the hypothesis, YTC only applies to the first element of PW1, which is the first morpheme of ***yi***-*bai*-*yi*-*shi*-*yi* (number '111'). No application happens in PW2 and PW3 since YTC is not applied cyclically.

5.2.2 BTC Rule Application

If the pword domain in (H1) can explain *bu* case, there will be the statement:

Bu Tone Change (BTC) only applies when the morpheme *bu* appears as the initial element of a phonological word.

There are two conditions can be tested by this hypothesis.

On one hand, when *bu* functions as an infix in the "A-not-A" or RCV structure, it always appears between content words as a clitic and attaches to the neighboring lexical host. Since there is always a content word preceding *bu* in these structures. *Bu* will never be at the initial position of a pword. According to (H2), BTC will not apply since *bu* is not at the initial position of a pword. This result is consistent with the fact that infix *bu* never undergoes the BTC rule.

On the other hand, when *bu* functions as a negative prefix in the negation structure, it is also a clitic. This bound prefix will attach to the following host, usually either a monosyllabic or disyllabic Adjective/Verb, forming a pword structure (*bu*-.σ) or (*bu*-.σ.σ). In such structures, *bu* is always at the initial position, which will undergo BTC according to (H2).

In conclusion, (H2) focusing on BTC has also been tested following the same pword domain proposed by (H1). I recapitulate that nearly all morpheme specific tone changing problems involving *yi* and *bu* are predictable, based on these proposed rules:

(1) *Yi* Tone Change (YTC) rules only apply when the morpheme *yi* appears as the initial element of a phonological word except in the string of digits.

(2) *Bu* Tone Change (BTC) rule only applies when the morpheme *bu* appears as the initial element of a phonological word.

CHAPTER 6 CONCLUSION

6.1 Summary of *yi* and *bu*

I have defined the Mandarin *yi-bu-qi-ba* rule as a form of morphologically conditioned tone change, containing a set of three different morpheme-specific tone change rules. The different morphological properties of each morpheme determine their various natures.

By stating these differences in Chapter 1, I have clarified that the tone changing of *yi* and *bu* are triggered by different phonological and morpho-syntactic environments.

On the other hand, the question of *yi* tone change is more complicated. Analyzing this through a rule-based approach, and applying the rule to *bu* case, I have concluded that TC rules only apply when *yi/bu* is at the initial position of any phonological word except in a string of digits.

6.2 The Historical Change of *qi* and *ba*

The reason why the morphemes *qi* (‘seven’) and *ba* (‘eight’) are exceptions to this general morphological tone change rule is not cleared. There are at least two possible explanations:

(i) The tone change rules are similar to the “exceptional” linguistic forms that are stored in speakers’ mental lexicon. *Qi* and *ba* are not used as frequently as *yi* in spoken language. They lack the non-numeral use that *yi* has in many situations. Similar to *wu,* the morphemes *qi* and *ba* are primarily used only as numerals. Speakers thus do not have to implement these tone change rules very often, which results in the rules being gradually forgotten over time.

(ii) Although the tone change rules of *qi* and *ba* have been removed from the most recent edition (the 5th edition, 2005) of the *Xian-dai Han-yu Ci-dian* ("Modern Chinese Dictionary"), the "standard manual" of spoken and written Mandarin Chinese, the tone change still remains in the speech of many elderly Chinese, and in some of the regional dialects in northeastern China. The social and regional status in these speakers' mind triggers the preservation of these tone change rules. In most of these cases, in order to remain a "standard" and well-educated form of speech, Mandarin speakers tend to maintain the citation tone of each syllable thus deny the tone change.

Either of these two reasons could explain the historical change of the *qi* and *ba* rules. At a glance, *yi, qi,* and *ba* are not the only numeral morphemes that have the citation H tone, nor are they the only ones to have undergone a tone changing process. There is one more numeral morpheme that has the H tone –*san* ('three'). However, no tone change had ever applied to this morpheme in recorded history. It is known that tone Sandhi or tone change is highly marked. Is this additional evidence that the trend in tonal languages favors citation tones over changed ones? This thesis did not explore very far on this historic change topic. It is worthwhile to be discussed in future research.

APPENDIX: DATA IN CHINESE

This appendix shows the original orthography ("Chinese characters") of all the data used in the analysis. Simplified characters are presented in this appendix.

	Pinyin (w/o tone markers)	Chinese Character	Meaning
Individual Morphemes	*Yi*	一	'one, a'
	Bu	不	'not'
	Qi	七	'seven'
	Ba	八	'eight'
	Wu	五	'five'
Group B: Complex Numeral Phrases	*yi bai yi shi yi*	一百一十一	'one hundred and eleven'
	yi qian yi bai yi shi yi	一千一百一十一	'one thousand one hundred and eleven'
	yi bai ling yi	一百零一	'one hundred and one'
	wu bai ling wu	五百零五	'five hundred and five'
Group C: Numeral Classifier Phrases	*yi ben shu*	一本书	'a book'
	yi bai ling yi ben shu	一百零一本书	'101 books'
	wu bai ling wu ben shu	五百零五本书	'505 books'
Group D: Ordinal Phrases	*di yi ben shu*	第一本书	'the first book'
	di yi bai ling yi ben shu	第一百零一本书	'the 101st book'
	di wu bai ling wu ben shu	第五百零五本书	'the 505th book'
	di yi bai yi shi yi ben shu	第一百一十一本书	'the 111st book'

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