

Chapter Two

MANDARIN CYCLICITY

Traditionally, with cyclical phonology, cyclicity is understood as having an operation or set of operations apply recursively over a domain as long as conditions for application of the operation are met. To be theory-neutral, cyclicity is a kind of contextual opacity where surface forms appear to have undergone excessive redundant change when underlying forms do not conform to the wellformedness requirements of that language. This in itself does not suffice to warrant the notion of the cycle. To illustrate that a language exhibit cyclicity, it is necessary to show that the change is cycling on some structure, so that the patterns of alternation is sensitive to the organizational structure of a given underlying string. This chapter will first present a discussion of Mandarin. Of central interest is its third-tone sandhi, a phenomenon that exhibits the crucial characteristics of cyclicity. Then drawing upon the ideas of percolation and non-terminal based approaches (see Chapter One and references cited therein), I shall present a treatment of Mandarin tone sandhi. The chapter ends with a summary.

2.1. Mandarin

Tone sandhi in Mandarin (Cheng 1968, Duanmu 1989, Liu 1980, Kaisse 1985, Zhang 1997, among many others) presents strong evidence for both cyclical treatment as well as the relevance of syntactic information in phonological processes (Shih 1986 and references cited therein). Before delving deeply into the issues of cyclicity, this section presents an introduction to some important characteristics of Mandarin. Crucially, two

kinds of tonal alternation will be introduced – the third tone sandhi and tone neutralization. While the relation between the latter and cyclicity is obscure, I shall nonetheless devote some paragraphs to outlining it for the following reasons. Firstly, it contrasts with tone sandhi in position stability. Secondly, it has implications on the prosody of Mandarin, an area of discussion inevitable in the study of Mandarin tone sandhi and cyclicity.

2.1.1. TONAL INVENTORY

There are four citation tones in Mandarin. (2.1-1) presents the tones in Mandarin.

(2.1-1) Tones in Mandarin

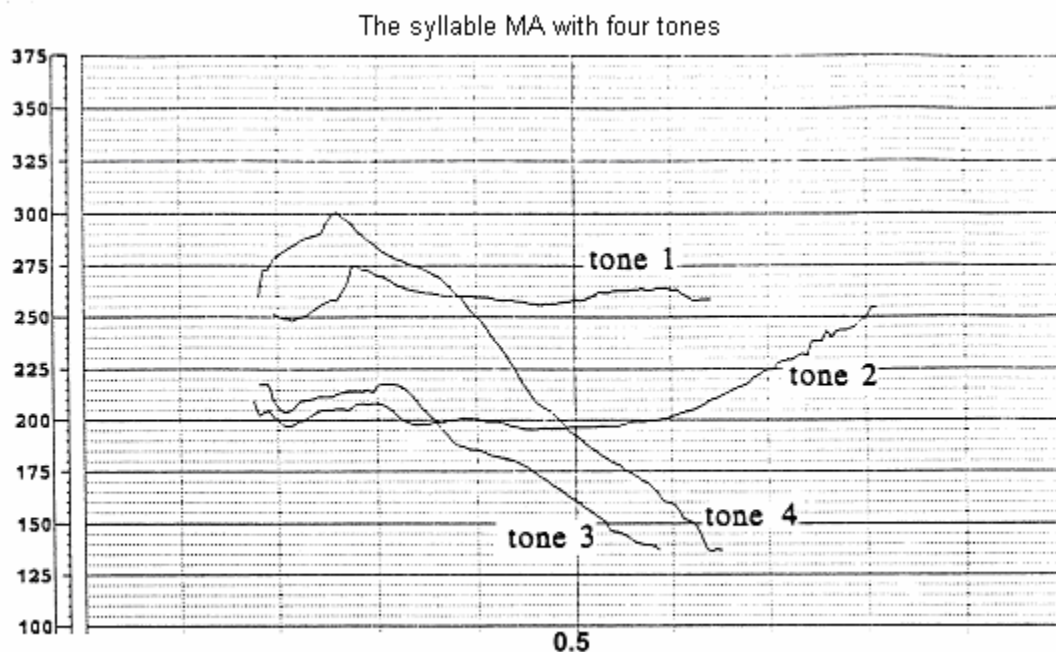
	Abbreviation	Pitch value	Yip (1980)	Description
First tone	T1	[55]	H,h	High, flat
Second tone	T2	[35]	H,lh	Rising
Third tone	T3	[11] or [214]	L,l or L,lh	Low, concave
Fourth tone	T4	[51]	H,hl	Falling

The third column in (2.1-1) presents the description of the Mandarin tone contours with the Chao “tone letter” system (Chao 1930). The digits 1 through 5 represent pitch height, 5 being highest. The descriptions provided in (2.1-1) are based on the survey of Chinese languages compiled in Yuan (1956).

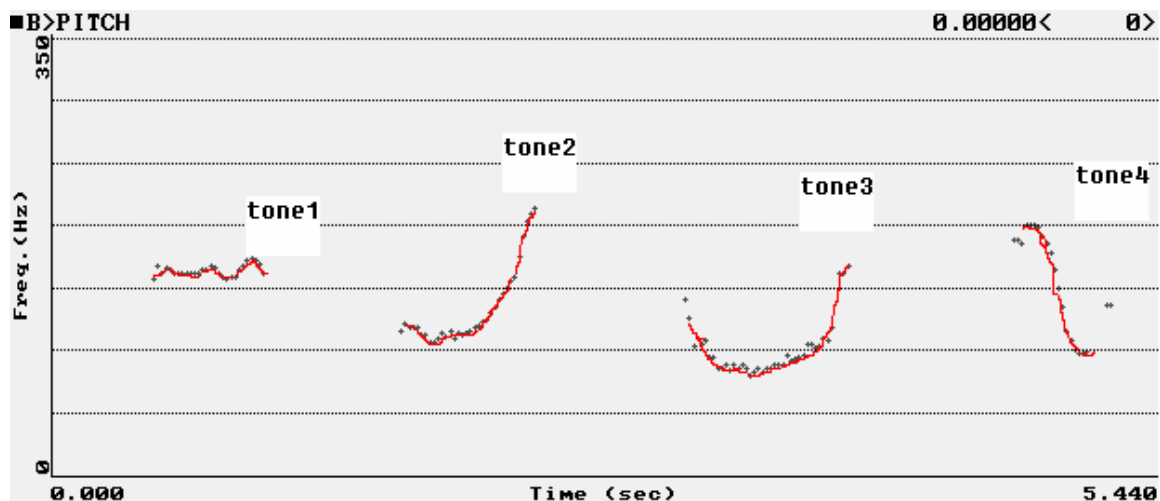
Following Yip (1980:283 and 1995) and references cited therein, in the third column, the upper case “H” denotes upper register while the lower case “h” denotes high pitch. “L” denotes lower register while “l” denotes low pitch. The contour of the tone is then described with lower case letters “h” and “l”. A sequence of [l] and [h] will denote a rising tone from low to high and the reverse would describe a falling tone.

As the reader may notice, there is some discrepancy using the system described under Yip (1980) with respect to the third tone. T_3 has been described as a complex contour tone (falling then rising) in citation and in slow careful speech, but is a flat low in fast speech. This matter is unfortunately not easily resolved through a pitch-track analysis. Shih (1988) reports that T_3 is low, while Hirayama (1984) reports that T_3 is slightly concave. Below, I offer Shih's (1988) pitch tracks and also a set that I made from my own articulation. In both sets of articulation, the syllable *ma* was pronounced in isolation using each of the 4 tones. Details on the articulator of Shih's report were not provided. It appears that my articulation agrees with that reported in Hirayama.

(2.1-2) a. Pitch Tracks of the Mandarin Tones from Shih (1988)



b. Pitch Tracks of the Mandarin Tones articulated by the writer



The figures are displays of the time function of F0 values, with the y-axis representing F0 in hertz and the x-axis representing time (in seconds). It is the pitch track of the syllable ma in four tones: ma1 'mother', ma2 'hemp', ma3 'horse', and ma4 'to scold'. The pitch tracks articulated by the writer are obtained from the pitch extraction function of the CLS computer program.

In addition to these four tones, there is a neutral tone that is generally not treated as part of the tonal inventory (Yip 1980:79ff, Beijing 1995). The phonetic nature of the neutral tone is not stable, that is, one cannot confidently say if it is high, low, falling or rising. Rather, its phonetic form varies. The variation of the neutral tone with its preceding tone is shown below.

(2.1-3) Phonetic value of neutral tone

Environment	Pitch value of neutral tone	
	Beijing (1995:7)	Yip (1980:80ff)
After T1	[3]	[3]
After T2	[2]	[3]
After T3	[4]	[4]
After T4	[1]	[4]

Without regard to the differences in the values reported by Beijing and Yip, the context sensitivity exhibited in (2.1-3) argues against treating the neutral tone as part of the underlying tonal inventory.¹

It is prudent to note that not all Mandarin speakers use neutral tones. Many Mandarin speakers who have roots in the Guangdong or Fujian provinces do not use the neutral tone at all.

2.1.2. TONAL STABILITY

Phonetic details aside, the following paragraphs will introduce tonal alternations found in Mandarin. Except where the tonal details are relevant, I will use the abbreviations provided in the first column of the table on Mandarin tones in (2.1-1). Essentially, given a disyllable sequence, tonal alternation is such that there is either (i) stability in the final syllable or (ii) stability in the initial syllable.

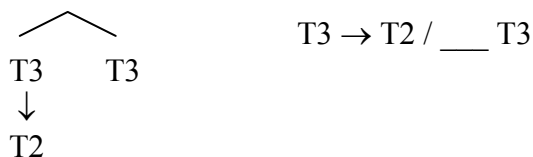
The case of stability in the final syllable is exemplified by the famous Mandarin third tone sandhi. When two T3 syllables are adjacent, the first will change into T2²,

¹ Wang (1997) analyses the neutral tone as a syllable without tonal specification and claims that their occurrences can be lexically specified or derived. He cites examples of multi-syllabic sequences which initial syllable carries a neutral tone (p.161) as well as toneless inflectional morphemes (p.171) as evidence. In some sense, then the neutral tone must be part of the underlying tonal inventory for Wang.

² It is perhaps helpful to mention that given the variation in the actual phonetic realization of T3 as shown by the pitch tracks, treating the sandhied T2 as derived from T3 by some tonal reduction process might not be feasible, especially for those speakers whose T3 is like that given in Shih (1988). To such speakers, a low tone cannot be reduced to becoming a rising tone.

expressed as a rule in (2.1-4). The tree version of the rule is a notational variant of the SPE type.

(2.1-4) Mandarin Tone Sandhi Rule



Excepting for various special conditions, such as sentential boundaries or recitation speed, (2.1-4) is an iron-clad rule, and will apply whenever conditions are met. Given below is a paradigm that would illustrate the third tone sandhi, as well as the lack of sandhi in and with the other tones. Clearly, only T3 adjacency triggers tone sandhi, all other collocations are stable.

(2.1-5) a. T3+T3 (Sandhi-triggering)

- | | | | |
|------|------------|--------------|------------------|
| i. | lao3hu3 | → lao2hu3 | ‘tiger’ |
| ii. | zong3tong3 | → zong2tong3 | ‘president’ |
| iii. | hao3jiu3 | → hao2jiu3 | ‘good wine’ |
| iv. | xie3gao3 | → xie2gao3 | ‘write a script’ |

b. T3+T (No tone sandhi)

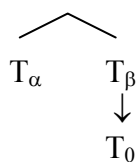
- | | | | |
|------|-----------|-------------|------------|
| i. | lao3shi1 | → lao3shi1 | ‘teacher’ |
| ii. | lao3nian2 | → lao3nian2 | ‘old age’ |
| iii. | lao3zhao4 | → lao3zhao4 | ‘Mr. Zhao’ |

c. Other tonal combinations (No tone sandhi)

- | | | | |
|-------|-------------|---------------|------------------|
| i. | deng1guang1 | → deng1guang1 | ‘light’ |
| ii. | bing1tang2 | → bing1tang2 | ‘rock sugar’ |
| iii. | feng1si3 | → feng1si3 | ‘sealed’ |
| iv. | bing1kuai4 | → bing1kuai4 | ‘ice cube’ |
| v. | yang2guang1 | → yang2guang1 | ‘sunlight’ |
| vi. | niu2tou2 | → niu2tou2 | ‘cow’s head’ |
| vii. | peng2you3 | → peng2you3 | ‘friend’ |
| viii. | nian2fen4 | → nian2fen4 | ‘year’ |
| ix. | bing4mao1 | → bing4mao1 | ‘sick cat’ |
| x. | nuo4yan2 | → nuo4yan2 | ‘promise’ |
| xi. | dian4yi3 | → dian4yi3 | ‘electric chair’ |
| xii. | fei4hua4 | → fei4hua4 | ‘gibberish’ |

The case stability of initial tones is exemplified by tone reduction (neutralization) (Detailed analysis see Wang 1997). As aforementioned, this is the process by which the neutral tones in Mandarin are obtained. Initial tones are never reduced. This is expressed schematically in (2.1-6).

(2.1-6)



0 = neutral tone

(2.1-7) Examples of neutralization (data from Zhang 1977)

a.	i.	sheng1xing4	‘nature of character’	noun
	ii.	sheng1xing0	‘untamed’	adjective
b.	i.	zhang4ren2	‘sir’	noun
	ii.	zhang4ren0	‘father-in-law’	noun
c.	i.	di3xia4	‘underneath’	adjective
	ii.	di3xia0	‘underneath’	noun
d.	i.	gao4shi4	‘relate, tell, proclaim’	verb
	ii.	gao4shi0	‘notice, proclamation’	noun
e.	i.	da2shou3 /da3shou3/	‘hit hand’	verb phrase
	ii.	da2shou0	‘bouncer, fighter’	noun

Only a small sample of neutralization is presented above, although all tonal collocations have neutralization examples. Notice in (2.1-7) that initial tones are never reduced, hence are stable. Note however, that the minimal pairs in (2.1-7) do not necessarily imply that the neutral tone is part of the underlying tonal inventory. The contrast between (i) and (ii) in (2.1-7) must come from some kind of morphology that reduces the tone of the second syllable. This is evident from the syntax~phonology co-variation that (i) and (ii) are often different in syntactic category. Further, constituents with reduced tones are never XPs. For example, (ei) is an XP, while (eii) is not.

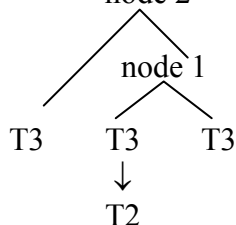
That Mandarin tonal alternations exhibit stability in both initial and final positions is peculiar if one attempts to relate this to prosodic issues. Argument by stability in tonal alternation points in opposite directions – in terms of stability, tone sandhi argues for

iambic and neutralization for trochees. The relevance of this issue should become clear later when one attempts an analysis for Mandarin tone sandhi.

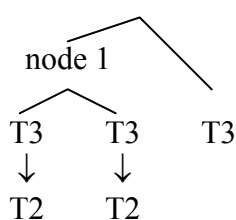
2.1.3. CYCLICITY AND INTERACTION WITH NEUTRALIZATION

Armed now with the two tonal alternations found in Mandarin, this section goes on to show that Mandarin T3 sandhi is described as cyclical because of its structure sensitivity. Given a string of 3 syllables, the resultant surface form is dependent on the prosodic structure of that string. (2.1-8) exemplifies this.

(2.1-8) a. node 2 (e.g. hao3 zong2tong3 ‘good president.’)



b. node 2 (e.g. zong2tong2 hao3 ‘Hello! President.’)



Looking at (2.1-8a) in isolation simply suggests the most economic way of satisfying the tone sandhi requirements. (2.1-8b) alone says nothing more than the fact that the tone on the right edge will not undergo sandhi, but otherwise requires every T3 to alternate into T2. However, when (2.1-8a) and (2.1-8b) are considered together, it appears that tone sandhi is applying from the smallest constituent upwards and will apply as long as the environment is met. It is thus that Mandarin T3 sandhi has been treated as

cyclical application of the tone sandhi rule. The opacity effect in (2.1-8b), which is the need to change more tones than necessary, is made transparent with recursive application from the innermost constituent upwards. This derivation is shown below.

(2.1-9) Cyclical derivations

	(2.1-8a)	(2.1-8b)
Node 1	/T ₃ T ₃ / → [T ₂ T ₃]	/T ₃ T ₃ / → [T ₂ T ₃]
Node 2	/T ₃ / + T ₂ T ₃ → [T ₃ T ₂ T ₃]	[T ₂ T ₃] + /T ₃ / → [T ₂ T ₂ T ₃]

T3 sandhi interacts with neutralization too, as may be seen in (2.1-7e), repeated here in a slightly different format for clarity.

(2.1-10)

UR	:	/da3/ ‘hit’ + /shou3/ ‘hand’
		↓
T3 sandhi	:	da2 shou3 ‘hit hand’
		↓
Neutralization	:	[da2 shou0] ‘bouncer/fighter’

More examples of the /T3+T3/ → [T2 T0] kind

- i. ba2shou0 ‘handle’
- ii. che2shou0 ‘hand-pulling (adj.)’
- iii. da2dian0 ‘arrange’
- iv. jiang2fa0 ‘saying’
- v. na2li0 ‘where’
- vi. qi2huo0 ‘become ablaze’
- vii. zao2qi0 ‘wake up early in the morning’

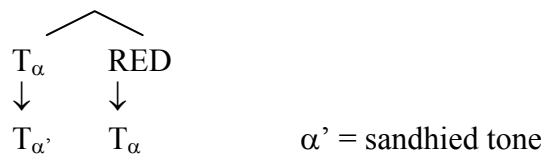
One finds more interaction between neutralization and tone sandhi with Mandarin reduplicated forms. Like (2.1-10), they exhibit contextual opacity in that they trigger T3 sandhi, consistent with the T3 Sandhi Rule (2.1-4). This suggests that the reduplicant must have tonal information relevant to sandhi. It is puzzling how tone sandhi could result from neutral tones unless the tones were there in the first place before they were neutralized. In any case, to wrap up this introduction to Mandarin, the following presents the patterns related to reduplication of a Mandarin syllable. Note that some reduplicants, whose base tones supposedly trigger sandhi, do not trigger sandhi (2.1-11a-iii).

(2.1-11)a. With Neutralized Tones (nouns)



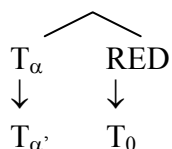
- i. gong1 ‘grandfather’ → gong1gong0 ‘eunuch’
- ii. niang2 ‘mother’ → niang2niang0 ‘lady’
- iii. nai3 ‘milk’ → nai3nai0 ‘granny’
- iv. ba4 ‘father’ → ba4ba0 ‘daddy’

b. With Tone Sandhi (other lexical categories)



- i. zou3 ‘walk’ → zou2zou3 ‘walk (emphatic)’
- ii. xiao3 ‘small’ → xiao2xiao3 ‘very small’

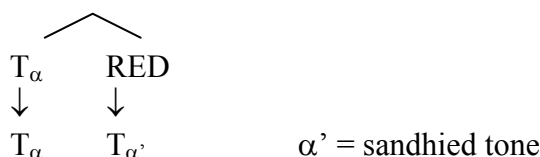
c. With Neutralized Tones and Tone Sandhi



i. zou3 ‘walk’ → zou2zou0 ‘take a short walk’

ii. xiao3 ‘small’ → xiao2xiao0 ‘smallish’

d. With Atypical Sandhi



i. hao3 ‘good’ → hao3hao1de0 ‘properly’

ii. man4 ‘slow’ → man4man1de0 ‘slowly’

2.2. Inter-tier correspondence and cyclicity

Putting aside for the moment the matter on neutralization, let us just instead assume that Mandarin has a right-headed prosody. Further, tone sandhi applies to phonological/prosodic structures, not syntactic structures. In the case of Mandarin, it happens that these two structures match. The interface between prosodic structures and syntactic configurations that will derive this match will be discussed in section 2.3. This provides the firmest grasp on the matter of tone sandhi, which is what is central to the cyclic nature that this chapter addresses. I will postpone matters on prosodic headedness till section 2.4.

This section zeroes-in on the third tone sandhi aspect of the problem since it is this that exhibits the crucial characteristics of cyclicity, i.e. the exhibition of both bleeding and counterbleeding rule-ordering effects depending on the recursivity of the

domain of application. The following paragraphs now move on to applying Inter-tier Correspondence Theory (ICT) to the tone sandhi phenomenon.

2.2.1. INTER-TIER CONSTRAINTS AND MANDARIN TONE SANDHI

The constraints relevant for tone sandhi are given as follows.

(2.2-1) ICT constraints and others relevant for tone sandhi

INT(ertier)F(aithfulness) HD(head)

If node A immediately dominates node B and B is the head constituent, then B must have an identical correspondent in A. (Mandarin is assumed here to be right headed.)

INTF

If node A immediately dominates node B, then B must have an identical correspondent in A.

OCP [T3]³

Do not have adjacent T3 (within a prosodic constituent)⁴.

Cast in OT, INTF in this analysis parallels the IDENT constraints while the tone sandhi is triggered by a markedness constraint, say OCP [T3]. By being positionally faithful to the constituent on the right, it will follow that the first T3 of a T3T3 sequence will be the one that changes. In this analysis, the IDENT constraints are replaced by INTF (Inter-tier Faithfulness, Wee (2000) uses a different name, PERCOLATE) and INTF-HD. However,

³ Following Bao (1999). The exact nature of this is not a main concern at this point.

⁴ That prosodic constituent here refers to the phonological phrase, which will be discussed in section 2.3.

faithfulness to other special positions such as left or head of the constituent is also possible. In any case, INTF-HD is really a kind of positional faithfulness constraint (See Beckman 1998 for detailed discussion on positional faithfulness). Given the way the ICT constraints are formulated, it is important to note that correspondence is strictly between immediately dominating nodes. This would become clear when one consider cases involving more tiers in the next sub-section. To see some of the constraints in action, consider the following candidates as outputs of the ditonal input /T3T3/ and a corresponding tableau. The attested candidate is (2.2-2b), indicated in parenthesis as ‘winner’.

(2.2-2) Input: /T3+T3/ e.g. hao jiu ‘good wine’

- a. candidate (i):
- ```

 T3+T3
 / \
 T3 T3

```
- b. candidate (ii):
- ```

      T2+T3 (winner)
     /  \
    T3   T3
  
```
- c. candidate (iii):
- ```

 T3+T2
 / \
 T3 T3

```

| Input: /T3T3/    | INTF-HD | OCP [T3] | INTF |
|------------------|---------|----------|------|
| Candidate (i)    |         | *!       |      |
| ☞ Candidate (ii) |         |          | *    |
| Candidate (iii)  | *!      |          | *    |

Legend: ☞ = attested optimum      \* = violation mark      ! = crucial violation mark

It is clear that candidate (i) violates one count of OCP [T3] since both tones have percolated faithfully, i.e. the dominating node has one occurrence of T3 adjacency. However, since both the left and the right nodes have perfect correspondence between the

two tiers, there is neither the general INTF violation nor the specific INTF-HD violation. At this point, it is probably worth noting that INTF and INTF-HD have a special relationship. Violation of INTF-HD entails violation of INTF, but not vice versa. Candidates (ii) and (iii) do not incur any violations of OCP [T3], but have other violations of their own. The left constituent of candidate (ii) does not have an identical correspondent at the dominating node. This translates to a violation of INTF. By virtue of not having an identical correspondence between the right constituent and the dominating node, candidate (iii) violates INTF-HD and also INTF. Candidate (iii) has all the violations of candidate (ii) in addition to one of its own, which makes it harmonically bound. There is no ranking that will make this candidate optimal. The competition is between candidate (i) and candidate (ii). To ensure that candidate (ii) surfaces as winner, one simply has to ensure that INTF-HD and OCP [T3] both outrank INTF. In the above tableau, the lack of crucial ranking between OCP [T3] and INTF-HD is indicated by the dashed line while the crucial ranking is reflected by the solid line.

It is important to note that under this analysis, the constraints are **checked at every node in the representation**. Candidate (ii) is predicted to be the optimal candidate under this ranking and would correspond to the phonetic articulation T2T3. The immediate question that arises is the choice of T2 over other tonal possibilities. I will side-step this for the moment (saving this for a later chapter on tonal selection) and concentrate on how this analysis preserves the insight that bleeding and counterbleeding of the Mandarin T3 Sandhi rule is simply the result of having right or left-branching structures. When faithful to the right constituent (i.e. the assumed prosodic head), right-branching structures produce bleeding because nodes on the left asymmetrically c-

command nodes on the right, while left-branching structures produce counterbleeding effects because nodes on the right asymmetrically c-command nodes on the left.

### 2.2.2. CAPTURING CYCLICITY

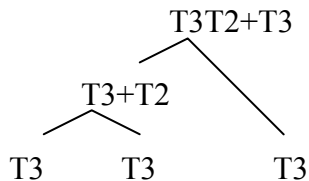
Having explained how the ICT constraints evaluate each candidate, consider now a tritonal left-branching input of T3s and some corresponding candidates. For ease of reference and clarity, violated constraints and the number of violations are indicated at every corresponding tier of each candidate.

(2.2-3) Input: /T3+T3/ +/T3/ e.g. [zong tong] hao ‘Hello!Mr. President.’

| Candidates                                                                                                  | Violations:count                    |
|-------------------------------------------------------------------------------------------------------------|-------------------------------------|
| a. candidate (i):                                                                                           |                                     |
| <pre> graph TD     A[T3T3+T3] --- B[T3+T3]     A --- C[T3]     B --- D[T3]     B --- E[T3]           </pre> | <p>OCP [T3]:2</p> <p>OCP [T3]:1</p> |
| b. candidate (ii): (winner)                                                                                 |                                     |
| <pre> graph TD     A[T2T2+T3] --- B[T2+T3]     A --- C[T3]     B --- D[T3]     B --- E[T3]           </pre> | <p>INTF:1</p> <p>INTF:1</p>         |

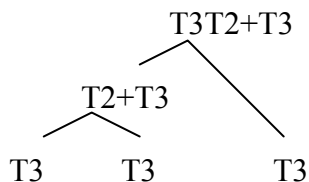


c. candidate (iii):



INTF-HD:1; INTF:1

d. candidate (iv):



INTF:2

INTF:1

In (2.2-3), evaluation of the candidate is done at every tier. The result of the evaluation is given by indicating the relevant constraint at each offending tier. The number of violations is given after a colon following the constraints. Semicolons separate different constraints that are simultaneously violated, for example candidate (iii). Using candidate (iv) as an example, the lower branching node has one count of INTF violation because the leftmost T3 does not have an identical correspondent at the intermediate tier. The highest branching node has two counts of INTF violations because in this case, it faithfully corresponds to both members of its left constituent. (2.2-4) provides an OT tableau to illustrate how the attested candidate is predicted to be optimal.

(2.2-4) Left-branching, tritonal T3 (counterbleeding effect)

| Input: /T3T3/ + /T3/ | INTF-HD | OCP [T3] | INTF |
|----------------------|---------|----------|------|
| Candidate (i)        |         | *!***    |      |
| ☞ Candidate (ii)     |         |          | **   |
| Candidate (iii)      | *!      |          | *    |
| Candidate (iv)       |         |          | ***! |

As may be seen from the above paragraphs, ICT correctly predicts the counterbleeding effects of Mandarin tone sandhi whenever given a left-branching structure. Next, consider a right-branching input. As above, so the below will present the candidate set, the relevant violations and their number of tokens, and also an OT tableau.

(2.2-5) Input: /T3/ +/T3+T3/ e.g. hao [zong tong] ‘good president.’

| Candidates                  | Violation : count                      |
|-----------------------------|----------------------------------------|
| a. candidate (i):           |                                        |
|                             | <p>OCP [T3]:2</p> <p>OCP [T3]:1</p>    |
| b. candidate (ii): (winner) |                                        |
|                             | <p>INTF:1</p>                          |
| c. candidate (iii):         |                                        |
|                             | <p>INTF:1</p> <p>INTF:1</p>            |
| d. candidate (iv):          |                                        |
|                             | <p>INTF:1</p> <p>INTF-HD:1; INTF:1</p> |

## (2.2-6) Right-branching, tritonal T3 (bleeding effect)

| Input: /T3/ + /T3T3/ | INTF-HD | OCP [T3] | INTF |
|----------------------|---------|----------|------|
| Candidate (i)        |         | *!***    |      |
| ☞ Candidate (ii)     |         |          | *    |
| Candidate (iii)      |         |          | ***! |
| Candidate (iv)       | *!      |          | **   |

The ICT has successfully mimicked the counterbleeding and bleeding effects of Mandarin tone sandhi. Crucially, it captures the insight that these effects stem from the recursive application of the same alternation process, in such a way sensitive to structure. Indeed, this approach guarantees structure sensitivity since it is upon this basis that information between tiers corresponds.

### 2.3. Phonological phrases<sup>5</sup>

Though ICT can capture the effects of cyclicity, the analysis presented thus far would not predict the data in (2.3-1), although it is attested. Such data suggest that any analysis of cyclicity must be complemented by some means of determining the domain within which a pattern cycles.

(2.3-1) [<sub>topic</sub> zhe4 zhong2 **jiu3**] [<sub>S</sub> wo3 ai4 he1].

this CL wine I love drink

“This kind of wine, I like to drink.”

<sup>5</sup> This section is adapted from Wee (2000) under the same heading. Thanks to Hubert Truckenbrodt for many of the ideas here.

Notice in (2.3-1), there are two T3s that are adjacent. Tone sandhi seems to have been blocked by the topic boundary. In fact, tone sandhi can also be blocked at the right edge of a preverbal XP when read slowly too. This is shown in (2.3-2).

(2.3-2) [<sub>NP</sub> zhe4 zhong2 **jiu3**] hao3 he1.

This CL wine good drink

“This kind of wine is good to drink”.

When read normally, (2.3-2) would not have two adjacent T3s. It is with very slow reading that (2.3-2) is possible. (2.3-1) and (2.3-2) do not contradict the analysis proposed so far. Rather, they point to some fine-tuning in the direction of finding out the domain of cyclicity. The challenge is in accounting for the tolerance of adjacent T3s in these special cases.

Sandhi blocking presented above is reminiscent of tone sandhi in Xiamen Chinese (Amoy), also Taiwanese, Chaozhou and other Southern Min languages. In Xiamen Chinese, within an XP, the right-most syllable will keep its citation/underlying tone while the tones of all the other syllables will undergo tone sandhi. (2.3-3) provides some examples. The numbers in (2.3-3) indicate the tonal contours, following Chao’s (1930) tone letters.

## (2.3-3) Data from Chen (1987)

p'ang /44/ 'frAGRANT' + tsui/53/ 'water' → p'ang [22] tsui[53] 'perfume'

we /24/ 'shoe' + tua /21/ 'laces' → we[22] tua [21] 'shoe laces'

ts'u /21/ 'house' + ting/53/ 'top' → ts'u[53] ting[53] 'roof top'

pang/21/ 'put' + hong/44/ 'wind' + ts'e /44/ 'kite' → pang[53] hong[22] ts'e [44]

'fly a kite'

Notice that in (2.3-3), the rightmost syllable preserves its tone while all the preceding ones undergo sandhi. However, sandhi is not unbounded. It is blocked when it encounters the right edge of another XP, schematically shown in (2.3-4).

(2.3-4) [[<sub>XP</sub> σ σ σ σ] [<sub>YP</sub> σ σ σ σ]]

The final syllable in the XP in (2.3-4) will not undergo tone sandhi. This is because here there is the right edge of that XP. Chen (1987) argues that there is a tone group boundary at the right edge of every XP in Xiamen Chinese and postulates the following rule.

## (2.3-5) Tone Sandhi Rule (TSR) from Chen (1987)

$T \rightarrow T' / \text{ \_\_\_\_ } T$  within a tone group

Key: T = base tone, T' = sandhi tone

### 2.3.1. CONSTRAINTS ON THE INTERFACE BETWEEN PROSODY AND SYNTAX

Since syntactic relevance is evident, this section shall take as its point of departure a set of constraints on the interface between prosody and syntax. Within OT, Selkirk (1995) and Truckenbrodt (1999) have proposed two relevant kinds of constraints for capturing the Xiamen tone sandhi phenomenon. Selkirk's alignment constraints attempt to map the boundaries of phonological phrases to the boundaries of syntactic phrases. She does so by requiring tone groups to be aligned with syntactic phrases. Truckenbrodt explains why the sandhi rule does not apply across the right edge of an XP with a constraint WRAP-XP. In so doing, Truckenbrodt treats tone groups as phonological phrases (P-phrases). The set constraints are stated in (2.3-6).

#### (2.3-6) **ALIGN-XP, R** (from Selkirk 1995)

For each XP, there is a P-phrase (phonological phrase) such that the right edge of the XP coincides with the right edge of P-phrase.

#### **ALIGN-XP, L** (from Selkirk 1995)

For each XP, there is a P-phrase such that the left edge of the XP coincides with the left edge of P-phrase.

#### **WRAP-XP**<sup>6</sup> (from Truckenbrodt 1999)

Each XP is contained in a P-phrase.

#### **NON-RECURSIVITY** (from Truckenbrodt 1999)

Any two P-phrases that are not disjoint in extension are identical in extension.

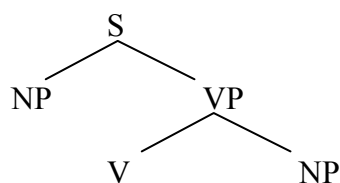
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<sup>6</sup> In Truckenbrodt (1999), XP does not include functional projections but only lexical projections.

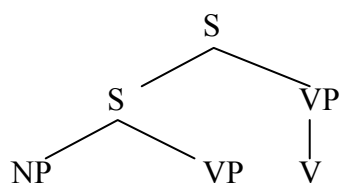
The insight behind the constraint WRAP-XP is that it allows phonological rules to be contained within a domain to prevent over-application. (For an illustration of its effect, see Truckenbrodt 1999 for treatment of Kimatuumbi tone insertion.)

To illuminate the insights behind the constraints listed in (2.3-6), one may consider the following two syntactic representations and how each constraint would respond to the kinds of corresponding prosodic structures. For current purposes, discussions on ALIGN-XP, L shall be withheld until later.

(2.3-7) a.



b.



The following tableaux (2.3-8) show the reaction of the constraints on prosodic constituency, which is marked by the square brackets.

(2.3-8)

| Input: (2.3-7a)   | ALIGN-XP, R | WRAP XP | NON-RECURSIVITY |
|-------------------|-------------|---------|-----------------|
| i. [NP] [V [NP]]  |             |         | *               |
| ii. [NP V NP]     | *           |         |                 |
| iii. [NP] [V NP]  |             |         |                 |
| iv. [NP] V [NP]   |             | *       |                 |
|                   |             |         |                 |
| Input: (2.3-7b)   | ALIGN-XP, R | WRAP XP | NON-RECURSIVITY |
| v. [NP] [VP] [VP] |             |         |                 |
| vi. [NP VP] [VP]  | *           |         |                 |
| vii. [NP VP VP]   | **          |         |                 |

Notice that in (2.3-8), one cannot see clearly the effects of ranking these constraints since all the candidates are harmonically bounded by either (2.3-8iii) or (2.3-8v)<sup>7</sup>. Nevertheless, it should exemplify how these constraints react to various prosodic configurations given a particular syntactic structure. At this point, let me introduce a new constraint that belongs to the WRAP family of constraints.

### (2.3-9) WRAP-IP

Each IP (Infl phrase) is contained in a P (phonological phrase).

Assuming ALIGN-XP, R to be undominated, one can consider the effects of including the WRAP IP constraint with respect to NON-RECURSIVITY. This is illustrated in (2.3-10).

<sup>7</sup> Ranking of ALIGN XP, R, WRAP XP and NON-RECURSIVITY is non-trivial if the input syntactic constituency has two complements [V NP NP]. When WRAP XP;ALIGN XP,R » NON-RECURSIVITY, one would expect a recursive structure [[V NP] NP]. When NON-RECURSIVITY » ALIGN XP, R, then one would get [V NP NP]. For details, see Truckenbrodt (1999).



(2.3-10)

| Input: (2.3-7a)       | ALIGN-XP, R | WRAP IP | NON-RECURSIVITY |
|-----------------------|-------------|---------|-----------------|
| i. [NP] [V NP]        |             | *       |                 |
| ii. [[NP] [V NP]]     |             |         | *               |
|                       |             |         |                 |
| Input: (2.3-7b)       | ALIGN-XP, R | WRAP IP | NON-RECURSIVITY |
| iii. [NP] [VP] [VP]   |             | **      |                 |
| iv. [[NP] [VP] [VP]]  |             | *       | *               |
| v. [[[NP] [VP]] [VP]] |             |         | **              |

As can be seen in (2.3-10), depending on the relative ranking between WRAP IP and NON-RECURSIVITY, one may obtain different prosodic structures given a particular syntactic constituency. Armed with these constraints on prosody-syntax interface, it is now possible to provide an account for the blocking effects in both Xiamen and Mandarin tone sandhi.

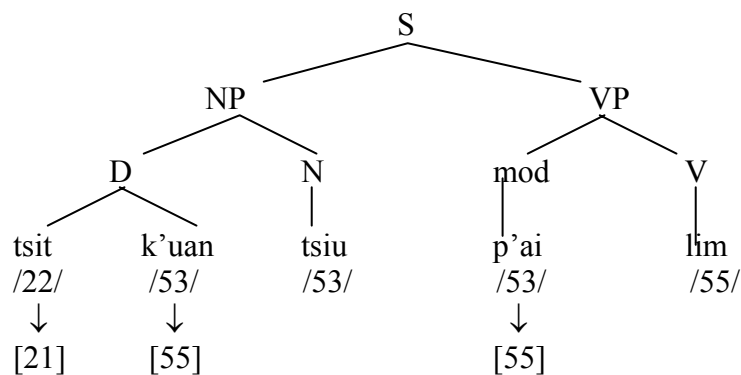
### 2.3.2. THE TONE SANDHI DOMAIN OF XIAMEN

Unlike Mandarin tone sandhi, tone sandhi in Xiamen has not been and need not be thought of as a cyclic phenomenon. The analyses that were provided by Chen (1987), Selkirk (1995) and Truckenbrodt (1999) have been treating the phenomenon as simple rule application within a domain. I will demonstrate this with (2.3-11).

(2.3-11) tsit[21] k'uan [55] tsiu[53] p'ai[55] lim [55].

This CL wine bad drink

This kind of wine drinks terribly.



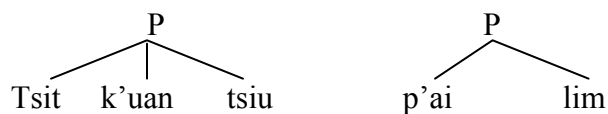
Given the syntactic structure in (2.3-11) and a ranking where NON-RECURSIVITY

» WRAP, one gets the following prosodic structure as optimal (See 2.3-10(i) and (iii)).

(2.3-12) Prosodic Structure of (2.3-11)

| Input: syntactic tree in (2.3-11) | ALIGN-XP, R | NON-RECURSIVITY | WRAP XP | WRAP IP |
|-----------------------------------|-------------|-----------------|---------|---------|
| i. ☞ [tsi k'uan tsiu] [p'ai lim]  |             |                 |         | *       |
| ii. [[tsi k'uan tsiu] [p'ai lim]] |             | *!              |         |         |

(candidate 2.3-12(i))



Now that one has arrived at the prosodic structure in (2.3-12i), the blocking effect of Xiamen tone sandhi may be accommodated by stipulating that a set of well-

formedness constraints, WF<sup>8</sup>, applying within the limits of a P-phrase. The ICT constraints would determine which tones should change. Thus, supposing that WF requires any non-phrase-final tone to undergo tone sandhi, a high-ranking INTF-HD. will dictate that at the first level, [tsit], [k'uan] and [p'ai] undergo tonal alternation. Now, when one looks at the next level, the markedness constraint cannot apply since [tsiu] and [p'ai] are no longer in the same P-phrase. So at this level all the tones may percolate without violating WF. The result will be the surface articulation in (2.3-11). Under this analysis, Xiamen tone sandhi would be similar to Mandarin in that the tone sandhi is the result of having a (set of) markedness constraint(s), WF, and INTF-HD outranking INTF. The difference lies in NON-RECURSIVITY which disallows further embedding of P-phrases in Xiamen. This will become evident in the following section where the blocking of Mandarin tone sandhi is addressed.

Though Xiamen tone sandhi is not cyclic (cf. earlier accounts of Chen 1987 and Truckenbrodt 1999), the apparatus developed here with ICT enables expression of the typological relation between Mandarin and Xiamen.

### 2.3.3. THE TONE SANDHI DOMAIN OF MANDARIN

Having seen how ICT can be compatible with blocking effects of Xiamen tone sandhi, one may employ the same strategy with the blocking effects of Mandarin tone sandhi. Essentially, one can say that in Mandarin, the places where adjacent T3s are tolerated are precisely phonological boundaries, such that the P-phrases are not constituents of a

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<sup>8</sup> Horwood (2000) hypothesizes quite successfully that these constraints are Anti-faithfulness constraints. For current purposes, I will simply use WF to represent the block of relevant constraints.

higher P-phrase. This is especially evident given that adjacent T3 tolerance is more likely in slow speech than fast ones.

Without further ado, consider a ranking such as WRAP-IP; ALIGN-XP, R » NON-RECURSIVITY » WRAP XP. Using this ranking hierarchy, consider (2.3-13), where an example of adjacent T3 tolerance is provided together with a tableau in which a few possible prosodic structures are evaluated against this input.

(2.3-13) Adjacent T3 tolerance (repeated from (2.3-1))

[<sub>topic</sub> zhe4 zhong2 **jiu3**] [<sub>s</sub> wo3 ai4 he1].

this CL wine I love drink

“This kind of wine, I like to drink.”

| Input: syntactic configuration                               | ALIGN-XP, R | WRAP IP | NON-RECURSIVITY | WRAP XP |
|--------------------------------------------------------------|-------------|---------|-----------------|---------|
| [ <sub>topic</sub> zhe4zhong2jiu3][ <sub>s</sub> wo3ai4he1]. |             |         |                 |         |
| i. ☞ [zhezhangjiu] [ [wo] [aihe]]                            |             |         | *               |         |
| ii. [zhezhangjiu] [wo ai he]                                 | *!          |         |                 |         |
| iii. [ [zhezhangjiu] [[wo] [aihe]] ]                         |             |         | **!             |         |
| iv. [zhezhangjiu] [wo] [aihe]                                |             | *!      |                 |         |

(Candidate (2.3-13i))



Under this ranking, candidate (2.3-13i) turns out to be the optimal corresponding prosodic structure. This is because undominated ALIGN-XP R will dictate that there are as many right P-phrase boundaries as there are XPs. WRAP IP requires that all these P-phrases be embedded within a P-phrase that covers the IP/S even if that were to violate NON-RECURSIVITY. Since NON-RECURSIVITY dominates WRAP XP, there may be no

recursive structures of P phrases beyond the highest syntactic node corresponding to the IP or S.

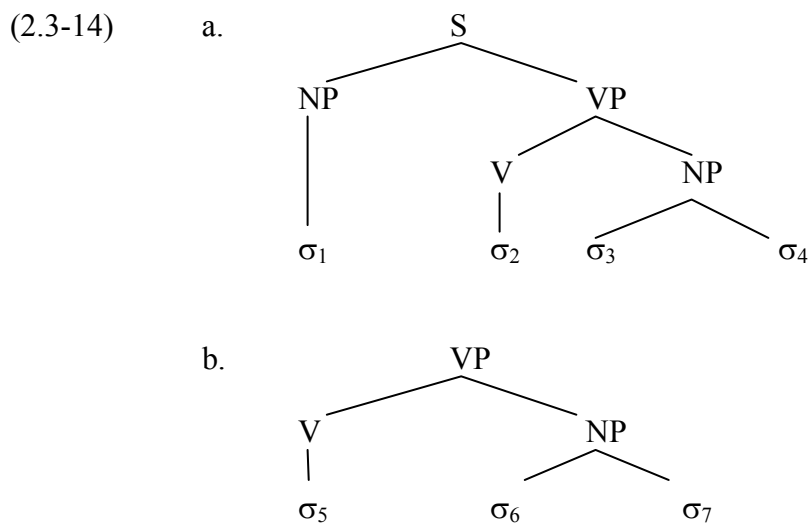
In a prosodic representation such as (2.3-13i), the topic and the sentence no longer belong to the same phonological phrase. Such a representation allows for an account of blocking in Mandarin tone sandhi similar to that in Xiamen. This is because the adjacent T3s no longer belong to the same phonological phrase. If OCP [T3] operates only within P-phrases, then this adjacency does not constitute a violation. These tones may faithfully percolate to the root node. (2.3-2) can be accounted roughly the same way. Notice that in this slow reading case, adjacent T3s are tolerated between the subject NP and the VP. To get this result, one simply has to assume that in slow speech, NON-RECURSIVITY outranks all the WRAP Constraints, similar to that in Xiamen. This mode of analysis may be extended to cover situations of fast speech. In fast speech, except for the rightmost T3, all consecutive T3 syllables undergo alternation. To achieve this result, one simply needs to rank NON-RECURSIVITY above ALIGN XP, R.

The appeal of this analysis extends beyond these two Chinese languages. Slave (Rice 1987) presents another case where phonological conditions seem to be sensitive to IP domains. In Slave, high tones are aligned to the right edge across phrasal boundaries and apparently are blocked only when one reaches the S or the S', corresponding to the IP or the CP in more modern syntactic frameworks.

#### 2.3.4. A LESSON FROM RIGHT-BRANCHING STRUCTURES

While the prosody-syntax interface constraints work well in predicting the tone sandhi blocking in Mandarin, it is useful to take a step back and apply them to simple right-

branching syntactic structures. In so doing, it will become clear that right-branching syntactic constituency actually yields a flat prosodic structure. This calls forth the need for a constraint such as ALIGN XP, L. (2.3-14) illustrates this.

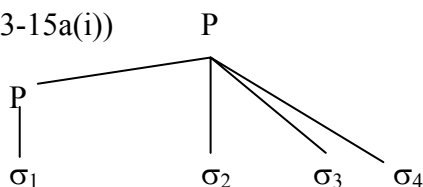


By ALIGN-XP R, one would have expected there to be a right edge of a P-phrase to be at  $\sigma_1$ ,  $\sigma_2$ ,  $\sigma_4$ ,  $\sigma_5$  and  $\sigma_7$  in the trees above. Since ALIGN-XP-R; WRAP IP » NON-RECURSIVE, one would expect recursive P-phrases to be possible. However, the effect of NON-RECURSIVITY can still be felt so that (2.3-14a) has the prosodic structure in (2.3-15a).

(2.3-15) a. Erroneous Prosodic tree for (2.3-14a)

| Input: syntactic tree in (2.3-14a)                 | ALIGN-XP, R | WRAP IP | NON-RECURSIVITY | WRAP XP |
|----------------------------------------------------|-------------|---------|-----------------|---------|
| i. $\wp$ $[[\sigma_1] \sigma_2 \sigma_3 \sigma_4]$ |             |         | *               |         |
| ii. $[[\sigma_1] [\sigma_2 \sigma_3 \sigma_4]]$    |             |         | **!             |         |
| iii. $[[\sigma_1] [\sigma_2 [\sigma_3 \sigma_4]]]$ |             |         | **!*            |         |
| iv. $[\sigma_1] [\sigma_2 \sigma_3 \sigma_4]$      |             | *!      |                 | *       |

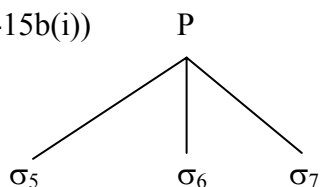
(Candidate (2.3-15a(i)))



b. Prosodic tree for (2.3-14b)

| Input: syntactic tree in (2.3-14b)      | ALIGN-XP, R | WRAP IP | NON-RECURSIVITY | WRAP XP |
|-----------------------------------------|-------------|---------|-----------------|---------|
| i. $\wp$ $[\sigma_5 \sigma_6 \sigma_7]$ |             |         |                 |         |
| ii. $[\sigma_5] [\sigma_6 \sigma_7]$    |             |         |                 | *!      |

(Candidate (2.3-15b(i)))



(2.3-15a) as the optimal candidate for a right-branching structure is problematic.

Suppose that  $\sigma_1, \sigma_2, \sigma_3$  and  $\sigma_4$  are all T3. With a flat structure and a requirement that the rightmost syllable to remain unchanged, two possibilities remain open to resolve the tone clash. One would predict that either  $\sigma_1$  and  $\sigma_3$  undergo tone sandhi or  $\sigma_2$  and  $\sigma_3$  undergo tone sandhi. This is because given a string of 4 syllables, minimally two must change to avoid adjacent third tones. However, the second case is not attested.

There is no problem with (2.3-15b). In (2.3-15b), by virtue of INTF-HD,  $\sigma_7$  must percolate faithfully. Thus, only  $\sigma_6$  will change since it is the minimal change required to satisfy OCP [T3].

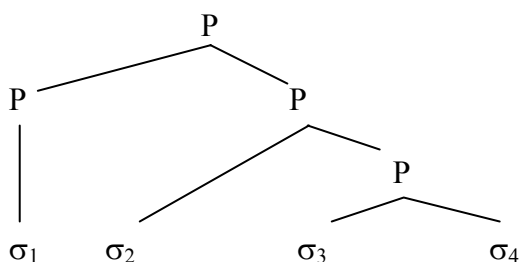
A simple way to resolving the problem caused by structures such as (2.3-15a) without creating adverse effects on the analysis thus far is to appeal to ALIGN XP, L, repeated below.

(2.3-16) **ALIGN-XP, L** (from Selkirk 1995)

For each XP, there is a P (phonological phrase) such that the left edge of the XP coincides with the left edge of P.

A high-ranking ALIGN XP, L would rule against the structure in (2.3-15ai) in preference for the structure (2.3-15aiii), shown below in (2.3-17).

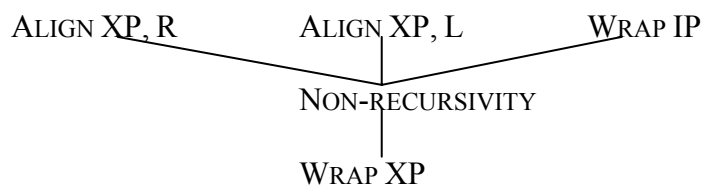
(2.3-17) Structure of candidate (2.3-15aiii)



(2.3-17) is a recursive right-branching structure. The workings of INTF, INTF-HD and OCP [T3] will be as per outlined earlier, producing the effect of modifying only the tones of  $\sigma_1$  and  $\sigma_3$ . To obtain this structure as optimal, it is crucial that ALIGN XP, L dominates NON-RECURSIVITY. The ranking hierarchy is now updated as follows.



## (2.3-18) Ranking hierarchy for Mandarin syntax~prosody interface



The high-ranking of ALIGN XP, L and ALIGN XP, R may make the use of WRAP XP look superfluous. To think so would be a grave mistake. WRAP XP would require that CPs be contained in phonological phrases. However, it is necessary that CPs be excluded from being contained in phonological phrases since tone sandhi does not apply across the topic boundary. At the risk of being repetitive, it is worth mentioning that the alignment constraints do not dictate that CPs be contained within phonological phrases. They simply require that the edges of CPs coincide with the edges of phonological phrases. Since the constituents of CPs are XPs, it follows that if these lower XPs correspond to phonological phrases, the edges of CPs would align with the edges of phonological phrases.

## 2.3.5. BLOCKING THE PREVERBAL NP

Recall now (2.3-2), where adjacent T3s are apparently tolerated between the preverbal NP and the following verb. The data are repeated below with a few other examples.

(2.3-19)a. [NP zhe4 zhong2 **jiu3**] **hao3** he1.

This CL wine good drink

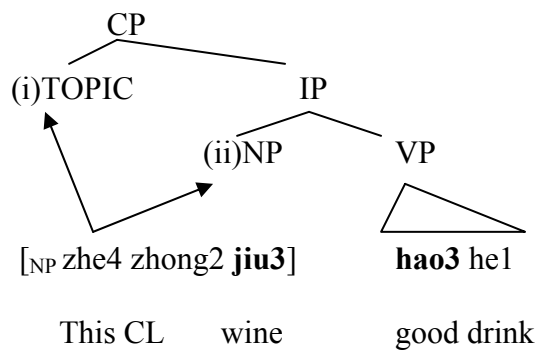
“This kind of wine is good to drink.”

- b. [NP **jiu3**] **hao3** he1.  
       wine good drink  
       “Wine is good to drink.”
- c.? [NP **wo3**] **hen3** pang4.  
       I very fat  
       “I am very fat.”
- d.\* Ma1ma0 xiang4xin0 [NP **wo3**] **hen3** pang4.  
       Mother believe I very fat  
       “Mother believes that I am very fat.”

In (2.3-19a, b) adjacent T3s are allowed. There is apparently less tolerance in (2.3-19c) and zero tolerance in (2.3-19d), indicated by the boldface typescript. It goes without saying that in all the above cases, applying tone sandhi would yield grammatical forms. It is the tolerance that is puzzling since if the preverbal NP is the subject in all these cases, then (2.3-19a-c) are certainly unexpected. After all, WRAP IP does require that subject NPs be contained within phonological phrases, subsequently undergoing tone sandhi.

The entire set of data can easily be accounted for if one assumes that cases where T3 adjacency is tolerated are where the preverbal NPs are topics rather than subjects. Given (2.3-19a), for example, there are two possible syntactic parses.

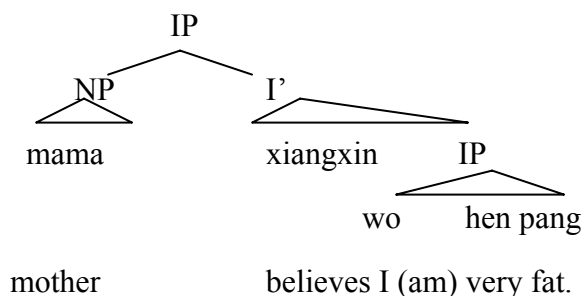
(2.3-20)



“This kind of wine is good to drink.”

The NP *zhe zhong jiu* may be parsed into the (i) spec IP position or into (ii) spec CP position. This is why in Mandarin, the distinction between topics and subjects is difficult. Subjects can often be topicalized leaving the spec IP position empty. Ex hypothesi, the domain of tone sandhi is contained within the IP, thus parsing *zhe zhong jiu* within or without the IP is tantamount to whether the T3 collocation is within the tone sandhi domain. One way of disambiguating the possible parses is through embedding, as in (2.3-19d). This forces the preverbal NP (in this case *wo3* “I”) to be in the spec (embedded) IP position, and hence within the sandhi domain, consequently must undergo tone sandhi.

(2.3-21)



### 2.3.6. INTERIM SUMMARY

The use of inter-correspondence accounts for cyclic effects, crucially capturing the insight of structure sensitivity. The locus of alternation is determined by asymmetries in the ranking of ICT constraints, in this case, crucially the dominance of INTF-HD over the general INTF. However, guarantee that tone sandhi does not overapply comes from the restriction of the markedness constraint to within a domain, i.e. the phonological phrase in the case of Mandarin tone sandhi. This brings forth the question of how phonological phrases are determined and is answered by syntax~prosody interface constraints proposed in Selkirk (1995) and Truckenbrodt (1999). Building on Truckenbrodt's WRAP family of constraints, I propose the use of WRAP-IP to partition the topic from IP/S that follows it, thus blocking of tone sandhi application across the topic boundary. Under this account of Xiamen and of Mandarin, cyclicity is simply the result of how two markedness constraints (tone sandhi triggering constraints and NON-RECURSIVITY) interact with syntax~prosody interface constraints. Cyclicity is therefore simply the result of having recursive phonological phrases that may be obtained only when NON-RECURSIVITY is dominated by ALIGN XP, R, ALIGN XP, L and WRAP.

To wrap up this section, the constraints and the ranking hierarchies relevant to the interface between prosody and syntax are given below.

(2.3-22) Constraints relevant to syntax~prosody interface<sup>9</sup>

**ALIGN-XP, R** (from Selkirk 1995)

For each XP, there is a P (phonological phrase) such that the right edge of the XP coincides with the right edge of P.

**ALIGN-XP, L** (from Selkirk 1995)

For each XP, there is a P (phonological phrase) such that the left edge of the XP coincides with the left edge of P.

**WRAP-XP** (from Truckenbrodt 1999)

Each XP is contained in a P.

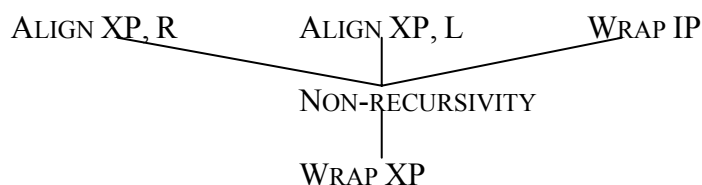
**WRAP-IP**

Each IP is contained in a P.

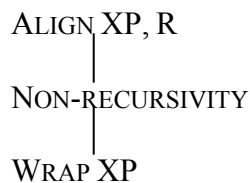
**NON-RECURSIVITY** (from Truckenbrodt 1999)

Any two P that are not disjoint in extension are identical in extension.

(2.3-23)a. Ranking for Mandarin Prosody



b. Ranking for Xiamen Prosody (Only relevant constraints shown)



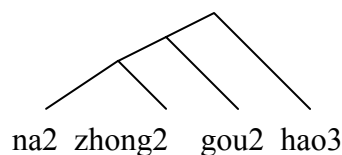
<sup>9</sup> For an alternative treatment on the Mandarin prosodic structures, see Lin (2002).



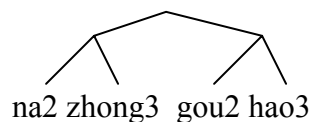


(2.4-3)

a.



b.



However, there is only one unique syntactic structure that corresponds to (2.4-2), and that structure is uniformly left-branching, i.e. (2.4-3a). If tone sandhi applies on prosodic structure, and that there may be more than one prosodic structure corresponding to a particular syntactic configuration (i.e. Shih's view), then the variation in (2.4-2) may be attributed to the prosodic structure being either (2.4-3a) or (2.4-3b). Cyclical application of (2.1-4) will thence produce different results.

An important point to note would be that with since Mandarin tone sandhi is regressive, prosodically recursively left-branching structures and flat binary foot structures yield different sandhi patterns. The former recursive structure produces counterbleeding effects while flat binary footing requires only odd-numbered syllables to undergo sandhi. Obviously also, uniformly right-branching structures and flat binary foot structures will produce identical sandhi patterns.

The relevance of prosody and the fact that tone sandhi in Mandarin is regressive warrant a discussion on the headedness of Mandarin prosody, itself an elusive topic. The difficulties surrounding the determination of the head in Mandarin prosody are already evident from the fact that in a disyllabic sequence neither the initial position (cf. third tone sandhi) nor the final position (cf. neutralization) is stable. Clearly then, an argument



for the location of the prosodic head based on this would not lead anywhere. Without further ado, the following sub-sections present a discussion on the headedness of Mandarin prosody.

#### 2.4.2. HEADLESS MANDARIN

A line of approach towards locating the head of Mandarin prosody, is to study the stress patterns and other phonetic effects of Mandarin. Presumably, prosodic heads carry stress, since heads are assigned grid marks for prominence eventually interpreted as stress (Hayes 1995:380). However, Mandarin stress is highly elusive, and speakers usually cannot feel stress in the language. There are also no pairs of words distinguishable by stress alone. While some have presented pairs consisting of neutral tones and full tones as evidence for stress in Mandarin (W. Li 1981 cited in Duanmu 2000), this is not convincing because their difference may be attributed to tone. As it is then, arguments constructed upon tonal stability may not be used to determine the location of prosodic heads, and Mandarin stress is so elusive that it may well be a stressless system, (a view held by researchers such as Gao and Shi 1963:68). Unable to determine the position of the prosodic head, one might be tempted to describe Mandarin prosody as headless.

#### 2.4.3. MANDARIN PROSODY AS HEAD-FINAL

Despite the lack of clarity in the intuition of native speakers, Chao (1968:35) claims that the final syllable is stressed. Thus, if stress is taken to be indication of prosodic headship, then the prosodic head of Mandarin must be on the right. Wee (2000) further argues for

this position by appealing to phonetic lengthening of the final syllable under emphasis (2.4-4).

(2.4-4) Under emphasis

John is trying to tell Bill about a horse-drawn carriage and Bill who did not catch what John has said, requests for John to repeat.

John says, “ma3 che1.” (ma3che1 = horse-car ‘horse-drawn carriage’)

Bill asks, “What did you just say?”

John repeats, “ ma3 **che1**.”

(2.4-4) parallels phonetic lengthening of English stressed syllables under emphasis. For example, if the situation in (2.4-4) were applied to the English word “banana”, it is the second syllable that gets lengthened, yielding “banaaaaaana”. The second syllable in “banana” is the one that carries primary stress and is the head of the foot that contains it. By analogy, the second syllable of ma3che1 ‘horse-car (horse-drawn carriage)’ is the head of the prosodic constituent that contains it. It is important to note that Wee’s argument rests on the correlation between headship and the possibility of phonetic lengthening. It does not mean that heads must be phonetically longer.

Wee (2000) notes two instances where the final syllable does not undergo phonetic lengthening – (i) where the final syllable has a neutral tone and (ii) where contrastive focus is being applied to some other syllable. These instances are given below.

## (2.4-5) Emphasis involving neutral tone

John is trying to tell Bill about a box and Bill, who did not catch what John had said, requests for John to repeat.

John says, “he2zi0” (he2zi0 = ‘box’)

Bill asks, “What did you just say?”

John repeats, “**he2zi0**”<sup>11</sup>

## (2.4-6) Contrastive focus

bu2 shi4 **qi4** che1, shi4 **ma3** che1.

NEG is motor-car, is horse car.

Not the car, the carriage.

(2.4-5) and (2.4-6) in an oblique way instantiate Wee’s (2000) claim that the prosodic head must be on the right because it shows that phonetic lengthening by default can only apply to the syllable on the right it unless affected by factors such as neutralization<sup>12</sup> and contrastive focus. Wee took pains to further argue for his position by providing a list of disyllabic compounds to show that right-headedness is clearly prosodic and not semantic nor syntactic since many of these compounds have both elements belonging to the same syntactic or semantic category. This is given in (2.4-7), with syllables that allow phonetic lengthening is given in boldface.

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<sup>11</sup> *zi0* is a toneless morpheme, it is not the result of neutralization.

<sup>12</sup> A syllable that has a neutral tone has a shorter articulation time and its surface tone is dependent on the syllable preceding it. This dependency may arguably explain why it cannot be lengthened.

(2.4-7)

| <u>Mandarin compounds</u> | <u>Gloss</u>        | <u>Meaning</u> |
|---------------------------|---------------------|----------------|
| dian4 <b>deng</b> 1       | electric light      | Lamp           |
| da4 <b>ma</b> 2           | marijuana           | marijuana      |
| duo1 <b>shao</b> 3        | more less           | how much       |
| mei3 <b>li</b> 4          | beautiful beautiful | beautiful      |

Other than the possibility of final lengthening, Wee (2000) cites two other phenomena that favor the assumption of Mandarin as being right-headed – (i) meter from Tang poetry (cf. Chapter 1.4) and (ii) stability of the final tone in the nominal reduplication found in lesser variants of Mandarin.

First, consider Tang poetry, a literary form that was extremely popular in the Tang dynasty (618-907) with many modern poets still producing poetry of this genre. In the strictest form of Tang poetry, there are 4 lines of equal length to a stanza. Two lines form a couplet. Each line contains 5 or 7 syllables. (See Chen 1979, Wang 1979 and references therein for detailed analyses.) Not all lines in Tang poetry are well-formed. An important rule in forming lines relates to the tonal category of the even-numbered syllables. (2.4-8) exemplifies this with a line of seven syllables.

(2.4-8)       $(\sigma_1 \sigma_2) (\sigma_3 \sigma_4) (\sigma_5 \sigma_6) \sigma_7$   
                   $T_a \quad T_b \quad T_a$

For the purposes of Tang poetry, tones are divided into two categories, even (E) and oblique (O). The first and second tones of Mandarin, T<sub>1</sub> and T<sub>2</sub>, are considered to belong to the category E and the third and fourth tones, T<sub>3</sub> and T<sub>4</sub>, belong to the category O. Their classification has historical origins irrelevant to our discussion. In Tang poetry, the odd-numbered syllables have a fairly large degree of freedom as to what tone they may bear. The even-numbered syllables however have to contrast, i.e.  $\sigma_2$  must have a different tonal category as  $\sigma_4$  and  $\sigma_4$  must have a different tonal category as  $\sigma_6$ . Since there are only two categories,  $\sigma_6$  will be the same as  $\sigma_2$ . In fact, a common rule of thumb found in old textbooks of Tang poetry states this generalization (though Wang 1979 warns that this generalization is no more than a useful mnemonic guide).

(2.4-9) yi1, san1, wu3 bu2 lun4, er4, si4, liu4 fen1 ming2.

One, three, five NEG discuss, two, four, six, divide clear.

The first, third and fifth (syllables) do not matter; the second, fourth and sixth (syllables) clearly contrasted.

The standard analysis of Tang poetry meter (again see Chen 1979 and references therein) is that each line is parsed into binary feet with the last syllable extrametrical. The feet are right-headed. Together with a principle that dictates the contrast of adjacent feet, the pattern in (2.4-8) is obtained.

It is conceivable that given a string like (2.4-8), one may construct trochaic feet with the first syllable being extrametrical. This line of attack is infeasible because:

- (2.4-10) i. The last syllable is arguably not part of any foot since syllables in the same foot in the poem generally belongs to the same tonal category. Hence, syllable 1 and 2 are both of the same tonal category under default circumstances. They may disagree only if to save a violation of a higher rule in the poetics or when the poet desires to mark the line. The seventh syllable does not exhibit any such dependency on an adjacent syllable.
- ii. The first syllable exhibits extreme dependency on the second syllable with respect to the amount of freedom it has as to what tone it may bear. If the second syllable is an O category tone, the first is usually O, though E is sometimes used. When the second syllable is an E category tone, the first syllable must be E unless the third is also an E. The dependency of the first syllable on the second strongly suggests that these two syllables belong to the same constituent.

It is to the iambic nature of Tang poetry that Wee (2000) appeals to for support in his claim that prosodic head of Mandarin is on the right.

Moving on to nominal reduplication in lesser variants of Mandarin, Wee (2000) noted that there is final tone stability. Among the Chinese community in Malaysia and Singapore (also among some Taiwanese people), pet forms of Mandarin names are obtained by making a copy of the final syllable of the first name. Hence a name such as “Chen Xiaoqiang” will become “qiangqiang”. (Chinese names of the Han ethnicity

typically have two or three syllables. The first syllable is the family name, though there are some disyllabic family names too. The remaining syllables are the first name.) Curiously, tone sandhi occurs with the second and third tones when under such reduplication.

- (2.4-11)
- a. RED + T1 → T1T1
  - b. RED + T2 → T3T2
  - c. RED + T3 → T2T3
  - d. RED + T4 → T4T4

Notice that in all the cases above, it is the syllable on the right that bears the tone of the base. If there were any changes, it is the syllable on the left that changes.

It is unclear why there is sandhi involving T2 but not T1 or T4. One might speculate that it might be that low tones trigger sandhi, since both the second tone and the third tone starts with a low tone. Cheng (1968), cited in Shih (1997), reports that the third tone sandhi applies to a T3 before an English unstressed syllable, which is always read with a low pitch. T3 remains unchanged if it precedes a stressed syllable. Stressed syllables are read with a high pitch.

- (2.4-12)
- a. hao2 professor 'good professor'
  - b. hao3 student 'good student'

In (2.4-12a), hao3 ‘good’, with an underlying T3, undergoes sandhi to become T2 when it precedes an unstressed syllable. With the lack of alternation in (2.4-12b), this suggests that among all the properties that trigger sandhi, the relevant element would be the presence of a low tone.

Neither poetic meter nor nominal reduplication argues conclusively for right-headedness. There is no a priori requirement that poetic meter must match linguistic prosody, as is evident from the mismatch between the iambic Shakespearean sonnets and the trochaic stress patterns of English (Chomsky and Halle 1968, Hayes 1995 especially p.88, Pater 1995 among many others). Likewise, there is no guarantee that variants of Mandarin match standard Mandarin in prosody. However, they do show an asymmetry that favors the element on the right. Such asymmetries support the idea that the prosody is right-headed.

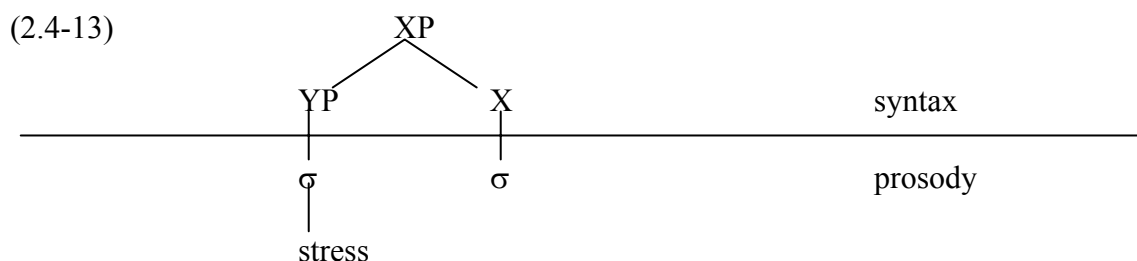
#### 2.4.4. OTHER HEAD POSSIBILITIES OF MANDARIN PROSODY

Wee’s (2000) strongest claim to right-headedness thus resides in the possibility of phonetic lengthening on final syllables. This is not to be confused with arguments for right-headedness that say something to the effect of “final syllables are phonetically longer, and hence are heads” (for example, Chao 1968, Xu 1980 which may be supported by phonetic studies such as Lin, Yan and Sun 1984 and Yan and Lin 1988). Duanmu (2000) discounts the latter argument by citing three different studies. Firstly, Yan and Lin (1988) (cited in Duanmu 2000, not available to the author) found that although the final syllable has the greatest length, it is the initial syllable that has the greatest pitch range. Secondly, Yang (1992) shows that when words are read in isolation, despite the fact that



the last syllable has the longest rhyme duration, the first syllable had the longest onset duration, the greatest amplitude and the highest F-0 peaks. Finally, Wang and Wang (1993) showed that given a target word, it is the initial syllable, not the final syllable, that has the longest duration, when the target word is read in a carrier sentence. In any case, Wee's argument apparently still stands, quite simply because it does not claim that final syllables are phonetically longer; it claims that final syllables can be lengthened.

But Wee's argument is but one argument for right-headedness - that is not convincing enough. Since a case cannot be convincingly made for no prosodic heads in Mandarin or for right-headedness in Mandarin prosody, a natural question to ask would be if a case could be made for left-headedness of Mandarin prosody. Duanmu (2000:pp.136ff) presents a hypothesis along this line. Essentially, his claim is that Mandarin prosody is trochaic, and that syntactic non-heads carry stress (see non-head stress in Cinque 1993). Thus,



Duanmu claims seven pieces of evidence in support of his idea. However, out of these seven, five pertain to the idea that stress exists in Mandarin, only two support the idea that prosody in Mandarin is trochaic. These two are, firstly the location of weak syllables and secondly, the restrictions on word length.

By the location of weak syllables, Duanmu alludes to the fact that neutral tones never occur at the initial position of a disyllabic sequence. However, this in itself is not convincing because one cannot be sure if the effect is due to a trochaic prosody or to some tone-reducing morphological suffixation. Also, by the same argument of tonal stability, third tone sandhi would argue for the opposite position. Thus, to repeat, tonal stability is not going to resolve the issue.

Moving on to the second piece of Duanmu's evidence which is the restriction of word length, consider the following pairs of synonyms and their collocations (data from Duanmu 2000:pp.140f), paying special attention to the syllabic length of the verb.

- |          |    |       |                   |                |
|----------|----|-------|-------------------|----------------|
| (2.4-14) | a. | i.    | zhong             | 'plant'        |
|          |    | ii.   | zhong-zhi         |                |
|          | b. | i.    | suan              | 'garlic'       |
|          |    | ii.   | da-suan           |                |
|          | c. | i.    | zhong suan        | 'plant garlic' |
|          |    | ii.   | zhong da-suan     |                |
|          |    | iii.* | zhong-zhi suan    |                |
|          |    | iv.   | zhong-zhi da-suan |                |

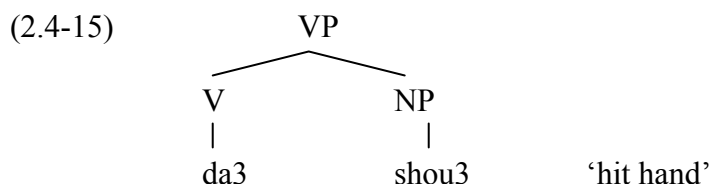
Notice that in (2.4-14), combination of the verb zhong or zhong-zhi 'plant' and the NP suan or da-suan 'garlic' to form a VP is possible except for (2.4-14ciii) when the verb is disyllabic and the object NP is monosyllabic. There is a restriction on the length of the verb. Duanmu's hypothesis provides an explanation to this by appealing to the

weight-to-stress principle (Prince 1990). This principle would require that stress be assigned to the disyllabic V in (2.4-14ciii). However, the V is the syntactic head and the NP is the non-head, it follows the non-head stress hypothesis require the NP to be stressed. Stressing the NP would not be consistent with the weight-to-stress principle. This contradiction is Duanmu's explanation for the word length restriction. Since there are only two pieces of evidence for a trochaic claim, there is as little evidence for this position as there is for Mandarin being iambic.

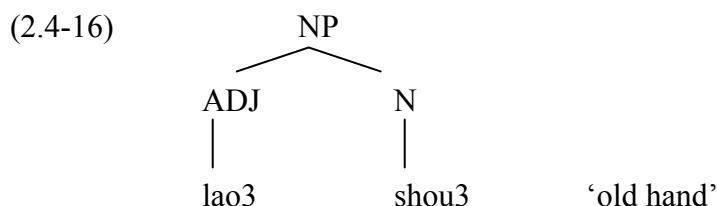
Before discarding the idea that Mandarin is trochaic, it bears noting that in relation to the Mandarin third tone sandhi and neutralization, a trochaic claim, with or without appeal to the non-head stress requirement, appears to provide a handle for a unified analysis for the two phenomena. With neutralization, it is fairly straightforward - the non-initial syllables are unstressed and hence do not carry tones. With third tone sandhi, one may appeal to de Lacy's (1999, 2003) hypothesis that Designated Terminal Elements (DTE) (as did Yip 2002: Chapter 7), i.e. prosodic heads, must avoid low tones. Recall that T3 in Mandarin is arguably a low tone [L] (cf (2.1-1) and (2.1-2)). If Mandarin were trochaic, then in a T3T3 sequence, the first T3 would not be consistent with the requirement that DTEs must not have a low tone. To fulfill this requirement, one might envisage the insertion of a high tone [H] to the initial T3, changing it to a rising tone, which is T2. However, this approach will ultimately fail because by the same token, T3T1 sequences would be predicted to undergo tone sandhi, contrary to fact.

Even if one puts the absence of tone sandhi with T3T1 sequences aside, there are other problems with adopting Duanmu's idea for treat T3 sandhi. Zooming in to

Duanmu's theory that (i) non-syntactic heads are stressed and that (ii) trochees are built rightward, consider a disyllabic VP, such as the one below.



By the non-head stress requirement, the NP should be stressed. However, by the requirement that trochees are built rightwards, the V should be stressed. Duanmu does not provide a way of resolving this. In any case, resolution by prioritizing one requirement over the other will only yield inconsistency in the location of the stressed syllable – iambic in some configurations and trochaic in others. This is exemplified below.



The syntactic head in (2.4-16) is the N. In this case, both Duanmu's requirements would place stress on the first syllable. Now if the trochaic requirement has priority, the non-head stress requirement would be redundant. This in turn creates trouble for Duanmu's observation on the restriction of word length (cf. (2.4-14)). On a different take, the prioritization of the non-head stress requirement would never yield a consistent trochee or iamb for both cases. This mixed situation is not desirable since the locus of

tone sandhi and of neutralization is fairly stable. In a disyllabic sequence, tone sandhi always applies to the initial syllable and neutralization to the final syllable. It therefore appears that whether or not one buys Duanmu's treatment of Mandarin prosody, a trochaic assumption would find one caught in a tug-of-war.

Needless to say, any approach with mixed-headedness for Mandarin prosody will render prosody inapplicable to treating Mandarin tone sandhi or neutralization. By this token, Yip's (1980:147ff, esp 155) idea that Mandarin is trochaic when the structures are left-branching and iambic when right-branching, whether right or wrong, would simply have no bearing on the Mandarin situation at hand. This matter will finally receive treatment in Chapter 4.

## **2.5. Tonological matters of Mandarin Tone Sandhi**

The ICT account for cyclic effects of Mandarin tone sandhi is in disagreement with those given Duanmu (2000) and Yip (2002). Duanmu and Yip assume that Mandarin is left-headed, while the solution proposed in the preceding sections assume that Mandarin is right-headed. In this respect, the motivations behind the tonal alternation differ. The solution to Mandarin tone sandhi in this chapter is thus in tonological disagreement with Duanmu and Yip.

With a left-headed approach, alternation must be due to satisfaction of a markedness constraint on heads. In such an approach, the initial T3, being L, is treated to be marked under the constraint that heads must have a high tone (De Lacy 1999, 2003). The right element which is a non-head under this analysis simply stays as it is. Under this analysis, it is immaterial if T3 is left-adjacent to any tone. As long as it is on the left, then

it is the head, and consequently wants to acquire a H tone, making it to a rising contour. However, in Mandarin, T3 only alternates when left adjacent to another T3. While it may be possible to postulate additional devices to ensure that T3 does not alternate in any other condition except when with another T3, it does seem to miss the point. After all, the strongest piece of evidence that points to left-headedness is that the locus of neutralization is on the right element.

With a right-headed approach, the main idea is that the right element remains faithful by virtue of being the head. The left element is thus the one that alternates due to there being a marked collocation of tones (i.e. the OCP against adjacent T3 tones, but not others possibly due to ranking hierarchies of the kind: Special markedness » Faithfulness » General Markedness). This offers a natural account to why only T3 adjacency triggers alternation. All other collocations do not trigger alternation. In chapter 3, Tianjin provides additional support for this position. In Tianjin, tone sandhi is essentially triggered by OCP, which includes adjacency of L, R and F tones. In fact, the set of Tianjin tone sandhi rules is a superset of the Mandarin T3 sandhi rule. It is clearly desirable that two languages so similar in pattern should be analyzed in fundamentally the same way, rather than to have radically different accounts. However, I hasten to add that a right-headedness approach encounters challenges from neutralization. This is not impossible to circumvent, and shall be addressed later. Having said all the above, I believe that the correct reason behind tone sandhi in Mandarin lies in the OCP rather than a markedness requirement on heads.

## 2.6. Summary

This chapter is dedicated to the treatment of cyclicity through the use of ICT. Essentially, it is the recursive nature of structures that gives rise to cyclical effects, and for that matter other effects of repetitive rule applications such as that found in Xiamen tone sandhi. The chapter began with a detailed introduction of Mandarin, though only the tone sandhi is intimate to this chapter's focus. This was followed by an exploration on the nature of Mandarin prosody, laying the groundwork for understanding the asymmetry in decision when deciding which of the two adjacent third tones undergoes alternation. Though there is a lack of consensus of the location of the prosodic head, it is assumed here that Mandarin is right-headed, thus *ex hypothesi*, modification to the left constituent every time tone sandhi is triggered by an OCP against T3. The structure upon which tone sandhi cycles, is determined by a set of interface constraints between morphosyntax and phonology.

In the next chapter, ICT will be extended to cover a case of directionality, which like cyclicity, is repetitive rule application (to borrow convenient derivational terminology). The challenge offered by directionality is that it does not obviously relate to morphosyntactic structures, which are hierarchical, consequently potentially recursive. Directional effects appear to work linearly which confront the appeal to hierarchies so dear to ICT.