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Phonetics and Phonology of Nantong Chinese

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Phonetics and Phonology of Nantong Chinese

DISSERTATION

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To the people of my hometown — Nantong, Jiangsu, China

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PUBLICATIONS
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2) Nantong Tone Sandhi and Feature Geometry, *Proceedings of the 7th Annual Meeting of the Eastern States Conference on Linguistics*, 1990, Ohio State University.

3) Proto-Chinese Reconstruction Revisited. *Language Sciences* 13:3, 1991.

4) A Generalized Theory of Phonological Timing, *Proceedings of the 3rd Student Conference in Linguistics*, 1991, MIT.

5) Metrical Constituents as Domains of Tone Sandhi, *CLS 28*, 1992, University of Chicago.

6) The Non-Uniqueness Condition and the Segmentation of the Chinese Syllable, *Working Papers in Linguistics*, 41, 1992, Ohio State University.

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CHAPTER I   GENERAL INTRODUCTION

1.0. Motivation, objectives and organization of the present study

The Chinese language consists of many hundreds of often mutually unintelligible dialects. Each of these dialects has its own unique characteristics that are instrumental to our understanding of the universal rules and laws that govern human languages in general, yet very few of them have been thoroughly described by professional linguists. Under the powerful influence of Mandarin, which is by government decree the language of education, of commerce, of performing arts and above all of radio and television broadcasts, these Chinese dialects are rapidly losing their unique characteristics and even becoming extinct. It is my belief that the situation facing these Chinese languages is no less urgent than that facing Amerindian languages nearly a century ago, and a rescue mission akin to the one led by Edward Sapir is needed for the Chinese dialects - not only for the sake of record keeping, but also for the sake of contributing to the foundation of linguistic theories.

Based on these considerations, I chose to study the phonological system of the Nantong dialect for my PhD dissertation. This is not just because the Nantong dialect is my mother tongue and echoes many fond memories of my youth and childhood, but more importantly, it is because the immense complexity of the phonological system of this unique language demands a reasonable account.

Therefore, the first objective of the present study is to provide a faithful description of a phonological system that has never before been studied by theoretical phonologists. From the phonetic characteristics of individual sounds to the phonemicization of the entire sound system, from phonotactic constraints to morphophonemic alternations, from the interactions between segmental and tonal features to the application of phonological rules,

from the prosodic conditioning of phonological rules to the influence of morphology and syntax on prosodic structures, I will demonstrate this novel phonological system with as many details as possible so that my readers might appreciate its beauty and complexity.

The second but equally important objective of this study is to make contributions to the advancement of phonological theories. Over the last century or so, great progress has been made in the scientific study of the organization and patterning of speech sounds. Especially since the publication of Chomsky and Halle (1968), linguists working in the generative framework have been moving closer and closer to a theory of phonology that is powerful enough to account for the rules and representations of speech sounds in all possible human languages, but not so powerful that it predicts patterns that are not and will not be found in any possible human language. Theoretical models have been constructed to deal with all aspects of phonology, from the representation and alternation of individual segments, to the prosodic organization of segments, to the relevance of prosodic and morphosyntactic structures to phonological rules. It is every linguist's responsibility to test these models with reliable data from real languages, and to improve these models whenever necessary. With its rich and complex phonological system, the Nantong dialect serves as a very good test case for this purpose.

This dissertation is divided into seven chapters. In the rest of this chapter, I will present some mostly nonlinguistic background knowledge of Nantong Chinese. In Chapter II, I will discuss certain aspects of modern phonological theory which will become relevant in the course of this study. A number of models for phonological representation will be proposed as an improvement of some existing models. Chapter III is devoted to a study of the underlying segmental and tonal inventory of this language. Phonotactic constraints on the cooccurrrence of consonants, vowels and tones are also discussed in this chapter. Chapter IV is a study of segmental morphophonemic alternations. Chapter V discusses tonal morphophonemic alternations. Chapter VI shows how metrical constituents define the

domains of application of various phonological rules. Chapter VII studies the role of morphological and syntactic structures in phonological processes, especially the relationship between these structures and prosodic structures.

1.1. Location, population and history of Nantong Chinese

Nantong Chinese is spoken by about one million people in an area of about 1000 km² (the area encircled in Figure 2) in and around Nantong City, Jiangsu Province, which is about 180 kilometers northwest of Shanghai across the Yangtse River, as shown below.

(1) Location of the area where Nantong Chinese is spoken
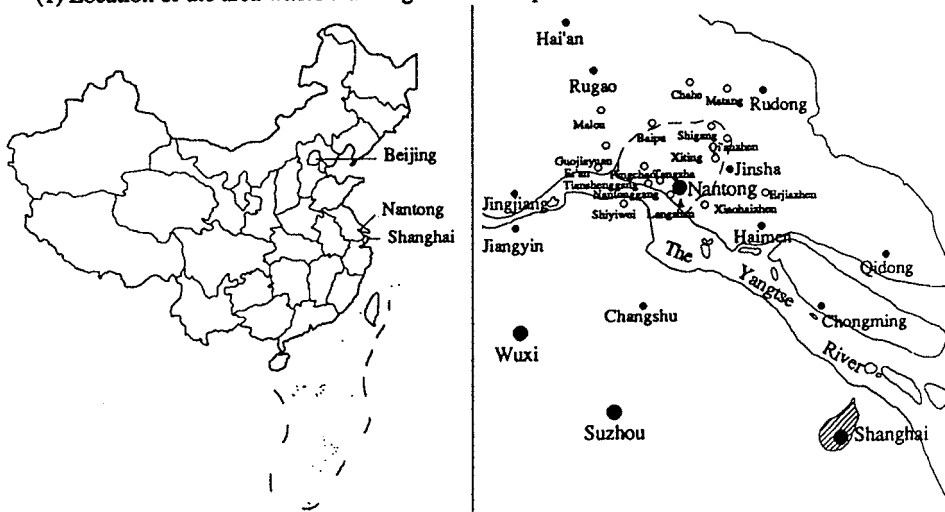
Figure 1 - Where is Nantong in China   Figure 2 - The Nantong area and vicinity

Nantong Chinese is spoken in an area located on the border between Mandarin and Wu dialects. The dialect to the north of this area is Rugao, a Yangtse-Huai variety of Mandarin, and the dialect to the southeast is Haimen, a northern variety of Wu. To the east of this area are two sister dialects of Nantong, called Tongdong and Jinsha. Nantong Chinese shares some characteristics with Yangtse-Huai Mandarin dialects and others with

Wu dialects, and it has characteristics of its own. As a matter of fact, it is unintelligible to speakers of both Yangtse-Huai Mandarin dialects such as Rugao and Wu dialects such as Haimen. The only dialect that is mutually intelligible with Nantong is Jinsha.

(2) Nantong Chinese and its neighboring dialects

Figure 3 - Nantong Chinese and its neighboring dialects

The uniqueness of Nantong Chinese is deeply rooted in its history. Up till the late third century A.D., the Nantong area was still submerged under water. By the end of that century, a sandbar island named Hudouzhou had emerged in the middle of the Yangtse River. It remained as an island for nearly 600 years until the end of the ninth century, when the northern waterway silted up and Hudouzhou became part of the north bank. Figure (3) shows the Nantong area as an island in the year 741 A.D. According to *Taiping Huanyu Ji [The Peaceful World]*, a book of geographical and historical facts published in the early tenth century, the inhabitants of Hudouzhou were exiles who made salt from sea water for a living. Given the location of Hudouzhou and the condition of transportation over a thousand years ago, it is likely that those exiles came from neighboring areas and spoke

different dialects. After a span of nearly 600 years, their dialects gradually merged into one

with mixed characteristics.

(3) The Nantong area as an island in 741 A.D. (adapted from Tan 1982:5-10)
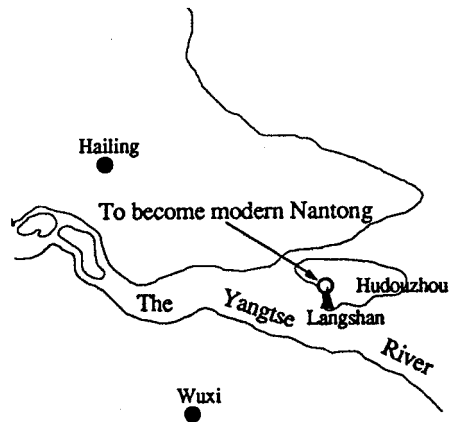
Figure 4 - The Nantong area as an island in 741 A.D.

The two sister languages of Nantong Chinese, Tongdong and Jinsha, were formed

under similar historical circumstances. Tongdong was originally spoken by exiles on

another sandbar island named Dongbuzhou, which was some 500 years younger than

Hudouzhou and became part of the mainland in the eleventh century when it was about 200

years old. Jinsha is simlar to Nantong in some ways and to Tongdong in others. It was

formed on a sandbar island called Nanbuzhou which was located closer to Hudouzhou and

became part of the north bank earlier than Dongbuzhou.

1.2. Relationship of Nantong Chinese with its neighboring dialects

Probably because of their history, the three dialects Nantong, Tongdong and Jinsha

are very closely related to each other. The most unique feature that unifies these three

dialects as one group is the palatalization of labialized alveolar sibilants [tsʷ tsʷʰ sʷ] into

[tɕʷ tɕʷʰ ɕʷ], due to a historical sound change not observed in any other Chinese dialects.

Following are some examples.

(4) The sound change of palatalization in Nantong, Jinsha and Tongdong

Rugao	Nantong	Jinsha	Tongdong	Haimen	Gloss
tsʷéi[1]	tɕʷé	tɕʷé	tɕʷɤ́	tsɤ́i	most
tsʷʰéi	tɕʷʰé	tɕʷʰé	tɕʷʰɤ̆	tsʰɤ́i	crispy
sʷéi	ɕʷé	ɕʷé	ɕʷɤ̆	sɤ́i	shatter

The above data also show that while Rugao and Haimen both allow off-glides in the

syllable coda, Nantong, Jinsha and Tongdong never do.

Among the three dialects Nantong, Jinsha and Tongdong, we note that the alveolar

sibilants [ts tsʰ s] are preserved before the vowel [o] in Nantong but are palatalized before

the same vowel in Jinsha and Tongdong, as shown in (5a); that the ancient contrast

between voiced and voiceless aspirated obstruents is lost in Nantong but retained in Jinsha

and Tongdong, as shown in (5b); and that a contrast between [i̜][2] and [ɛ] is retained in

Nantong but lost in Jinsha and Tongdong, as shown in (5c). These make Nantong distinct

from its two sister dialects Jinsha and Tongdong.

(5) Differences between Nantong and Jinsha/Tongdong

	Nantong	Jinsha	Tongdong	Gloss
a.	tsʰö	tɕʰó	tɕʰó	vehicle
	tsʰö	dzó	dzó	tea
	sö	ɕó	ɕó	snake
b.	tʰö̜	dö̜	dö̜	sugar
cf.	tʰö̜	tʰö̜	tʰö̜	soup
	pʰi̜	bi̜	bi̜	argue
cf.	pʰi̜	pʰi̜	pʰi̜	deceive
c.	tɕɛ̜	tɕi̜	tɕi̜	award
	tɕɛ̜	tɕi̜	tɕi̜	simple

---

[1] The tone marks used in this study are [´], ['], [` ] and combinations of the three. [ ´ ] represents H, or 5 in Chao letters; [ ' ] represents M, or 3 in Chao letters; and [ `] represents L, or 1 in Chao letters.

[2] The tilde indicates nasality. It is used underneath instead of on top of vowel symbols in order to avoid poor legibility when a tone mark is also used.

| tɕí | tɕí | tɕí̢ | shear |

The vocalism in Nantong, though sometimes similar to that in Jinsha, is also quite different from that in its neighboring dialects, as shown below.

(6) Vocalism in Nantong and its neighboring dialects

Rugao	Nantong	Jinsha	Tongdong	Haimen	Gloss
ɕòu	ɕə̌	ɕǔ	ɕǔ	ɕə̂ɯ	repair
kǒŋ	kə̂ŋ	kǒŋ	kóŋ	kô̂ŋ	work
kâŋ	kə̢̌	kǔ̢	ká̢	kâ̂ŋ	steel
tɕǎŋ	tɕɛ̢̂	tɕí̢	tɕí̢	tɕǎ̢	award
sə̂n	sɛ̢̂	sɛ̢̌	sə́ŋ	sə̂ŋ	deep
lɛ̌	lǎ	lǎ	lɛ̌	lɛ̌	come
pò	pə̂	pʊ̌	pó	pô	wrap

There are many other differences among the phonological systems of these dialects. For example, there are six surface tones in Rugao, eight in Haimen, ten in Tongdong, but seven in Nantong and Jinsha. There are lexical differences as well. It is beyond the scope of this study to discuss all these differences. What has been presented so far suffices to establish that Nantong Chinese is a unique Chinese dialect in its own right.

1.3. Dialectal differences within Nantong Chinese

There are internal dialectal differences within Nantong Chinese. Roughly speaking, there are two varieties of this dialect: urban and rural. The urban variety is spoken by most residents of Nantong City and its satellite towns Tianshenggang, Tangzha etc. The rural variety is spoken by most residents of the vast rural area.

There are at least three major differences between the sound systems of the two varieties of Nantong Chinese. Firstly, the contrast between the onset fricative [z] and the onset glide [j] in the rural variety is lost in the urban variety, even though the same contrast is preserved in various forms in many other dialects, as shown below.

(7) The [j] - [z] correspondence

	Rural Nantong	Urban Nantong	Rugao	Haimen	Gloss
a.	zɛ̌	jɛ̌	lɕ̌n	n̠ʲǐn	person
	zó?	jó?	ló?	n̠ǒ?	meat
	zʊ̌	jʊ̌	lǎ̢	n̠ǎ̢	yield
b.	jó?	jó?	já?	já?	medicine
	jǎ	jǎ	jó	jǒ	want

Secondly, when occurring before the vowel [i], urban [tʃ tʃʰ ʃ] corresponds to rural [ts tsʰ s], as shown in the following data.

(8) The [tʃ tʃʰ ʃ] - [ts tsʰ s] correspondence

Urban	Rural	Gloss
tʃɨ̂ŋ	tsɨ̂ŋ	stingy
tʃʰɨ̂ŋ	tsʰɨ̂ŋ	light
tʃʰɨ̂?	tsʰɨ̂?	eat
ʃɨ̂ŋ	sɨ̂ŋ	new

Thirdly, the vowel [u] has merged with [o] before a coda obstruent in every lexical item of the urban variety except for one word ([kɑ?] "that"), but is preserved in many words of the rural variety, as shown below.

(9) The [u?] - [o?] contrast

Urban	Rural	Gloss
tsô?	tsɑ̌?	porridge
tsô?	tsô?	make
lô?	lʊ̌?	green
lô?	lô?	drop

There are a number of sporadic but conspicuous differences in the pronunciation of the two varieties, for example:

(10) Sporadic but conspicuous differences between the two varieties of Nantong

Urban	Rural	Gloss
tʰɨ̌	tʃʰʊ̌	ground
nɨ̌	nʊ̌	mud
nǒ	nʊ̌	take

Again, it is beyond the scope of this study to discuss all the internal dialectal differences of Nantong Chinese. In the rest of this study, I will ignore the rural variety, and focus on the phonetics and phonology of the urban variety of Nantong Chinese.

1.4. Previous studies of Nantong Chinese

The earliest study of Nantong Chinese is a list of 193 words with brief definitions included in a local city annals (*Guangxu Tongzhou Zhi*) published in 1875. A dictionary entitled *Nantong Fangyan Shuzheng [A Glossary of the Nantong Dialect]* was compiled by a local scholar Sun Jinbiao and was published in 1911. A four-volume dictionary entitled *Nantong Changyan Shuzheng [A Glossary of Commonly used words in the Nantong Dialect]* by the same author was published in 1925. Unfortunately, no indication of the sound system of Nantong Chinese is given in any of these publications. The first description of the Nantong sound system appeared in the published results of a 1960 survey of dialects spoken in Jiangsu Province and Shanghai City. A more complete description of dialects spoken in the Nantong area (*Nantong Fangyan Zhi*) is now underway, but so far no publishable results are available.

CHAPTER II   THEORETICAL BACKGROUND

2.0. Introduction

In this chapter, I discuss some theoretical issues in segmental and tonal phonology. I will present, compare and evaluate some models for the representation of segmental and tonal features, and suggest some improvements. I will also outline the basic assumptions of feature underspecification, moraic theory and metrical phonology as a background for readers who are not familiar with these theoretical frameworks.

2.1. Segmental features and feature geometry

2.1.1. Representation of the segment

The theory of distinctive features dates back to the work of the Prague school linguists in the 1930's led by Roman Jacobson and Nicolaj Trubetzkoy, and is fundamental to modern generative phonology. In traditional linear phonology, this theory means that each distinct speech sound is composed of a set of distinctive features, and is distinguished from every other sound by at least one of these features. Phonological processes that change one sound to another operate on distinctive feature(s), not segments. For example, the sounds [s] and [z] differ only in the feature [±voice], as shown below.

(11) Distinctive features in linear phonology

$$
\begin{array}{cc}
[s] & [z] \\
\begin{bmatrix}
\text{-voice} \\
\text{-nasal} \\
\text{+coronal} \\
\text{+anterior} \\
\text{+consonantal} \\
\text{+continuant} \\
\text{-sonorant} \\
\ldots
\end{bmatrix}
&
\begin{bmatrix}
\text{+voice} \\
\text{-nasal} \\
\text{+coronal} \\
\text{+anterior} \\
\text{+consonantal} \\
\text{+continuant} \\
\text{-sonorant} \\
\ldots
\end{bmatrix}
\end{array}
$$

And the alternation between these two sounds as we see in [bæks] "backs" vs [bægz] "bags" where the English plural suffix /z/ surfaces as [s] after voiceless segments but as [z] after voiced ones is due to a phonological process that changes the feature [+voice] of /z/ to [-voice] after a [-voice] sound, which is formulated as C → [-voice] / [-voice] _____.

The assumption embodied in the linear phonological feature theory that each segment is in some way atomic and has its own feature specifications not shared by other segments came under scrutiny as people's attention shifted to studies of suprasegmental phenomena such as tone, stress, syllable structure etc. in the 1970's. Because of the lack of one-to-one mapping between features and feature bearing units, Goldsmith (1976) proposes that tonal features be specified on a partially autonomous tier and connected with tone bearing units with association lines. Clements (1977) organizes vowel features in a similar way to account for vowel harmony processes which resemble tonal processes. Such autosegmental organization of distinctive features makes it possible to prohibit arbitrary feature changing operations and allows one to assume that features can be altered only by deletion followed by either feature spreading or default feature specification. For example, the change from /z/ to [s] is now viewed as due to a process that deletes the [+voice] feature of /z/ and spreads the [-voice] feature from the preceding sound, as shown below. Obviously, if feature changing is realized only by feature spreading from a neighboring segment, then /z/ cannot become [-voice] if its preceding sound is [+voice]

(12) Devoicing in autosegmental phonology

Feature specifications [+voi] [+voi] [-voi] [+voi]   [+voi] [+voi] [-voi]

Feature bearing units

b   æ   k   z   →   b   æ   k   s
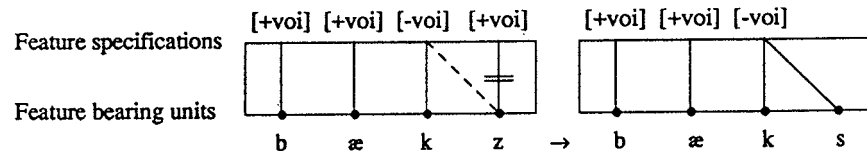
If all features are treated equally this way, then the segment becomes a congregation of many coaxial tiers of autosegmental features, as shown below.

(13) Coaxial feature tiers
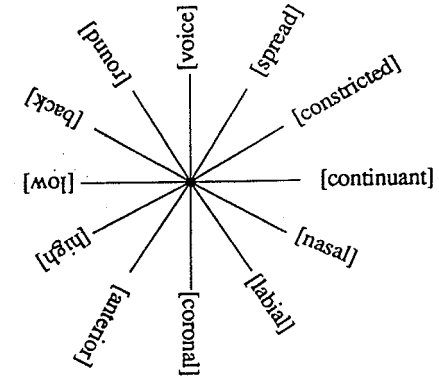
A serious problem with such a model is that it does not explain why some features are often operated on as a cluster, while others are not. For example, it is common for place features ([labial], [coronal], [dorsal] etc.) of a consonant to spread to a neighboring consonant so that the two become homorganic, yet it never occurs in any human language that any arbitrary collection of features such as [labial], [nasal] and [high] may spread together.

Because of this problem, phonologists now agree that phonological feature tiers are not coaxial, but are organized into an hierarchical structure known as the feature geometry. Early models that embody this idea are proposed by Clements (1985), Sagey (1986) and Steriade (1987). The Sagey (1986) model (the S model) is shown on the next page. With such feature geometry models, we can say that features like [labial], [coronal] and [dorsal] tend to spread together because they are grouped under the same place feature class node, which is what is being spread; and that features such as [labial], [nasal] and [high] do not spread together because they are not grouped under the same feature class node.

(14) The S model of feature geometry

```
                    root
         laryngeal        cont
    constr               cons
     spread        supralaryngeal
      stiff             soft palate
          slack  nasal          place
                         labial    dorsal
                    round   coronal   high low back
                          ant    dist
                            dist
```
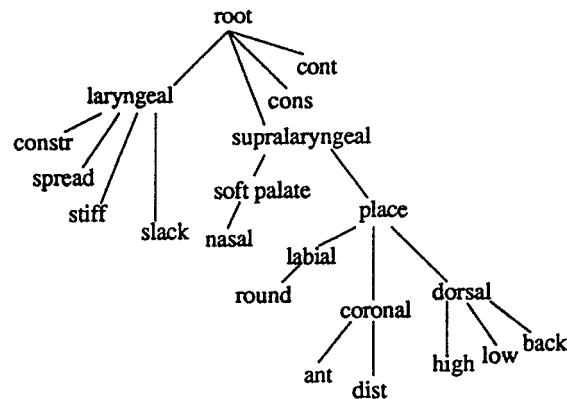
Despite obvious advantages brought about by early models like the S model, there are still problems. One problem is the relationship between the features [round] and [back]. Odden (1991) provides evidence that these features must spread simultaneously as one cluster. Yet this is not possible given their arrangement in the S model, where [round] and [back] do not share a feature class node. Another problem is the interaction between consonantal and vocalic place features. Clements (1989), Hume (1992) and Clements & Hume (1992) provide ample evidence that [round] is related to [labial], [-back] is related to [coronal] and [+back] is related to [dorsal] in various languages. The S model offers no principled explanation for such interactions given the fact that consonantal and vocalic place features are on different tiers in the S model. These problems are attacked in Clements (1989), Hume (1992) and Clements & Hume (1992), among others. From the solutions offered by these authors, we can piece together a new feature geometry model as shown below, which we will refer to as the C&H model.

(15) The C&H feature geometry model

```
                    root
              ±sonorant
              ±approximant
              ±vocoid
         laryngeal        oral cavity
     [voice]                  C-place
     [spread glottis]
     [constricted glottis]              vocalic
          [±continuant]                       aperture
                                 V-place          [±open]
                      [labial]           [±open]
                               lingual
                   [pharyngeal]
                       [coronal]
                             [dorsal]
```
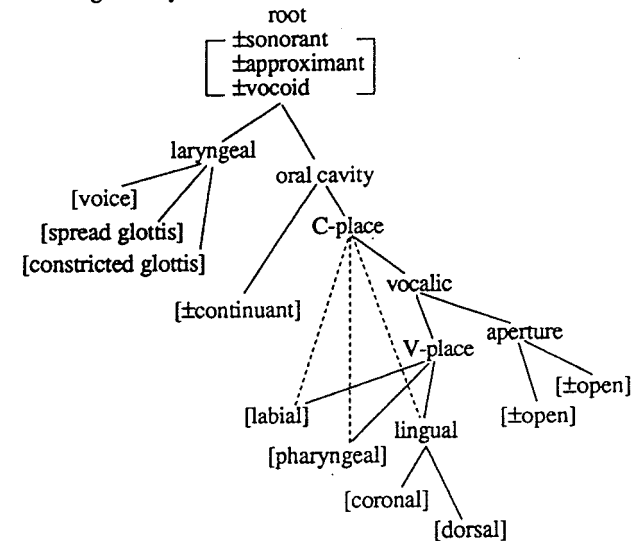
The crucial improvement of the C&H model over the S model is the use of a unified set of place features for both consonants and vowels, with the feature class node being the C-place node and the V-place node respectively. Place features dominated by the V-place node may be used on consonants, but then they are considered secondary features and are interpreted differently from those dominated by the C-place node which are primary place features for consonants. For example, the place features of labial consonants and labialized consonants are represented as follows.

(16) Place features of labialized consonants

```
labialized labial          labialized coronal         cf. plain labial
C-place                    C-place                    C-place

     vocalic                    vocalic
      |                  lingual   |
     V-place                 |    V-place                   |
                        [coronal]
[labial]                            [labial]             [labial]
```
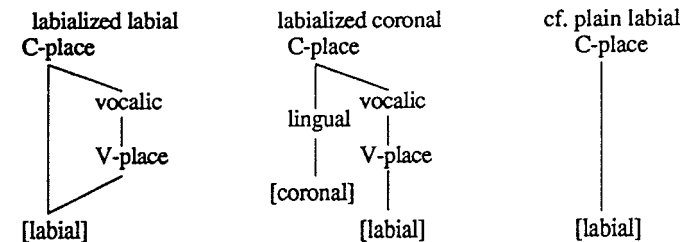
The C&H model captures many well-supported generalizations about the interaction between consonantal and vocalic place features. However, in its present form, this model is so powerful that it can generate many nonexistent phonological contrasts. Since each of the six paths that connect the C-place node and the features [labial], [coronal] and [dorsal] may either stand alone or combine with any other path(s) to represent a simple or complex articulation, a total of 63 such simple or complex articulations can be formed. Most of these articulations are either certainly (indicated with *) or probably (indicated with ?) unattested, as shown in the following table,[1] where primary features are capitalized.

(17) Possible combinations of place features in the C&H model

	Feature combination	IPA	Description
a.	[LAB]	p	labial
	[COR]	t	alveolar
	[DOR]	k	velar
	[LAB][COR]	tp	labioalveolar
	[LAB][DOR]	kp	labiovelar
	[lab]	w	labialized
	[LAB][lab]	pʷ	labialized labial
	[COR][lab]	tʷ	labialized alveolar
	[DOR][lab]	kʷ	labialized velar
	[LAB][COR][lab]	tpʷ ?	labialized labioalveolar ?
	[LAB][DOR][lab]	kpʷ ?	labialized labiovelar ?
	[cor]	i j	unrounded front or palatalized
	[LAB][cor]	pʲ	palatalized labial
	[COR][cor]	tʲ	palatalized alveolar
	[DOR][cor]	kʲ	palatalized velar
	[LAB][COR][cor]	tpʲ ?	palatalized labioalveolar ?
	[LAB][DOR][cor]	kpʲ ?	palatalized labiovelar ?
	[dor]	ɨ ɣ	unrounded back or velarized
	[LAB][dor]	pˠ	velarized labial
	[COR][dor]	tˠ	velarized alveolar
	[lab][cor]	y ɥ	rounded front or labiopalatalized
	[LAB][lab][cor]	pᶣ	labiopalatalized labial
	[COR][lab][cor]	tᶣ	labiopalatalized alveolar
	[DOR][lab][cor]	kᶣ	labiopalatalized velar
	[LAB][COR][lab][cor]	tpᶣ ?	labiopalatalized labioalveolar ?
	[LAB][DOR][lab][cor]	kpᶣ ?	labiopalatalized labiovelar ?
b.	[COR][DOR]	!	alveolovelar
	[COR][DOR][lab]	*	unattested
	[COR][DOR][cor]	*	unattested
	[COR][DOR][lab][cor]	*	unattested
c.	[DOR][dor]	kˠ ?	unattested
	[LAB][DOR][dor]	*	unattested
	[LAB][COR][dor]	*	unattested
	[COR][DOR][dor]	*	unattested
	[lab][dor]	u	rounded back
d.	[LAB][lab][dor]	?	?
	[COR][lab][dor]	?	?
	[DOR][lab][dor]	?	?
	[LAB][COR][lab][dor]	?	?
	[LAB][DOR][lab][dor]	?	?
	[COR][DOR][lab][dor]	?	?
cf.	[LAB][lab]	pʷ	labialized labial
	[COR][lab]	tʷ	labialized alveolar
	[DOR][lab]	kʷ	labialized velar
	[LAB][COR][lab]	tpʷ ?	labialized labioalveolar ?
	[LAB][DOR][lab]	kpʷ ?	labialized labiovelar ?
	[COR][DOR][lab]	*	unattested
	[LAB][COR][DOR][lab]	*	unattested
e.	[cor][dor]	*	unattested
	[LAB][cor][dor]	*	unattested
	[COR][cor][dor]	*	unattested
	[DOR][cor][dor]	*	unattested
	[LAB][COR][cor][dor]	*	unattested
	[LAB][DOR][cor][dor]	*	unattested
	[COR][DOR][cor][dor]	*	unattested
	[lab][cor][dor]	*	unattested
	[LAB][lab][cor][dor]	*	unattested
	[COR][lab][cor][dor]	*	unattested
	[DOR][lab][cor][dor]	*	unattested
	[LAB][COR][lab][cor][dor]	*	unattested
	[LAB][DOR][lab][cor][dor]	*	unattested
	[COR][DOR][lab][cor][dor]	*	unattested
f.	[LAB][COR][DOR]	*	unattested
	[LAB][COR][DOR][lab]	*	unattested
	[LAB][COR][DOR][cor]	*	unattested
	[LAB][COR][DOR][dor]	*	unattested
	[LAB][COR][DOR][lab][cor]	*	unattested
	[LAB][COR][DOR][lab][dor]	*	unattested
	[LAB][COR][DOR][cor][dor]	*	unattested
	[LAB][COR][DOR][lab][cor][dor]	*	unattested

---

[1] This table does not include any uvular or pharyngeal articulations. Also notice that many of the unattested articulations in this table may be generated by Sagey's (1986) model as well.

A number of observations can be made from the unattested articulations shown in this table. First of all, since [DOR] and [dor] are as distinct as [LAB] and [lab] or [COR] and [cor], we expect to find dorsalized dorsals in (17c) as easily as we find labialized

(rounded) labials or coronalized (palatalized) coronals in various languages. Yet such sounds never surface in any human language[2].

Secondly, the C&H model predicts the existence of labiodorsalized consonants such as those in (17d) which presumably contrast with labialized consonants such as those in (17a). Such contrasts are superfluous.

Thirdly, there is no principled way in the C&H model to rule out coronodorsal vowels and coronodorsalized consonants, such as those in (17e), even though Clements (1989) admits that such vowels are non-existent.

Finally, the C&H model predicts that there can be complex articulations involving three primary articulators, such as those in (17f), which have never been found to exist.

All these problems result from the assumption that [dorsal] is just like [labial] and [coronal] and may serve as a feature both for a consonant-like major articulation and for a vowel-like minor articulation. The overgenerativity of the place feature model based on this assumption suggests that it is an incorrect assumption.

To avoid this overgenerativity problem of the C&H model without losing its insight that consonants and vowels share the same set of place features, I propose a new place feature geometry model. In this model, the features [labial] and [coronal] are each linked to the C-place node either directly or through the V-place node, depending on whether these features represent a primary or secondary articulation. The feature [dorsal], on the other hand, is always linked to the C-place node through the V-place node, whether this feature represents a velar consonant or a back vowel. This model is shown as follows.

---

[2] Clements and Sezer's (1982) claim that Turkish contrasts plain dorsal stops that are transparent to back harmony with coronalized or dorsalized dorsal stops that are opaque to back harmony is theory-specific. Assuming that the transparent dorsals are underspecified and opaque dorsals are fully specified, we can explain the transparency and opacity of Turkish dorsal stops without having to recognize dorsalized dorsals.

(18) Place feature geometry[3]

This place feature geometry is different from the C&H model in a number of ways. First, a dorsalized dorsal is structurally impossible, since it would be specified with a primary [dorsal] and a secondary [dorsal], a contrast that does not exist in this model. Second, since there is only one interpretation of [dorsal], the alleged contrast between plain labialized and dorsolabialized consonants (i.e. [lab][COR] vs [lab][dor][COR]) no longer exists. Third, since the secondary feature [coronal] is no longer sister to [dorsal], coronodorsal vowels are structurally impossible. Finally, the fact that there is no designated primary [dorsal] feature makes the representation of triply complex primary articulation impossible. For these reasons, combining terminal features in the new place feature geometry yields an inventory of only 17 articulations as listed below. Since it is meaningless in this place feature model to refer to the feature [dorsal] as primary or secondary, it is represented as [Dor], i.e neither [DOR] nor [dor].

(19) Inventory of complex and secondary articulations in the new place feature geometry

Feature combination	IPA	Description
[LAB]	p	labial
[COR]	t	alveolar
[COR][Dor]	ʈ	velarized alveolar (retroflex)
[Dor]	k ɨ	velar or unrounded back
[LAB][COR]	t͡p	labioalveolar
[LAB][Dor]	k͡p	labiovelar
[lab]	w	rounded or labialized

---

[3] In the following discussion, I will ignore placement of the feature [pharyngeal] and leave that to future investigations.

[LAB][lab]	pʷ	labialized labial
[COR][lab]	tʷ	labialized alveolar
[COR][Dor][lab]	ʈʷ	labialized velarized alveolar (retroflex)
[Dor][lab]	kʷ u	labialized velar or rounded back
[LAB][Dor][lab]	k͡pʷ	labialized labiovelar
[cor]	c i	palatal or unrounded front
[LAB][cor]	pʲ	palatalized labial
[COR][cor]	tʲ tɕ	palatalized alveolar or alveopalatal
[cor][lab]	cʷ y	labialized palatal or rounded front
[LAB][lab][cor]	pᶣ	labialized palatalized labial
[COR][lab][cor]	tᶣ	labialized palatalized alveolar
[LAB][COR][lab]	t͡pʷ ?	labialized labioalveolar ?
[LAB][COR][cor]	t͡pʲ ?	palatalized labioalveolar ?
[LAB][COR][lab][cor]	t͡pᶣ ?	labialized palatalized labioalveolar ?
[LAB][COR][Dor]	*	unattested
[LAB][COR][Dor][lab]	*	unattested

Notice that [cor] may not cooccur with terminal [Dor], because it is dominated by [Dor] and thereby rendering the latter nonterminal.

Although this new place feature geometry model is much more constrained than the C&H model, there are still a number of problematic or unattested feature combinations. The explanation for this seems to be the fact that it is hard to find plain complex segments such as k͡p or t͡p in the first place and therefore it is even harder to find secondarily articulated complex segments.

A potential problem with this new place feature geometry is total vowel harmony. For example, Clements and Hume (1992) report that in the Servigliano dialect of Italian, post-tonic stem vowels are identical to the vowel in the suffix, as shown below.

(20) Servigliano vowel harmony

a.	birikɔ́kan-a	apricot tree	birikókun-u	apricot
	pétten-e	comb	péttin-i	combs
	álam-a	soul	álem-e	souls
b.	prédok-o	I preach	prédik-i	you preach
	stómmuk-u	stomach	stómmik-i	stomachs
	doménnak-a	Sunday	doménnek-e	Sundays

Clearly, the Servigliano vowel harmony process involves simultaneous spreading of all vowel features. Given the assumption that the [dorsal] feature is linked to the C-place node via the V-place and the vocalic node, one would predict that dorsal consonants block total vowel harmony. Yet the Servigliano data in (20) show that dorsal consonants are as transparent to total vowel harmony as labial and coronal consonants are. To explain this paradox, we must assume that in Servigliano the dorsal consonants are underspecified for place features. Thus, plain coronal or labial consonants do not block vowel harmony because they do not have a vocalic node; and dorsal consonants do not block vowel harmony either because their vocalic node is underlyingly not specified, as shown below.

(21) Dorsal transparency in Servigliano vowel harmony

péttVn-i > péttin-i   prédVk-i > prédik-i
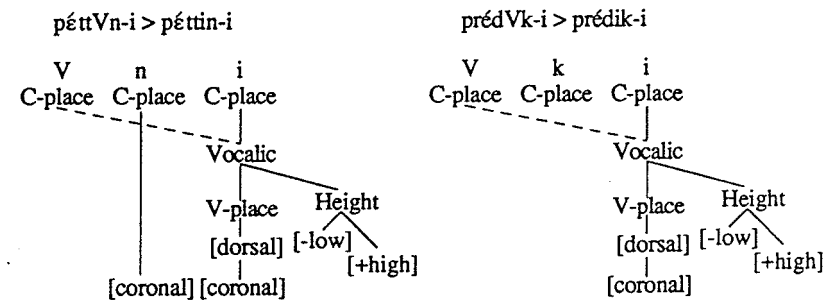
A seemingly problematic case is the Klamath vowel harmony reported by Barker (1963). In this language, the vowel in the causative prefix always agrees with that of the stem, as shown below.

(22) Klamath vowel harmony

ǧeːy̆ig-ɑ	"is tired"	sne-ǧeːy̆ig-ɑ	"makes tired"
qdoːč-ɑ	"it rains"	sno-qdoːč-ɑ	"makes it rain"
m'aːsʔ-ɑ	"is sick"	sna-m'aːsʔ-ɑ	"makes sick"

Since dorsals (e.g. [g]) and uvulars (e.g. [q]) are contrastive in Klamath, it seems that they cannot both be unspecified for [dorsal]. However, if we follow McCarthy (1989) and assume that the [dorsal] feature of uvulars is associated with the pharyngeal node, as

opposed to the [dorsal] of velars which is associated with the C-place node. Since the only pharyngeal consonants in Klamath are the uvulars, their [dorsal] feature is predictable. Thus, the uvulars can be distinguished from the velars by the presence or absence of the pharyngeal node. Consequently, the [dorsal] feature can be unspecified for both uvulars and velars.

A real problematic case is the vowel harmony in Maltese Arabic reported by Hume (1992). In this language, the second person singular suffix surfaces as [-ik] word-medially, as [-ek] word-finally, but as [-ok] if the stem vowel is [o], as shown below.

(23) Maltese Arabic vowel harmony

a.	ʃorob	"he drank"	jiʃrob	"he drinks"	jiʃroblok	"he drinks for you"
b.	tebaħ	"he cooked"	jitboħ	"he cooks"	jitboħlok	"he cooks for you"
c.	tines	"he cried"	jitnos	"he cries"	jitnoslok	"he cries to you"
d.	gideb	"he lied"	jigdeb	"he lies"	jigdiblek	"he lies to you"
e.	daħak	"he laughed"	jidħak	"he laughs"	jidħaklek	"he laughs to you"
f.	siredʒ	"he fried"	jisredʒ	"he fries"	jisredʒlek	"he fries for you"

Hume (1992) argues for independent reasons that the default place feature in Maltese Arabic must be [coronal]. Therefore, [dorsal] must be specified underlyingly and ought to block complete vowel harmony, which is not the case.

On the other hand, in languages with both dorsals and coronalized dorsals, we predict that the coronalized dorsals cannot be transparent to total vowel harmony or back harmony, since they must have their V-place node specified in order to be distinct from the plain dorsals. Furthermore, the plain dorsals can be either transparent or opaque to vowel harmony depending on whether they are underlyingly specified for vowel place features. There is some empirical evidence for these predictions. In Turkish, for example, coronalized dorsals are always opaque to back harmony, though plain dorsals may be either transparent or opaque to back harmony, as shown below.

(24) Dorsal opacity in Turkish vowel harmony

	Nom. sg.	*Acc. sg.*	*Gloss*
a.	ip	ip-i	"rope"
	el	el-i	"hand"
	kiz	kiz-i	"girl"
	sap	sap-i	"stalk"
b.	harʲf	harʲf-i	"letter"
	hilʲalʲ	hilʲālʲ-i	"crescent"
	imsak	imsākʲ-i	"fasting"
c.	sevk	sevk-i	"drive"
	hālʲik	hālʲik-i	"creator"
d.	renk	renkʲ-i	"color"

The data in (24a) show that the vowels in the stem and the suffix must agree in backness, which can be accounted for by spreading the [dorsal] node from the stem vowel to the suffix vowel. Since the intervening labial or coronal consonant does not have any vocalic or dorsal specification, it will not block the spreading process. On the other hand, the consonants [rʲ], [lʲ] and [kʲ] in (24b) are coronalized consonants according to Clements and Hume (1992) and are therefore specified with the secondary place feature [coronal] which is dominated by [dorsal] in the present model. If the spreading of [dorsal] were to start from the stem vowel, then the new association line between the [dorsal] feature of the stem vowel and the V-place node of the suffix vowel will cross the association line between the [dorsal] feature and the V-place node of the intervening dorsal consonant, violating the constraint that association lines may not cross. However, if we assume that the spreading starts from the intervening dorsal consonant, then the suffix vowel's being [coronal] (i.e. a front vowel) can be attributed to the fact that the intervening dorsal is also [coronal]. A similar account can be made for the data in (24c). Assuming that this set of data is reliable[4], we can say that in this case, spreading of the [dorsal] feature also starts from the intervening dorsal consonant, except that this time the consonant is not coronalized, and

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[4] According to Clements and Sezer (1982), such words are very few and only used in certain idiolects.

therefore the suffix vowel becomes back instead of front. With regard to (24d), a possible analysis treats the stem-final consonant as underlyingly a plain dorsal, which is tranparent to the back harmony triggered by the stem vowel [e], and becomes coronalized after the back harmony.[5] This is believed to be evidence that while dorsalized or coronalized dorsals are opaque to back harmony, plain dorsals are transparent. However, since the so-called dorsalized dorsals have never been found to surface as phonetically distinct in any language, a better analysis is to assume that the transparent dorsals are not specified for place features while opaque dorsals are. Following is an illustration of this new analysis.

(25) Dorsal transparency and opacity in Turkish back harmony

```
renk-I > renkʲ-i
    e        n        k        I
 C-place  C-place  C-place  C-place
    |        |                 |
 Vocalic              Vocalic
    |                    |
 V-place              V-place
    |                    |
 [dorsal]     |
    |         |
 [coronal] [coronal]
```

```
imsākʲ-I > imsākʲ-i
    ā        kʲ        I
 C-place  C-place  C-place
    |        |        |
 Vocalic  Vocalic  Vocalic
    |        |        |
 V-place  V-place  V-place
    |        |
 [dorsal] [dorsal]
             |
          [coronal]
```

```
hālʲik-I > hālʲik-ɨ
    i        k        I
 C-place  C-place  C-place
    |        |        |
 Vocalic  Vocalic  Vocalic
    |        |        |
 V-place  V-place  V-place
    |        |
 [dorsal] [dorsal]
    |
 [coronal]
```

In contrast to Turkish, both palatals and velars are transparent to back harmony as shown below.

(26) Hungarian vowel harmony

olvɑs-unk	"to read"
vɑɟ-unk	"to be"
mɛɟ-ynk	"to go"
jøv-ynk	"to come"

If, as we assume, palatals are coronalized dorsals, then their transparency to back (coronal) harmony is inexplicable. Moreover, since palatals and velars are contrastive, it is not possible that they are both unspecified for place features. Hume (1992) proposes that the Hungarian palatals do not have a secondary place feature [coronal] whereas the Turkish palatalized velars do. I have no objection to that proposal.

In the present model of feature geometry, the combination of consonantal [coronal] and [dorsal] features is assigned to retroflexes, instead of coronodorsal clicks, as it is in Sagey (1986) and Clements and Hume (1992). There are two reasons for this. First, since clicks and non-clicks are produced with entirely different aerodynamic control, they cannot be distinguished by place feature alone. As a matter of fact, Chomsky and Halle (1968) propose and Traill (1985) adopts the feature [±suction] to distinguish clicks and non-clicks made at the same place of articulation as non-clicks. For example, Traill (1985) reports that in the Khoisan language !Xóõ, there are clicks and non-clicks at each of the three places of

---

[5] Alternatively, the stem-final consonant may be analyzed as a coronalized dorsal, in which case it blocks harmony triggered by the stem vowel but triggers back harmony itself.

articulation: bilabial, dental and post-dental. Therefore, it does not make sense to save some place features solely for clicks.

The second reason is more compelling. It involves the analysis of a rule in Sanskrit, the so-called RUKI rule, which changes the dental fricative [s] into a retroflex [ʂ][6] when immediately preceded by [r], [u], [k] or [i] (including the syllabic [r̥] and diphthongs which may be analyzed as containing a final [i] or [u]), as shown below.

(27) Sanskrit RUKI alternation

	progeny	foot	thought	earth	voice
Nom. sg.	dʒá-s	pát	dhí-s	bhú-s	vák
Loc. pl.	dʒá-su-	pat-sú-	dhī-ʂú-	bhū-ʂú-	vák-ʂú

Hume (1992) analyzes a similar rule in Sanskrit, which involves the retroflexion of a coronal nasal when preceded by a retroflex sound [ʂ], [r] or [r̥], as involving the spreading of the coronal node from the preceding retroflex sound. However, such an analysis does not apply to the RUKI process, since one of the triggering sounds ([i]) does not have a retroflex coronal node and two of them ([u] and [k]) do not have a coronal node at all. Alternatively, we may assume that retroflex sounds are coronodorsals, and that all sounds that trigger the RUKI rule have a dorsal node, as follows.

(28) Place feature geometry of RUKI sounds
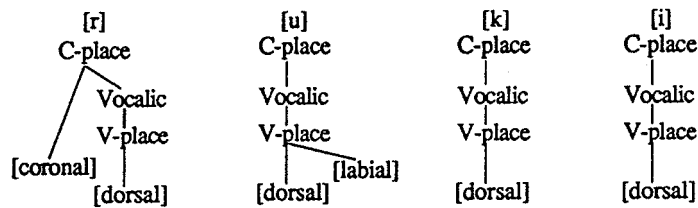
Thus, the four RUKI sounds are a natural class that share the [dorsal] feature. The RUKI rule can therefore be formulated as follows.

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[6] The traditional symbol for Sanskrit retroflexion is a dot underneath the symbol for a corresponding non-retroflex sound, e.g. [s]. For the sake of consistency, this symbol will be replaced with the standard IPA symbol for retroflexion which is a hook underneath the corresponding non-retroflex symbol, e.g. [ʂ]. Also, the symbol [j] representing a voiced postalveolar stop is replaced with the standard IPA symbol [dʒ].

(29) The RUKI rule

The RUKI rule is thus seen as involving the spreading of the feature [dorsal], which is not possible if retroflex consonants are treated as just posterior coronals. Notice that in order for this rule to produce a true retroflex instead of a palatalized one, the feature [coronal] must be left unspecified for [i]. This is not a problem, since there are only three underlying vowels in Sanskrit, and [i] is distinct from [a] by being [high] and from [u] by not being [labial]. The important point is that by treating retroflex consonants as coronodorsals, we capture the generalization that "the assimilating influence ... of k and the other vowels appears to be due to a somewhat retracted position of the tongue in the mouth during their utterance, causing its tip to reach the roof of the mouth more easily at a point further back than the dental one," (Whitney 1887:61-2).

A major implication of the place feature geometry presented above is that the feature [dorsal] is different from the consonant place features [labial] and [coronal] in that it is more closely related to vowel place features. There is strong phonetic evidence for this. Öhman (1967) observes from his X-ray studies of the vocal tract show that during the closures for /idi/, /udu/ and /ada/ the global shapes of the vocal tract are determined by the vowel with a relatively invariant tongue tip constriction superimposed on the vowel shapes, but for /igi/ and /ugu/ the actual position of the constriction is shifted. This observation is also accomodated into such theoretical models as the articulatory phonology model developed by Browman and Goldstein (1987) and the task-dynamic model developed by

Saltzman and Munhall (1989), both of which are independent of mainstream phonological feature geometry models.

2.1.2. Representation of affricates

The articulation of affricates involves two phases, the first being [-continuant] and the second [+continuant]. Chomsky and Halle (1968) use the segmental feature [delayed release] to identify affricates. Sagey (1986) argues that since affricates behave like stops with respect to phonological rules sensitive to their left edge, but like fricatives with respect to rules sensitive to their right edge, they must be treated as contour segments specified with both [-continuant] and [+continuant], as follows.

(30) Sagey's (1986) representation of affricates

$$
\begin{array}{c}
X \\
| \\
root \\
\diagup \diagdown \\
[-cont]\ \ [+cont]
\end{array}
$$
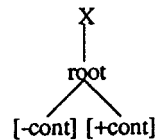
A problem with Sagey's approach is how to determine which features may branch and which may not, because without proper constraint, nonexistent contour segments, such as [td] which contours for [±voice], [tc] which contours for [±anterior] etc., can be predicted to exist.[7]

An alternative approach to representing contour segments is proposed by Clements (1987) among others. This approach treats a contour segment as having two root nodes, each linked to the same timing unit and dominating a feature specification characterizing the corresponding portion of the contour segment. No feature branching under the root node is allowed. Thus, an affricate will be represented in part as follows.

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[7] Sagey (1986) shows that the !Xõ effluxes branch in laryngeal features [constricted glottis] and [spread glottis], so k?ʰ [+c.g.,-c.g.,-s.g.,+s.g.] contrasts with k [-c.g.,-s.g.], kʰ [-c.g.,+s.g.] and k? [+c.g.,-s.g.]. From a phonological point of view, however, k?ʰ is simply [+c.g.,+s.g.]. The sequencing of these features is merely a phonetic adjustment to their physically impossible simultaneous realization.

(31) Clements' (1987) representation of affricates

$$
\begin{array}{c}
X \\
\diagup \diagdown \\
root \ \ \ root \\
| \ \ \ \ \ | \\
[-cont]\ [+cont]
\end{array}
$$
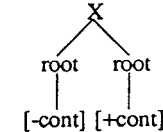
A similar proposal is made by Steriade (1991), where an affricate is assumed to have two aperture positions A_0 and A_f which, according to the author, are analogous to the root nodes. Following is a partial representation of an affricate in Steriade's model.

(32) Steriade's (1991) representation of affricates

$$
\begin{array}{c}
A_0 \ A_f \\
\diagdown \diagup \\
place
\end{array}
$$
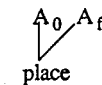
Clements's model and Steriade's model can both be referred to as two-root models. The problem with such models is similar to that with Sagey's feature branching approach. Without further constraint, each root node may dominate a different set of segmental features, and therefore nonexistent contour segments that can be generated with the feature branching approach may also be generated with the two-root approach.

Not only is the phonological representation of affricates unsettled, but the whole concept of contour segments is controversial. The most commonly recognized contour segments are affricates, prenasalized stops and postnasalized stops. McCawley (in Chomsky and Halle 1968:317:fn20) suggests that prenasalized stops should be regarded as obstruent nasals. Postnasalized stops can be treated the same way, since there is no clear evidence that they contrast with prenasalized stops in any language[8]. Thus the only real contour segments appear to be affricates. However, there is little phonological evidence that affricates are contour segments. None of the three cases reported in Sagey (1986:94-5) where affricates appear to pattern with fricatives have anything to do with the affricates'

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[8] Sagey (1986) talks about such contrasts in Land Dayak, yet she provides no phonological evidence for what she believes to be prenasalized and postnasalized stops. In fact, the same data are analyzed in Kenstowicz and Kisseberth (1979) as nasal-stop or stop-nasal sequences.

being [+continuant] at their right edge. Specifically, the epenthesis of a schwa between a stem-final fricative or affricate and the suffix -z in English, as in /bʌs + z/ → [bʌsəz] "buses", is due to the avoidance of two successive [+strident], not necessarily [+continuant], segments, because a schwa is not inserted between any sequence of [+continuant] consonants. For example, underlying /glʌv + z/ "gloves" does not become [glʌvəz], even though both /v/ and /z/ are [+continuant]. The labialization of stops and labiodentalization of fricatives and affricates in Kutep, whereby labialization results in a bilabial after stops but a labiodental after affricates and fricatives, e.g. [batwap] "they picked up" but [batçfak] "they sleep" and [basfa] "they kneel" (Ladefoged 1968:31,62), can be reanalyzed as the spreading of [+strident] from the fricative or affricate to the labial glide. The aspiration of word-final stops, not affricates or fricatives, in Sierra Popoluca can be regarded as the release of an oral closure, which is inherent in affricates and fricatives, and therefore has nothing to do with the second half of an affricate being [+continuant]. In fact, there is no evidence whatsoever that affricates pattern with any other continuant consonants (glides, flaps) except fricatives, and the fact that affricates are [+continuant] at their right edge may be a phonetic artifact that accompanies the fricative release of affricates. Thus, affricates and fricatives may form a natural class identifiable by some stricture feature such as [+strident], as proposed in Jacobson, Fant and Halle (1952:24). In other words, an affricate is simply a strident stop, and whether or not its second half is continuant is a matter of phonetic detail. (See also arguments offered in Hualde (1988) and Lombardi (1990) against the contour segment analysis of affricates.)

Since the contour segment analysis of affricates has many problems and since there is no evidence that such an analysis is necessary, I will treat affricates as strident stops specified with [-continuant] and [+strident].[9]

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[9] Since there is little evidence that affricates with different places of articulation may form a natural class in phonological processes, more localized features may be needed to identify labial, coronal and dorsal affricates respectively. However, for the purpose of the present study, I will not pursue this any further.

2.1.3. Representation of other features

So far, I have discussed the organization of consonant and vowel place features and the representation of affricates. As for the laryngeal features [stiff] and [slack] (=[-voice] and [+voice]), [spread glottis] (for aspiration) and [constricted glottis] (for glottalization), we notice that they are not contrastive in every language. In Nantong Chinese, for example, the only contrastive laryngeal feature is [spread glottis], whereas voicing and glottalization are both predictable.

A number of features that have been used in the literature are omitted in the above discussion. These include [lateral], [pharyngeal], [anterior] and [distributed] among others. None of these features is relevant for the phonological system of Nantong Chinese. I will leave the scrutiny of the relevance and possible position of these features for future studies.

With all the relevant features discussed above, the segmental feature geometry model I propose is illustrated below.

(33) Segmental feature geometry
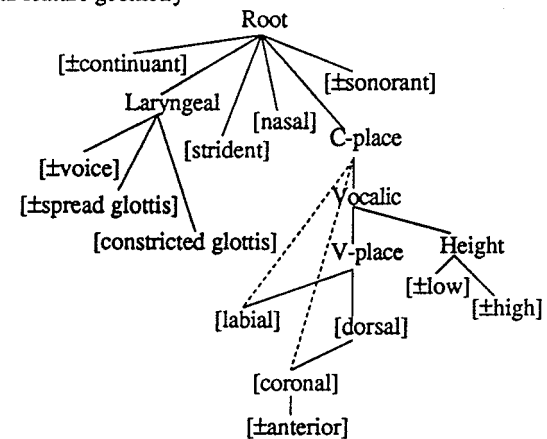
2.2. Tonal features and feature geometry

2.2.1. Tonal features

In the early days of descriptive linguistics, various numerical systems were used to represent tones. One such system is the famous "Chao letters", first introduced in Chao (1930) and used by students of Chinese linguistics to this day. In this system, numbers 1 through 5 are used to represent five pitch levels, with 1 being the lowest and 5 the highest, as shown in (37a). Level tones are represented with two identical numbers if used on a sonorant-final syllable or with one number on an obstruent-final syllable, also known as a checked syllable. Contour tones are represented with two or three juxtaposed numbers, which are underlined if used on a checked syllable. In practice, these numbers are often accompanied with mock pitch contours drawn at a reference line, as shown in (34b).

(34)   a. the Chao letter   b. Mandarin tones represented with Chao letters

55   35   214   51
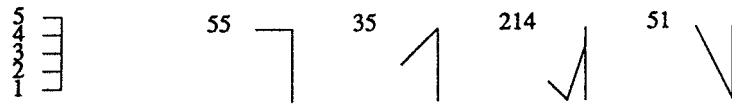
The Chao letters are a convenient tool for annotating pitch values, but not suitable for a system of distinctive features. Various attempts were made to represent tones in terms of distinctive features. For example, Halle & Stevens (1971) use two segmental features [stiff vocal cords] and [slack vocal cords] to represent tones, while Wang (1967) proposes seven prosodic features: [contour], [high], [central], [mid], [rising], [falling] and [convex]. Wang's system is too powerful to be of any use. Halle & Stevens' system, on the other hand, is too constrained, since by using segmental features as tonal features, they fail to account for the many observed cases of tone stability (cf. Goldsmith (1976), inter alia), i.e. tones unaffected by segmental deletion rules or tones spreading independently of the laryngeal features of the affected segments.

A very different model of tonal representation is proposed by Yip (1980). In this model, a maximum of four tone levels can be represented with combinations of two binary

features: register and tone. A contour tone is treated as a sequence of two tonal features with opposite values. Since register is assumed to be constant over the syllable in Chinese, the basic inventory of contour tones is restricted to include no more than two of any given contour type.

(35)   Level tones and contour tones in the Yip (1980) model

Register	Tone			
+ Upper	+ High (H)	+ Upper	L H	Rising
	- High (L)		H L	Falling
- Upper	+ High (H)	- Upper	L H	Rising
	- High (L)		H L	Falling

Yip's model is superior to previous models in a number of ways. By using two rather than seven binary features, this model is much simpler and more constrained. And by dissociating tonal features from segmental features, one is no longer obliged to bind every tonal change to segmental alternations.

Despite its apparent advantages, Yip's model has been criticized for being vague about the nature of register. Two recent works attempt to define this feature on articulatory basis. Bao (1990:11) suggests that "the cricothyroid executes the register feature [stiff] and the vocalis executes the contour feature [slack]", while Duanmu (1990:119) suggests the opposite, that "voicing/register probably relates to the vocalis muscles and pitch to the cricothyroid muscles". These conflicting speculations are not substantiated by any phonetic or phonological evidence, and neither adds anything new to the well-known fact that pitch variation is jointly executed by a number of muscles including the cricothyroid muscles and the vocalis muscles. More importantly, what is wrong with Bao's and Duanmu's meta-theory is that they assume without argumentation (and incorrectly) that knowing the articulatory facts immediately produces the phonological facts. In other words, perceptual and functional questions are totally ignored.

A real problem with the Yip model is its inability to represent more than four tone levels, despite the fact that the maximal number of tone levels in a human language is five[10].

The most indisputable and well-documented evidence for more than four contrastive tone levels comes from the Gaoba Dong language reported by Shi et al (1985). This language has five level tones (labelled 1', 2, 3, 5 and 6), three rising tones (labelled 1, 3' and 5') and one falling tone (labelled 4). Following are the normalized pitch contours of these nine tones.

(36) Pattern curves of Gaoba Dong tones in monosyllables (Shi et al 1985:343)
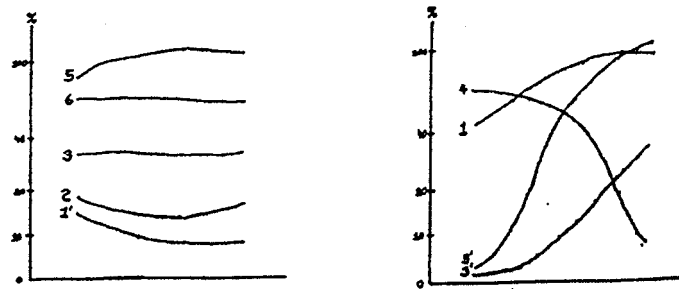
Figure 5 - Level tones Gaoba Dong   Figure 6 - Contour tones in Gaoba Dong

Amazingly, all tones in Gaoba Dong are contrastive, as can be seen from the following chart of minimal pairs, where pitch values are indicated with the Chao letters.

(37) Tonal minimal pairs in Gaoba Dong (adapted from Shi et al 1985:337)

ta^{11}	catch	ma^{11}	come
ta^{22}	build	ma^{22}	tongue
ta^{33}	mountain forest	ma^{33}	soft
ta^{44}	pass	ma^{44}	chew

---

[10] Dihoff (1977:44ff) reports that the Nigerian language Chori has six surface tones with different pitch levels. However, there is no acoustic data to show whether all six are level tones. In fact, since three of the six tones are entirely predictable and derive from sequences of tones with different pitch levels, it is possible that they are actually contour tones.

ta^{55}	middle	ma^{55}	chop
ta^{13}	male	ma^{13}	ink
ta^{24}	nail	wa^{24}	paint
ta^{45}	fish	ma^{45}	vegetable

Aware of the need for representing five tone levels, Duanmu (1990) proposes a model that allows for three voicing/register states and three pitch levels in each state, giving "a total of nine tone levels" (p.120), as shown in the following diagram.

(38) Duanmu's (1990) tonal feature model
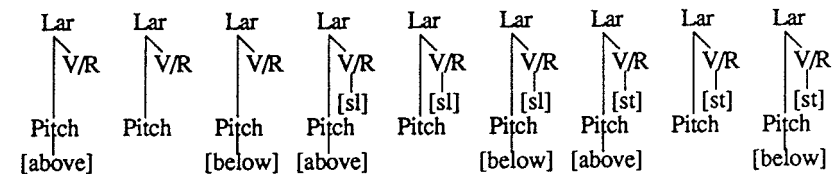
There is no way of knowing exactly what tone level each of the nice tonal feature representations corresponds to, since, according to Duanmu, Register may be reflected by voice quality and therefore the nine tone levels need not be nine pitch levels. To justify the obvious overgenerativity of his model, Duanmu claims that "five out of nine is not an unreasonable ratio, considering how few segments a language uses out of the entire known inventory" (Duanmu (1990:121)). This is a very weak justification, because we are not dealing with a segmental inventory, but with the gradation in a specific dimension — pitch level. If we could allow nine tone level contrasts while in reality there are no more than five, then we might as well propose a theory which allows nine vowel height contrasts despite the fact that the actual number of contrastive vowel heights in any language is much smaller.

A better way to solve the representational problem of the Yip model is to keep the basic model intact and give it a reinterpretation. From the diagram in (35), it is clear that Yip views each tone level as a sub-pitchrange. Now if we do away with this idea and

instead regard each tone level as the target of pitch defined as the end points of each pitch range, then, with four pitch subranges, we get five target points which represent five tone levels.

To elaborate, let's say that within a given pitch range, which we call a register, high tone corresponds to the highest pitch value and low tone to the lowest. Assuming in mathematical language that subranges are closed intervals, we can say that the lowest value of the upper subrange equals the highest value of the lower subrange. In other words, an upper register L is equal in pitch value to a lower register H. Thus, a two register language has three tone levels instead of four. To account for the fact that there are four tone level and even five tone level languages, we further divide each register into two subregisters. Thus, if either the upper register or the lower register is divided into two subregisters, we get a four tone level language; and if both registers are divided into two subregisters, we have a five tone level language. In a two tone level language, the entire pitch range is a single register, which may be called the base register. These ideas are illustrated below, where H' means extra high and L' means extra low.

(39) A reinterpreted tonal feature model

a. Two tone level language

————————H

base reg

————————L

b. Three tone level language

————————H   = H
upper reg
————————— L H = M
lower reg
————————— L = L

or

c. Four tone level language

upper reg	upper upper reg	————H = H'
	lower upper reg	L H = H
		L H = M
lower reg		
		L = L

upper reg		————H = H
		L H = M
lower reg	upper lower reg	
	lower lower reg	L H = L
		L = L'

d. Five tone level language

upper reg	upper upper reg	————H = H'
	lower upper reg	L H = H
		L H = M
lower reg	upper lower reg	L H = L
	lower lower reg	L = L'

For four tone level or five tone level languages, we use two features [±upper] and [±extra] to represent the subregisters, with the feature [±extra] referring to subregisters at the extremities of the overall pitch range. Thus, [+upper,+extra] represents the upper upper register, [+upper,-extra] represents the lower upper register, [-upper,-extra] represents the upper lower register, and [-upper,+extra] represents the lower lower register. For three tone level languages, the feature [extra] is irrelevant and hence unspecified. Notice there is an inherent ambiguity in this model with regard to the representation of four tone levels, since either the upper register or the lower register may be further divided. To eliminate this ambiguity, we arbitrarily assume that unless there is evidence to the contrary, only the upper register may be divided.

The model proposed above preserves all the merits of the Yip (1980) model, and in addition, it can handle five and no more contrastive tone levels. Moreover, since more tone levels entail more registers and greater structural complexity, this model predicts that the greater the number of tone levels, the rarer the language, which is correct. Finally, the idea that some tone letters have two feature representations (e.g. M = L[+upper] or H[-upper]) allows us to analyze certain tonal changes in a more natural way. For example, in the Yuncheng dialect reported by Lü (1991), there are four lexical tones: ML, LM, HM and M. Three tone sandhi rules are found in compound words, as shown below.

(40) Yuncheng tone sandhi rules (adapted from Lü (1991))

	ML	LM	HM	M
ML	LM.ML	ML.LM	ML.HM	ML.M
LM	LM.ML	MH.LM	LM.HM	LM.M
HM	HM.ML	HM.LM	ML.HM	HM.M
M	M.ML	M.LM	M.HM	M.M

A number of tone sandhi processes can be extracted from the above data. One process dissimilates the registers of two adjacent tones, so that underlying [-upper] LH (=LM) becomes [+upper] LH (=MH) before another [-upper] LH, and underlying [+upper] HL (=HM) becomes [-upper] HL (=ML) before another [+upper] HL. Following Odden's (1987a) thesis that feature dissimilation should be analyzed as feature deletion followed by automatic insertion of the opposite value of the deleted feature, this rule can be formalized as follows.

(41) Register Dissimilation

```
        σ          σ
        |          |
      Tonal      Tonal
       =|         |
    [αupper]  [αupper]
```
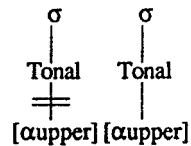
This rule is obviously an effect of the Obligatory Contour Principle (OCP). It predicts that there are no tonal sequences with identical register feature in this language. In fact, there are some apparent exceptions. First of all, before another [-upper] HL (=ML), [-upper] HL (ML) changes into a rising contour LH but remains [-upper] (=LM). The underlying sequence ML.ML clearly does not undergo Register Dissimilation. We can account for this assuming that this sequence first undergoes a regressive tone spreading rule formalized below.

(42) Regressive Spreading

```
         σ                σ
        /\               /\
     Tonal  Tonal------Tonal  Tonal
       |  \  /           |  \  /  |
       |[-upper]|        |[-upper]|
       H       L         H       L
```
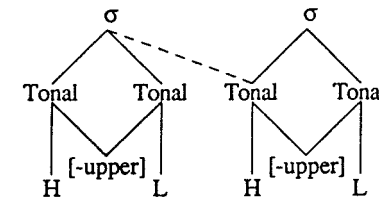
Since there can be no more than two tonal nodes per syllable in this language, the output of Regressive Spreading will be pruned by a structure preservation rule which deletes the first tonal node of any syllable containing more than two tonal nodes, yielding the following surface form.

(43) Final result of Regressive Spreading

```
          σ            σ
         /\           /\
     Tonal  Tonal  Tonal
       |  \  /   \  /  |
    [-upper]|  [-upper]|
            L  H       L
```
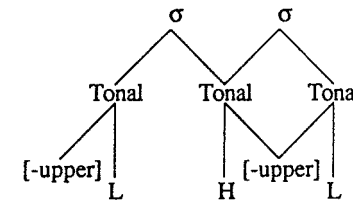
Since this structure contains an ambisyllabic tonal node and therefore does not satisfy the structural description of Register Dissimilation, it does not undergo this rule.

The second set of exceptions include the lower register tonal sequences LM.ML and ML.LM. Since the second tonal node of the first tonal contour and the first tonal node of the second tonal contour are identical in both sequences, we assume that the two tonal nodes are fused into one by OCP, as follows.

(44) Tonal nodes fused by OCP

a. LM.ML
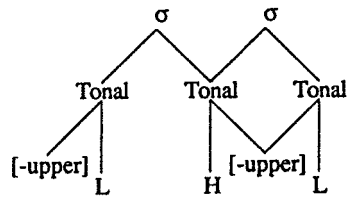
b. ML.LM
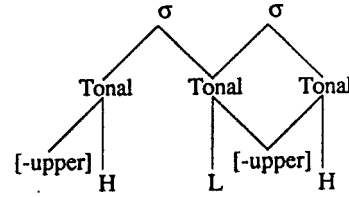
Again, these structures do not satisfy the structural description of Register Dissimilation, and therefore they do not undergo this rule.

As for the M tone, which does not undergo or trigger any tonal process, we assume that it is underlying unspecified for tone or register.

The process of register dissimilation is not an isolated instance. According to Yip (1980), the Mandarin tone sandhi process which changes a low rising tone (214) to a high rising tone (35) before another low rising tone also involves changing a lower register into an upper register before another lower register. An interesting problem for Yip's analysis is that in her tonal feature model, raising the register of the low rising tone LM will produce an extra high rising tone HH' instead of the expected high rising tone MH that neutralizes with the underlying high rising tone MH. There is no principled way to translate HH' into MH. Of course, one could assume that the underlying high rising tone is in fact extra high rising, yet this does not square with the phonetic fact that when uttered in isolation, the final pitch of LM (i.e. the 4 of 214) is not lower than the initial pitch of the putative HH' (i.e. the 3 of 35), and it forces us to say that Mandarin has four tone levels when there is no other evidence that this is the case. This is not a problem for the tonal feature model proposed in this study, because in this model, a lower register H is the same as an upper register L in pitch value.

2.2.2. Tonal feature geometry

The analysis of register dissimilation as register feature deletion is possible only if we assume that tonal features are not dominated by the register feature. Otherwise, deletion of the register feature will necessarily cause the tonal features to be deleted as well, making it impossible to preserve the basic tonal contour. Therefore, the proposal of Yip (1989a,b) and Chen (1992) that register dominates tone needs to be reconsidered.[11]

On the other hand, when the feature [±extra] is specified in a four or five tone level language, it must be dominated by [±upper], since it has no interpretation without the latter. We thus derive a tonal feature geometry as follows.

(45) Tonal feature geometry
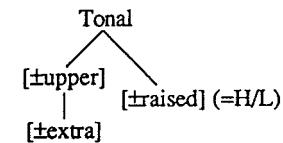
2.2.3. Tone bearing unit

The tone bearing unit has been assumed by many to be the mora. This hypothesis leads to a number of theoretical problems. First, assuming that each mora may carry more than one tone, there can be three distinct representations of a contour tone in a bimoraic syllable, as shown below.

(46) Possible representations of contour tone in bimoraic syllable with mora as TBU

---
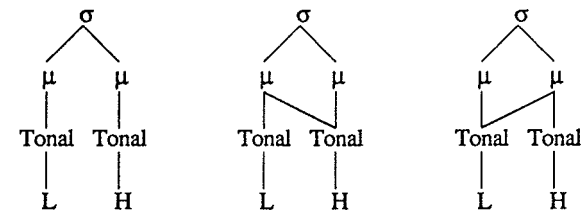
[11] Another prediction that follows tone-register independence is that register features may spread without affecting the tonal features, e.g. LM becomes MH before MH. This prediction has not been attested yet.

This implies that a language may contrast three rising tones (or falling tones) with exactly the same pitch value but different onset time. Such a contrast has never been found to exist. This problem cannot be solved by assuming that each mora may carry at most one tone, as Duanmu (1990) suggests, because a short vowel, which is monomoraic, can carry a contour tone. On the other hand, if we assume that the tone bearing unit is the syllable, then no more than one representation per syllable is possible for any contour tone, as shown below. No more ambiguity exists.

(47) Representation of contour tone in bimoraic syllable with syllable as TBU

$$\sigma$$
$$\text{Tonal} \quad \text{Tonal}$$
$$\text{L} \qquad \text{H}$$
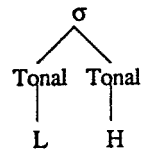
Based on this observation, I assume that the tonal node that dominates tonal features is attached to the syllable node. I further assume that every syllabic segment is underlyingly associated with a syllable node, which may be specified with an underlying tone, as follows.

(48) Partial representation of an underlyingly toned syllabic segment

$$\sigma$$
$$\text{Tonal} \quad \text{Tonal}$$
$$\mu$$
$$\text{L} \qquad \text{H}$$
$$\text{Root}$$
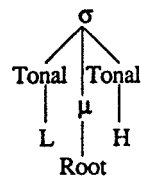
2.3. Feature underspecification

If a phoneme is not specified in its underlying representation for features that are present in its surface form, it is said to be underspecified. Phonologists differ on whether phonemes must be underspecified a priori, but they do agree that if a predictable feature gets in the way of an otherwise successful phonological operation, it must not be specified in the underlying representation but should be filled in later by default feature specification

rules. For example, Ao (1990) reports that in the Bantu language Kikongo, a suffixal alveolar consonant becomes a nasal if the verb stem contains a nasal, as shown below.

(49) Kikongo nasal harmony

tu-kun-ini	we planted	cf.	m-bud-idi	I hit
ma-kin-unu	it was planted	cf.	m-bul-ulu	I was hit
tu-nik-ini	we ground	cf.	n-suk-idi	I washed
ma-nik-unu	it was ground	cf.	n-sul-ulu	I was washed

This nasalization process can be understood as the spreading of [+nasal] from the nasal consonant in the verb stem to the coronal consonant in the suffix, as follows.

(50) Kikongo nasal harmony

$$[+cor,-str]$$
Place node $\quad [+nas]$
Supralaryngeal node
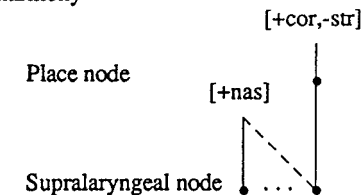
If both [-nasal] and [+nasal] features are marked, then the spreading of [+nasal] results in a violation of the ban on crossing association lines, as shown below.

(51) Cross association line condition

$$[+nas] \ [-nas] \ [-nas] \ [-nas] \ [-nas] \ [-nas]$$

$$\text{n} \qquad \text{i} \qquad \text{k} \qquad \text{i} \qquad \text{d} \qquad \text{i}$$
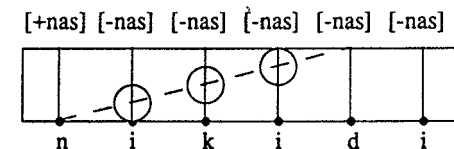
Therefore, we assume that [-nasal] is not specified in the underlying representation.

An even more convincing case of underspecification exists in the following data.

(52) Apparent counterexamples to Kikongo nasal harmony

tu-bing-idi	we hunted	cf.	tu-meng-ini	we hated
tu-bing-ulu	we were hunted	cf.	tu-meng-ono	we were hated
tu-kong-idi	we tied	cf.	tu-mant-ini	we climbed
tu-kong-olo	we were tied	cf.	wu-mant-unu	it was climbed

If non-nasals are transparent to nasal harmony, then the failure of the suffixes in the left-hand column to undergo nasal harmony is unexpected. Again, this can be explained by an appeal to underspecification. Since nasals are the only consonants that can immediately precede another consonant, the [+nasal] feature for the [n] in [bing], [kong] etc. is entirely predictable. Suppose this feature is underlyingly unspecified, then we can say that there is no nasal harmony in *tu-bing-idi* etc., because there is no [+nasal] feature to spread, and there is nasal harmony in *tu-meng-ini* etc. because the [+nasal] feature comes from the stem-initial nasal and is not blocked by anything.

We have seen how important underspecification is for avoiding crossing association lines and for deriving the correct surface forms of a language. We will see later that underspecification is instrumental in accounting for both tonal and segmental alternations in Nantong Chinese as well.

2.4. Moraic theory and representation of the syllable

Moraic theory deals with such phenomena as length and syllable weight. The model of moraic theory to be used in this study is first introduced in Hayes (1989). This model assumes that underlyingly long vowels are each associated with two moras, short vowels and geminate consonants are each associated with one mora. Nongeminate consonants are not associated with any mora underlyingly, but may be associated with one in the surface as the result of "weight by position" (Hayes 1989) if they occur in the syllable coda. Thus, an open syllable with a short vowel is monomoraic or light, and an open syllable with a long vowel or a closed syllable with a short vowel is bimoraic or heavy. Following is the moraic representation of these basic syllable types.

(53) Moraic representation of basic syllable types
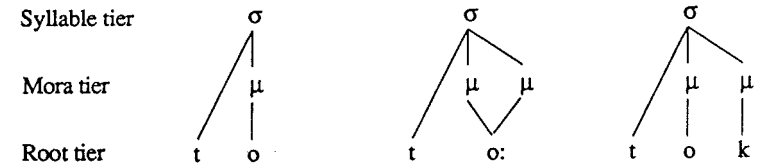
In addition to representing vowel length and syllable weight, moraic theory is also used to explain facts about gemination. Specifically, an ambisyllabic geminate consonant is represented as a root node linked to the second mora of the first syllable and to the syllable node of the second syllable, as shown below.

(54) Geminate consonant in moraic theory
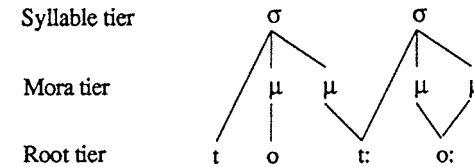
The moraic theory outlined above is adopted in this study to identify syllable peak, onset and coda, and to account for several gemination processes. Vowel length is not contrastive in underlying forms in Nantong Chinese: vowels are short in closed syllables and long in open syllables. In surface forms, vowel length is potentially contrastive. As the result of a morphophonemic rule, the coda obstruent [k] is deleted when followed by a vowel or glide. In principle, the short vowel preceding the deleted coda obstruent should contrast with its corresponding long vowel, as shown below.

(55) Potentially contrastive vowel length in surface forms

/pʰɔ́k.jɛ̃ŋ/	[pʰɔ́.jɛ̃ː]	"servant"	vs	/pʰɔ́.jɛ̃ŋ/	[pʰɔ́ː.jɛ̃ː]	"anthropophobic"
/tsɔ́k.ɣ́/	[tsɔ́.ɣ́ː]	"bamboo oil"	vs	/tsɔ́.ɣ́/	[tsɔ́ː.ɣ́ː]	"extract oil"
/kɔ́k.jɛ̃ŋ/	[kɔ́.jɛ̃ː]	"each person"	vs	/kɔ́.jɛ̃ŋ/	[kɔ́ː.jɛ̃ː]	"marry someone"
/tɕɔ́k.jĩŋ/	[tɕɔ́.jĩː]	"potassium salt"	vs	/tɕɔ́.jĩŋ/	[tɕɔ́ː.jĩː]	"borrow salt"
/tɕɣ́k.jɛ̃ŋ/	[tɕɣ́.jɛ̃ː]	"stubborn person"	vs	/tɕɣ́.jɛ̃ŋ/	[tɕɣ́ː.jɛ̃ː]	"rescue a person"

In reality, however, every non-final syllable is shortened in normal and fast tempo speech. Therefore, the actual difference in duration between the derived short vowels and the underlying long vowels in non-final open syllables is very small, and native speakers usually do not detect any difference in vowel length, even though it is possible to deliberate a contrast between short and long vowels in slow speech. Another relevant fact about vowel length is the lack of any phonological rules in this language that refer to vowel length or syllable weight. For these reasons, vowel length will not be addressed in this study.

As far as the representation of the timing units that comprise a syllable is concerned, the CV Theory developed by Clements and Keyser (1983) is just as good as the moraic theory. Although I have chosen the moraic theory to represent positions in the syllable, such as onset and coda, and to represent geminate consonants, every one of these moraic representations can be converted to a CV representation without any negative consequence.

2.5. Metrical theory and the prosodic hierarchy

Metrical phonology handles the rhythmic alternation of stress, which is indicative of the prosodic organization of segments into prosodic units such as syllables and metrical feet etc. There is evidence that the prosodic structure plays an important role in conditioning phonological processes in various languages, including Nantong Chinese. According to studies in metrical phonology, a syllable may be strong or weak, depending on its position in a metrical foot. Each strong syllable heads a metrical foot, which may contain any number of weak syllables. If the strong syllable is the leftmost in the foot, then the foot is trochaic, or left-dominant. If the strong syllable is the rightmost, then the foot is iambic, or right-dominant. If the number of syllables in a foot is fixed, then the foot is bounded; otherwise, it is unbounded. A bounded foot can be unary, binary or ternary depending on the number of syllables it contains. A foot is quantity sensitive if the stress on the strong syllable it contains is sensitive to syllable weight; otherwise, the foot is quantity insensitive.

Just as syllables can be grouped into a metrical foot, so can metrical feet be grouped into a phonological word. Similar to the metrical foot, the phonological word may also be bound or unbound, left-dominant or right-dominant, etc.

Prosodic constituents larger than the phonological word include phonological phrases, intonation phrases and utterances. These prosodic constituents, along with prosodic constituents at lower levels, form a prosodic hierarchy, which is illustrated as follows in Selkirk (1978).

(56) The prosodic hierarchy à la Selkirk (1978)

<pre>
                utterance
                    |
            intonation phrase
                    |
          phonological phrase
                    |
           phonological word
                    |
              metrical foot
                    |
                 syllable
</pre>
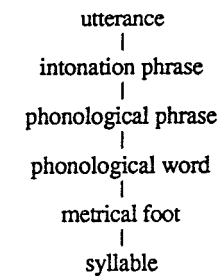
There have been two models for representing the prosodic structure above the level of the syllable. One model may be referred to as the tree model, which is first proposed by Hayes (1980). In this model, the relationship between prosodic constituents at different levels is indicated with association lines, as exemplified below.

(57) A tree representation of prosodic structure

<pre>
Phonological word   ω
                            /   \
                          s   w
                          | |
Metrical foot   φ   φ
                         / \   / \
                        s   w   s   w
Syllable tier   σ   σ   σ   σ
                       mét al   lùr gy
</pre>
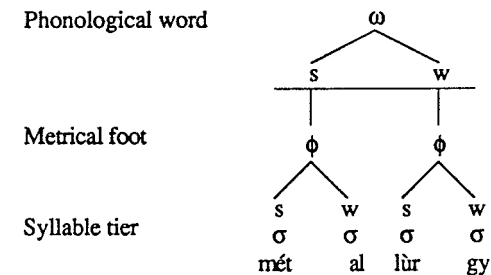
The tree model is abandoned by many recent studies in metrical phonology, such as Prince (1983) and Halle & Vergnaud (1987), among others, in favor of a grid model, which represents the degree of stress with stacked grids and the relationship between different prosodic constituents with parentheses or brackets at different levels. For example, the prosodic structure shown above can be represented in Halle and Vergnaud's (1987) model as follows.

(58) A grid representation of prosodic structure

```
line 2   ( *    ·    ·    · )
line 1   ( *    · )( *    · )
line 0   ( * )( * )( * )( * )
         mét  al  lùr  gy
```

Both the tree model and the grid model represent a dominance and membership relationship between adjacent layers of prosodic constituents, e.g. all syllables dominated by a foot are members of that foot. An apparent advantage of the grid model is the elimination of illicit representations such as multiply dominated constituents (59a) and multi-layered embedded structures between adjacent layers of prosodic constituents (59b), which can be represented with the tree model.

(59) Illicit metrical trees

a. Multiply dominated structure   b. Multi-layered embedded structure
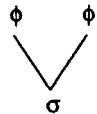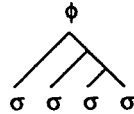
However, like every other theory, the metrical theory is constrained with its own axioms. The most important is the Strict Layer Hypothesis proposed by Selkirk (1984, 1986), which is intended to enforce the well-formedness of metrical trees, as shown below.

(60) Strict Layer Hypothesis

   a. A given nonterminal unit of the prosodic hierarchy, X^P, is composed of one or more units of the immediately lower category, X^{P-1}.

   b. A unit of a given level of the hierarchy is exhaustively contained in the superordinate unit of which it is a part.

Given that no intermediate nodes are allowed in a metrical tree between adjacent prosodic levels, and that every daughter constituent is exhaustively included in her mother constituent, the tree model and the grid model become notational variants. To conform to structural representations in other components of nonlinear phonology while avoiding the clumsiness of Hayes's tree model, I shall follow Lerdahl and Jackendoff (1983), Beckman (1986), Hammond (1986) and Goldsmith (1990), among others, and adopt the "head-marked notation" which places a mother node above her head constituent, links the two with a vertical association line, and links the mother node with her non-head constituents with slanted association lines, as shown below.

(61) The head-marked notation of prosodic structure
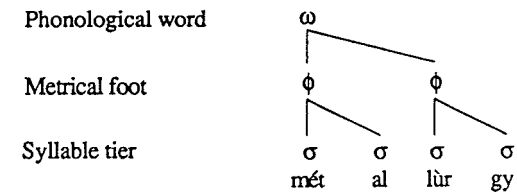
2.6. Summary

In this chapter, I have proposed a new model of segmental place feature geometry, and a new model of tonal feature and feature geometry. Both models are more constrained than some existing models, and more adequate in their descriptive and explanatory power than others. I have also discussed the representation of contour segments, the notion of underspecification, and theories of prosodic phonology. All these theories, models and notions are instrumental for the analysis of the phonological system of Nantong Chinese to be presented in the rest of this study.

CHAPTER III   THE UNDERLYING SOUND INVENTORY

3.0. Introduction

The underlying sound inventory refers to the inventory of sounds that are used to construct utterances before any phonological processes take place. Unlike traditional distributionalists, whose main interest in linguitic analysis is to classify speech sounds on distributional grounds into contrastive units (i.e. phonemes), we analyze the phonemic status of speech sounds based on their morphophonemic alternations, not just on their distribution. In this view, an underlying sound is the same as its surface realization, unless there is morphophonemic evidence to the contrary. Distributional facts alone are not considered to be sufficient grounds for treating distinct surface sounds as variants of the same underlying sound. This point will be further discussed in section 3.1. The rest of this chapter will be divided into four sections. Section 3.2 deals with consonants, section 3.3 with vowels, section 3.4 with tones, and section 3.5 with phonotactic constraints.

3.1. Against the distributionalist approach to phonemicization

Early studies of Chinese language phonemicization, such as Hockett (1947) and Chao (1968), inter alia, were heavily influenced by the American distributionalist tradition, according to which sounds that are in contrastive overlapping distribution are classified as different phonemes, and those that are not in such distribution are usually considered variants of some other phonemes. For example, in Mandarin (Peiping) Chinese, the alveopalatal consonants [tɕ tɕʰ ɕ] occur before high front vowels [i] or [y], but not before any other vowels. In contrast, the alveolar sibilants [ts tsʰ s] and velar obstruents [k kʰ x]

never occur where the alveopalatals do but do occur where the alveopalatals do not, as shown in the following table.

(62) Distribution of alveolars, alveopalatals and velars in Mandarin Chinese

	tɕ	tɕʰ	ɕ	ts	tsʰ	s	k	kʰ	x
i	tɕi	tɕʰi	ɕi	-	-	-	-	-	-
y	tɕy	tɕʰy	ɕy	-	-	-	-	-	-
u	-	-	-	tsu	tsʰu	su	ku	kʰu	xu
a	-	-	-	tsa	tsʰa	sa	ka	kʰa	xa

Based on the distribution of these consonants, traditional studies in Chinese phonemic analysis treat the alveopalatals as allophones of the velar obstruents or the alveolar sibilants. There are a number of problems with this.

One problem with the distributionalist approach to phonemic analysis involves the non-uniqueness condition first noted by Chao (1934). For example, since the Mandarin alveopalatals are in complementary distribution with the velars, one might assume that they are allophones of the velars, so that surface [tɕi], [tɕy] etc. are underlyingly /ki/, /ky/ etc. However, since the alveopalatals are also in complementary distribution with the alveolar sibilants, one might also assume that they are allophones of the alveolar sibilants, so that surface [tɕi], [tɕy] etc. are underlyingly /tsi/, /tsy/ etc. Since the putative derivation of the alveopalatals is motivated by their distribution but not supported by any morphophonemic alternation, it is not possible to determine which analysis is correct. As a result, there can be no unique underlying representation of morphemes containing alveopalatals. Such a condition is undesirable, because it implies that phonological representations could be arbitrarily determined, and thereby undermines the validity of phonemic analysis. We can avoid this condition by assuming that the alveopalatals are underlying, not derived. Obviously, doing so would require a departure from the distributionalist tradition.

Another problem with the distributionalist approach to phonemic analysis is the excessive abstractness it leads to. When surface phonetic forms are treated on purely distributional grounds as deriving from some phonetically distinct underlying forms which

neither surface nor trigger any morphophonemic processes, it is impossible to find out if such alleged underlying forms ever existed at any level of the linguistic representation, and it is also impossible to find out if the rules that are supposed to derive these surface phonetic forms from their alleged underlying forms are psychologically real, i.e. if they are part of the synchronic grammar. For example, there is no way of knowing whether the alleged underlying forms /ki/ and /ky/ (or /tsi/ and /tsy/, for that matter) of surface [tɕi] and [tɕy] are indeed part of the underlying representation, and whether the change from /k/ (or /ts/) to [tɕ] is a real synchronic phonological process. Such abstract and unverifiable underlying forms and derivational rules should be eliminated from any phonological representation intended to reflect the synchronic grammar which is part of the native speakers' linguistic knowledge.

One motivation for the distributionalist approach to phonemic analysis appears to be the possibility to produce a smaller phonemic inventory. For example, if the Mandarin alveopalatals [tɕ tɕʰ ɕ] derive from underlying velars /k kʰ x/ or alveolar sibilants /ts tsʰ s/, and are therefore eliminated from the phonemic inventory, then the inventory is smaller by three. Presumably, a smaller inventory is easier to learn and is hence better than a larger inventory. However, under this analysis, the underlying forms of morphemes containing alveopalatals also become abstract, because they are different from their surface forms. An abstract phonemic system is harder to learn than a concrete one. Thus, as far as learnability is concerned, whatever benefit the smaller size of a distributionally motivated phonemic inventory may bring about is offset by its greater degree of abstractness. Therefore, there is nothing to be gained with the distributionalist approach.

Another motivation for the distributionalist approach seems to be its capability to account for distributional gaps. For example, assuming the Mandarin alveopalatals derive from underlying velars or alveolar sibilants before front high vowels, we can explain why velars and alveolar sibilants do not surface before high front vowels, because they become

alveopalatals. However, such an explanation is possible only if we assume that there exists an abstract rule that changes the velars or alveolar sibilants into alveopalatals. At times, such explanations can be very difficult even with the recognition of abstract rules. For example, the rounded front high vowel [y] never occurs after a labial consonant (e.g. *[py]) or an alveolar obstruent consonant (e.g. *[ty] but [ly]), but the unrounded front high vowel and the back high vowel do follow these consonants (e.g. [pi], [pu], [ti] [tu]). Are we to say that the rounded front high vowel becomes unrounded or back in these environments? Now consider the non-occurrence of any front high vowel after the labiodental [f], (e.g. *[fi] and *[fy] but [fu]). Are we to say that both front vowels become back in this case? The point I am trying to make here is that such abstract rules are not only difficult to verify, but also extremely powerful and unprincipled.

A more straightforward and concrete way to express the phonotactic constraints in a language is possible with the use of positive or negative filters, such as those used quite extensively in Ito (1986). Thus, we can have a filter stating that a sequence is ill-formed if it contains a labial consonant or a coronal obstruent followed by a rounded front high vowel. We can have another filter stating that a sequence is ill-formed if it contains a strident consonant (i.e. [f] and [ts tsʰ s]) followed by a front high vowel. To explain the distributional gap between the alveopalatals and the alveolar sibilants and velars, the only other filter we need is one that states a sequence is ill-formed if it contains a velar consonant followed by a front high vowel. Now that distributional gaps can be expressed more straightforwardly with the use of filters, the second motivation for the distributionalist approach to phonemic analysis also becomes untenable.

In the following analysis of the Nantong sound system, every underlying sound is assumed to be the same as its surface realization, unless there is morphophonemic evidence to the contrary. For example, what traditional distributionalist phonologists treat as consonant glide sequences, e.g. /pj/, /lj/, /kj/, /kw/ etc., are analyzed as consonants with

secondary articulation, i.e. /pʲ/, /lʲ/, /tɕ/, /kʷ/ etc., because there is no morphophonemic evidence that there is such a thing as medial glide in this language. To avoid confusion with the traditional distributionalist notion of phonemicization, I shall refer to the phonemic inventory derived this way as the underlying sound inventory.

3.2. The consonants

3.2.1. Underlying consonants and their surface phonetic characteristics

There are 38 underlying consonants in Nantong Chinese, as shown below.

(63) Underlying consonants (38)

			labial	pal'd labial	alveol	pal'd alveol.	post-alveol.	alveo-palatal	velar
stop	unaspirated	unround	p	pʲ	t	tʲ			k
		round							kʷ
	aspirate	unround	pʰ	pʲʰ	tʰ	tʲʰ			kʰ
		round							kʷʰ
affricate	unaspirated	unround			ts		tʃ	tɕ	
		round						tɕʷ	
	aspirate	unround			tsʰ		tʃʰ	tɕʰ	
		round						tɕʷʰ	
fricative		unround	f		s		ʃ	ç	x
		round						çʷ	xʷ
nasal		unround	m	mʲ	n	nʲ			ŋ
lateral		unround			l	lʲ			
glide		unround	ʋ					j	
		round	w					ɥ	

The phonetic value of most consonants in the above chart can be inferred from the standard interpretation of the IPA symbols that represent them. In addition to these 38 consonants, there is also a glottal stop in the surface, which alternates with the velar stop [k] when followed by a sonorant onset of a toneless syllable, which will be discussed in chapter IV.

With regard to the other consonants, we notice that the coexistence of postalveolars [tʃ tʃʰ ʃ] and alveopalatals [tɕ tɕʰ ç] in one language is quite rare cross-linguistically. The

postalveolars are like those in English, but with a little retroflexion. The alveopalatals, on the other hand, are like those in Mandarin Chinese. These two sets of sounds are different both articulatorily and acoustically. The following palatograms show that the area of contact between the tongue and the palate is greater with alveopalatals than with postalveolars.[1] The alveopalatals are produced with the tongue body raised against the palate, so that the tongue tip is behind the lower teeth, whereas the postalveolars are produced with the tongue blade raised against the front part of the palate, so that the tongue tip is away from the lower teeth.

(64) Palatograms of postalveolar and alveopalatal

Figure 7 - Palatograms of postalveolar and alveopalatal

The acoustic difference between these two sets of consonants is evident from the following averaged power spectra (average intensity (in dB) against frequency (in kHz) during the two fricatives) obtained with a DSP Sona-Graph Model 5500 speech analyzer. We can see that the peak intensity is about 3200 Hz for [ʃ] but about 5000 Hz for [ç], and there is a sudden decrease in intensity at about 4500 Hz in the power spectrum of [ʃ] but not in that of [ç]. Also notice that the F2 value of [ʃ] (3200 Hz) is much lower than that of [ç] (4000 Hz). The lower F2 value of [ʃ] is partly due to the lip rounding that accompanies and negatively enhances the non-palatality of [ʃ].

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[1] These palatographs are obtained by painting the tongue with a mixture of charcoal powder and vegetable oil and then photographing the impression the tongue leaves on the palate after pronouncing each sound.

(65) Average power spectra of postalveolars and alveopalatals
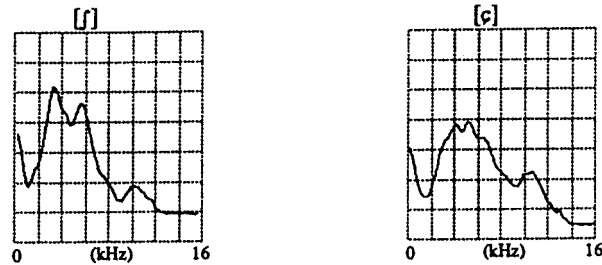
Figure 8 - Average power spectra of postalveolars and alveopalatals

3.2.2. Feature representation of the consonants

Based on their manner of articulation, the 38 consonants can be divided into the following six major classes.

(66) Major consonant classes

stops:	p pʰ pʲ pʲʰ t tʰ tʲ tʲʰ k kʰ kʷ kʷʰ
affricates:	ts tsʰ tʃ tʃʰ tɕ tɕʰ tɕʷ tɕʷʰ
fricatives:	f s ʃ ɕ ɕʷ x xʷ
nasals:	m mʲ n nʲ ŋ
liquids:	l lʲ
glides:	ʋ w j ɥ

These six classes can be differentiated with the features [±sonorant], [±continuant] [strident] and [nasal], as follows.

(67) Feature representation of major consonant classes

stops Root	affricates Root	fricatives Root	nasals Root	liquids Root	glides Root
[-son]	[-son] [strid]	[-son]	[+son] [nasal]	[+son]	[+son]
[-cont]	[-cont]	[+cont]	[-cont]	[-cont]	[+cont]
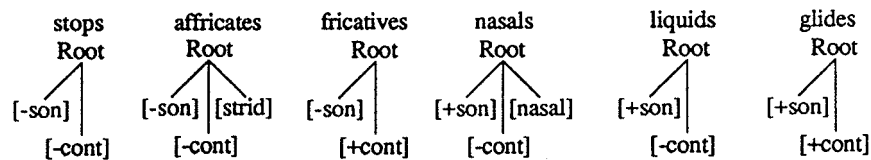
Since sonorant consonants are always voiced and obstruent consonants always voiceless, the feature [±voice] need not be specified; and since the only glottal sound

occurs in a prepausal syllable coda, the feature [constricted glottis] need not be specified, either. The only contrastive laryngeal feature is [±spread glottis] (henceforth [±spread]), as shown in the minimal pairs [tà] "silly" vs [tʰà] "fetus", [tsà] "plant" vs [tsʰà] "guess", [tì] "low" vs [tʰì] "ladder" etc. Of the 20 plosives, 10 are [+spread] and 10 are [-spread].

According to their place of articulation, the 38 consonants can be divided into the following nine groups.

(68) Supralaryngeal consonants with different places of articulation

labials:	p pʰ m f ʋ
alveolars:	t tʰ n l ts tsʰ s
postalveolars:	tʃ tʃʰ ʃ
alveopalatals:	tɕ tɕʰ ɕ j
velars:	k kʰ x ŋ
palatalized labials:	pʲ pʲʰ mʲ
palatalized alveolars:	tʲ tʲʰ nʲ lʲ
labialized alveopalatals:	tɕʷ tɕʷʰ ɕʷ ɥ
labialized velars:	kʷ kʷʰ xʷ w

Of the nine places of articulation, the first five are represented as follows.

(69) Feature representation of major places of articulation

labial C-place	alveolar C-place	postalveolar C-place	alveopalatal C-place	velar[2] C-place
			Vocalic	Vocalic
			V-place	V-place
[labial]			[dorsal]	[dorsal]
	[coronal]	[coronal]	[coronal]	
	[+anterior]	[-anterior]		
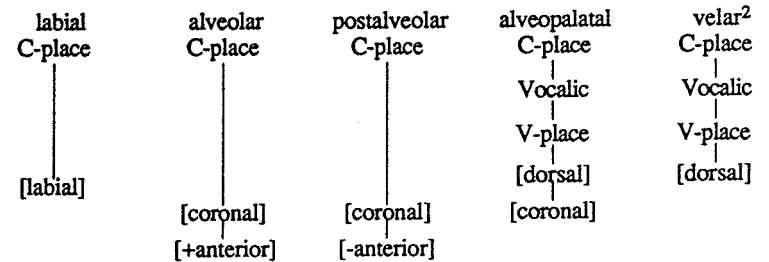
Palatalized labials and palatalized alveolars both have the secondary place feature [coronal] specified in addition to their respective primary place features, as follows.

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[2] This represents a surface velar consonant. There are good reasons to believe that plain velar consonants are underlyingly unspecified for place features, because the only segments that may occur in a syllable coda are velars. This will be discussed later in this chapter.

(70) Feature representation of palatalized consonants

palatalized labial
C-place
    Vocalic
    V-place
[labial]
    [dorsal]
    [coronal]

palatalized alveolar
C-place
    Vocalic
    V-place
    [dorsal]
    [coronal]
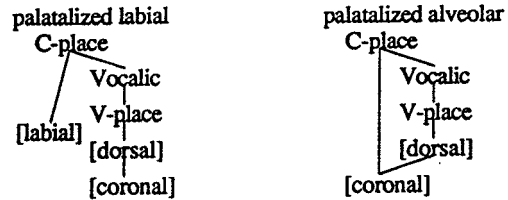
Similarly, labialized alveopalatals and labialized velars have a secondary place feature [labial] specified in addition to their respective primary (and secondary) place features, as shown below.

(71) Feature representation of labialized consonants

labialized alveopalatal
C-place
Vocalic
V-place
    [labial]
[dorsal]
[coronal]

labialized velar
C-place
Vocalic
V-place
    [labial]
[dorsal]
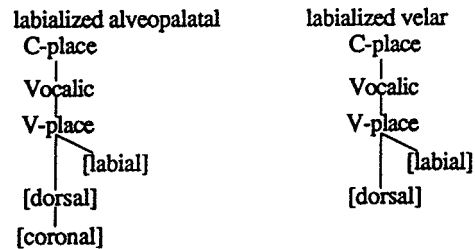
3.3. The vowels

3.3.1. Underlying vowel and their surface phonetic characteristics

There are 22 surface vowels, as shown in the following chart.

(72) Surface vowels (22)

i	y		ɜ	ɻ		ɨ	ʑ	β	u
	ɪ	ʏ							ʮ
		e					ə		o
		ɛ̝					ɚ		ʊ
			ɛ						ɔ
			ɛ̞				a		ɒ

Each of the seven nasal vowels [ĩ ɣ̃ ɥ̃ ɛ̃ ɔ̃ ɛ̃ ɒ̃] behaves like a Vŋ sequence in causing the onset sonorant of a following toneless syllable to become [ŋ]. Furthermore, the oral counterparts of these nasal vowels never surface before a coda nasal . For these reasons, the nasal vowels shall be analyzed as Vŋ sequences in chapter IV. As a result of this analysis, there are 15 underlying vowels, as shown in the following chart.

(73) Underlying vowels (15)

i	y		ɜ	ɻ		ɨ	ʑ	β	u
		e					ə		o
							ɚ		
		ɛ							ɔ
							a		

As we can see, this language is extremely rich in high vowels. The common ones are the front unrounded [i], the front rounded [y], the central unrounded [ɨ] and the back rounded [u]. These vowels have similar F1 values, meaning they are produced with similar tongue height, but have distinct F2 values: 2200 Hz for [i], 2000 Hz for [y], 1700 Hz for [ɨ] and 900 Hz for [u] for this speaker (myself). Following are the spectrograms of these four high vowels.

(74) Spectrograms of the four common high vowels

(Hz)	[i]	[y]	[ɨ]	[u]
7000				
6000				
5000				
4000				
3000				
2000				
1000				
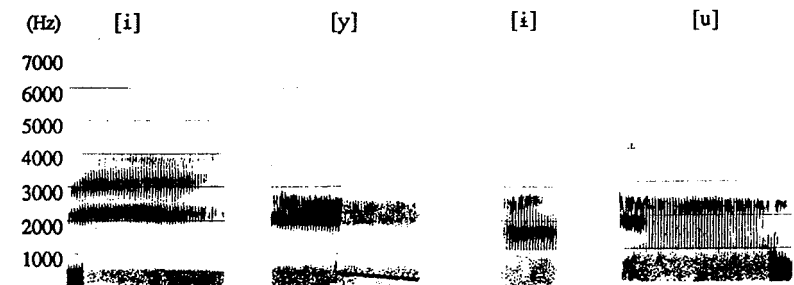
Figure 9 - Spectrograms of four common high vowels

In addition to the four common high vowels, there are four rare "fricative" vowels [ʒ], [ʒ], [β] and [ʐ]. These vowels sound exactly like what their transcriptions indicate, i.e. [ʒ] is a syllabic [ʒ], [ʒ] a syllabic [ʒ] (labialized [ʒ]), [β] a syllabic [β] and [ʐ] a syllabic [ʐ]. The last sound is also found in Mandarin and many other Chinese dialects, often referred to as an apical vowel and transcribed with the symbol [ɿ]. The palatograms below show the articulatory difference between the fricative vowel [ʒ] and the plain front high vowel [i]. Notice how they resemble those in (64), i.e the palatogram of [ʒ] is like that of [ʃ], and the palatogram of [i] is like that of [ç].

(75) Palatograms of [ʒ] and [i]
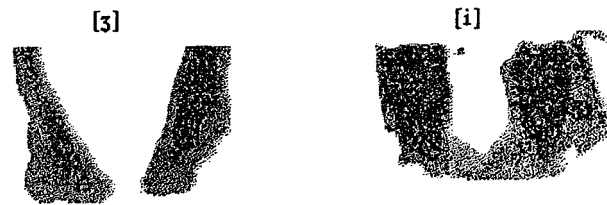
Figure 10 - Palatographs of [ʒ] and [i]

Following are the spectrograms of the four fricative vowels.

(76) Spectrograms of the four fricative vowels
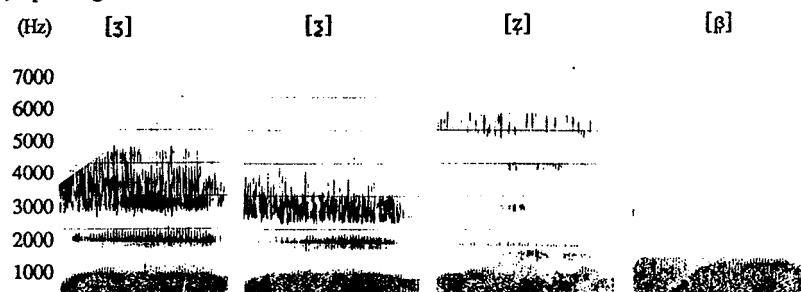
Figure 11 - Spectrograms of four fricative vowels

In the above spectrograms, the F1 value is about 280 Hz for [ʒ], [ʒ] and [ʐ]. This shows that these vowels are all high vowels. The F2 value is about 1500 Hz for [ʒ] and

1300 Hz for [ʒ] and [ʐ], suggesting that these are central vowels. The F1 value for [β] is very difficult to determine, because it is often blended into F0. The F2 value for [β] is about 1100 Hz, which shows that this is a back vowel. The lack of a well-defined formant structure of the vowel [β] is probably due to the narrow lip closure blocking most of the resonances in the oral cavity and to the lack of a resonator prior to the labial constriction.

In addition to formant energy at the F1 and F2 values noted, we see that with the vowels [ʒ] and [ʐ] there is a huge amount of energy concentration in the higher frequency region (between 2500 Hz and 4000 Hz for [ʒ] and between 5000 Hz and 7000 Hz for [ʐ], respectively). This indicates that there is strong frication. With the vowel [ʒ], the overall energy level is lower due to lip rounding, though there is a moderate energy concentration between 2000 Hz and 3200 Hz. With the vowel [β], on the other hand, there is no high frequency energy concentration. This is typical of sounds made with a labial constriction, because of the lack of any resonator prior to the constriction. The extremely low overall energy is all concentrated at the lowest end of the spectrum, which is probably due to the narrow labial closure that masks much of the resonances in the oral cavity.

A phonetic detail about the vowel [β] is its exact place of articulation. This vowel is bilabial if preceded by a bilabial or a velar, labiodental if preceded by a labiodental, and half way between bilabial and labiodental, with the upper teeth touching the upper inside of the lower lip, if preceded by an alveolar. Such a variation is phonetically interesting but phonologically insignificant, since the difference between labiodental and bilabial is not involved in any phonological contrasts or phonological processes in this language. Therefore, this variation will not be further pursued in this study.

In addition to the fricative vowels, the retroflex vowel [ɚ] is worth mentioning. It is similar to the retroflex vowel in English, except that with the Nantong [ɚ] the jaw is lower and the tongue tip is raised higher and further back. This vowel has prominent F1 and F2

with an average value of 600 and 1500 respectively, and a weak F3 at about 2000 for this speaker. Following is the spectrogram of this vowel.

(77) Spectrogram of the retroflex vowel
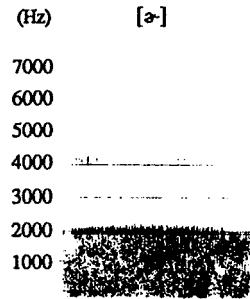
Figure 12 - Spectrogram of the retroflex vowel

With the exception of the fricative vowels, the retroflex vowel and the low central vowel [a], all vowels may occur before the coda nasal [ŋ] underlyingly. However, only [ɨ] or [ə] may surface before the coda nasal, while all other other vowels that precede the coda nasal underlyingly (i.e. [i], [y], [u], [e], [o], [ɛ] and [ɔ]) surface as nasal vowels, with the coda nasal deleted. This will be discussed in greater detail in chapter IV.

3.3.2. Feature representation of the vowels

When followed by a coda nasal, the central vowels [ɨ] and [ə] behave differently from other vowels in a number of ways. They fail to merge with the coda nasal to become a nasal vowel (e.g. /tɨŋ/ > [tɨ̃] but /tɨŋ/ ≯ *[tɨ̃]), and they fail to trigger deletion of the coda nasal followed by a retroflex vowel (e.g. /tɨŋ.ə/ > [tɨ.ɚ] but /tɨŋ.ə/ ≯ *[tɨ.ɚ]). In order to account for these processes, we must assume that the central vowels are not specified for vowel place features, i.e. they lack a V-place node.

Given the above assumption, and with the place feature geometry model discussed in chapter II, the four common high vowels should be represented as follows.

(78) Feature representation of common high vowels
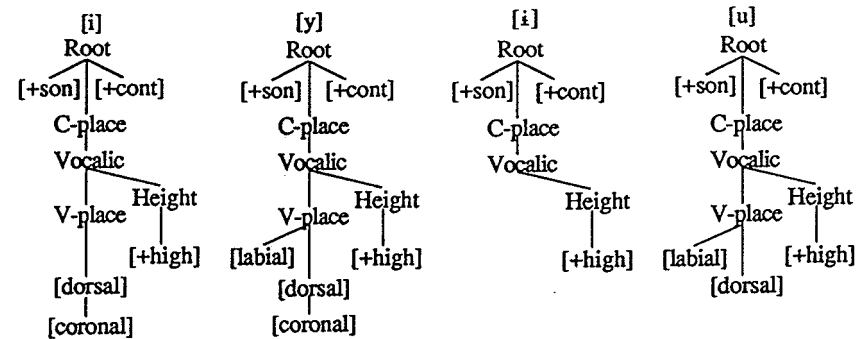
The mid vowels [e ə o] are represented with the respective place features of [i ɨ u], with the height feature changed to [-high]. Similarly, the low vowels [ɛ a ɔ] are also represented with the respective place features of [i ɨ u], with the height feature changed to [+low].

The four fricative vowels are essentially sonorant fricatives. Their articulation does not involve any vowel-like lingual gestures. Therefore, they should have the same place feature specification as their non-sonorant counterparts, i.e. [ʒ] and [ʐ] are postalveolar vowels, [z] is an alveolar vowel and [β] is a labial vowel. Following are their feature representations.

(79) Feature representation of fricative vowels
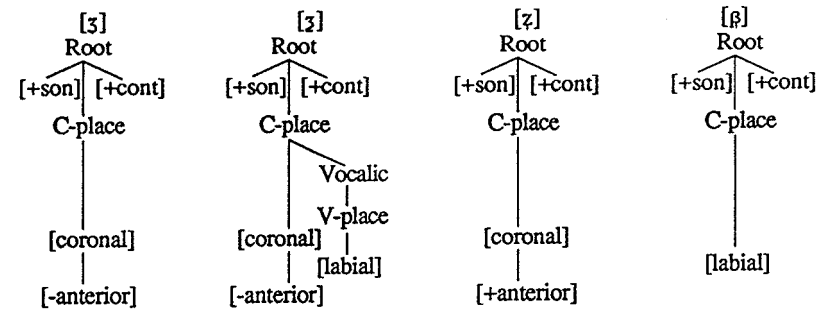
Finally, based on our discussion of retroflexes in chapter II, we treat the retroflex vowel as a coronodorsal vowel, as shown below.

(80) Feature representation of the retroflex vowel [ɚ]

```
              Root
             /    \
        [+son]    [+cont]
         C-place
             \
              Vocalic
              |
              V-place
    [coronal]  |
              [dorsal]
```
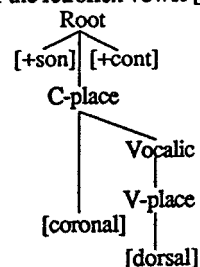
3.4. The tones

3.4.1. Underlying tones and their surface phonetic characteristics

There are five underlying tones in Nantong Chinese. They include two level tones L and H, two rising tones LM and MH, and a falling tone HM, as shown below.

(81) Underlying tones in Nantong Chinese

L e.g. /tʰɿ/ "ladder" LM e.g. /tʰɿ/ "ground"

H e.g. /tʰɿ/ "body" MH e.g. /tʰɿ/ "raise"

HM e.g. /tʰɿ/ "go"

We transcribe the three tone level primitives H, M, L as [´], ['], [`], respectively. And we transcribe a sequence of tonal primitives (e.g. LM) which represents a contour tone as a combination of these tonal diacritics (e.g. ˅). Following are narrowband sprectrograms of the five underlying tones found in monosyllabic words uttered by this speaker. Notice that L and LM are realized as ML and MLM respectively in this environment.

(82) Narrowband spectrogram of surface forms of five underlying tones

ML = L	MH	H	HM	MLM = LM
[tʰɿ]	[tʰɿ]	[tʰɿ]	[tʰɿ]	[tʰɿ]
"ladder"	"raise"	"body"	"go"	"ground"
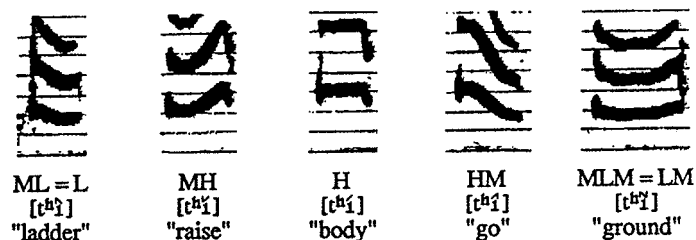
Figure 13 - Narrowband spectrogram of surface forms of five underlying tones

Ignoring the initial segmental perturbation and the final trailing toward the mid pitch level in some cases, we get the following mean pitch values (in Hz) from five tokens of each of the five surface tones at the start point, mid point and end point respectively, the mean duration (in milliseconds) of each contour, and the standard deviation of each value.

(83) Mean pitch value of surface tones

Sample word	Tone letter	Start Point F_0(Hz) SD	Mid Point F_0(Hz) SD	End Point F_0(Hz) SD	Duration Dur.(ms) SD
[tʰɿ] "ladder"	ML	150.0 3.6	123.3 7.3	111.0 4.5	231.2 17.7
[tʰɿ] "raise"	MH	138.3 7.4	151.0 8.2	202.5 5.4	315.6 18.5
[tʰɿ] "body"	H	199.8 3.1	199.5 2.3	200.8 1.9	264.4 14.2
[tʰɿ] "go"	HM	223.5 5.2	180.0 4.2	114.8 5.8	230.6 11.6
[tʰɿ] "ground"	MLM	131.0 9.7	104.8 5.3	131.5 4.9	448.1 29.3

It seems from these measurements that the target values of the three tone levels L, M and H are about 110, 140 and 200 respectively for this speaker in this overall pitch range.

Of the five underlying tones, L and LM are the most variant. In addition to its word-final surface form ML, underlying L may surface as M in non-final positions. And in addition to its prepausal surface form MLM, underlying LM may surface as M, MH, ML etc. These alternations will be discussed in chapter V.

All the tonal contours and their measurements and variations shown above occur in sonorant-final syllables. Two of them, HM and LM, also occur in obstruent-final syllables, where they surface as HM and H[3] respectively in prepausal positions, as shown below.

(84) Surface forms of HM and LM in prepausal positions

HM	H
[tʰɿʔ]	[tʰɿʔ]
"iron"	"enemy"
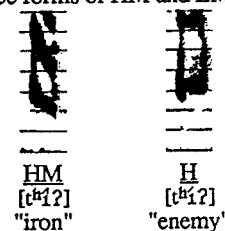
Figure 14 - Narrowband spectrograms of HM and H in prepausal positions

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3 These tonal primitives are underlined to indicate their short duration.

The same kind of measurements as those shown in (83) can be made for these tonal contours, as shown below.

(85) Mean pitch value of surface tones in obstruent-final syllables

Sample word	Tone letter	Start Point F_0(Hz) SD	Mid Point F_0(Hz) SD	End Point F_0(Hz) SD	Duration Dur.(ms) SD
[tʰ12] "iron"	HM	206.5 6.8	172.3 5.4	138.0 4.0	99.4 8.4
[tʰi2] "enemy"	H	223.5 6.7	230.2 6.7	236.9 6.7	100.6 13.3

The supposition that surface H derives from underlying LM is based on the fact that it alternates morphophonemically with other surface forms of underlying LM (i.e. MH and M), for example, [sɛ2] "ten", [sɛs.s̩] "thirteen", but [sɛ.ji2] "eleven", [sɛ.ʋβ] "fifteen". These alternations will be discussed in more detail in chapter V.

Traditional Chinese phonologists divide Middle Chinese tones into four categories: level, rising departing and entering. Each category is divided into two subcategories *yin* and *yang*. The *yin* subcategories cooccur with voiceless onset consonants and the *yang* subcategories with voiced onset consonants. The reflexes of these tonal categories in Nantong Chinese are shown as follows.

(86) Reflexes of Middle Chinese tonal categories in Nantong Chinese

level	*yin*	L (ML)	tʰ1	"ladder"	*yang*	MH	tʰi	"raise"
rising	*yin*	H	tʰi	"body"	*yang*	LM (MLM)	tʰi	"brother"
departing	*yin*	HM	tʰi	"shave"	*yang*	LM (MLM)	tʰi	"ground"
entering	*yin*	HM (HM)	tʰ12	"iron"	*yang*	LM (H)	tʰi2	"flute"

3.4.2. Feature representation of surface tones

With the tonal feature model discussed in Chapter II, the five underlying tones can be represented in feature geometry as follows.

(87) Feature representation of underlying tones
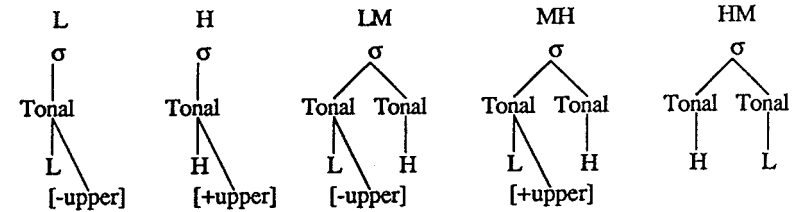
Notice that under the assumption that there is one register per syllable, only the first tonal node of a contour tone is specified for register. This is because in order to account for a process that changes an underlying LM into a surface H, there must be a rule that fills the second tonal node with the default register feature [+upper] after the first tonal node is deleted. If both tonal nodes are specified with [-upper], then deleting the first tonal node will not result in a registerless second tonal node, and therefore we must forcibly change the register feature on the second tonal node from [-upper] to [+upper], which is against the tacit principle that features may be spread, deleted or specified by default, but may not be arbitrarily changed. Also notice that the falling tone HM has no specification for register. This is necessary because it does not pattern with either upper register tones or lower register tones with regard to tonal processes that refer to register features, and it is possible because HM is the only underlying falling tone in this language. In any case, a tonal node that has no register specification will receive one by register default if there is no register specification in the syllable or by register spreading if there is register specification on at least one tonal node in the syllable. These processes will be discussed in chapter V.

3.5. Phonotactic constraints

3.5.1. Distributional gaps of the underlying sounds

The canonic syllables in Nantong Chinese are V, VC, CV and CVC. If the 38 underlying consonants and 15 underlying vowels could combine freely, we would expect to find $15 + 2 \times (38 \times 15) + (38 \times 15 \times 38) = 22815$ syllables. In reality, there are only 400

possible syllables, most of which are shown in the following table, where the symbol(s) at the intersection of each onset in the left-hand column and each rhyme in the top row indicate a possible syllable and its surface vocalism. Underlined symbols represent syllables used only in loan words, italicized symbols represent those used only in interjections, and underlined italicized symbols represent those used only in onomatopoeia (cf. Appendix I).

(88) Possible combinations of underlying consonants and vowels

	i	y	ɨ	ʒ	ʐ	ʅ	β	u	e	o	ə	ɔ	a	iŋ	yŋ	uŋ	eŋ	oŋ	ɛŋ	ɔŋ	iŋ	əŋ	ik	yk	ok	ek	ɔk	ak
ø		y		ʒ	ʐ			u	e	o		ɔ	a		yŋ	uŋ			ɛŋ			əŋ		yk				
f							β		e									oŋ	ɛŋ	ɔŋ		əŋ			ok	ek	ɔk	
ʋ							β		e				a						ɛŋ							ek		
w										o								oŋ		ɔŋ					ok		ɔk	
p				ʒ			β	u	e	o	ə	ɔ	a	iŋ		uŋ		oŋ	ɛŋ	ɔŋ	iŋ	əŋ	ik		ok	ek	ɔk	ak
pʰ				ʒ			β	u	e	o	ə		a	iŋ		uŋ		oŋ	ɛŋ	ɔŋ	iŋ	əŋ	ik		ok	ek	ɔk	ak
m				ʒ				u	e	o	ə		a	iŋ		uŋ		oŋ	ɛŋ	ɔŋ	iŋ	əŋ	ik		ok	ek	ɔk	
t	i	y					β	u	e		ə	ɔ	a	iŋ	yŋ			oŋ	ɛŋ	ɔŋ	iŋ	əŋ	ik	yk	ok	ek	ɔk	ak
tʰ	i						β	u	e	o	ə		a	iŋ	yŋ			oŋ	ɛŋ	ɔŋ	iŋ	əŋ	ik	yk	ok	ek	ɔk	ak
n	i	y		ʒ				u	e	o	ə	ɔ	a	iŋ	yŋ			oŋ	ɛŋ	ɔŋ		əŋ	ik		ok	ek	ɔk	
l	i	y					β	u	e	o	ə	ɔ	a	iŋ	yŋ			oŋ	ɛŋ	ɔŋ	iŋ	əŋ	ik	yk	ok	ek	ɔk	ak
ts					ʐ		β	u	e	o	ə		a					oŋ	ɛŋ	ɔŋ		əŋ			ok	ek	ɔk	ak
tsʰ					ʐ		β	u	e	o	ə		a					oŋ	ɛŋ	ɔŋ		əŋ			ok	ek	ɔk	ak
s					ʐ		β	u	e	o	ə		a					oŋ	ɛŋ	ɔŋ		əŋ			ok	ek	ɔk	ak
k							β	u	e	o	ə		a			uŋ		oŋ	ɛŋ	ɔŋ		əŋ			ok	ek	ɔk	ak
kʰ							β	u	e	o	ə		a			uŋ		oŋ	ɛŋ	ɔŋ		əŋ			ok	ek	ɔk	ak
x							β	u	e	o	ə	ɔ	a			uŋ		oŋ	ɛŋ	ɔŋ		əŋ			ok	ek	ɔk	
ŋ								u	e	o	ə		a					oŋ	ɛŋ	ɔŋ					ok	ek	ɔk	
tʃ				ʒ	ʐ																iŋ							
tʃʰ				ʒ	ʐ																iŋ							
ʃ				ʒ	ʐ																iŋ							
pʲ											ə																	
pʰʲ											ə		a															
mʲ											ə		a															
tʲ											ə	ɔ																
tʰʲ											ə																	
nʲ											ə						eŋ										ɔk	
lʲ											ə						eŋ										ɔk	
tɕ		y							ɛ		ə	ɔ		iŋ	yŋ		eŋ					əŋ	ik	yk			ɔk	
tɕʰ		y							ɛ		ə	ɔ		iŋ	yŋ		eŋ					əŋ	ik	yk			ɔk	
ɕ		y							ɛ		ə	ɔ		iŋ	yŋ		eŋ					əŋ	ik	yk			ɔk	
j									ɛ		ə	ɔ	a	iŋ			eŋ		ɛŋ		iŋ	əŋ	ik			ek	ɔk	
kʷ									e	o			a					oŋ	ɛŋ	ɔŋ					ok	ek	ɔk	ak
kʰʷ									e	o			a					oŋ	ɛŋ	ɔŋ					ok		ɔk	ak
xʷ									e	o			a					oŋ	ɛŋ	ɔŋ					ok	ek	ɔk	ak
tɕʷ									e	o			a					oŋ	ɛŋ			iŋ			ok			
tɕʰʷ									e									oŋ	ɛŋ			iŋ			ok	ek		
ɕʷ									e				a					oŋ	ɛŋ	ɔŋ		iŋ			ok	ek		
ɥ									e	o								oŋ	ɛŋ			iŋ			ok	ek		

In addition, there are four more syllables: ɚ, tɚ, kuk, tʃʰɨk.

Since the number of well-formed syllables is much smaller than that of logically possible syllables, there are obviously many distributional gaps.

In addition to restrictions on possible consonant-vowel combinations, there are restrictions on possible tone-syllable combinations, as shown in the following data.

(89) Possible combinations of tones and syllables

	p	t	k	ts	pʰ	tʰ	kʰ	tsʰ	s	x	m	n	l	ŋ	j
LM	-	-	-	-	pʰɤ̌	tʰɤ̌	kʰɤ̌	tsʰɤ̌	sɤ̌	xɤ̌	mɤ̌	nɤ̌	lɤ̌	ŋɤ̌	jɤ̌
LM	-	-	-	-	pʰók	tʰók	kʰók	tsʰók	sók	xók	mók	nók	lók	ŋók	jók
MH	-	-	-	-	pʰɤ́	tʰɤ́	kʰɤ́	tsʰɤ́	sɤ́	xɤ́	mɤ́	nɤ́	lɤ́	ŋɤ́	jɤ́
H	pɤ́	tɤ́	kɤ́	tsɤ́	pʰɤ́	tʰɤ́	kʰɤ́	tsʰɤ́	sɤ́	xɤ́	mɤ́	nɤ́	lɤ́	ŋɤ́	jɤ́
L	pɤ̀	tɤ̀	kɤ̀	tsɤ̀	pʰɤ̀	tʰɤ̀	kʰɤ̀	tsʰɤ̀	sɤ̀	xɤ̀	mɤ̀	nɤ̀	lɤ̀	ŋɤ́	jɤ̀
HM	pɤ̂	tɤ̂	kɤ̂	tsɤ̂	pʰɤ̂	tʰɤ̂	kʰɤ̂	tsʰɤ̂	sɤ̂	xɤ̂	-	-	-	ŋɤ̂	jɤ̂
HM	pók	tók	kók	tsók	pʰók	tʰók	kʰók	tsʰók	sók	xók	-	-	-	ŋók	jók

We can see that there are also many systematic distributional gaps in possible tone-syllable combinations. First, LM and MH may not occur in a syllable with an unaspirated onset plosive. Second, HM may not occur in a syllable with an onset lateral or onset labial

or alveolar nasal. Third, L, H and MH may not occur in an obstruent-final syllable, even though underlying LM may surface as H̲ in such a syllable.

3.5.2. Phonotactic constraint — a few case studies

As I argued earlier in this chapter, distributional facts alone are not sufficient grounds for phonemicization. On the other hand, however, native speakers do seem to know which combinations are acceptable syllables and which ones are not. To incorporate this knowledge into the grammar, we can utilize positive or negative phonotactic filters. To elaborate on this point, we consider a few case studies.

3.5.2.1. Case study I — distribution of unrounded high front vowels

To account for the complementary distribution of the unrounded high vowels [ɿ], [i] and [ʅ], we assume that these vowels are all underlying and each subject to a set of phonotactic filters stated as follows.

(90) [ʅ] occurs after postalveolar consonants [tʃ tʃʰ ʃ] in open syllables;
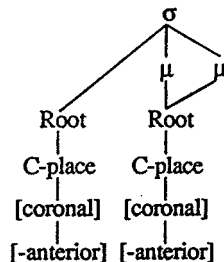
This is a positive filter. It states that a syllable is well-formed if it contains a postalveolar onset and a postalveolar vowel dominated by two moras.

(91) [ʅ] occurs after labial consonants [p pʰ m] in open syllables;
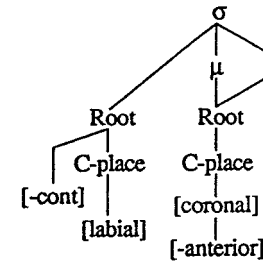
This filter is also positive. It states that a syllable is well-formed if it contains a non-continuant labial onset and a postalveolar vowel dominated by two moras.

(92) [ʅ] occurs in isolation in open syllables;
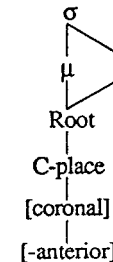
This is another positive filter. It states that a syllable is well-formed if it contains an initial postalveolar vowel which is dominated by two moras.

(93) [ɿ] occurs after strident coronals [ts tsʰ s] in open syllables;
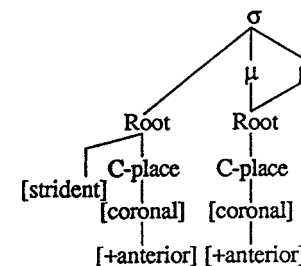
This is yet another positive filter. It states that a syllable is well-formed if it contains a strident coronal onset and a coronal vowel dominated by two moras.

Finally, we need a general negative filter which states that a syllable is ill-formed if it contains an alveolar or postalveolar vowel, as shown below.

(94) [ʒ] and [ʐ] do not occur anywhere else;

```
        *   σ
            |
            μ
            |
          Root
            |
         C-place
            |
        [coronal]
```
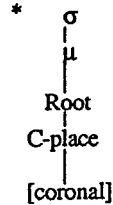
Since this filter is more general than and contradictory with filters (90) through (93), it applies under the Elsewhere Condition discussed in Kiparsky (1973). In other words, it applies after all other filters referring to the alveolar and postalveolar vowels have applied, and rules out every syllable containing an alveolar or postalveolar vowel not licensed by one of the phonotactic filters (90) through (93).

(95) [i] does not occur after strident coronals [ts tsʰ s tʃ tʃʰ ʃ];

```
          *   σ
             / \
            /   μ
           /    |
        Root   Root
        /        |
   C-place    C-place
      |          |
  [strident]  Vocalic
      |          |
  [coronal]   V-place   Height
                |         |
            [dorsal]   [+high]
                |
            [coronal]
```
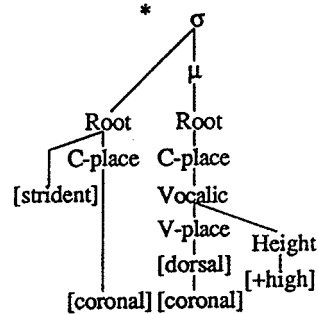
This negative filter means that a syllable is ill-formed if it contains a strident coronal onset and a front high vowel. This bleeds the next more general filter.

(96) Front vowels occur after coronal consonants [t tʰ n l];

```
             σ
            / \
           /   μ
          /    |
       Root   Root
        |       |
    C-place  C-place
                |
             Vocalic
                |
             V-place
                |
             [dorsal]
   [coronal] [coronal]
```
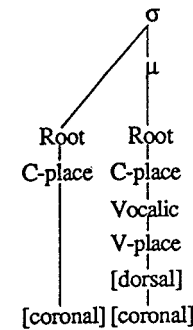
This positive filter states that a syllable is well-formed if it contains a coronal onset and a front vowel.

(97) Front vowels occur after labial consonants [p pʰ m] in closed syllables;

```
                σ
              / | \
             /  μ  μ
            /   |
         Root  Root
          |      |
      C-place  C-place
          |      |
  [-continuant] Vocalic
          |      |
       [labial] V-place
                  |
               [dorsal]
                  |
               [coronal]
```
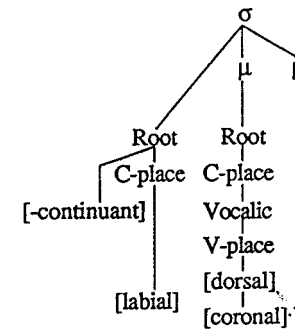
This filter states that a syllable is well-formed if it contains a noncontinuant labial onset and a front vowel in a closed syllable (dominated by a mora which is followed by another one).

(98) [i] occurs after palatal consonants [tɕ tɕʰ ɕ j] in closed syllables;

```
            σ
          / |\
         /  μ  μ
        /   |
     Root  Root
       |    |
   C-place C-place
       |    |
   Vocalic Vocalic
       |    |
   V-place V-place
       |    |
   [dorsal] [dorsal]
       |    |
  [coronal] [coronal]
```
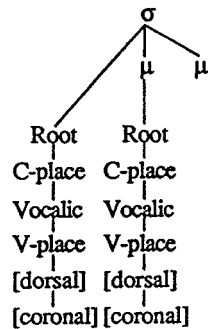
This positive filter states that a syllable is well-formed if it contains an alveopalatal onset and a front vowel in a closed syllable (dominated by a mora which is followed by another mora).

(99) [i] does not occur anywhere else;

```
    *
        σ
        |
        μ
        |
      Root
        |
    C-place
        |
    Vocalic
        |
    V-place
        |       Height
   [dorsal]       |
        |      [+high]
   [coronal]
```
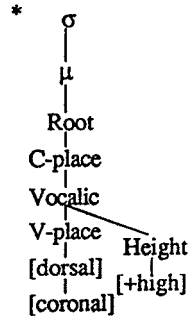
This negative filter states that a syllable is ill-formed if it contains a front high vowel. Like filter (94), it also applies under the Elsewhere Condition, and excludes every syllable containing a front high vowel not licensed by a phonotactic filter.

The following illustration shows how these phonotactic filters operate on a group of arbitrarily generated syllables, licensing well-formed ones and ruling out ill-formed ones.

(100) Sample derivation of well-formed syllables with unrounded high vowel

Input	ʃʒ	pʒ	ʒ	sʐ	ti	pik	çik	sʒ	ʃʒk	pʐ	tsi	pi
Filter (90)	ʃʒ	.	.	.	.	.	.	.	.	.	.	.
Filter (91)	.	pʒ	.	.	.	.	.	.	.	.	.	.
Filter (92)	.	.	ʒ	.	.	.	.	.	.	.	.	.
Filter (93)	.	.	.	sʐ	.	.	.	.	.	.	.	.
Filter (94)	.	.	.	.	.	.	.	—	—	—	.	.
Filter (95)	.	.	.	.	.	.	.	.	.	—		.
Filter (96)	.	.	.	.	ti	.	.	.	.	.	.	.
Filter (97)	.	.	.	.	.	pik	.	.	.	.	.	.
Filter (98)	.	.	.	.	.	.	cik	.	.	.	.	.
Filter (99)	.	.	.	.	.	.	.	.	.	.	.	—
Output	ʃʒ	pʒ	ʒ	sʐ	ti	pik	çik	*sʒ	*ʃʒk	*pʐ	*tsi	*pi

3.5.2.2. Case study II — distribution of consonants in syllable coda

As a second case study, we now consider the fact that only plain dorsals [k] and [ŋ] may occur in the syllable coda. This appears to be another instance of the universal phenomenon that segments in the syllable coda tend to have little or no difference in place features. Following the licensing theory developed by Ito (1986) and summarized by Goldsmith (1992), we may assume that the syllable coda in Nantong Chinese does not license place features, and that the plain dorsals may occur in the syllable coda because they are underlyingly not specified with place features. Notice that while plain dorsals can be unspecified for place features, dorsals with secondary features cannot, because their secondary features need to be docked under the C-place node. Also notice that if [dorsal] is underlyingly unspecified for plain dorsals, then it is the default place feature, and therefore [labial] and [coronal] cannot be underlyingly unspecified. Thus, the first phonotactic filter regarding well-formed syllable codas states that a syllable coda is ill-formed if it contains a segment with a C-place node, as formalized below.

(101) Consonants with place features may not occur in syllable coda
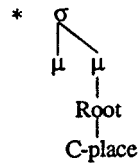
Of the four plain dorsals [k ŋ kʰ x], only two may occur in the syllable coda. To account for this, we need a filter that rules out continuant segments , as formalized below.

(102) Continuant segments may not occur in syllable coda
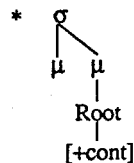
In addition, we need a filter that rules out aspirate segments from the syllable coda, as formalized below.

(103) Aspirate segments may not occur in syllable coda
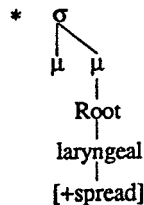
The following illustration shows how the four rules proposed above operate on arbitrarily generated syllables to license those with a well-formed coda and rule out those with an ill-formed coda.

(104) Sample derivation of well-formed syllable coda

Input	pik	piŋ	pikʰ	pix	pit	pitɕ	pikʷ
Rule (101)	pik	piŋ	pikʰ	pix	—	—	—
Rule (102)	.	.	.	—	.	.	.
Rule (103)	.	.	—	.	.	.	.
Output	pik	piŋ	*pikʰ	*pix	*pit	*pitɕ	*pikʷ

One should notice that the coda filters proposed above only apply to underlying forms. In surface forms, it is possible to find consonants other than [k] and [ŋ] in the syllable coda, which are derived by assimilation to the following onset consonant. For example, /lǒk.sʑ/ "sixty four" surfaces as [lós.sʑ], /lǒk.pɔ́k/ "sixty eight" surfaces as [lóp.pɔ́ʔ], etc. These surface forms defy the coda filters, because the root node dominated by the second mora of the first syllable is also dominated by the the second syllable node, as is shown below, and is therefore structurally distinct from those singly linked root nodes which *are* subject to coda filters.

(105) Doubly linked root nodes in surface forms
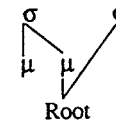
According to the Linking Constraint proposed by Hayes (1986), "Association lines in structural descriptions are interpreted as exhaustive". Since a doubly linked root node is structurally different from a singly linked one, it is not constrained by coda filters that apply to the latter. More importantly, according to the licensing theory, consonants that do appear in the coda "will share the point of articulation autosegment that is licensed by the following onset" (Goldsmith 1990:125). This explains why consonants that are not licensed by coda filters may occur in the coda only if they are homorganic to the following consonant.

3.5.2.3. *Case study III — distribution of rising tones*

As a third example of phonotactic constraint, we study a rare case of distributional gaps of tone-syllable combination. As is shown earlier, the surface tones LM, MH and H̱ never occur in syllables with an unaspirated onset. In the present tonal feature model, LM and MH are LH contours differing only in register, i.e. LM is lower register LH and MH is upper register LH. We also know that surface H̱ is underlyingly LM, because it alternates with LM in morphophonemic processes, e.g. [sɛ́ʔ] "ten", [sɛ́s.sʑ̱] "thirteen", but [sɛ̌.jî?]

"eleven", [sɛ́.uβ] "fifteen". Since the three surface tones involved in this tone-syllable distributional gap all have an underlying LH contour, we can formalize a phonotactic rule as follows.

(106) LH contour does not occur in syllables with unaspirated onset

```
    *      σ
          /|\
        / Tonal Tonal
      Root   |     |
       |     L     H
   Laryngeal
       |
   [-spread]
```
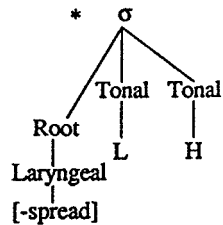
This tone-syllable phonotactic constraint is easy to understand if put in historical perspective. According to traditional Chinese phonology, there are four tonal categories in Middle Chinese, each later divided into two subcategories *yin* and *yang*. The *yin* tones co-occur with voiceless onset consonants while the *yang* tones co-occur with voiced onset consonants. In Nantong, surface LM, MH and H̲ are the reflexes of Middle Chinese *yang* tones. Moreover, all Middle Chinese voiced obstruents have developed into voiceless aspirated obstruents in Nantong Chinese. Therefore, while we can find both *yin* tones and *yang* tones in syllables with aspirated onset obstruents, we cannot find any *yang* tones in syllables with unaspirated onset obstruents.

Finally, the fact that this tone-syllable phonotactic constraint applies to unaspirated consonants only is theoretically significant, because it falsifies Lombardi's (1991) claim that the feature [spread] is monovalent and therefore no rule can refer to [-spread].

3.6.Summary

In this chapter, I have argued against the traditional distributionalist approach to phonemic analysis. Accordingly, I have analyzed the underlying sound system of Nantong Chinese as one with 38 consonants, 15 vowels, and 5 tones. I have shown the acoustic and/or articulatory characteristics of the postalveolar and alveopalatal consonants, the high

vowels, the fricative vowels, the retroflex vowel, and the tones. With three case studies, I have shown how phonotactic constraints are to be incorporated into the grammar. The following chapters will handle the morphophonemic alternations of the underlying sounds.

CHAPTER IV   SEGMENTAL MORPHOPHONEMIC ALTERNATIONS

4.0. Introduction

When morphemes are concatenated to form new words, the phonological shape of individual morphemes may change. Such a change is referred to as a morphophonemic process. In this chapter, I will discuss morphophonemic processes involving segmental alternations. Four classes of such alternations are discussed in four sections. There are obligatory and optional glide deletion processes and an onset assimilation process that occur in underlyingly toneless syllables. These will be discussed in 4.1. When followed by a retroflex vowel, a coda nasal either geminates or deletes. These processes are handled in 4.2. Four other processes, including coda deletion, coda nasal assimilation, coda obstruent gemination and coda obstruent deletion, are analyzed in 4.3. Two lenition processes, one affecting the syllable coda and the other affecting the syllable onset, will be dealt with in 4.4. In the course of these discussions, I will also show that many of these processes are prosodically conditioned.

4.1. Alternations of toneless morphemes

Some morphemes are made of underlyingly toneless syllables, which derive their surface tone by tone spreading or tonal default. The tonal alternations of these morphemes will be discussed in chapter V. In this section, I only discuss their segmental alternations. The toneless morphemes include a number of sentence-final particles that indicate the communicative function, the verbal aspect or the speaker's attitude. Following are some examples.

(107) Sentential particles

Perfective interrogative (PI)-la, e.g.	kù....tsʰɛ̀ tʰî là?	Has PRO left yet?
	whether Prf go PI	
Imperfective interrogative (IpI)-a, e.g.	kù má á?	Is PRO buying?
	whether buy IpI	
Exclamative (Exc)-jɔ, e.g.	xá tá jɔ̀!	How big!
	well big Exc	
Vocative (Voc)-a, e.g.	lá tǎ à, ...	Old Dai, ...
	old Dai Voc	
Imperative (Imp)-sa, e.g.	tʰî sà!	Get going!
	go Imp	
Requestive (Req)-se, e.g.	tʰî sè.	Please go.
	go Req	
Suggestive (Sug)-pɔ, e.g.	tʃʰîp pɔ̀.	Let's eat.
	eat Sug	
Persuasive (Prs)-ja, e.g.	má jà.	Come on, buy (it)!
	buy Prs	
Retortive (Ret)-lo, e.g.	ŋú ỳ pɛ́ tʰî lò!	But I'm not going!
	I and not go Ret	
Commentive (Cmt)-le, e.g.	á pɛ́.tsʰɛ̀ tʰî lè.	(It's remarkable) PRO hasn't left yet.
	yet not Prf go Cmt	

Two morphophonemic processes take place in toneless morphemes. One involves the deletion of an onset glide, the other involves the assimilation of an onset sonorant to the preceding coda consonant. We analyze these two processes as follows.

4.1.1. Deletion of onset glide

Two of the sentential particles in (107) start with an onset glide [j]. When preceded by a non-low oral vowel ([i], [y], [ɜ], [ʐ], [ʑ], [u], [e], [ə], [ɚ] or [o]), the glide deletes, as shown below.

(108) Deletion of onset glide after non-low vowels

Exclamative (Exc)-jɔ, e.g.	xá kʷé ɔ̀!	How expensive!
	well expensive Exc	
	xá kʰβ̀ ɔ̀!	How bitter!
	well bitter Exc	
	xá ʃʐ̀ ɔ̀!	How fine!
	well fine Exc	
Persuasive (Prs)-ja, e.g.	tsé à.	Come on, go!
	go Prs	

tsʰṳ́ á.
sit Prs — Come on, sit!

sǫ̃ tsʰò̃ á.[1]
on vehicle Prs — Come on, get on the vehicle!

When preceded by a low vowel ([a] or [ɔ]), the onset glide is optionally deleted if the flanking vowels are different, but it does not delete if the flanking vowels are identical, as shown in the following data. It is not possible to test what happens if the glide is preceded by the low vowel [ɛ], because underlyingly this vowel never occurs in an open syllable.

(109) Onset glide after low vowels

Exclamative (Exc)-jɔ, e.g.

xɔ́ xʷá (j)ɔ́! — How crafty!
well crafty Exc

cf. xɔ́ tɔ́ jɔ̀! — How big!
well big Exc

Persuasive (Prs)-ja, e.g.

lɔ̀ (j)à. — Come on, pull it.
pull Prs

cf. lá já. — Come on, come here.
buy Prs

Glide deletion also occurs with the repetitive affix (Rep) -ja- in the V-ja-V structure, where V refers to a reduplicated verb, as shown in (110a), and with the enumerative affix (Enm) -ja, as shown in (110b).

(110) Glide deletion in other toneless morphemes

a. Glide deletion in V-ja-V structures

pʰò.á.pʰò́, pʰò̀.tɕʷɛ́ʔ jĩk.kʷá tsɟ̃.mò́.tʰɕ̃.
crawl Rep crawl out one piece sesame candy
PRO crawled and crawled, and a sesame candy appeared. (nursery verse)

lɔ̀.(j)á.lɔ̀.rì, lɔ̀ tʰɥ̀.tʰi.rɔ̀.
pull Rep pull break away Prf
PRO pulled and pulled, and broke it.

xá.já.xá.rí, sǫ̃.tsɟ̃ tɔ̀ xǎ.só.rɔ̀.
yell Rep throat even hoarse Prf
PRO yelled and yelled, and his/her throat became hoarse.

---

[1] The surface tone of the sentential particle -ja derives from the underlying tone of the preceding morpheme, which is LM for /tsʰṳ̀/ "sit" but L for /tsʰò̃/ "vehicle". Hence the difference in the surface pitch values of -a. This will be discussed in greater detail in chapter V.

b. Glide deletion in enumerative structures

má.rɔ̀ rɔ̀ pṳ̀.tsʰà.jà, fɟ̀.tɕʰɔ́.(j)á, wǫ̃.kʷò̀.à
bought some spinach Enm tomatoes Enm cucumbers Enm
PRO bought some spinach, tomatoes (and) cucumbers.

Glide deletion does not occur if the glide is in the onset of a syllable that has an underlying tone. In the following data, for example, the toned syllable [jó] retains its onset glide, but the toneless syllable [jɔ] loses its onset glide when preceded by a nonlow vowel.

(111) No glide deletion in toned syllables

/tʰá tsʰβ̃.jó/ — [tʰá tsʰβ̃.jó] — *[tʰá tsʰβ̃.ó] — "Too rude."

cf. /xɔ́ tsʰβ̃ jɔ/ — *[xɔ́ tsʰβ̃ jɔ̀] — [xɔ́ tsʰβ̃ ɔ̀] — "How thick!"

Glide deletion also does not occur if the glide is in the onset of a pseudo-toneless syllable, one that is usually toneless, but may be toned with questionable acceptance, as shown below.

(112) No glide deletion in pseudo-toneless syllables

/tsʰɔ́.jɛ̃ŋ/	[tsʰɔ̀.jɛ̃]	*[tsʰɔ̀.ɛ̃]	?[tsʰɔ́.jɛ̃]	*[tsʰɔ́.ɛ̃]	"feeling hungry"
/kʷó.jɛ̃ŋ/	[kʷó.jɛ̃]	*[kʷó.ɛ̃]	?[kʷó.jɛ̃]	*[kʷó.ɛ̃]	"feeling lack of oil"
/mò.jɛ̃ŋ/	[mò.jɛ̃]	*[mò.ɛ̃]	?[mò.jɛ̃]	*[mò.ɛ̃]	"hot and spicy"

To account for obligatory glide deletion after non-low vowels, we need a rule that deletes a root node which is in the onset position, i.e. is directly linked to the syllable node, and preceded by a [-low] vowel. To condition this rule so that it does not apply in either toned or pseudo-toneless syllables, we may assume that it applies only under the weak branch of a metrical foot, which dominates an underlyingly toneless syllable but not a toned or pseudo-toneless syllable, because the latter two either are underlyingly toned or undergo tone deletion at a later stage. This analysis allows us to formalize the obligatory glide deletion rule as follows.

(113) Obligatory Glide Deletion

```
            φ
          ┌─┐
        σ     σ
        │     ╪
        μ
        │
      Root   Root
      C-place    \  [+cont]
        │         [+son]
      Vocalic
        │
      Height
        │
      [-low]
```
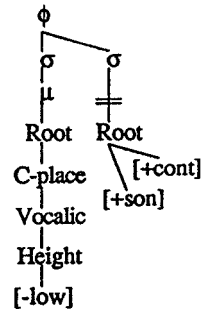
As for the optional glide deletion after low vowels, we need a rule that applies only when the vowels flanking the glide do not agree in lip rounding. However, there is no mechanism in nonlinear phonology that allows us to do so directly. What is involved in this case appears to be a vocalic version of the antigemination condition discussed in McCarthy (1986) and Odden (1988). Specifically, it is assumed that successive identical consonants resulting from a phonological process are a violation of the arguably universal Obligatory Contour Principle, unless they fuse together by language specific rules to form a geminate. Similarly, if we assume that an antigemination condition in Nantong Chinese prohibits identical hiatus vowels, then the failure of glide deletion to occur between identical vowels can be seen as the result of the antigemination condition keeping an ill-formed structure from being created.

Such an account, however, does not explain why identical hiatus vowels do occur in underlying forms such as /ku má a/ → [kù má á] "Is PRO buying?", /lá tá a/ → [lá tá à] "Old Dai, ...", etc. The solve this problem, we assume that what the OCP defines is a desirable state, and that phonological rules do not apply if their output is not in a desirable state. Thus, forms like /ku má a/ or /lá tá a/ are undesirable, yet they never went from good to worse by any phonological rule. On the other hand, glide deletion does not occur in forms like /xá tá jɔ/ "how big" or /lá ja/ "come here", because if it did, it would have

changed them into the undesirable *[xá tá ɔ] or *[lá a] etc. Based on these observations, we formally state the antigemination condition as follows.

(114) Antigemination Condition

Identical hiatus vowels in adjacent syllables should be avoided.

With this provision, the rule for optional glide deletion after low vowels can be simply formalized as follows.

(115) Optional Glide Deletion

```
            φ
          ┌─┐
        σ     σ
        │     ╪
        μ
        │
      Root   Root
      C-place    \  [+cont]
        │         [+son]
      Vocalic
        │
      Height
        │
      [+low]
```
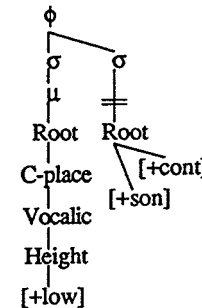
Notice that the prosodic condition of this rule is identical to that of Obligatory Glide Deletion. This rule applies in a toneless syllable with an onset glide whenever such a syllable is preceded by a [+low] vowel, unless its application results in two identical hiatus vowels being created, which violates the antigemination condition.

4.1.2. Assimilation of onset sonorant

In addition to glide deletion, there is a process by which the onset glide [j] and the onset liquid [l] in a sentential particle becomes [k] when preceded by [k], or becomes [ŋ] when preceded by [ŋ] or a nasal vowel[2]. Since [j] and [l] are the only sonorant segments in the onset of underlyingly toneless syllables, we assume that this process affects onset sonorants. Following are some examples.

---

[2] This is the only clear evidence that the coda obstruent is underlyingly /k/, and that the nasal vowels are underlyingly vowel-nasal sequences.

(116) Alternation of onset glide and onset liquid

Perfective interrogative (*PI*)-*la*, e.g.

kù....tsʰɡ̀ tʃʰɪ̀k kà? whether *Prf* eat *PI*		Has PRO eaten yet?
kù....tsʰɡ̀ tə́ŋ ɡá? whether *Prf* understand *PI*		Does PRO understand it yet?
kù....tsʰɡ̀ kʷʰɡ̀ ŋá? whether *Prf* go *PI*		Is PRO asleep yet?
cf.	kù....tsʰɡ̀ tʰɪ́ là? whether *Prf* go *PI*	Has PRO left yet?

Retortive (*Ret*)-*lo*, e.g.

ɡú ỳ pɛ̀ tʃʰɪ̀k kò! I and not eat *Ret*		But I won't eat!
ɡú ỳ pɛ̀ tə́ŋ ŋó! I and not understand *Ret*		But I did know it!
ɡú ỳ pɛ̀ kʷʰɡ̀ ŋò I and not go *Ret*		But I won't sleep!
cf.	ɡú ỳ pɛ̀t tʰɪ́ lò! I and not go *Ret*	But I'm not going!

Exclamative (*Exc*)-*jɔ*, e.g.

xə́ jík kə́! well hot *Exc*		How hot!
xə́ tsʰə̀ŋ ŋó! well heavy *Exc*		How heavy!
xə́ tʰɪ̀ ŋə́! well sweet *Exc*		How sweet!
cf.	xə́ tə́ jɔ̀! well big *Exc*	How big!

Persuasive (*Prs*)-*ja*, e.g.

tʃʰɪ̀k kà. eat *Prs*		Come on, eat!
fə̀ŋ ŋà. seal *Prs*		Come on, seal it!
kʷʰɡ̀ ŋà. sleep *Prs*		Come on, go to sleep!
cf.	má jà. buy *Prs*	Come on, buy it!

This process is also found in the repetitive V-ja-V structure, as shown in (117a), as well as in the enumerative structure, as shown in (117b).

(117) Onset assimilation with other toneless morphemes

    a. in V-ja-V structures

çɥ́k.ká.çɥ́t.tì, ŋɡ̀.lì xə̀.là.ɾə̀
talk *Rep* tears down *Dir Prf*
PRO talked and talked, and burst into tears.

tsʰɡ̀.ŋá.tsʰɡ̀.nì, sɡ̀.tsɡ́ tə̀ xǎ.sǒ.ɾə̀.
sing *Rep* throat even hoarse *Prf*
PRO sang and sang, and his/her throat became hoarse.

tʰɪ̀ŋ.ŋá.tʰɪ̀ŋ.nì, tʰɪ̀ŋ kʷʰɡ̀.tsʰò.ɾə̀.
listen *Rep* listen sleep reach *Prf*
PRO listened and listened, and fell asleep.

cf. pʰò.á.pʰò́, pʰò.tçʷɛ́? jík.kʷá tsɡ́.mó.tʰɡ̀.
crawl *Rep* crawl out one piece sesame candy
PRO crawled and crawled, and a sesame candy appeared. (nursery verse)

    b. in enumerative structures

má.ɾə̀ ɾə̀ jók.ká, tʰɡ̀.ŋá, jɡ̀.tsʰə̀ŋ.ŋà, tʰɡ̀.fβ̀.á
bought some meat *Enm* eggs *Enm* onions *Enm* beancurd *Enm*
PRO bought some meat, eggs, onions (and) beancurd.

This process does not occur in sentential particles with an onset obstruent, as the following data show.

(118) Invariance of obstruent-initial sentential particles

Requestive (*Req*)-*se*, e.g.

tʃɪ̀k sè. eat *Req*		Please eat.
tʰɪ̀ŋ sè. listen *Req*		Please listen.
kʰɡ̀ sè. look *Req*		Please look.
tʰɪ́ sè. go *Req*		Please go.

Assuming that nasal vowels are underlyingly vowels followed by a coda nasal [ŋ], all the alternations can be seen as resulting from a total assimilation of an onset sonorant ([l] or [j]) to the preceding coda consonant ([k] or [ŋ]). Such a generalization needs to be constrained, because onset sonorants of underlyingly toned syllables never assimilate to a preceding coda consonant, as we can see from the following data.

(119) Onset assimilation does not occur in underlyingly toned syllables

/tsʰə̀ŋ.jə̂/	[tsʰə̀ŋ.jə̂]	*[tsʰə̀ŋ.ŋə̂]	"important"
/pɪ̂k.jə̂/	[pɪ̂.jə̂]	*[pɪ̂k.kə̂]	"necessary"
/ɥ̀ŋ.lǎ/	[ɥ̀.lǎ]	*[ɥ̀.ŋǎ]	"originally"
/lɪ̀k.lǎ/	[lɪ̀l.lǎ]	*[lɪ̀k.kǎ]	"historically"

We might conclude that the assimilation of an onset sonorant occurs only in a toneless syllable. However, this appears to be problematic with regard to the following

data, where the sonorant onset of toneless syllables in the directional -la "toward speaker" (a post-verbal particle that indicates direction) and the locative -lit^he " inside" (a post-nominal particle that indicates location) fails to assimilate to the preceding coda consonant.

(120) Onset assimilation fails to occur in directionals and locatives

/tʃî ŋ-la/	[tʃîn.là]	*[tʃîŋ.ŋà]	"come in"
/tɕʰɛ́k-la/	[tɕʰɛ́l.là]	*[tɕʰɛ́k.kà]	"come out"
/nó.tə lɛ̌.sòŋ-la/	[nó.rɛ́ lɛ̌.sʂ̩.là]	*[nó.rɛ́ lɛ̌.sʂ̩.ŋà]	"bring it upstairs"
/fɔ̌.kɔ̀ŋ-li.tʰe/	[fɔ̌.kʂ̩.lì.tʰè]	*[fɔ̌.kʂ̩.ŋì.tʰè]	"inside the room"
/tʰɔ̌ŋ.cɔ̌k-li.tʰe/	[tʰɔ̌ŋ.cɔ́l.lí.tʰɛ́]	*[tʰɔ̌ŋ.cɔ́k.kí.tʰɛ́]	"among the classmates"

Like the pseudo-toneless syllables mentioned earlier, an important characteristic of the directionals and locatives in (120) is that they have an underlying tone which can surface under special circumstances such as in slow tempo or with emphasis. Thus, the words in (120) may be pronounced in slow speech (sometimes with questionable acceptance) as follows.

(121) Directionals and Locatives in slow tempo

/tʃî ŋ-la/	[tʃîn.lǎ]	"come in"
/tɕʰɛ́k-la/	[tɕʰɛ́l.lǎ]	"come out"
/nó.tə lɛ̌.sòŋ-la/	[nó.rɛ́ lɛ̌.sʂ̩.lǎ]	"bring it upstairs"
/fɔ̌.kɔ̀ŋ-li.tʰe/	[fɔ̌.kʂ̩.lǐ.tʰɛ̌]	"inside the room"
/tʰɔ̌ŋ.cɔ̌k-li.tʰe/	?[tʰɔ̌ŋ.cɔ́l.lí.tʰɛ̌]	"among the classmates"

The above data suggest that the directionals and locatives are pseudo-toneless, i.e. they are underlyingly toned and become toneless after onset assimilation has taken place. Such a scenario makes it possible to maintain the hypothesis that onset assimilation only occurs in underlyingly toneless syllables. Assuming that an underlyingly toneless syllable is under the weak branch of a metrical foot, we formalize the rule of onset assimilation as follows.

(122) Onset assimilation
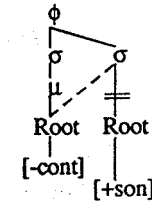
We have assumed in the previous chapter that the coda consonants are underlyingly unspecified for place features. Since they surface as dorsal consonants, a place feature default rule is needed. We formalize this rule as follows.

(123) Place Feature Default

Root
|
C-place
|
[dorsal]
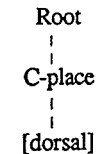
Later we will see that this rule must be revised so that it does not apply to prepausal segments. Following is a sample derivation of toneless syllables with a sonorant onset.

(124) Sample derivation of toneless syllables with sonorant onset

	Underlying	/tsé ja/	/lɔ̀ ja/	/má ja/	/tʃʰîk ja/	/fɔ̀ŋ ja/
Obl. Glide Deletion		/tsé a/	—	—	—	—
(Opt. Glide Deletion)		—	/lɔ̀ a/	—	—	—
Onset Assim. & PFD		—	—	—	/tʃʰîk ka/	/fɔ̀ŋ ŋa/
Surface		[tsé à]	[lɔ̀ à]	[má jà]	[tʃʰîk kà]	[fɔ̀ŋ ŋà]
Gloss		"Go!"	"Pull!"	"Buy it!"	"Eat!"	"Seal it!"

4.1.3. Against a lexical phonology analysis

In the previous two sections, we have seen that the sonorant onset rules (Obligatory Glide Deletion, Optional Glide Deletion and Onset Assimilation) only apply to truly toneless syllables. Because of the small number of morphemes that do undergo those rules, it is tempting to assume that those morphemes are lexically marked for undergoing those rules. However, this approach is undesirable, because it fails to capture the generalization

that morphemes that undergo those rules do not have any underlying tones, whereas those that do not undergo those rules do have underlying tones that may surface.

A more principled approach might appear to be possible using the framework of lexical phonology. This theory deals primarily with interactions of phonology with morphology and syntax. The basic idea is that the derivational and inflectional processes of a language are organized into a series of levels, where different sets of phonological rules apply. After words are combined into sentences, a different set of phonological rules, the postlexical rules, apply. This idea is illustrated in Kiparsky (1982) as follows.

(125) Structure of the lexicon (à la Kiparsky 1982)
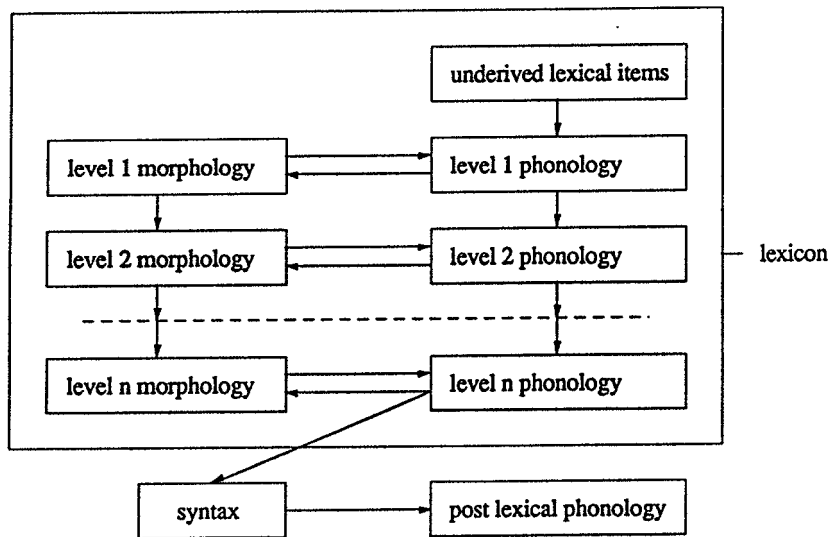
Lexical phonology offers a principled account for the observation that certain phonological rules apply to some lexical categories but not to others. For example, in English, *in-* plus *licit* becomes *il-licit* but *un-* plus *limited* does not become **ul-limited*. Presumably, *in-* is a level 1 morpheme and *un-* a level 2 morpheme. The failure of *un-* to become *ul-* is because the rule that changes *in-* into *il-* is a level 1 rule which does not apply to level 2 morphemes.

We might assume that all sonorant onset rules apply at level 1, and that morphemes that undergo these rules are level 1 morphemes while those that do not are level 2 morphemes. However, lexical levelling is not totally arbitrary, but must reflect the morphological relationship of the lexical items involved. If morpheme A always occurs closer to the root than morpheme B, then it must be at a lower level than morpheme B. The following examples show that morphemes that do not undergo sonorant onset rules may occur closer to the root than those that do, and therefore cannot be level 2 morphemes.

(126) Morphemes that fail to undergo sonorant onset rules may occur at lower level

/ku tsʰʐ.jɔ́ ja/   [kù tsʰʐ.jɔ́ á]   *[kù tsʰʐ.ɔ́ á]   "Is PRO rude?"

/ku.tsʰɛŋ tʃĩŋ.la la/   [kù.tsɕ tʃĩn.là là]   *[kù.tsɕ tʃĩŋ.ŋà là]   "Has PRO entered?"

For this reason, we conclude that the sonorant onset rules cannot be constrained in terms of lexical levelling.

4.2. Alternations of coda consonants triggered by the retroflex vowel

If the coda nasal /ŋ/ is preceded by /i/ or /ə/ and followed by the retroflex vowel, it geminates, as shown below.

(127) Gemination of coda nasal before retroflex vowel

/pʰiŋ.ɚ/	[pʰiŋ.ŋɚ]	"bottle"
/liŋ.ɚ/	[liŋ.ŋɚ]	"zero-two"
/jiŋ.ɚ/	[jiŋ.ŋɚ]	"silver ear (an edible white fungus)"
/tsʰəŋ.ɚ/	[tsʰəŋ.ŋɚ]	"insect"
/tʰəŋ.ɚ/	[tʰəŋ.ŋɚ]	"hole"
/tsəŋ.ɚ/	[tsəŋ.ŋɚ]	"middle ear"

Otherwise, if the coda nasal is preceded by any other vowel and followed by the retroflex vowel, it deletes, as shown below.

(128) Deletion of coda nasal before retroflex vowel

/tɕʰyŋ.ɚ/	[tɕʰy.ɚ]	"silk worm"	cf. /tɕʰyŋ.sʐ/	[tɕʰy.sʐ]	"silk fiber"
/pʰəŋ.ɚ/	[pʰə.ɚ]	"small stick"	cf. /pʰəŋ.tʰe/	[pʰə.tʰe]	"stick"
/jəŋ.ɚ/	[jə.ɚ]	"figure"	cf. /jəŋ.tsʰə/	[jə.tsʰə]	"man-made"
/səŋ.ɚ/	[sə.ɚ]	"three-two"	cf. /səŋ.səŋ/	[sə.sʐ]	"three-three"

The coda obstruent /k/, on the other hand, always deletes when it is followed by the retroflex vowel, as the following data show.

(129) Deletion of coda obstruent before retroflex vowel

/tsʰɛ̌k.ɚ/ [tsʰɛ̌.ɚ] "nephew" cf. /tsʰɛ̌k.çʷɛ̀ŋ/ [tsʰɛ́ç.çʷɛ̌] "grandnephew"

/mǒk.ɚ́/ [mǒ.ɚ́] "tree ears" cf. /mǒk.kʷǒ/ [mǒk.kʷǒ] "tree melon"

/tsók.ɚ/ [tsó.ɚ̌] "pawn" cf. /tsé tsók/ [tsé tsóʔ] "walking pawn"

I will show in 4.3 that the coda obstruent is always deleted before a vowel. Therefore, I will concentrate only on the alternations of the coda nasal. We first consider the case of coda nasal deletion. There are seven vowels that may precede the deleted coda nasal. They are [i], [y], [u], [e], [o], [ɛ] and [ɔ]. An interesting fact about these vowels is that they are either coronal (front) or labial (rounded). As such, each of them must have a V-place node, to which either [coronal] (via [dorsal]) or [labial] or both can be attached. In contrast, the two vowels [ɨ] and [ə] which do not precede the deleted [ŋ] are neither labial nor coronal, and therefore need not have a V-place node to anchor any vowel place feature. Thus, we can identify the seven coronal or labial vowels as a natural class to the exclusion of the two noncoronal and nonlabial vowels by assuming that each of the former has a V-place node and none of the latter has one. Furthermore, the short vowel that precedes the deleted nasal surfaces as a long vowel (although as I mentioned earlier vowel length is not really distinctive in this language), suggesting that there is compensatory lengthening on the part of this vowel. Based on these observations, we formalize the following rule of coda nasal deletion.

(130) Coda Nasal Deletion
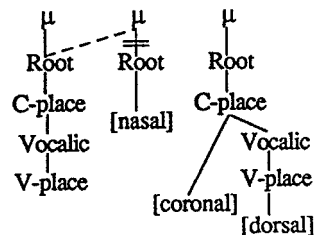
This rule deletes a mora-dominated (coda) nasal preceded by a segment with a V-place node (one of the seven coronal or labial vowels) and followed by a non-high corono-dorsal (retroflex) vowel. Meanwhile, the vacated mora reassociates with the preceding root node.

Now the only coda nasal left before the retroflex vowel is the one preceded by [ɨ] or [ə], which is exactly when coda nasal gemination takes place.

The coda nasal gemination process can be accounted for with the following rule which associates the coda nasal to the syllable node dominating the retroflex vowel.

(131) Coda Nasal Gemination
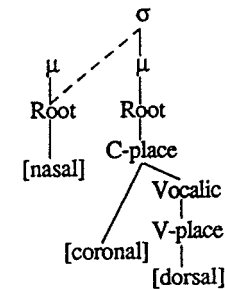
Following is a sample derivation of the coda nasal followed by a retroflex vowel.

(132) Sample derivation of coda nasal followed by retroflex vowel

Underlying	/tʰə́ŋ.ɚ/	/pʰǒŋ.ɚ/
Coda Nasal Del.	—	/pʰǒ.ɚ/
Coda Nasal Gem.	/tʰə́ŋ.ŋɚ/	—
Surface	/tʰə́ŋ.ŋɚ̌/	/pʰǒ.ɚ̌/

4.3. Other alternations of coda consonants

4.3.1. Deletion of coda consonants

A number of sentence-final particles are vowel initial. They include the imperfective interrogative marker -a and the vocative marker -a. When followed by one of these, both the coda nasal and the coda obstruent are deleted, as we can see from the following data.

(133) Deletion of coda consonants

a. Before imperfective interrogative *(Ipl)-a*, e.g.

    kù   só   á? (cf. pɛ̂? só? "PRO (is) not ripe.")
    whether ripe *Ipl*
    Is PRO ripe?

    kù   tsʰ‌ə̰   á? (cf. xə́ tsʰə̀ŋ ŋɔ̀! "How heavy!")
    whether heavy *Ipl*
    Is (it) heavy?

b. Before vocative *(Voc)-a*, e.g.

    lə́   sɛ́   á, ... (cf. lə́ sɛ́k kɔ̀ɹà.rə̀ "Old Sek is back home")
    old Sek *Voc*
    Old Sek, ...

    lə́   tə̰   á, ... (cf. lə́ tə̀ŋ kɔ̀ɹà.rə̀ "Old Ding is back home")
    old Ding *Voc*
    Old Ding, ...

The coda deletion in this case is different from the coda nasal deletion triggered by a retroflex vowel. First, the coda nasal deleted before a retroflex vowel does not nasalize the preceding vowel, but the coda nasal deleted in this case does nasalize the preceding vowel. Second, the retroflex vowel that triggers coda nasal deletion can be either toned or toneless, but there is evidence that the syllable that triggers coda deletion in this case must be underlyingly toneless, as the following data show.

(134) Coda nasal does not delete if following syllable is toned

    /xə̀ŋ.ẙ/   [xə̀ŋ.ẙ]   "red (chili) oil"
    /tʃə̀ŋ.ʑ/   [tʃə̀ŋ.ʑ]   "golden fish"
    /tsə̀ŋ.ʒ/   [tsə̀ŋ.ʒ]   "Chinese medicine"

Assuming as we did in 4.1 that a toneless syllable is a weak syllable dominated by the weak branch of a metrical foot, we can formalize the coda deletion rule as follows.

(135) Coda Deletion
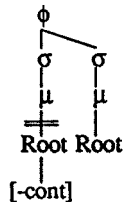
4.3.2. Assimilation of coda nasal

    The coda nasal /ŋ/ surfaces as [m] before labial consonants [p pʰ m pʲ pʲʰ mʲ], as [ɱ] before labiodentals [f ʋ], as [n] before coronal consonants [t tʰ n l tʲ tʲʰ nʲ lʲ ts tsʰ s tʃ tʃʰ ʃ tɕ tɕʰ ɕ tɕʷ tɕʷʰ ɕʷ], or as [ŋ] before dorsal consonants [k kʰ x kʷ kʷʰ xʷ], as shown below.

(136) Place assimilation of coda nasal

a.	/tʃə̀ŋ.pʲɔ́/	[tʃə̀m.pʲɔ́]	"golden watch"
	/xə́ŋ.mɛ̌/	[xə́m.mɛ̌]	"red plum"
b.	/xə̀ŋ.fɛ̀ŋ/	[xə̀ɱ.fɛ̀]	"red powder"
	/xə̀ŋ.ʋɛ̌.pʲ̀ŋ/	[xə̀ɱ.ʋɛ̌.pʲ̀ŋ]	"red guards"
c.	/tʃə̀ŋ.tʲɔ́/	[tʃə̀n.tʲɔ́]	"gold bar"
	/xə̀ŋ.tʰɔ̀ŋ/	[xə̀n.tʰɔ̰̀]	"red egg"
	/xə̀ŋ.lɪ̀/	[xə̀n.lɪ̰̀]	"red interest (dividend)"
	/xə̀ŋ.tsʰɔ́/	[xə́n.tsʰɔ́]	"red tea (black tea)"
	/xə̀ŋ.tʃʰɛ̀/	[xə́n.tʃʰɛ̀]	"red flag"
	/xə̀ŋ.tɕý/	[xə̀n.tɕý]	"red wine"
	/xə̀ŋ.nʲɔ́/	[xə̀n.nʲɔ́]	"red bird"
	/xə̀ŋ.sɛ̀k/	[xə́n.sɛ̀?]	"red color"
d.	/xə̀ŋ.kù/	[xə̀ŋ.kù]	"red fruit (haw)"
	/xə̀ŋ.kʷɔ̀ŋ/	[xə̀ŋ.kʷɔ̰̀]	"red light"
	/xə̀ŋ.xʷɔ̀/	[xə̀ŋ.xʷɔ̀]	"red flower"

    The coda nasal surfaces as [ŋ] when followed by a vowel or glide, as the following data show.

(137) Coda nasal does not change before vowel or glide

    /xə̀ŋ.ẙ/   [xə̀ŋ.ẙ]   "red (chili) oil"
    /xə̀ŋ.ʑ/   [xə̀ŋ.ʑ]   "red fish"
    /xə̀ŋ.wɔ́/   [xə̀ŋ.wɔ́]   "red tile"
    /xə̀ŋ.ɥɪ̀ŋ/   [xə̀ŋ.ɥɪ̀ŋ]   "red cloud"
    /xə̀ŋ.jɔ̀k.ɕʷé/   [xə̀ŋ.jɔ́.ɕʷé]   "red lotion (mercurochrome)"

    This process is common in many languages. It is easily analyzed with a rule that spreads the place node of a consonantal segment to the preceding coda consonant, as shown below.

(138) Coda Nasal Assimilation

```
        Root      Root
         |  \   /  |
         |   \ /   |
         |  C-place |
      [+cons]    [+cons]
```
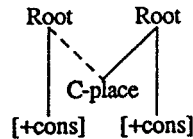
Given the above analysis and the fact that nasals may have a secondary articulation, such as palatalization, we might wonder why there is no secondary articulation on the coda nasal after place assimilation. For example, /tʃíŋ.pʲə̀/ could have become [tʃímʲ.pʲə̀] instead of [tʃím.pʲə̀] "tournament", /pʰə̀ŋ.tʲʰʊ̌/ could have become [pʰə̀nʲ.tʲʰʊ̌] instead of [pʰə̀n.tʲʰʊ̌] "cuisine", etc. The explanation of this apparent problem lies in the fact that features of secondary articulation are most salient at the release, but the coda nasal is never released. In other words, even if there is secondary articulation on the coda nasal after place assimilation, its effect will not be heard until the point of release of the following onset consonant is reached. Of course, this is a phonetic detail that does not require phonological representation.

4.3.3. Vowel nasalization and loss of coda nasal

The coda nasal never surfaces if it is preceded by a labial (rounded) or coronal (front) vowel. Instead, the preceding vowel becomes a nasal vowel, as shown below.

(139) Vowel nasalization and loss of coda nasal

	/mǐŋ/	[mǐ̃]	"noodle"
	/xɔ́ŋ/	[xɔ̃́]	"salty"
	/tʰɔ̌ŋ/	[tʰɔ̃̌]	"candy"
	/mǐŋ.pə̀/	[mǐ̃.pə̀]	"bread (roll)"
	/xɔ́ŋ.tʰə̌ŋ/	[xɔ̃́.tʰə̃̌]	"salinated egg"
	/tʰɔ̌ŋ.tsɨ́/	[tʰɔ̃̌.tsɨ́]	"candy wrapper"
	/fóŋ.tɕɔ́/	[fṍ.tɕɔ́]	"on leave"
	/tʰə̌ŋ.kə̀/	[tʰə̃̌.kə̀]	"(egg) cake"
cf.	/mǐŋ/	[mǐŋ]	"life"
	/mə̌ŋ/	[mə̌ŋ]	"dream"

We have seen earlier that the labial and coronal vowels are underlyingly specified with a V-place node. This allows us to treat vowel nasalization and coda nasal deletion with one rule which vocalizes the coda nasal by spreading the V-place node to the coda nasal. The vowels [ɨ] and [ə] are not specified with a V-place node, and therefore do not undergo this rule. We formalize this rule as follows.

(140) Coda Nasal Vocalization

```
            σ
          /   \
         μ     μ
         |     |
       Root   Root
         |     |
     C-place C-place
         |     |       [nasal]
     Vocalic Vocalic
         |     |  - - - ╪
      V-place V-place
```
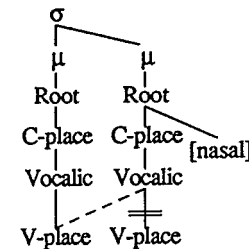
This rule must be ordered after Coda Nasal Deletion triggered by the retroflex vowel, because the loss of the coda nasal in that case does not leave behind a nasal vowel.

4.3.4. Total assimilation of coda obstruent

We have seen that the coda obstruent /k/ surfaces as [k] before a toneless syllable with an onset [l] or [j] which also becomes [k]. Otherwise, /k/ surfaces as [p] before [p pʰ pʲ pʲʰ], as [t] before [t tʰ tʲ tʲʰ ts tsʰ tʃ tʃʰ tɕ tɕʰ tɕʷ tɕʷʰ], [k] before [k kʰ kʷ kʷʰ], [m] before [m mʲ], [n] before [n nʲ], [l] before [l lʲ], [f] before [f ʋ], [s] before [s], [ʃ] before [ʃ], [ɕ] before [ɕ] and [x] before [x xʷ]. These alternations are exemplified below.

(141) Alternations of the coda obstruent

a.	/tʰɨ́k/	[tʰɨ́ʔ]	"iron"
	/tʰɨ́k.pɔ́ŋ/	[tʰɨ́p.pɔ̃́]	"iron plate"
	/tʰɨ́k.pʰʊ̌/	[tʰɨ́p.pʰʊ̌]	"iron sheet"
	/tʰɨ́k.tʰě/	[tʰɨ́t.tʰě]	"iron head"
	/tʰɨ́k.tɕʰeŋ/	[tʰɨ́t.tɕʰə̃̌]	"blacksmith"
	/tʰɨ́k.kʷʰɔ́ŋ/	[tʰɨ́k.kʷʰɔ̃̌]	"iron ring"
	/tʰɨ́k.mɛ́ŋ/	[tʰɨ́m.mɛ̃̌]	"iron gate"

/tʰí k.lʂ̩/	[tʰíl.lʂ̩]	"railroad"
/tʰí k.sʐ̩/	[tʰís.sʐ̩]	"iron wire"
/tʰí k.ɕú/	[tʰíɕ.ɕʷý]	"iron rust"
b. /kók/	[kó?]	"nation"
/kók.pá/	[kóp.pá]	"national treasure"
/kók.kù/	[kók.kù]	"national anthem"
/kók.tɕɔ̀/	[kót.tɕɔ̀]	"country"
/kók.tʃʰ-̌/	[kót.tʃʰ-̌]	"national flag"
/kók.tsʰɔ́ŋ/	[kót.tsʰɔ́]	"made in home-country"
/kók.nɛ̌/	[kón.nɛ̌]	"domestic"
/kók.ʃɔ́ŋ/	[kóʃ.ʃɔ́]	"national defense"
/kók.uǎ/	[kóu.uǎ]	"overseas"
/kók.xʷɛ̀/	[kóx.xʷɛ̀]	"national emblem"

This process is different from Coda Nasal Assimilation, because it involves all the features under the root node, including [±sonorant], [±continuant] etc. which are directly associated with the root node. Therefore, this is a case of total assimilation, which involves the spreading of the root node of an onset consonant to the dominating mora of a preceding coda obstruent. Following is the formalization of this rule. Notice that it is not necessary to specify the second root node as a consonant node, because after the deletion of the coda obstruent before vowels and glides, all non-final coda obstruents that remain are followed by consonants.

(142) Coda Obstruent Assimilation

$$\mu$$

Root   Root

[-son]
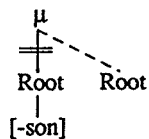
Since the only [-sonorant] segment dominated by a mora is the coda obstruent [k], nothing more needs to be said in the rule.

Just as the coda nasal never surfaces with a secondary place feature after place assimilation, so too the coda obstruent never becomes secondarily articulated or aspirated

or affricated after total assimilation. For example, /tʰík.tʰɛ́/ becomes [tʰít.tʰɛ́] but not *[tʰítʰ.tʰɛ́]; /tʰík.tɕʰeŋ/ becomes [tʰít.tɕʰɛ̀] but not *[tʰítɕʰ.tɕʰɛ̀]; /kók.tsʰɔ́ŋ/ becomes [kót.tsʰɔ́], not *[kótsʰ.tsʰɔ́]; /tʰík.kʷʰɔ́ŋ/ becomes [tʰík.kʷʰɔ́], not *[tʰíkʷʰ.kʷʰɔ́]; etc. As in the case of nasal place assimilation, this is due to the fact that aspiration, fricative release and secondary articulations are salient only at the point of release. Therefore, they are not heard until the point of release of a geminate consonant. This explains why there are no such geminates as [tʰtʰ], [tɕtɕ], [tsts], [kʷkʷ] in Nantong or in any other languages.[3] Again, this is a phonetic detail that need not be represented in phonology.

4.3.5. Deletion of coda obstruent

When followed by a vowel or a glide, the coda obstruent is always deleted, as shown in the following data.

(143) Prevocalic deletion of coda obstruent

/tsɛ́k.jɔ́/	[tsɛ́.jɔ́]	"excerpt"
/kók.wɔ́ŋ/	[kó.wɔ́]	"king"
/tsʰɛ̌k.ɚ/	[tsʰɛ̌.ɚ]	"nephew"
/tsɛ́k.ʂ́/	[tsɛ́.ʂ́]	"inquire"
/mŏk.ʒ/	[mŏ.ʒ]	"wooden fish"

This process can be formalized into the following rule.

(144) Coda Obstruent Deletion

$$\mu$$

Root   Root

[-son] [+son] [+cont]

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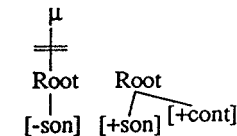
[3] Brian Joseph points out that geminates in some onomatopoetic words in Sanskrit are transcribed as [kʰkʰ] as opposed to those transcribed as [kk]. However, it is impossible to know whether such transcriptions represent real geminates or simply juxtaposed identical consonants, because they do not exhibit any morphophonemic alternations.

4.3.6. Glottalization of coda obstruent

None of the assimilation rules that affect the syllable coda may apply if the coda is prepausal. In this case, a coda nasal surfaces as [ŋ], which is straightforward, but a coda obstruent surfaces as a glottal stop, which needs an explanation. The following data show the effect of the pause (represented with a check mark "√") on the surface realization of coda consonants.

(145) Alternations of coda consonants blocked by pause

a. /tʃîŋ jǐŋ tʰɕ̌ŋ tʰîk ç̌k/
    [tʃîŋ][jǐn][tʰɕ̌n][tʰîç][ç̌ʔ]
    "gold, silver, copper, iron, tin"

b. /tʃîŋ jǐŋ√tʰɕ̌ŋ tʰîk ç̌k/
    [tʃîŋ][jǐŋ]√[tʰɕ̌n][tʰîç][ç̌ʔ]
    "gold, silver, copper, iron, tin"

c. /tʃîŋ√jǐŋ√tʰɕ̌ŋ√tʰîk√ç̌k/
    [tʃîŋ]√[jǐŋ]√[tʰɕ̌ŋ]√[tʰîʔ]√[ç̌ʔ]
    "gold, silver, copper, iron, tin"

As the coda obstruent is assumed to be underlyingly unspecified for place features, it seems that we need to specify it as [constricted glottis] in order to make it a glottal stop. However, there are reasons to believe that this is entirely unnecessary. First, the feature [constricted glottis] is not distinctive in this language, since the glottal stop is the only segment specified with this feature. Second, if an obstruent is placeless, i.e. produced without supralaryngeal constriction, then the only way it can be non-continuant is by having a temporary closure at the glottis. In other words, the coda obstruent's being [constricted glottis] is a direct consequence of its being placeless and non-continuant. Therefore, there is no need to specify the feature [constricted glottis]. Instead, we need to explain why this underlyingly placeless obstruent does not surface as [k] in prepausal positions. We can do so assuming that the place feature default rule that supplies the default

[dorsal] feature for placeless obstruents only applies to non-final segments with a domain bounded by pauses. Thus, we revise that rule as follows.

(146) Place Feature Default (revised)

Root   Root
|
C-place
|
[dorsal]
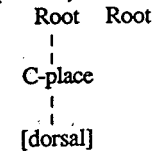
4.4. Onset and coda lenition

In section 4.1, we have seen processes like glide deletion and onset assimilation which occur only in toneless syllables. In this section, we examine two processes with a similar condition.

In normal tempo speech, a word-medial syllable flanked by two toned syllables always loses its underlying tone, and either inherits the tonal specifications of the terminal tonal node of the preceding syllable or receives a default tone in its surface form. For example, the word /jɛ̌.kə̀ŋ.xɓ/ "man-made lake" surfaces as [jɛ̌.kə̀ŋ.xɓ] in slow tempo, where the only change is the underlying L becoming M in the medial syllable. In normal tempo, however, the same word surfaces as [jɛ̌.ŋə́ŋ.xɓ], where the medial syllable loses its underlying tone and inherits the second half of the preceding MH tone. At the same time, the onset stop [k] becomes a nasal [ŋ]. Following are the waveforms of the two surface forms of this word.

(147) Waveforms of /jɛ̌.kə̀ŋ.xɓ/ "man-made lake" in

a. slow tempo   b. normal tempo
[jɛ̌.kə̀ŋ.xɓ]   [jɛ̌.ŋə́ŋ.xɓ]
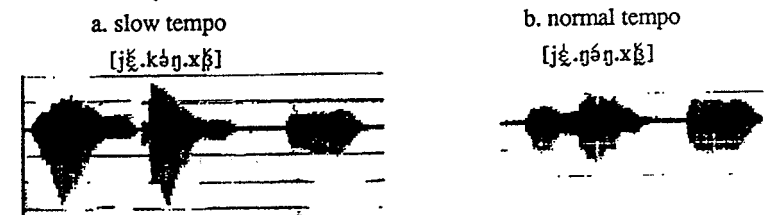
Figure 15 - Waveforms of /jɛ̌.kə̀ŋ.xɓ/ in slow and normal tempos

We see from these waveforms that the first two syllables both have less intensity and shorter duration in normal tempo than in slow tempo. However, since the word-medial syllable is the one that loses its underlying tone and undergoes lenition processes, only it will be referred to as a weak syllable. In what follows, I will discuss the lenition processes that occur in weak syllables. The tonal alternations will be handled in chapter V.

4.4.1. Lenition of onset obstruent

In a weak syllable, an unaspirated onset plosive[4] is always changed into a flap when used after a vowel, or into a nasal when used after a coda nasal. If the underlying onset consonant is an affricate, then the frication feature is preserved in the lenited form. No lenition takes place if the weak syllable is preceded by an obstruent. The following table shows the alternating forms of unaspirated underlying plosives.

(148) Lenition of onset consonants[5]

Underlying	—	p	pʲ	t	tʲ	ts	tʃ	tɕ	tɕʷ	k	kʷ
After V	—	β	βʲ	ɾ	ɾʲ	z	ʒ	ʐ	ʐʷ	ɣ	ɣʷ
After Vŋ	—	m	mʲ	n	nʲ	nz	nʒ	nʐ	nʐʷ	ŋ	ŋʷ

Following are example words in which these alternations take place. Note that from now on, each pair of parentheses in the surface phonetic transcription mark the boundaries of a metrical foot, which is defined as a toned (strong) syllable followed by any number of toneless (weak) syllables.

(149) Words undergoing onset lenition

/jǐk.kə/	[(jík.kə́)]	"(of) the Iqs' family"
/lǐ.kə/	[(lí.ɣə́)]	"(of) the Lis' family"
/ní.kə/	[(ní.ɣə́)]	"(of) your family"
/ŋú.kə/	[(ŋú.ɣə́)]	"(of) my family"
/wóŋ.kə/	[(wɔ̰.ŋə́)]	"(of) the Uons' family"
/tǐŋ.kə/	[(tǐŋ.ŋə̀)]	"(of) the Dings' family"

---

[4] Actually, there appear to be some lenition effects on aspirated plosives and fricatives in this environment as well. More experimental work is needed to determine what exactly these effects are.

[5] All the phonetic symbols in the first row represent flaps, i.e. short sonorant approximants, with [z ʒ ʐ ʐʷ] being flaps with frication.

/lǐk.tə.xə/	[(lít.tə́.xə́)]	"standing"
/tsʰǔ.tə.xə/	[(tsʰǔ.ɾə́.xə́)]	"sitting
/tʰóŋ.tə.xə/	[(tʰɔ̰.nə́.xə́)]	"lying"
/ʃǐŋ.tə.xə/	[(ʃíŋ.nə́.xə́)]	"awake"
/lǐk.pɔ/	[(líp.pɔ́)]	"let's stand"
/tsʰǔ.pɔ/	[(tsʰǔ.βɔ́)]	"let's sit"
/tʰóŋ.pɔ/	[(tʰɔ̰.mɔ́)]	"let's lie down"
/tʃʰǐŋ.pɔ/	[(tʃʰǐm.mɔ̀)]	"let's press"
/pʲɔ̀.pʲə/	[(pʲɔ̀.βʲə̀)]	"peek a little"
/tʲɔ́.tʲə/	[(tʲɔ́.ɾʲə̀)]	"suspend a little"
/tɕɔ̀.tɕɔ/	[(tɕɔ̀.ʐɔ̀)]	"add a little"
/tɕʷɔ̀.tɕʷo/	[(tɕʷɔ̀.ʐʷɔ̀)]	"scratch a little"
/tɕʷɔ̀ŋ.tɕʷoŋ/	[(tɕʷɔ̰.nʐʷɔ̰)]	"load a little"
/tʃɔ́.tʃʒ/	[(tʃɔ́.ʒʒ̀)]	"squeeze a little"
/tʃíŋ.tʃiŋ/	[(tʃín.nʒìŋ)]	"soak a little"
/kʷó.kʷo/	[(kʷó.ɣʷɔ̀)]	"hang a little"
/kʷɔ́ŋ.kʷɔŋ/	[(kʷɔ̰.ŋʷɔ̰)]	"caress a little"

The onset lenition process does not occur in a syllables that retains its underlying tone, because such a syllable is not weak. Following are some contrasting pairs illustrating this.

(150) Words with and without onset lenition

/tʃʰǐŋ.tɔ́/	[(tʃʰǐn)(tɔ́)]	"Green Island"
cf. /tʃʰǐŋ.tə/	[(tʃʰǐn.nə̀)]	"has become green"
/ɕɔ́.tà.ə̀/	[(ɕɔ́)(tà.ə̀)]	"small knife"
cf. /ɕɔ́.tə/	[(ɕɔ́.ɾə́)]	"has become small"
/nǐŋ.kɔ̀/	[(nǐ)(kɔ̀)]	"rice cake"
cf. /nǐŋ.kə/	[(nǐ.ŋə́)]	"the Nins'"

The onset lenition process can be understood as the articulators, which are moving toward a target position to form an oral closure, being moved away before reaching this target position toward the target position of the next articulatory event. Since no complete oral closure is ever sustained, the intended stop becomes a flap.

From the phonological point of view, the feature involved in the flapping process can be either [+sonorant] or [+voice] or both. Since there are no voiced stops in Nantong Chinese, it is possible to assume that flapping in this language involves spreading [+voice] to an underlying stop, which is phonetically realized as a flap. However, this analysis must be rejected on typological grounds, because in languages where voicing is contrastive, flapping cannot be effected by spreading [+voice]. For example, in English, underlying /læda-/ "ladder" surfaces as [lærə-]. Since underlying /d/ is already [+voice] (as opposed to underlying /t/, which is [-voice], in /læta-/ "latter"), its flapping must involve some feature in addition to [+voice]. Following Kahn (1976:99), I assume that this other feature is [+sonorant].

Based on the above discussion, we formalize the onset lenition rule such that it spreads the [+sonorant] feature from a mora-dominated root node, which is a vowel or a coda consonant, under the strong branch of a metrical foot to a syllable-dominated root node, which is an onset consonant, under the weak branch of a metrical foot, as follows.

(151) Onset Lenition
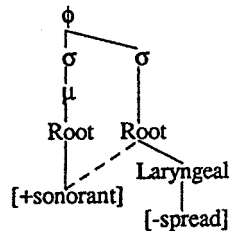
To account for the nasalization of the onset plosive, we need another rule. Instead of spreading the feature [+sonorant], this rule spreads the feature [nasal] from a mora-dominated root node under the strong branch of a metrical foot to a syllable-dominated root node under the weak branch of a metrical foot, as follows.

(152) Onset Nasalization
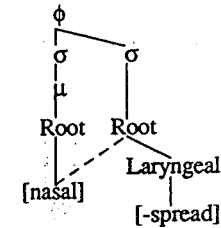
4.4.2. Lenition of coda consonants

In addition to onset lenition, another segmental alternation applicable to weak syllables is the deletion of its coda obstruent. Since an underlyingly toned word-medial syllable remains toned in slow tempo but becomes toneless (weak) in normal tempo, we may observe alternation of the coda obstruent in these different speech rates. Following are some examples.

(153) Alternation of coda obstruent in word-medial syllables

a. Deletion of coda obstruent in weak syllables in normal tempo

/ɚ̀.pók.uɓ/	[(ɚ̀.ɓó)(uɓ)]	"two hundred and fifty"
/tʰɔ̀ŋ.pʰɔ̌k.tsɛ́k/	[(tʰɔ̀.pʰó)(tsɛ́ʔ)]	"egg white essence (protein)"
/çɔ̌k.tɕʰˀk.pɔ̀ŋ/	[(çɔ́t.tɕʰí)(pɔ̀)]	"study class (seminar)"
/tsə̀ŋ.kók/	[(tsə̀ŋ.ŋò)]	"center country (China)"
/kʰû.çɔ̌k/	[(kʰû.çɔ̀)]	"science"

b. No deletion of coda obstruent in weak syllables in slow tempo

/ɚ̀.pók.uɓ/	[(ɚ̀)(póu)(uɓ)]	"two hundred and fifty"
/tʰɔ̀ŋ.pʰɔ̌k.tsɛ́k/	[(tʰɔ̀)(pʰót)(tsɛ́ʔ)]	"egg white essence (protein)"
/çɔ̌k.tɕʰˀk.pɔ̀ŋ/	[(çɔ́t)(tɕʰíp)(pɔ̀)]	"study class (seminar)"
/tsə̀ŋ.kók/	[(tsə̀ŋ)(kóʔ)]	"center country (China)"
/kʰû.çɔ̌k/	[(kʰû)(çɔ́ʔ)]	"science"

This process can be referred to as coda lenition, since it occurs in weak syllables only. Assuming as we did before that a weak syllable is dominated by the weak branch of a

metrical foot, we can formalize a rule which deletes a [-sonorant] root node from its dominating mora under the weak branch (the tilted branch) of the metrical foot, as follows.

(154) Coda Lenition
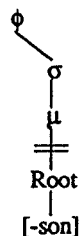
4.5. Summary

To recapitulate, I have divided segmental morphophonemic alternations in Nantong Chinese into four classes: alternations of toneless morphemes, alternations triggered by the retroflex vowel, alternations involving the coda consonants, and alternations involving lenition. The following 13 rules have been proposed to account for these alternations: Obligatory Glide Deletion, Optional Glide Deletion, Onset Assimilation, Place Feature Default, Coda Nasal Deletion, Coda Nasal Gemination, Coda Deletion, Coda Nasal Assimilation, Coda Nasal Vocalization, Coda Obstruent Assimilation, Coda Obstruent Deletion, Onset Lenition and Coda Lenition.

CHAPTER V   TONAL MORPHOPHONEMIC ALTERNATIONS

5.0. Introduction

In this chapter, I discuss morphophonemic alternations of tones. There are three types of tone sandhi in Nantong Chinese: progressive tone spreading, tone deletion, and regressive tone sandhi. These will be discussed in sections 5.1, 5.2 and 5.3 respectively.

5.1. Tone spreading and tonal default

In word-final positions, toneless syllables surface as L when preceded by L or HM; as M when preceded by LM, as H when preceded by MH, or as either H or L when preceded by H. At the same time, word-initial L surfaces as ML, and word-initial LM and MH surface as ML and M respectively when followed by a toneless syllable. These patterns are shown in the following table, where boldface tonal letters represents derived surface tones.

(155) Tonal patterns in words with final toneless syllables

1st tone	1 toneless σ	2 toneless σ's	3 toneless σ's
LM	ML.M	ML.M.M	ML.M.M.M
MH	M.H	M.H.H	M.H.H.H
H	H.L	H.L.L	H.L.L.L
	H.H	H.H.H	H.H.H.H
L	ML.L	ML.L.L	ML.L.L.L
HM	HM.L	HM.L.L	HM.L.L.L

In word-medial positions, a toneless syllable surfaces as M when preceded by L, HM and LM, as either H or M when preceded by H, or as H when preceded by MH. At the same time, the word-initial L surfaces as M, and LM and MH may surface as ML and M

respectively. These patterns are illustrated in the following table, where T represents any tone, and boldface tone letters represent derived surfaces tones.

(156) Tonal patterns in words with medial toneless syllables

1st tone	1 med toneless σ	2 med toneless σ's
LM	ML.M.T	ML.M.M.T
MH	M.H.T	M.H.H.T
H	H.M.T	H.M.M.T
	H.H.T	H.H.H.T
L	M.M.T	M.M.M.T
HM	HM.M.T	HM.M.M.T

In word-initial positions, toneless syllables always surfaces as M, as shown below.

(157) Toneless syllables in initial positions

/la tɕók soŋ/	[lá tɕós sɔ̀]	"on the table"
/la tɕʰɛ́ŋ soŋ/	[lá tɕʰɛ́ sɔ̀]	"on the wall"
/la.xə tʃʰík.fɔ́ŋ/	[lá.xə́ tʃʰíf.fɔ̌]	"Pro is eating"
/la.xə kʰdŋ.sɓ̥/	[lá.xə́ kʰd̥.sɓ]	"Pro is reading"

The following narrowband spectrograms show the surface tonal contour of three words with different initial tone and a toneless syllable. Note how the surface pitch values at the end of these contours differ.

(158) Surface forms of toneless syllables
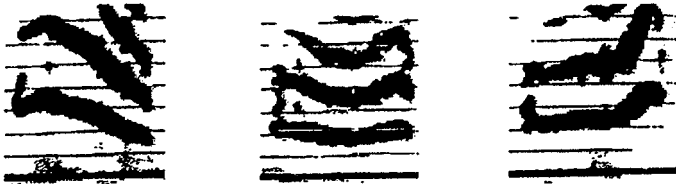
a. /jə̂.tə/ → [(jə̂.ɾə̀)]
"asked for"
i.e. HM.Ø → HM.L

b. /jə̌.tə/ → [(jə̌.ɾə̌)]
"circled"
i.e. LM.Ø → ML.M

c. /jə̌.tə/ → [(jə̌.ɾə́)]
"pardoned"
i.e. MH.Ø → MH.H

Figure 16 - Spectrograms of surface toneless syllables

In what follows, I will show that the surface tones of toneless syllables are the result of two separate processes: tone spreading and tonal default.

5.1.1. Tone redistribution and tone spreading

Tone redistribution is a special kind of tone spreading. It dissociates a tone from one syllable and reassociates it with another syllable. When a toneless syllable is preceded by a rising tone, the toneless syllable surfaces with exactly the same pitch as the terminal pitch of the preceding rising tone, with the rising tone losing its second half and becoming a level or falling tone. Some examples follow.

(159) Surface tones of underlyingly toneless syllables preceded by rising tone

a. /MH.Ø/ → [(M.H)]

/jə̌/	[(jə̌)]	"pardon"
/jə̌.tə/	[(jə̌.ɾə́)]	"pardoned"
/jə̌.tə tʰo/	[(jə̌.ɾə́ tʰó)]	"pardoned him"
/ŋǒ.ə/	[(ŋǒ.ə́)]	"child"
/ŋǒ.ə.wǒ/	[(ŋǒ.ə́).wǒ]	"childish language"

b. /LM.Ø/ → [(ML.M)]

/jə̌/	[(jə̌)]	"circle"
/jə̌.tə/	[(jə̌.ɾə̀)]	"circled"
/jə̌.tə tʰo/	[(jə̌.ɾə̀ tʰó)]	"circled (around) him"
/pʰǒŋ.ə/	[(pʰǒ.ə́)]	"stick"
/pʰǒŋ.ə.tʰóŋ/	[(pʰǒ.ə́).tʰǒ]	"stick candy (lollipop)"

The change of initial L into ML in (159b) is due to a M Insertion rule to be discussed later. The rest of this process can be understood as a toneless syllable deriving its surface tone from the preceding rising tone. We account for this fact with a rule that deletes the second tonal node of a rising tone from the syllable node it is attached to, and reattaches it to a following syllable, as shown below.

(160) Tone Redistribution
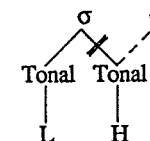
Notice that according to the tonal feature system we adopt, LM is a lower register LH and MH an upper register LH. By mentioning the LH contour and omitting the register feature, this rule applies to both LM and MH.

When preceded by a high level tone, a toneless syllable may surface as H, but may also surface as M if followed by a toned syllable (e.g. the second syllable in /xɔ́.tə tʰò/ → [(xɔ́.ɾə̄ tʰò)] "gave him") or as L otherwise (e.g. the second syllable in /xɔ́.tə tʰo/ → [(xɔ́.ɾə̀ tʰò)] "gave him"). These two patterns are shown in (161a) and (161b) respectively.

(161) Surface forms of underlyingly toneless syllables preceded by high level tone

a. H.∅ → H.H

/xɔ́/	[(xɔ́)]	"give"
/xɔ́.tə/	[(xɔ́.ɾɔ́)]	"gave"
/xɔ́.tə tʰo/	[(xɔ́.ɾɔ́ tʰɔ́)]	"gave him"
/xɔ́.tə tʰo pɛŋ sβ̞/	[(xɔ́.ɾɔ́ tʰɔ́ pɛ̰́)][(sβ̞)]	"gave him a book"
/tɕ.ə˞/	[(tɕ.ə̋)]	"tripe"
/tɕ.ə˞.tʰòŋ/	[(tɕ.ə̋).tʰɔ̰̀]	"tripe soup"
/tɕ.ə˞ sə̀ jŏk/	[(tɕ.ə̋)][(sə̀)(jɔ́ʔ)]	"tripe cooked with meat"

b. H.∅ → H.L, H.∅.T → H.M.T

/xɔ́/	[(xɔ́)]	"give"
/xɔ́.tə/	[(xɔ́.ɾə̀)]	"gave"
/xɔ́.tə tʰo/	[(xɔ́.ɾə̀ tʰò)]	"gave him"
/xɔ́.tə tʰo pɛŋ sβ̞/	[(xɔ́.ɾə̀ tʰò pə̰́)][(sβ̞)]	"gave him a book"
/tɕ.ə˞/	[(tɕ.ə̂)]	"tripe"
/tɕ.ə˞.tʰòŋ/	[(tɕ.ə̂).tʰɔ̰̀]	"tripe soup"
/tɕ.ə˞ sə̀ jŏk/	[(tɕ.ə̂)][(sə̀)(jɔ́ʔ)]	"tripe cooked with meat"

The surface tone of toneless syllables in (161a) is the result of tone spreading from the preceding syllable, as is formalized in the following rule. This rule is optional, because toneless syllables preceded by the high level tone do not always surface as H. Furthermore, when this rule applies, it applies to all toneless syllables preceded by a H level tone within the same domain. In other words, partial application resulting in *[(xɔ́.ɾə̀ tʰò)] "gave him" is not possible.

Neither Tone Redistribution nor Tone Spreading takes a toned syllable as the target of tone spreading, as shown in the following data.

(162) No tone spreading to toned syllables

	/má tə̀/	[(má tə̀)]	*[(má tə̄)]	"buy knife"
cf.	/má.tə/		[(má.ɾə́)]	"bought"
	/mǘ tə̀/	[(mǘ tə̀)]	*[(mǘ tə̄)]	"grind knife"
cf.	/mǘ.tə/		[(mǘ ɾə́)]	"ground"

Note in particular that if a syllable is the target of tone spreading, it also undergoes onset lenition as we discussed in chapter IV. Otherwise, if the syllable does not undergo lenition, it is not the target of tone spreading either. We have shown that lenition occurs in toneless syllables which are dominated by the weak branches of a metrical foot. It follows that the two rules Redistribution and Tone Spreading must apply within a metrical foot, i.e. a toned syllable followed by some toneless syllable(s). The following sample derivation shows how the surface tones of some toneless syllables are derived with these two rules.

(163) Sample derivation of surface tones with Redistribution and Tone Spreading

σ   σ

Tonal

H

[+upper]

[(xɔ́.ɾə́)]

Tone Spreading —

Output   [(jə̀.ɾə́)]   [(xɔ́.ɾə́)]
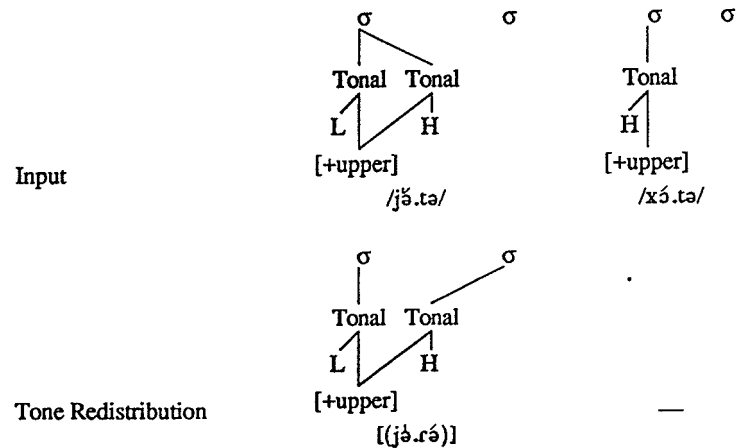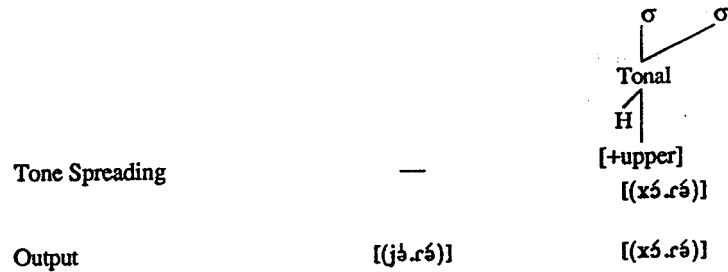
5.1.2. Tonal default

When Tone Spreading does not apply, the toneless syllable preceded by H gets its surface tone by default, which is lower register L (=L) word-finally and upper register L (=M) otherwise, as shown in (161b). The tonal default rule can be formalized as follows.

(165) Tonal Default

σ

Tonal

L
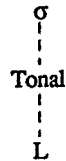
A surface tonal node must have a register feature in order to be properly interpreted, therefore, some register feature default rules are also needed. Since the default L tone is lower register L word-finally, and upper register L word-medially, I propose that one register default rule inserts a [-upper] feature on a word-final registerless tonal node, and another one inserts a [+upper] feature on other registerless tonal nodes. Since the first rule is more specific, it applies before the second by the Elsewhere Condition. Following are the formalization of these rules.

(166) Register default rules

Final Register Default

Tonal]ω

[-upper]

Register Default

Tonal

[+upper]
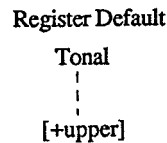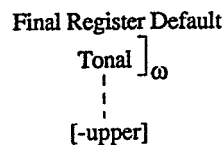
Notice that the same set of tonal and register default rules also account for the surface M tone of underlying toneless syllables in word-initial positions, as shown in (157). Furthermore, the surface tones of toneless syllables preceded by HM or L can be derived by the same set of tonal default rules, since they are also lower register L word-finally and upper register L word-medially, as shown below.

(167) Surface forms of underlyingly toneless syllables preceded by HM or L

a. HM.Ø → HM.L

/jə̂/	[(jə̂)]	"ask for"
/jə̂.tə/	[(jə̂.ɾə̀)]	"asked for"
/tʰβ̩.ə˞/	[(tʰβ̩.ə̀˞)]	"rabbit"
/tʰβ̩.ə˞-pʰʐ̩/	[(tʰβ̩.ə̀˞).pʰʐ̩]	"rabbit fur"

b. L.Ø → ML.L

/sè/	[(sè)]	"receive"
/sè.tə/	[(tsè.ɾə̀)]	"received"
/xɔ̀.ə˞/	[(xɔ̀.ə̀˞)]	"shrimp"
/xɔ̀.ə˞-tʰɔ̀ŋ/	[(xɔ́.ə̀˞).tʰɔ̰̀]	"shrimp soup"

In the above data, the low level tone surfaces as ML instead of L, e.g. /sè/ → [(sè)] "receive" and /sè.tə/ → [(tsè.ɾə̀)] "received". In addition, we have seen earlier that the low rising tone LM surfaces as MLM instead of LM, e.g. /jə̌/ → [(jə̌)] "circle" and /jə̌.tə/ → [(jə̌.ɾə́)] "circled". Since no toned syllable may start with a low tone, we can view the insertion of an initial mid tone in syllables with an underlying L or LM tone as the result of a rule of phonetic implementation, which inserts a high tone in front of a lower register low tone, as formalized below.

(168) M Insertion

σ

Tonal   Tonal

H   L
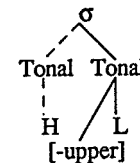
[-upper]

To ensure that the new tonal node is specified for a register feature, this rule will be followed by a rule that spreads a register feature already in the syllable to every tonal node in the same syllable, which produces in this case [-upper] H, i.e. M. Such a register spreading rule can be formalized as follows.

(169) Register Spreading (mirror image)
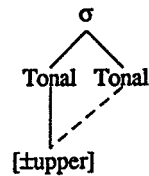
Below is a sample derivation showing how these rules apply.

(170) Sample derivation of default tones

Final Register Default
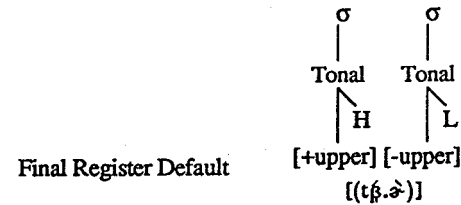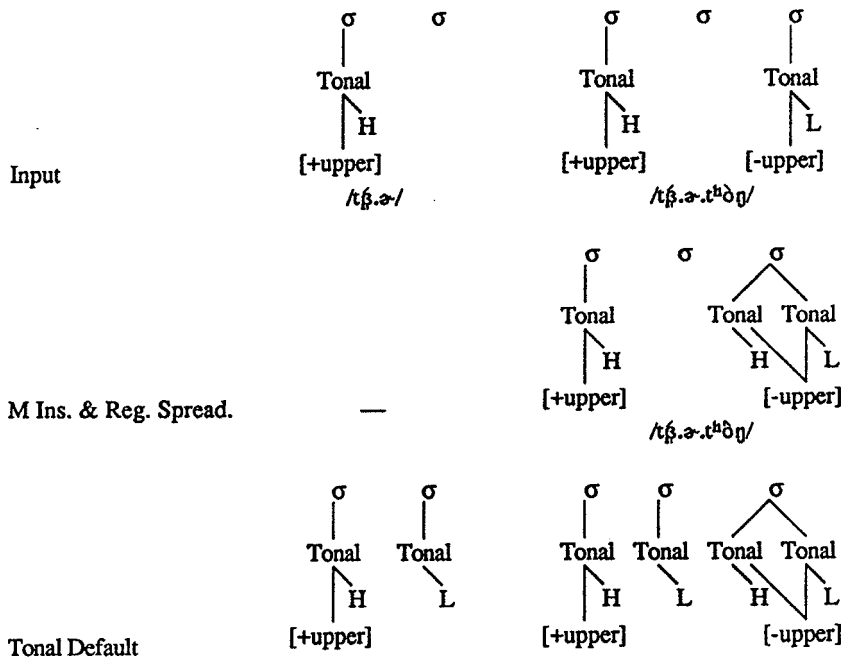
Register Default
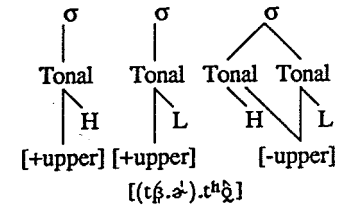
5.2. Tone deletion

We have shown that underlyingly toned syllables cannot be the target of tone spreading. However, in normal tempo speech, the second syllable of a trisyllabic word always loses its underlying tone and may become the target of tone spreading, as is evident in the following data and narrowband spectrogram.

(171) Loss of underlying tone and subsequent tone spreading in normal tempo speech

| /jɛ̃ŋ.kə̀ŋ.xʂ/ | [(jɛ̃.ŋə́ŋ)(xʂ)] | "man-made lake" |
| /pʰʂ.tã.pʰʮŋ/ | [(pʰʂ.ɾá)(pʰʮ)] | "leather belt wheel" |

cf. disyllabic

| /jɛ̃ŋ.kə̀ŋ/ | [(jɛ̃)(kə̀ŋ)] | "man-made" |
| /pʰʂ.tã/ | [(pʰʂ)(tã)] | "leather belt" |

cf. slow tempo speech

| /jɛ̃ŋ.kə̀ŋ.xʂ/ | [(jɛ̃)(kə̀ŋ)(xʂ)] | "man-made lake" |
| /pʰʂ.tã.pʰʮŋ/ | [(pʰʂ)(tã)(pʰʮ)] | "leather belt wheel" |

115

116

(172) Narrowband spectrograms of /jɛ̌.kə̀ŋ.xβ̠/ in normal and slow tempo

[(jɛ̌)(kə̀ŋ)(xβ̠)]   [(jɛ̌.ŋə́ŋ)(xβ̠)]
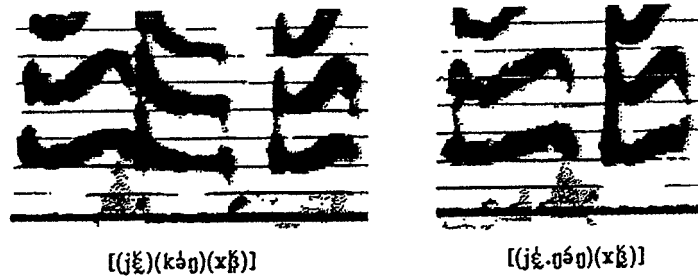
Figure 17 - Narrowband spectrograms of /jɛ̌.kə̀ŋ.xβ̠/ in normal and slow tempo

The interesting fact is that the medial syllable that loses its underlying tone becomes not only the target of tone spreading, but also the site where lenition processes take place. Since lenition processes take place under the weak branch of a metrical foot, tone deletion can also be thought to occur in that position. Based on these observations, we can construct a tone deletion rule as shown below.

(173) Tone Deletion

We assume that in disyllabic words and in slow tempo polysyllabic words, every toned syllable constitutes a metrical foot by itself. Since no toned syllable is under the weak branch of a foot, tone deletion never occurs in such cases, as shown below.

(174) Different foot structures

a. disyllabic   b. slow tempo   c. normal tempo
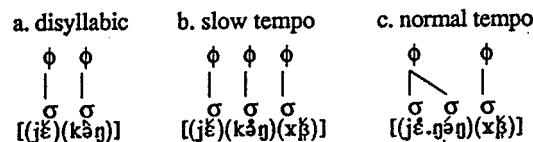
Tone Deletion, Onset Lenition etc. apply here

Thus, the derivation of the surface form of /jɛ̌ŋ.kə̀ŋ.xβ̠/ "man-made lake" in normal tempo can be shown as follows.

175) Sample derivation of /jɛ̌ŋ.kə̀ŋ.xβ̠/ "man-made lake" in normal tempo

Underlying	Tone Deletion	Onset Lenition	Tone Redistr.	Nasal Vocal.

/jɛ̌ŋ.kə̀ŋ.xβ̠/   [(jɛ̌ŋ.kəŋ).xβ̠]   [(jɛ̌ŋ.ŋəŋ).xβ̠]   [(jɛ̌ŋ.ŋə́ŋ).xβ̠]   [(jɛ̌.ŋə́ŋ).xβ̠]

1.3. Regressive tone sandhi

A toned syllable may undergo certain tonal changes when it is followed by another toned syllable. This kind of tonal change is referred to as regressive tone sandhi. In word-initial positions, an underlying LM surfaces as M if followed by an upper register tone (H, MH or H̱), or as MH if followed by any other tone; an underlying MH surfaces as M if followed by a high level tone (H or H̱); and an underlying L surfaces as M when followed by any other tone. The surface forms of word-initial syllables are summarized as follows.

176) Tonal alternations of word-initial syllables preceding a toned syllable

Init. syl.	-LM	-L	-HM	-MH	-H	-H̱
LM	MH.MLM	MH.ML	MH.HM	M.MH	M.H	M.H̱
L	M.MLM	M.ML	M.HM	M.MH	M.H	M.H̱
HM	HM.MLM	HM.ML	HM.HM	HM.MH	HM.H	HM.H̱
MH	MH.MLM	MH.ML	MH.HM	MH.MH	M.H	M.H̱
H	H.MLM	H.ML	H.HM	H.MH	H.H	H.H̱
H̱	H̱.MLM	H̱.ML	H̱.HM	H̱.MH	H̱.H	H̱.H̱

In word-medial positions, an underlying LM surfaces as MH if followed by a lower register tone (L or LM) or as ML if followed by any other tone; and an underlying L surfaces as M when followed by any other tone, just as it does in word-initial positions. If the word-medial syllable precedes a toneless syllable, the regular tone redistribution or tone spreading processes are observed. The following table shows these alternations.

(177) Tonal alternations of word-medial syllables

a. preceding a toned syllable

Med.T	-LM	-L	-HM	-MH	-H	-H̱
LM	T.MH.MLM	T.MH.ML	T.ML.HM	T.ML.MH	T.ML.H	T.ML.H̱
L	T.M.MLM	T.M.ML	T.M.HM	T.M.MH	T.M.H	T.M.H̱
HM	T.HM.MLM	T.HM.ML	T.HM.HM	T.HM.MH	T.HM.H	T.HM.H̱
MH	T.MH.MLM	T.MH.ML	T.MH.HM	T.MH.MH	T.MH.H	T.MH.H̱
H	T.H.MLM	T.H.ML	T.H.HM	T.H.MH	T.H.H	T.H.H̱
H̱	T.H̱.MLM	T.H̱.ML	T.H̱.HM	T.H̱.MH	T.H̱.H	T.H̱.H̱

b. preceding a toneless syllable

Med.T	-LM	-L	-HM	-MH	-H	-H̱
LM	T.M.H.MLM	T.M.H.ML	T.ML.MHM	T.ML.M.MH	T.ML.M.H	T.ML.M.H̱
L	T.M.M.MLM	T.M.M.ML	T.M.M.HM	T.M.M.MH	T.M.M.H	T.M.M.H̱
HM	T.HM.M.MLM	T.HM.M.ML	T.HM.M.HM	T.HM.M.MH	T.HM.M.H	T.HM.M.H̱
MH	T.M.H.MLM	T.M.H.ML	T.M.H.HM	T.M.H.MH	T.M.H.H	T.M.H.H̱
H	T.H.H.MLM	T.H.H.ML	T.H.H.HM	T.H.H.MH	T.H.H.H	T.H.H.H̱
	T.H.M.MLM	T.H.M.ML	T.H.M.HM	T.H.M.MH	T.H.M.H	T.H.M.H̱
H̱	T.H̱.H.MLM	T.H̱.H.ML	T.H̱.H.HM	T.H̱.H.MH	T.H̱.H.H	T.H̱.H.H̱

A special alternation involves the underlying LM surfacing as H̱ in syllables with a coda obstruent, except when such a syllable is word-initial and followed by a sonorant, in which case it remains as LM and falls into all the alternation patterns of a regular LM. In what follows, I will offer a more detailed discussion of all these alternations.

5.3.1. Initial decontour and initial register raising

In word-initial positions, an underlying LM surfaces as M if followed by an upper register tone (MH, H or H̱), as shown below. Notice that the falling tone HM cannot be underlyingly specified with an upper register feature, since it does not trigger this process, as shown in (178b).

(178) Tone sandhi of syllable-initial LM before upper register tones

   a.   /tʰǐŋ.ļ̊/   [(tʰɨ̌)(ļ̊)]   "electric stove"

         /tʰǐŋ.jíŋ/   [(tʰɨ̌)(jíŋ)]   "electric image (movie)"

        /tʰǐŋ.lʲ̌k/   [(tʰɨ̌)(lǐʔ)]   "electric power"

   cf. /tʰǐŋ/   [(tʰɨ̌)]   "electricity"

   b.   /tʰǐŋ.sʓ̌/   [(tʰɨ̌)(sʓ̌)]   "electric view (television)"

This process does not occur if the word-initial LM is separated from the upper register tone by a toneless syllable, either underlying or derived. What happens instead is the insertion of a M tone before the initial L and the redistribution of the M following L to the toneless syllable, as shown below.

(179) Initial LM fails to become M when followed by toneless syllable

   /xǒŋ.tsʐ.tsók/   [(xʐ̌.tsʓ̌)(tsóʔ)]   "oatmeal porridge"

   /tʰǐŋ.xʷǒ.ỹŋ/   [(tʰɨ̌.xʷó)(ɣ̌)]   "telephone operator"

   /tʰǐŋ.xʷǒ.wóŋ/   [(tʰɨ̌.xʷó)(wʓ̌)]   "telephone network"

   /tʰǐŋ.xʷǒ.çǐŋ/   [(tʰɨ̌.xʷó)(çǐ)]   "telephone line"

At first sight, it appears that this process can be accounted for with a rule which deletes the first tonal node of the underlying LM. This means that the resulting M is a lower register H, since LM is lower register LH. However, as we see from (176), a word-initial lower register tone always becomes a tone that can be characterized as an upper register tone. This suggests that the lower register tone is prohibited in word-initial positions, and is probably the underlying phonetic motivation for all the sandhi processes that affect word-initial lower register tones. Such a generalization would become impossible if we allowed a lower register tone to remain in the word-initial position of the output of a phonological rule. For this reason, we will adopt a different analysis, which accounts for this process with two rules. The first deletes the second tonal node of the low rising tone followed by an upper register tone in an adjacent syllable, as follows.

(180) Initial Decontour
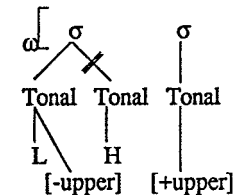
Notice that HM does not trigger this rule, since underlyingly it is not specified for register features. The output of this rule feeds into a second rule, which deletes the feature [-upper] from any non-final tonal node, as shown below.

(181) Register Deletion
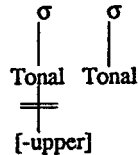
There is independent motivation for the Register Deletion rule, since an underlying lower register L always surfaces as M preceding another tone, as the following data show.

(182) Tone sandhi of word-initial L

/fè.tʃʒ/	[(fè)(tʃʒ)]	"flying machine (airplane)"
/fè.lɛ̌ŋ/	[(fè)(lɛ̌)]	"flying wheel"
/fè.tʰǐŋ/	[(fè)(tʰǐŋ)]	"flying boat (blimp)"
/fè.jǯ/	[(fè)(jǯ)]	"flying and leaping"
/fè.tʰǯŋ/	[(fè)(tʰǯ)]	"flying bullet (missile)"
cf. /fè/	[(fè)]	"fly"

After Register Deletion, the tonal node deprived of the register feature will obtain its surface register feature by the register default rules discussed earlier, as shown in the following sample derivation.

(183) Sample derivation of word-initial LM becoming M

A word-initial LM surfaces as MH instead of M when followed by a tone which is not an upper register tone, as shown below.

(184) Tone sandhi of word-initial LM before tones other than upper register tones

/tʰǐŋ.çǐŋ/	[(tʰǐ)(çǐ)]	"electric wire"
/tʰǐŋ.tʰǐ/	[(tʰǐ)(tʰǐ)]	"electric ladder (elevator)"
/tʰǐŋ.xʷŏ/	[(tʰǐ)(xʷŏ)]	"electric speech (telephone)"
cf. /tʰǐŋ/	[(tʰǐ)]	"electricity"

Like initial decontour, this process also does not occur if the second syllable is toneless either underlyingly or by Tone Deletion in normal tempo speech, as shown in (179) copied below.

(179) Word-initial LM fails to become MH when followed by toneless syllable

/xɔ́ŋ.tsʐ̩.tsók/	[(xɔ̂.tsʐ̩)(tsó?)]	"oatmeal porridge"
/tʰǐŋ.xʷŏ.ỹŋ/	[(tʰǐ.xʷó)(ỹ̩)]	"telephone operator"
/tʰǐŋ.xʷŏ.wóŋ/	[(tʰǐ.xʷó)(wǒ̩)]	"telephone network"
/tʰǐŋ.xʷŏ.çǐŋ/	[(tʰǐ.xʷó)(çǐ)]	"telephone line"

The Register Deletion rule in (181) requires that the target tonal node be followed by a tonal node linked to an adjacent syllable. Since a contour tone is represented with two tonal nodes linked to the same syllable, the register feature on the first of the two tonal nodes cannot be deleted by Register Deletion. Moreover, Register Deletion applies in both word-initial and word-medial syllables as long as they are followed by some other tone, as shown in (185a), but LM does not always become MH in word-medial syllables (in slow tempo), as shown in (185b).

(185) Lower register tones in word-medial syllables

a. /fè.tʃʒ.tsʰɓ̃ŋ/   *[(fè)(tʃʒ)(tsʰɓ̃ŋ)]   [(fè)(tʃʒ)(tsʰɓ̃ŋ)]   "airplane field (airport)"

    /fè.tʃʒ.pʲʰɕ̃/   *[(fè)(tʃʒ)(pʲʰɕ̃)]   [(fè)(tʃʒ)(pʲʰɕ̃)]   "airplane ticket"

b. /tʰǐŋ.xʷð.ʝ̃ŋ/   [(tʰǐ)(xʷð)(ʝ̃)]   *[(tʰǐ)(xʷð)(ʝ̃)]   "telephone operator"

    /tʰǐŋ.xʷð.wó̃ŋ/   [(tʰǐ)(xʷð)(wó̃)]   *[(tʰǐ)(xʷð)(wó̃)]   "telephone network"

    /tʰǐŋ.xʷð.çǐŋ/   [(tʰǐ)(xʷð)(çǐ)]   *[(tʰǐ)(xʷð)(çǐ)]   "telephone line"

For these reasons, I propose a more specific register deletion rule to handle the change from LM to MH. This rule deletes the [-upper] feature of a word-initial LM tone followed by a tonal node of an adjacent syllable, as formalized below.

(186) Initial Register Deletion
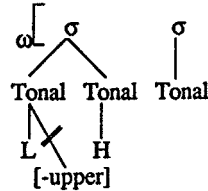
The same set of register default rules will supply the output of this rule with the correct surface register feature [+upper], as shown in the following sample derivation.

(187) Sample derivation of word-initial LM before tones other than upper register tones
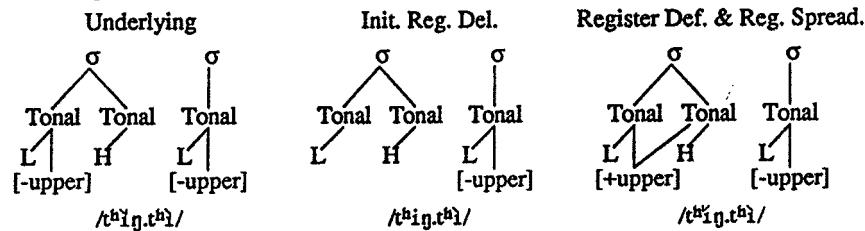
To ensure that only grammatical forms are generated by these rules, we must apply Initial Decontour first, Initial Register Deletion next and Register Deletion last, as shown below.

(188) Order of word-initial decontour and register deletion rules

Underlying Representation	/tʰǐŋ.lɓ̃/	/tʰǐŋ.çǐŋ/	/fè.j̃ɕ/
Initial Decontour	[(tʰǐ)(lɓ̃)]	—	—

Initial Register Deletion	—	[(tʰǐ)(çǐ)]	—
Register Deletion	[(tʰǐ)(lɓ̃)]	—	[(fè)(j̃ɕ)]
Surface Representation	[(tʰǐ)(lɓ̃)]	[(tʰǐ)(çǐ)]	[(fè)(j̃ɕ)]
Gloss	"electric wire"	"electric stove"	"flying and leaping"

5.3.2. Register dissimilation and non-initial decontour of LM

Another instance where LM becomes MH is when LM is followed by a word-final lower register tone L or LM, as shown below.

(189) LM becomes MH when followed by word-final lower register tone

a. Slow tempo

   /tʰǐŋ.xʷð.tʃʒ/   [(tʰǐ)(xʷð)(tʃʒ)]   "telephone machine"

   /tʰǐŋ.xʷð.pʰɓ̃/   [(tʰǐ)(xʷð)(pʰɓ̃)]   "telephone book"

   cf. /tʰǐŋ.xʷð.çǐŋ/   [(tʰǐ)(xʷð)(çǐ)]   "telephone line"

b. Normal tempo

   /tʰǐŋ.xʷð.tʃʒ/   [(tʰǐ.xʷó)(tʃʒ)]   "telephone machine"

   /tʰǐŋ.xʷð.pʰɓ̃/   [(tʰǐ.xʷó)(pʰɓ̃)]   "telephone book"

   cf. /tʰǐŋ.xʷð.çǐŋ/   [(tʰǐ.xʷó)(çǐ)]   "telephone line"

c. Normal tempo

   /tʰǐŋ.xʷð.xʷɛ̌ʒ/   [(tʰǐ.xʷó)(xʷɛ̌)(ʒ)]   "telephone conference"

   cf. /tʰǐŋ.xʷð.xʒ̃.m6/   [(tʰǐ.xʷó)(xʒ̃)(m6)]   "telephone number"

   /tsʰǯ.tʰʒ̃ŋ.tʰǐŋ.xʷð.tʃʒ/   [(tsʰǯ.tʰʒ̃ŋ)(tʰǐ.xʷó)(tʃʒ)]   "automatic telephone machine"

   cf. /tsʰǯ.tʰʒ̃ŋ.tʰǐŋ.xʷð.wó̃/   [(tsʰǯ.tʰʒ̃ŋ)(tʰǐ.xʷó)(wó̃)]   "automatic telephone network"

In (189a), the change from LM to MH in the second syllable cannot be due to Initial Register Deletion (186), because the syllable involved is not word-initial. In (189b), where the second syllable loses its underlying tone due to Tone Deletion, the change from LM to MH in the first syllable before Tone Redistribution (160) cannot be due to Initial Register Deletion either, because the latter does not apply if the the target syllable is followed by a toneless syllable, as shown in (179). Since the change of LM into MH in this case is triggered by a lower register tone (L or LM), we may refer to this process as register dissimilation. The data in (189c) show that register dissimilation only occurs in a penultimate foot. In other words, this process is triggered by a word-final lower register

tone. Notice that HM does not trigger this rule, because underlyingly it is not specified for any register features. Following is the formalized rule accounting for this process.

(190) Penultimate Register Dissimilation
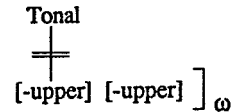
Tonal
$$\neq$$
[-upper] [-upper]] $_\omega$

Since the change from LM to MH is not blocked by toneless syllables, as shown in (189b) and (189c), this rule does not require the target tonal node to be followed by another tonal node.

The change from LM to surface ML, as in the third syllable of /tʰǐŋ.xʷǒ.xǎ.mó/ → [(tʰǐ.xʷó)(xǎ)(mó)] "telephone number", is due to a process that deletes the second tonal node of LM and thereby changes it into L before any other tone, as formalized below.

(191) Non-Initial Decontour

σ   σ

Tonal Tonal Tonal

L   H
[-upper]
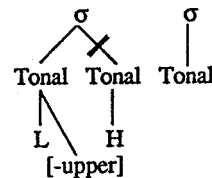
Non-Initial Decontour and Initial Decontour both delete the second tonal node of the lower register rising tone LM. Like Initial Decontour, Non-Initial Decontour also fails to apply if LM is followed by a toneless syllable, so that underlying /tsʰʔ.tʰǎŋ.tʰǐŋ.xʷǒ.wǫ́/ "automatic telephone network" surfaces as [(tsʰʔ.tʰǎŋ)(tʰǐ.xʷó)(wǫ́)], but not as *[(tsʰʔ.tʰǎŋ)(tʰǐ.xʷǒ)(wǫ́)]. This fact is incorporated into both rules by requiring the target of each rule to be followed by another tonal node in an adjacent syllable.

In spite of their apparent similarities, there are two important differences between Non-Initial Decontour and Initial Decontour. First, Non-Initial Decontour is triggered by a following syllable with any tone (actually H, H̲, MH and HM), while Initial Decontour

must be triggered by a following syllable specified with an upper register tone (i.e. H, H̲ and MH). Second, the output of Initial Decontour feeds into Register Deletion so it becomes M (e.g. /tʰǐŋ.wóŋ/ → [(tʰǐ)(wǫ́)] "electrical net"); whereas the output of Non-Initial Decontour does not feed into Register Deletion to become M, but it feeds into M Insertion to become ML (e.g. /tʰǐŋ.xʷǒ.wóŋ/ → [(tʰǐ)(xʷǒ)(wǫ́)] but *[(tʰǐ)(xʷó)(wǫ́)] "telephone network"). To account for this fact, Initial Decontour must be ordered before Register Deletion while Non-Initial ordered after Register Deletion. In addition, Penultimate Register Dissimilation must be ordered before Non-Initial Register Deletion, since it applies to medial syllables which may otherwise undergo the latter rule.

To sum up, I have proposed six regressive tone sandhi rules, including two register deletion rules, two decontour rules, a register dissimilation rule and a M tone insertion rule. These rules apply in an order illustrated below.

(192) Order of initial and non-initial decontour rules and other tonal rules

Underlying Representation	/tʰǐŋ.wóŋ/	/tʰǐŋ.xʷǒ.wóŋ/	/tʰǐŋ.xʷǒ.pʰ̥/
Initial Decontour	[(tʰǐ)(wǫ́)]	—	—
Initial Register Deletion	—	[(tʰǐ)(xʷǒ)(wǫ́)]	[(tʰǐ)(xʷǒ)(pʰ̥)]
Penultimate Register Dissim.	—	—	[(tʰǐ)(xʷó)(pʰ̥)]
Register Deletion	[(tʰǐ)(wǫ́)]	—	—
Non-Initial Register Deletion	—	[(tʰǐ)(xʷǒ)(wǫ́)]	—
M Insertion	—	[(tʰǐ)(xʷǒ)(wǫ́)]	[(tʰǐ)(xʷó)(pʰ̥)]
Surface Representation	[(tʰǐ)(wǫ́)]	[(tʰǐ)(xʷǒ)(wǫ́)]	[(tʰǐ)(xʷó)(pʰ̥)]
Gloss	"electric net"	"telephone network"	"telephone book"

5.3.3. Obstruent-induced upper register

When used in a syllable with an underlying coda obstruent, a low rising tone LM may alternate in exactly the same way that it does when it is used in other syllables. It surfaces as M word-initially when followed by an upper register tone H, H̲ or MH, as in (193a). It surfaces as MH word-initially when followed by a non-upper register tone or word-medially when followed by a word-final lower register tone, as in (193b). And it

surfaces as ML in non-final positions, as in (193c), provided that the speech rate is normal or fast, and provided that the underlying coda obstruent either deletes before a following vowel or glide, or assimilates to a following sonorant consonant. Following are some examples.

(193) Alternation of LM in obstruent-final syllables followed by a sonorant

a. /lŏk.lŏk/	[(lól)(ló?)]	"six-six"
/lŏk.lʼŋ/	[(lól)(lʼŋ)]	"six-zero"
/lŏk.ʋʃ/	[(ló)(ʋʃ)]	"six-five"
b. /lŏk.jîk/	[(lŏ)(jî?)]	"six-one"
/lŏk.ə̀/	[(lŏ)(ɚ̀)]	"six-two"
c. /lŏk.ʋʃ.lŏk.ʋʃ/	[(ló.ʋʃ)(lŏ)(ʋʃ)]	"six-five-six-five"
/lŏk.ʋʃ.lŏk.lʼŋ/	[(ló.ʋʃ)(lŏ)(lʼŋ)]	"six-five-six-zero"

If the coda obstruent of the syllable to which LM is linked is not deleted or assimilated to a sonorant, then LM surfaces as H, as shown in the following examples.

(194) Alternation of LM in obstruent-final syllables not followed by a sonorant

/lŏk.sɔ̀ŋ/	[(lós)(sɔ̰́)]	"six-three"
/lŏk.sʼ/	[(lós)(sʼ)]	"six-four"
/lŏk.pɔ́k/	[(lóp)(pɔ́?)]	"six-eight"
/lŏk.tɕɥ́/	[(lót)(tɕɥ́)]	"six-nine"
/lŏk.sɛ̆k/	[(lós)(sɛ́?)]	"six-ten"
/lŏk.sɔ̀ŋ.lŏk.sʼ/	[(lós.sɔ̰́)(lós)(sʼ)]	"six-three-six-four"
/lŏk.pɔ́k.lŏk.tɕɥ́/	[(lóp.pɔ́)(lót)(tɕɥ́)]	"six-eight-six-nine"

In slow tempo speech, LM always surfaces as H, even if the coda obstruent of the syllable it is linked to is deleted or assimilated to a sonorant, as the following data show.

(195) Alternation of LM in slow tempo obstruent-final syllables

/lŏk.lŏk/	[(lól)(ló?)]	"six-six"
/lŏk.lʼŋ/	[(lól)(lʼŋ)]	"six-zero"
/lŏk.ʋʃ/	[(ló)(ʋʃ)]	"six-five"
/lŏk.jîk/	[(ló)(jî?)]	"six-one"
/lŏk.ə̀/	[(ló)(ɚ̀)]	"six-two"
/lŏk.lŏk.lŏk/	[(lól)(lól)(ló?)]	"six-six-six"
/ə̀.lŏk.jîk/	[(ɚ̀)(ló)(jî?)]	"two-six-one"

It thus appears that in most cases LM surfaces as H in obstruent-final syllables. We account for this process with two rules. One rule assigns a [+upper] feature to a rising contour associated with an underlying obstruent-final syllable, i.e. with a syllable node which dominates a mora which dominates a [-sonorant] root node, as shown below.

(196) Register Insertion
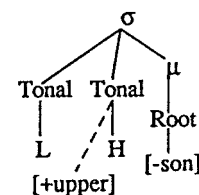
The upper register feature inserted by this rule can be considered as induced by the obstruent coda consonant, and is therefore not arbitrary. The second rule deletes the first tonal node of a rising contour associated with an underlying obstruent-final syllable, as shown below.

(197) Obstruent-Induced Decontour
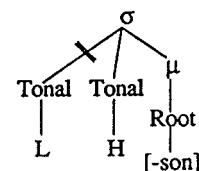
In order to always generate the correct surface forms, it is necessary to order these rules differently relative to Coda Obstruent Deletion and Coda Obstruent Assimilation in slow and normal tempos. Thus, in slow tempo, Register Insertion and Obstruent-Induced Decontour apply before Coda Obstruent Deletion and Coda Obstruent Assimilation, and therefore they apply to every syllable that has an underlying coda obstruent, as shown in the following sample derivation.

(198) Sample derivation of /lŏk.uɓ/ → [lŏ.uɓ] "six-five" in slow tempo

Underlying   Reg. Ins. & Obs. Ind. Del.   Coda Obs. Del.

[diagram of tonal feature trees with nodes labeled [-upper], [+upper], L, H, Tonal, σ, μ, Root, [+son], [-son]]

/l ŏ k. uɓ/   /l ŏ k. uɓ/   /l ŏ. uɓ/
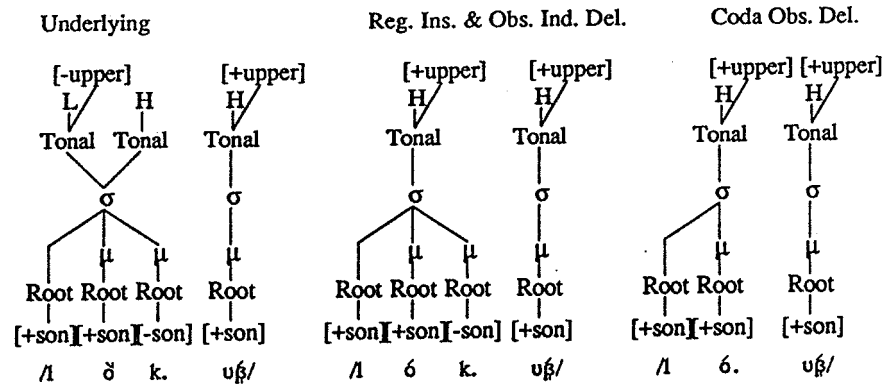
In normal tempo, on the other hand, Register Insertion and Obstruent-Induced Decontour apply after Coda Obstruent Deletion and Coda Obstruent Assimilation, and therefore they only apply to those syllables that retain their underlying coda obstruent because they fail to undergo Coda Obstruent Deletion or Coda Obstruent Assimilation. This is shown in the following sample derivation.

(199) Sample derivation of /lŏk.uɓ/ → [lŏ.uɓ] "six-five" in normal tempo

Underlying   Coda Obs. Del.   Init. Decont. & Reg. Del.

[diagram of tonal feature trees]

/l ŏ k. uɓ/   /l ŏ. uɓ/   /l ŏ. uɓ/
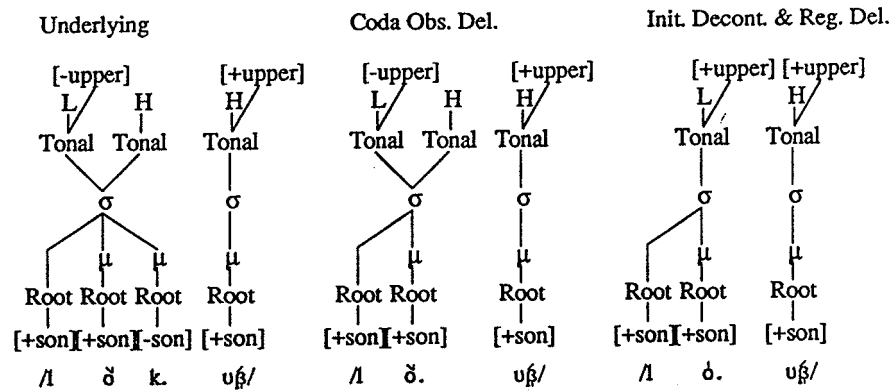
In addition to their ordering relative to segmental rules such as Coda Obstruent Deletion and Coda Obstruent Assimilation, Register Insertion and Obstruent-Induced

Decontour must also apply before all other rules of tonal alternations. This is because the short high level tone H̲ produced by Register Insertion and Obstruent-Induced Decontour always patterns with underlying upper register tones MH and H in triggering other tonal processes such as initial decontour. On the other hand, if Register Insertion and Obstruent-Induced Decontour do not change an underlying LM into H̲, then the surviving LM will undergo all other tonal processes that affect LM. The following table shows the ordering of Register Insertion and Obstruent-Induced Decontour with other tone sandhi rules.

(200) Order of initial and non-initial decontour rules and other tonal rules

Underlying Representation	/lŏk.ə̀/	/lŏk.sʑ̀/	/lŏk.lŏk/
Coda Obstruent Assimilation	—	/lŏs.sʑ̀/	/lŏl.lŏk/
Coda Obstruent Deletion	/lŏ.ə̀/	—	
Coda Obstruent Glottalization	—	—	/lŏl.lŏʔ/
Register Insertion	—	/lŏs.sʑ̀/	/lŏl.lŏʔ/
Obstruent-Induced Decontour	—	/lŏs.sʑ̀/	/lŏl.lŏʔ/
Initial Decontour	—	—	/lŏl.lŏʔ/
Initial Register Deletion	/lŏ.ə̀/	—	—
Register Deletion	—	—	/lŏl.lŏʔ/
M Insertion	/lŏ.ə̀/	—	/lŏl.lŏʔ/
Surface Representation	[(lŏ)(ə̀)]	[(lŏs)(sʑ̀)]	[(lŏl)(lŏʔ)]
Gloss	"six-two"	"six-four"	"six-six"

5.3.4. Decontour of upper register rising tone

The upper register rising tone MH becomes M when followed by H or H̲, as shown in the following data.

(201) Decontour of MH before H or H̲

/xǔ.çʷé/	[(xǔ)(çʷé)]	"river water"
/tsʰŏ.jǐk/	[(tsʰŏ)(jǐʔ)]	"tea leaves"
/tʰə̌ŋ.çŏk/	[(tʰə̌ŋ)(çŏʔ)]	"co-student (classmate)"
/ə̀.pŏk.lǐŋ.uɣ/	[(ə̀.pŏ)(lǐŋ)(uɣ)]	"two hundred and five"
/ə̀.pŏk.lǐŋ.lŏk/	[(ə̀.pŏ)(lǐl)(lŏʔ)]	"two hundred and six"

Unlike LM, MH does not become M before MH, as the following data show.

(202) Invariance of MH before MH

/xŭ.ʂ/	[(xŭ)(ʂ)]	"river fish"
/tsʰŏ.xʂ/	[(tsʰŏ)(xʂ)]	"tea pot"
/tʰʂŋ.mŭ/	[(tʰʂm)(mŭ)]	"co-conspirator (accomplice)"
cf. /xŭ.nʲŋ/	[(xŭ)(nʲ)]	"New Year's greetings"
/jɔ.xʂ/	[(jɔ)(xʂ)]	"night pot"
/kʰʂŋ.mŭ/	[(kʰʂm)(mŭ)]	"conspirator"

If the upper register rising tone is followed by a toneless syllable, it does not decontour, as shown in the following examples.

(203) No decontour of MH followed by toneless syllable

/ŋŏ.ɚ.wŏ/	[(ŋŏ.ɚ)(wŏ)]	*[(ŋŏ.ɚ)(wŏ)]	"childish language"
/tsʰŏ.jʲk.tʰʂŋ/	[(tsʰŏ.jí)(tʰʂ)]	*[(tsʰŏ.jí)(tʰʂ)]	"eggs cooked with tea"
/jɛŋ.kɔŋ.xʂ/	[(jɛ.ŋɔŋ)(xʂ)]	*[(jɛ.ŋɔŋ)(xʂ)]	"man-made lake"

Based on these observations, the rule for decontouring the upper register rising tone can be formalized as follows.

(204) High Rising Decontour

Notice that HM does not trigger this rule, because underlyingly it is not specified for register features. Also notice that since this rule is triggered by the short high level tone H produced by Register Insertion and Obstruent-Induced Decontour, it must be ordered after these two rules. No ordering is necessary between this and any other rules of tonal alternation. Following is a sample derivation with High Rising Decontour.

(205) Sample derivation with High Rising Decontour

5.4. Summary

By now, I have discussed all the possible tonal alternations in Nantong Chinese. Fifteen rules have been proposed to account for these alternations. These include Tone Redistribution, Tone Spreading, Tonal Default, Final Register Default, Register Default, M Insertion, Tone Deletion, Initial Decontour, Register Deletion, Initial Register Deletion, Register Dissimilation, Decontour, Register Insertion, Obstruent-Induced Decontour, and High Rising Decontour. Many of these rules refer to the metrical foot or the word boundary in their structural descriptions. These entities will be discussed in greater detail in the next chapter.

CHAPTER VI PROSODIC DOMAINS OF RULE APPLICATION

6.0. Introduction

A span of segmental material in which a phonological rule applies is a domain of rule application. In this chapter, I will show that at the word level, the domains of various phonological rules in Nantong Chinese can be defined by the prosodic constituents metrical foot and phonological word. I will justify the existence of these prosodic constituents in 6.1, and I will explain in 6.2 how they are constructed as a function of speech tempo and how various rules apply in the domains they define. Prosodic constituents at higher levels, i.e. phonological phrase and intonational phrase, will be discussed in chapter VII.

6.1. Prosodic hierarchy at the word level

The existence of the prosodic hierarchy is not always self-evident. In fact, it has been quite controversial in the literature whether the domain of a phonological rule, i.e. the segmental material involved in a phonological process, corresponds to a constituent of the prosodic hierarchy or to one of the morphosyntactic hierarchy. Shih (1986) argues that the tone sandhi process in Mandarin by which LM becomes MH before another LM "operates on 'prosodic' structures, which are sensitive to but by no means isomorphic to syntactic structures". Chan (1980) argues that the dominant syllable of a tone sandhi domain in Fuzhou Chinese correlates to the head of a syntactic constituent, but Chan (1985) shows that tonal alternations in the same language are conditioned by stress, which is a derivative of the prosodic structure. Chen (1987), on the other hand, argues that the domain of tone sandhi (or tone group) in Xiamen Chinese can be formed with direct reference to syntactic information, such as XP, head, adjunct and the c-command relationship.

From the various segmental and tonal morphophonemic processes that have been studied so far, we can see that Nantong Chinese has a richer and more complicated phonological system than both Mandarin and Xiamen. Therefore, it is a good test case for the existence of the prosodic hierarchy. To find out whether such a hierarchy exists in this language, we can use the phonological rules that we uncovered in the previous chapters as diagnostic tools. Thus, given a sequence ABC, if one or more rules apply within AB but no rule applies within BC, then AB should be considered a domain. If such domains are consistent with prosodic constituents but are at odds with morphological or syntactic constituents, then we have evidence that there is a prosodic hierarchy which is independent of the morphosyntactic hierarchy. To ensure that possible influences on rule application from prosody are not mixed with those from morphology, I start by using morphologically simple words including transliterations of foreign names. These words are as good for our purpose as those composed of juxtaposed monosyllabic morphemes such as sequences of monosyllabic numerals, because each syllable of these foreign names is represented with a Chinese character which has a unique underlying segmental and tonal representation. We will discuss patterns of rule application in morphologically complex words in chapter VI.

6.1.1. The metrical foot

The notion of the metrical foot has been used all through chapters IV and V. A metrical foot in this language consists of a toned syllable followed by any number of toneless syllables. Many rules of segmental and tonal alternation make reference to the metrical foot. Specifically, Tone Redistribution and Tone Spreading both apply within the domain of a metrical foot (from a toned syllable to toneless syllables), M Insertion applies under the strong branch of a metrical foot, while Tonal Default and Tone Deletion apply under the weak branch of a metrical foot. For example, in fast tempo speech, Tone Deletion applies to every non-initial syllable within a metrical foot, as shown in the following data.

(206) Domain of tone deletion in fast tempo

/ué.ně.ç^wě.ló/	[(ué.né.ç^wé)(ló)]	"Venezuela"
/t^hɔ́ŋ.sòŋ.ní.jò/	[(t^hɔ́.sɔ́.ní)(jò)]	"Tanzania"
/ɔ̀.ɔ̀.ɔ̀.ɔ̀/	[(ɔ̀.ɔ̀.ɔ́)(ɔ̀)]	"2-2-2-2"
/sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ/	[(sɔ̀.sɔ̀.sɔ́)(sɔ̀)]	"3-3-3-3"
/nɣ̀ŋ.sɔ̀.ló.fɓ/	[(nɣ̀.sɔ́.ló)(fɓ)]	"Yugoslavia"
/mɔ́.lí.t^hɔ́k.ní.jò/	[(mɔ́.lí.t^hɔ́.ní)(jò)]	"Mauritania"
/ɔ̀.ɔ̀.ɔ̀.ɔ̀.ɔ̀/	[(ɔ̀.ɔ̀.ɔ̀.ɔ́)(ɔ̀)]	"2-2-2-2-2"
/sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ/	[(sɔ̀.sɔ̀.sɔ̀.sɔ́)(sɔ̀)]	"3-3-3-3-3"

More importantly, lenition rules, such as Onset Lenition which changes an unaspirated onset plosive into a flap after a vowel or into a nasal after a nasal, Coda Lenition which deletes a coda obstruent, etc. always apply under the weak branch of the metrical foot.

As a domain of rule application, the metrical foot is purely prosodic and has nothing to do with morphology or syntax. For example, none of the metrical feet in the following data correspond to any morphological or syntactic unit.

(207) Polysyllabic words in normal tempo

/pù.lí.ué.jò/	[(pù.lí)(ué)(jò)]	"Bolivia"
/jò.lí.sòŋ.nɔ̀k/	[(jò.lí)(sɔ̀)(nɔ́ʔ)]	"Arizona"
/ɔ̀.ɔ̀.ɔ̀.ɔ̀/	[(ɔ̀.ɔ̀)(ɔ́)(ɔ̀)]	"2-2-2-2"
/sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ/	[(sɔ̀.sɔ̀)(sɔ́)(sɔ̀)]	"3-3-3-3"
/pù.lí.ní.ʃɔ̀.jò/	[(pù.lí)(nì.ʃɔ́)(jò)]	"Polynesia"
/jɔ́k.xǔŋ.ně.sɔ̀.pɔ́/	[(jɔ́x.xǔ)(ně.sɔ̀)(pɔ́)]	"Johannesburg"
/ɔ̀.ɔ̀.ɔ̀.ɔ̀.ɔ̀/	[(ɔ̀.ɔ̀)(ɔ̀.ɔ́)(ɔ̀)]	"2-2-2-2-2"
/sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ/	[(sɔ̀.sɔ̀)(sɔ̀.sɔ́)(sɔ̀)]	"3-3-3-3-3"

We conclude that the metrical foot is a legitimate prosodic unit that defines the domain of application of many rules.

6.1.2. The phonological word

Many tonal rules discussed in chapter V refer to the word boundary. For example, Initial Decontour, which changes a LM into L (which later becomes M by another rule)

before an upper register tone, and Initial Register Deletion, which changes a LM into MH before a non-upper register tone, both apply to word-initial syllables. On the other hand, Register Dissimilation, which changes a word-medial LM into MH before another lower register tone, requires that its trigger be word-final. Similarly, Final Register Default assigns a [-upper] feature only to a word-final tonal node. Moreover, the Register Deletion rule which deletes the [-upper] feature before any other tonal node must apply within the boundaries of a word, since the [-upper] feature is never deleted in word-final positions.

Assuming that the domain of the rules mentioned above is the morphological word, then we expect that a word-medial syllable will never undergo the rules that refer to the word-boundary, and it will never fail to undergo rules that apply to word-medial syllables, as long as the structural descriptions of the relevant rules are satisfied. However, in the following set of data, we find some unexpected applications of these rules. Firstly, the underlying L of the second syllable of words in (208a) ought to surface as M since it is word-medial, yet it surfaces as ML as if it were word-final and underwent M Insertion. Secondly, the third syllable of words in (208b) ought to surface as ML, because it is neither word-initial nor followed by a word-final lower register tone, yet it surfaces MH as if it were word-initial.

(208) Unexpected application of rules referring to word boundary

a.	/tçɔ̀.ló.tçɔ̀.sɔ̀/	[(tçɔ̀)(ló)(tçɔ̀)(sɔ̀)]	"Caracas"
	/ɔ̀.ló.sɔ̀.tçɔ̀/	[(ɔ̀)(ló)(sɔ̀)(tçɔ̀)]	"Alaska"
	/sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ/	[(sɔ̀)(sɔ̀)(sɔ̀)(sɔ̀)]	"3-3-3-3"
	/sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ/	[(sɔ̀)(sɔ̀)(sɔ̀)(sɔ̀)(sɔ̀)]	"3-3-3-3-3"
b.	/tɔ́.mó.ts^hɔ̀.kɛ́k/	[(tɔ́)(mó)(ts^hɔ̀)(kɛ́ʔ)]	"Damascus"
	/jɔ́k.xǔŋ.ně.sɔ̀.pɔ́/	[(jɔ́x)(xǔ)(ně)(sɔ̀)(pɔ́)]	"Johannesburg"
	/ɔ̀.ɔ̀.ɔ̀.ɔ̀/	[(ɔ̀)(ɔ̀)(ɔ̀)(ɔ̀)]	"2-2-2-2"
	/ɔ̀.ɔ̀.ɔ̀.ɔ̀.ɔ̀/	[(ɔ̀)(ɔ̀)(ɔ̀)(ɔ̀)(ɔ̀)]	"2-2-2-2-2"

The following is a more detailed illustration showing why these words seem to be exceptional given the sandhi rules we discussed in chapter V.

(209) An incorrect derivation of words with "unexpected" tonal rule application

Gloss	"Caracas"	Damascus"
Underlying	/tɕɔ̀.lɔ̀.tɕɔ̀.s̀/	/tɔ́.mó.tsʰ̀.kɛ́k/
Metrical Structure	[(tɕɔ̀)(lɔ̀)(tɕɔ̀)(s̀)]	[(tɔ́)(mó)(tsʰ̀)(kɛ́k)]
Initial Register Deletion	—	—
Register Deletion	[(tɕɔ̀)(lɔ̀)(tɕɔ̀)(s̀)]	—
Decontour	—	[(tɔ́)(mó)(tsʰ̀)(kɛ́k)]
M Insertion	[(tɕɔ̀)(lɔ̀)(tɕɔ̀)(s̀)]	[(tɔ́)(mó)(tsʰ̀)(kɛ́k)]
Output	*[(tɕɔ̀)(lɔ̀)(tɕɔ̀)(s̀)]	*[(tɔ́)(mó)(tsʰ̀)(kɛ́k)]

The solution to this problem lies in the fact that a morphologically word-medial syllables is not necessarily phonologically word-medial. In other words, those syllables that are morphologically word-medial but behave as if they were word-intial or word-final may well be phonologically word-initial or word-final, as shown below, where each pair of brackets represent the boundaries of a phonological word.

(210) Phonological words within morphological words in slow tempo speech

a.
/tɕɔ̀.lɔ̀.tɕɔ̀.s̀/	[(tɕɔ̀)(lɔ̀)][(tɕɔ̀)(s̀)]	"Caracas"
/ɔ̀.lɔ̀.s̀.tɕɔ̀/	[(ɔ̀)(lɔ̀)][(s̀)(tɕɔ̀)]	"Alaska"
/ɔ̀.ɔ̀.ɔ̀.ɔ̀/	[(ɔ̀)(ɔ̀)][(ɔ̀)(ɔ̀)]	"2-2-2-2"
/sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ/	[(sɔ̀)(sɔ̀)][(sɔ̀)(sɔ̀)]	"3-3-3-3"

b.
/ŋɔ̀.tɔ́.lɔ̀.jɔ̀/	[(ŋɔ̀)(tɔ́)][(lɔ̀)(jɔ̀)]	"Australia"
/jɔ́k.xɔ̀ŋ.nɛ̀.s̀.pɔ́/	[(jɔ́x)(xɔ̀)][(nɛ̀)(s̀)(pɔ́)]	"Johannesburg"
/ɔ̀.ɔ̀.ɔ̀.ɔ̀.ɔ̀/	[(ɔ̀)(ɔ̀)][(ɔ̀)(ɔ̀)(ɔ̀)]	"2-2-2-2-2"
/sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ.sɔ̀ŋ/	[(sɔ̀)(sɔ̀)][(sɔ̀)(sɔ̀)(sɔ̀)]	"3-3-3-3-3"

Consequently, the L in the second syllable becomes ML because it is now word-final, and the LM in the third syllable becomes MH because it is now word-initial, as shown in the following illustration.

(211) The correct derivation of words with "unexpected" tonal rule application

Gloss	"Caracas"	Damascus"
Underlying	/tɕɔ̀.lɔ̀.tɕɔ̀.s̀/	/tɔ́.mó.tsʰ̀.kɛ́k/
Metrical Structure	[(tɕɔ̀)(lɔ̀)][(tɕɔ̀)(s̀)]	[(tɔ́)(mó)][(tsʰ̀)(kɛ́k)]
Initial Register Deletion	—	[(tɔ́)(mó)][(tsʰ̀)(kɛ́k)]
Register Deletion	[(tɕɔ̀)(lɔ̀)][(tɕɔ̀)(s̀)]	—

Decontour	—	—
M Insertion	[(tɕɔ̀)(lɔ̀)][(tɕɔ̀)(s̀)]	[(tɔ́)(mó)][(tsʰ̀)(kɛ́k)]
Output	[(tɕɔ̀)(lɔ̀)][(tɕɔ̀)(s̀)]	[(tɔ́)(mó)][(tsʰ̀)(kɛ́k)]

We thus show that it is the phonological word, not the morphological word, that defines the domain of word level sandhi processes.

6.2. Metrical structure as a function of speech tempo

Having justified metrical feet and phonological words as domains of phonological rules at the word level, we now consider how these prosodic constituents are constructed. Again, we use monomorphemic words in order to rule out any possible influences from morphology. In these words, the only thing that affects the construction of the prosodic hierarchy is speech tempo. A word may have three different tonal patterns depending on speech tempo. For example, the word /pù.lì.ʋɛ̌.jɔ̀/ "Bolivia" is [(pù.lì.ʋɛ̌)(jɔ̀)] in fast tempo, [(pù.lì)(ʋɛ̌)(jɔ̀)] in normal tempo and [(pù)(lì)][(ʋɛ̌)(jɔ̀)] in slow tempo, as shown in the following narrowband spectrogram.

(212) Tonal patterns of /pù.lì.ʋɛ̌.jɔ̀/ "Bolivia" at various speech rates

Slow tempo	Normal tempo	Fast tempo

[(pù)(lì)][(ʋɛ̌)(jɔ̀)]	[(pù.lì)(ʋɛ̌)(jɔ̀)]	[(pù.lì.ʋɛ̌)(jɔ̀)]
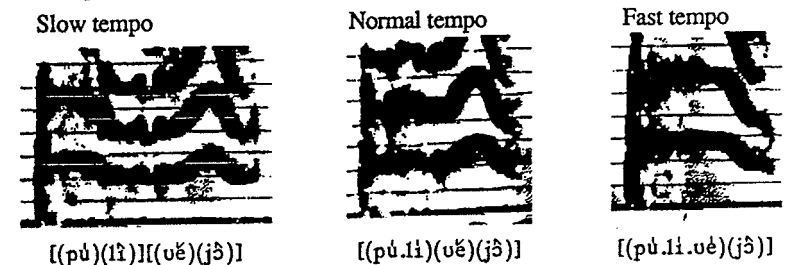
Figure 18 - Tonal patterns of /pù.lì.ʋɛ̌.jɔ̀/ "Bolivia" at various speech rates

These different tonal patterns are totally predictable, if we assume that the internal structure of the phonological word varies according to speech tempo, as shown below.

(213) Internal structure of phonological words in various speech tempos

Slow tempo	Normal tempo	Fast tempo
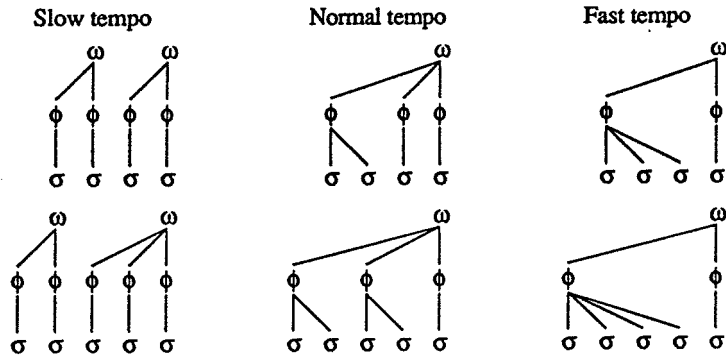
6.2.1. Metrical feet and phonological words in slow tempo

In slow tempo speech, tone deletion never occurs, but rules affecting word-initial or word-final syllables may apply in the middle of a morphological word, suggesting that there is more than one phonological word in a morphological word, as shown below.

(214) Tone sandhi in polysyllabic words (slow tempo)

/pù.lì.uɛ̆.jɔ̀/	[pù.lì][uɛ̆.jɔ̀]	"Bolivia"
/jɔ̀.lì.sòŋ.nɔ̆k/	[jɔ̀.lì][sɔ̆.nɔ́ʔ]	"Arizona"
/pù.lì.nì.ʃ̠.jɔ̀/	[pù.lì][nì.ʃ̠.jɔ̀]	"Polynesia"
/jɔ̀k.xǔŋ.nɛ̆.sʐ̩.pɔ́/	[jɔ̀x.xʊ̩][nɛ̆.sʐ̩.pɔ́]	"Johannesburg"
/tɕʰìk.kʰɛ̆k.sʐ̩.lɔ̆k.fɔ̀k.kʰɛ̆k/	[tɕʰìk.kʰɛ́ʔ][sʐ̩.lɔ́ʔ][fɔ́k.kʰɛ́ʔ]	"Czechoslovakia"[1]
/mé.sɔ̂k.pɛ̆k.tʰɔ́k.mʃ̩.jɔ̀/	[mé.sɔ́ʔ][pɛ́t.tʰɔ́ʔ][mʃ̩.jɔ̀]	"Mesopotamia"
/pβ̩.ɔ̆.nɔ̀k.sʐ̩.ŋà.lì.sʐ̩/	[pβ̩.ɔ̆][nɔ́s.sʐ̩][ŋà.lì.sʐ̩]	"Buenos Aires"
/fʂ̩.lɔ̀.tʰìk.wɔ́k.sʐ̩.tʰɔ́k.kɛ̆k/	[fʂ̩.lɔ̀][tʰí.wɔ́ʔ][sʐ̩.tʰɔ́k.kʰɛ́ʔ]	"Vladivostok"
/ʔ.ʔ.ʔ.ʔ/	[ʔ.ʔ][ʔ.ʔ]	"2-2-2-2"
/ʔ.ʔ.ʔ.ʔ.ʔ/	[ʔ.ʔ][ʔ.ʔ.ʔ]	"2-2-2-2-2"
/ʔ.ʔ.ʔ.ʔ.ʔ.ʔ/	[ʔ.ʔ][ʔ.ʔ][ʔ.ʔ]	"2-2-2-2-2-2"
/ʔ.ʔ.ʔ.ʔ.ʔ.ʔ.ʔ/	[ʔ.ʔ][ʔ.ʔ][ʔ.ʔ.ʔ]	"2-2-2-2-2-2-2"

---

[1] Some hexasyllabic words are lexically marked to be pronounced as two trisyllabic sequences, as shown in the following examples.

/tɕʰìk.kʰɛ̆k.sʐ̩.lɔ̆k.fɔ̀k.kʰɛ̆k/	[tɕʰìk.kʰɛ́s.sʐ̩][lɔ̆f.fɔ́k.kʰɛ́ʔ]	"Czechoslovakia"
/jɔ̀.lì.sʐ̩.jɔ̀.pɛ̆.pɔ̀/	[jɔ̀.lì.sʐ̩][jɔ̀.pɛ́.pɔ̀]	"Addis Ababa"
/tʰɔ̆k.lɛ̆.sʐ̩.sɔ̆k.lɔ̀.mú/	[tʰɔ́l.lɛ̆.sʐ̩][sɔ́l.lɔ̀.mú]	"Dar es Salaam"
/tʰɛ̆k.kʂ̩.ʃ̩.tɕɔ̆.ʔ.pɔ̀/	[tʰɛ̆k.kʂ̩.ʃ̩][tɕɔ̆.ʔ.pɔ̀]	"Tegucigalpa"

The fact that tone deletion does not apply in this set of data suggests that no toned syllable is under the weak branch of a metrical foot. In other words, all feet constructed on underlyingly toned syllables are unary. On the other hand, the change of LM into MH in the third syllable and the change of L into ML in the second syllable indicate that a word boundary between the second and the third syllables divides each morphological word into two phonological words, which is either binary or ternary in slow tempo, since it contains no more than three and no less than two metrical feet.

On the other hand, underlyingly toneless syllables, such as the repetitive affix *-ja-*, always surface with tones derived by tone spreading or tonal default, as shown below.

(215) Underlyingly toneless syllables in slow tempo speech

/mɔ̆.ja.mɔ̆.ti/	[(mɔ́.á)(mɔ̆.rì)]	"scolded and scolded"
/cʲk.ja.cʲk.ti/	[(cʲk.ká)(cʲt.tì)]	"talked and talked"
/tɛ̆ŋ.ja.tɛ̆ŋ.ti/	[(tɛ̆.ŋá)(tɛ̆.nì)]	"waited and waited"

Since tone spreading occurs within a metrical foot, the first and second pairs of syllables in each word must be each under a binary foot. Moreover, since the first LM in /mɔ̆.ja.mɔ̆.ti/ undergoes Register Dissimilation to become MH in [(mɔ́.á)(mɔ̆.rì)], the two feet of this word must be under the same phonological word.

Based on these observations, we propose the following set of rules for constructing the prosodic structure in slow tempo speech, with a sample derivation shown in (217).

(216) Foot and Word Construction
  a. Place a unary foot on every underlyingly toned syllable;
  b. Link every underlyingly toneless syllable to the first foot on its left;
  c. Build right-dominant binary phonological words from left to right;[2]
  d. Build a unary phonological word on the remaining foot or adjoin it to the preceding phonological word if possible.

---

[2] The phonological word has never been reported in the literature to be bounded. Therefore, it is possible that what we are dealing with here is a superfoot or cola, which is a constituent larger than the metrical foot but smaller than the phonological word, and is usually bounded, according to Hammond (1983) inter alia. However, since what we call a phonological word corresponds in most cases to a morphological word, and since no phonological rules in this language refer to any other prosodic constituent that could be construed as the phonological word, I will continue to refer to this bounded prosodic constituent as the phonological word. What is important here is the content, not the label.

(217) Sample derivation of prosodic structure in slow tempo speech

(216a) Feet on toned syllables

/pù.l̃ì.ʋɛ̌.jɔ̀/

/mǒ.ja.mǒ.ti/

(216b) Link toneless syllables

/mǒ.ja.mǒ.ti/

(216c) Binary words on feet

/pù.l̃ì.ʋɛ̌.jɔ̀/
"Bolivia"

/mǒ.ja.mǒ.ti/
"scolded and scolded"
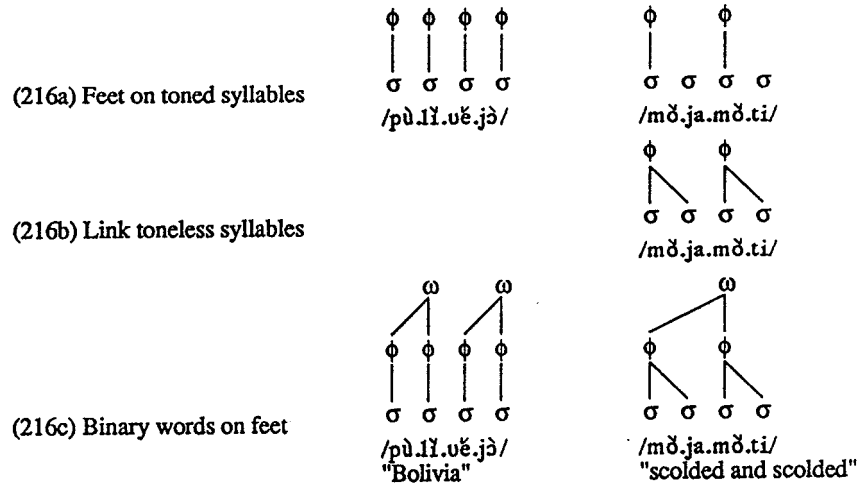
The different prosodic structures in words with or without underlyingly toneless syllables may explain the behavior of the glide deletion and onset assimilation rules, which delete the onset glide [j] after a vowel, or assimilate the onset sonorant [j] and [l] to the preceding coda consonant. It is argued in 4.1.3 that these rules must be prosodically conditioned, i.e. they do not apply in toned syllables, but do apply in underlyingly toneless syllables, such as those used in sentential particles and in the repetitive and the enumerative affixes. The following sample derivation shows how the onset glide [j] of an underlyingly toneless syllable undergoes Onset Assimilation, but the same onset glide of a toned syllable does not.

(218) Sample derivation of toned and toneless syllables with regard to onset assimilation

Second syllable is	toned	toneless
Gloss	"East Asia"	"How heavy!"
After foot & word building	/(tà ŋ)(jɔ̀)/	/(xə́)(tsʰɔ̌ ŋ.jɔ)/
Onset Assimilation	—	/(xə́)(tsʰɔ̌ ŋ.ŋɔ)/
Tone Deletion	/(tà ŋ)(jɔ̀)/	/(xə́)(tsʰɔ̌ ŋ.ŋɔ)/
Output after other rules	[(tɔ̀ ŋ)(jɔ̀)]	[(xə́)(tsʰɔ̌ ŋ.ŋɔ́)]

Similarly, the onset glide of the second syllable of /mǒ.ja.mǒ.ti/ "scolded and scolded" is deleted in the surface form [mǒ.á.mǒ.ɾi], because this syllable is underlyingly toneless. In contrast, the onset glide of the fourth syllable of /pù.l̃ì.ʋɛ̌.jɔ̀/ "Bolivia" is not deleted in the surface form [pù.l̃ì.ʋɛ̌.jɔ̌], because this syllable is toned.

The behavior of pseudo-toneless syllables in slow tempo speech is most interesting. They may or may not undergo tone spreading processes that affect toneless syllables, but either way, they never undergo glide deletion or onset assimilation rules, as shown in the following examples.

(219) Toneless syllables versus pseudo-toneless syllables

   a. No glide deletion in pseudo-toneless affixes

/tsʰɔ̌.jɛ̀ ŋ/	[tsʰɔ̌.jɛ̀]	*[tsʰɔ̌.ɛ̀]	?[tsʰɔ̌.jɛ̀]	*[tsʰɔ̌.ɛ̀]	"feeling hungry"
/kʷó.jɛ̀ ŋ/	[kʷó.jɛ̀]	*[kʷó.ɛ̀]	?[kʷó.jɛ̀]	*[kʷó.ɛ̀]	"feeling lack of oil"
/mɔ́.jɛ̀ ŋ/	[mɔ́.jɛ̀]	*[mɔ́.ɛ̀]	?[mɔ́.jɛ̀]	*[mɔ́.ɛ̀]	"hot and spicy"

   b. Onset assimilation fails to occur in pseudo-toneless directionals and locatives

/tʃɨ́ ŋ-la/	[tʃɨ́n.là]	*[tʃɨ́ŋ.gà]		"come in"
/tɕʰɛ̌k-la/	[tɕʰɛ̌l.là]	*[tɕʰɛ̌k.kà]		"come out"
/nó.tə lɛ̌.sɔ̌ ŋ-la/	[nó.ɾɔ́ lɛ̌.sɔ̣̌.lá]	*[nó.ɾɔ́ lɛ̌.sɔ̣̌.gá]		"bring it upstairs"
/l̃ón.kɔ̀ ŋ-li.tʰe/	[l̃ɔ̣́.kɔ̣̀.lì.tʰɛ̀]	*[l̃ɔ̣́.kɔ̣̀.ɲì.tʰɛ̀]		"inside the room"
/tʰɔ́ ŋ.çɔ̌k-li.tʰe/	[tʰɔ̀ ŋ.çɔ́l.lì.tʰé]	*[tʰɔ̀ ŋ.çɔ́k.kí.tʰé]		"among the classmates"

To account for the behavior of the pseudo-toneless syllables, we assume that they are underlyingly toned, but are lexically marked (represented as σ!) for tone deletion. Since tone deletion occurs under the weak branch of a metrical foot, what this means is that they are lexically marked to undergo a foot deletion rule, formalized as follows.

(220) Lexical Defooting

σ σ!

The Lexical Defooting rule causes a pseudo-toneless syllable to become dominated by the weak branch of a metrical foot. This rule is optional in slow tempo: if it applies, then the pseudo-toneless syllable undergoes tone deletion, tone spreading and lenition rules that

apply within the foot; but if it does not apply, then none of those rules will apply and the pseudo-toneless syllable will surface like a regular toned syllable. With regard to the glide deletion and onset assimilation rules, as long as they are ordered before Lexical Defooting, they will not affect pseudo-toneless syllables whether or not Lexical Defooting applies, because when they apply, the pseudo-toneless syllables are still dominated by unary feet, and therefore do not satisfy their structural description. The following sample derivation shows how the surface tone of pseudo-toneless syllables are derived with or without Lexical Defooting applying.

(221) Sample derivation of pseudo-toneless syllables with regard to onset assimilation

Second syllable is	pseudo-toneless	pseudo-toneless
Gloss	"chewy"	"chewy"
After foot & word building	/(tʃîŋ)(jɛ̆ŋ)/	/(tʃîŋ)(jɛ̆ŋ)/
Onset Assimilation	—	—
Lexical Defooting & Tone Deletion	—	/(tʃîŋ.jɛŋ)/
Output after other rules	[(tʃîŋ)(jɛ̀)]	[(tʃîŋ)(jɛ̀)]

6.2.2. Metrical feet and phonological words in normal tempo

Although Lexical Defooting is optional in slow tempo speech, it is obligatory in normal tempo speech, as the following data show.

(222) Pseudo-toneless syllables in normal tempo speech

/çɣk.lǎ.çɣk.tʰî/   [(çɣl.lá)][(çɣt)(tʰî)]   "talk fro talk to (after all the talking)"
             but *[(çɣl)(lǎ)][(çɣt)(tʰî)]

/tɛ̆ŋ.lǎ.tɛ̆ŋ.tʰî/   [(tɛ̆.lá)][(tɛ̆)(tʰî)]   "wait fro wait to (after all the waiting)"
             but *[(tɛ̆)(lǎ)][(tɛ̆)(tʰî)]

/mǒ.lǎ.mǒ.tʰî/   [(mǒ.lá)][(mǒ)(tʰî)]   "scold fro scold to (after all the scolding)"
             but *[(mǒ)(lǎ)][(mǒ)(tʰî)]

Words containing toneless syllables have the same tonal pattern in normal tempo speech as in slow tempo speech, as shown below.

(223) Underlyingly toneless syllables in normal tempo speech

/mǒ.ja.mǒ.ti/   [(mǒ.á)(mǒ.ɹì)]   "scolded and scolded"

/çɣk.ja.çɣk.ti/   [(çɣk.ká)(çɣt.tì)]   "talked and talked"
/tɛ̆ŋ.ja.tɛ̆ŋ.ti/   [(tɛ̆.ŋá)(tɛ̆.nì)]   "waited and waited"

Words containing no toneless syllables, on the other hand, undergo Tone Deletion, so that even-numbered syllables become toneless as long as they are not the rightmost toned syllable. Therefore, these words have a completely different tonal pattern in normal tempo speech than in slow tempo speech, as shown below (cf. slow tempo data in (214)).

(224) Tone sandhi in polysyllabic words (normal tempo)

/pǔ.lǐ.ʋɛ̆.jɔ̀/	[(pǔ.lì)(ʋɛ̆)(jɔ̀)]	"Bolivia"
/jɔ̀.lǐ.sòŋ.nɔ̆k/	[(jɔ̀.lì)(sɔ̆)(nɔ̆ʔ)]	"Arizona"
/pǔ.lǐ.nǐ.ʃɣ.jɔ̀/	[(pǔ.lì)(nì.ʃɣ)(jɔ̀)]	"Polynesia"
/jɔ̆k.xǔŋ.nɛ̆.sɣ.pɔ̆/	[(jɔ̆x.xǔ)(nɛ̆.sɣ)(pɔ̆)]	"Johannesburg"
/tɕʰǐk.kʰɛ̆k.sɣ.lɔ̆k.fɔ̆k.kʰɛ̆k/	[(tɕʰǐk.kʰɛ̆)(sɣ.lɔ̆)(fɔ̆k)(kʰɛ̆ʔ)]	"Czechoslovakia"[3]
/mɛ̆.sɔ̆k.pɛ̆k.tʰɔ̆k.mʃ.jɔ̀/	[(mɛ̆.sɔ̀)(pɛ̆t.tʰɔ̀)(mʃ)(jɔ̀)]	"Mesopotamia"
/pβ.ʒ.nɔ̆k.sɣ.ŋà.lǐ.sɣ/	[(pβ.ʒ)(nós.sɣ)(ŋá.lì)(sɣ)]	"Buenos Aires"
/fβ.lɔ̆.tʰǐk.wɔ̆k.sɣ.tʰɔ̆k.kɛ̆k/	[(fβ.lɔ̀)(tʰǐ.wɔ̀)(sɣ.tʰɔ̀)(kʰɛ̆ʔ)]	"Vladivostok"
/ɔ̀.ɔ̀.ɔ̀.ɔ̀/	[(ɔ̀.ɔ̀)(ɔ̀)(ɔ̀)]	"2-2-2-2"
/ɔ̀.ɔ̀.ɔ̀.ɔ̀.ɔ̀/	[(ɔ̀.ɔ̀)(ɔ̀.ɔ̀)(ɔ̀)]	"2-2-2-2-2"
/ɔ̀.ɔ̀.ɔ̀.ɔ̀.ɔ̀.ɔ̀/	[(ɔ̀.ɔ̀)(ɔ̀.ɔ̀)(ɔ̀)(ɔ̀)]	"2-2-2-2-2-2"
/ɔ̀.ɔ̀.ɔ̀.ɔ̀.ɔ̀.ɔ̀.ɔ̀/	[(ɔ̀.ɔ̀)(ɔ̀.ɔ̀)(ɔ̀.ɔ̀)(ɔ̀)]	"2-2-2-2-2-2-2"

It appears that to construct the prosodic structure of these words in normal tempo speech, we can first build a unary foot on the rightmost toned syllable, then build binary feet from left to right, and finally do something about the remaining syllable if there is one. Such an approach predicts that even-numbered non-final syllables are always under the weak branch of a metrical foot and therefore toneless. This is incorrect, because, as we can see from the following example words, an even-numbered non-final syllable can be under the strong branch of a metrical foot if it is followed by an underlyingly toneless syllable.

---

[3] Hexasyllabic words that are lexically marked as two separate phonological words in slow tempo speech are also treated as two separate words in normal speech, e.g.

/tɕʰǐk.kʰɛ̆k.sɣ.lɔ̆k.fɔ̆k.kʰɛ̆k/	[(tɕʰǐk.kʰɛ̆)(sɣ)][(lɔ̆f.fɔ̆k)(kʰɛ̆ʔ)]	"Czechoslovakia"
/jɔ̀.ɹì.sɣ.jɔ̀.pɛ̆.pò/	[(jɔ̀.ɹì)(sɣ)][(jɔ̀.pɛ̀)(pò)]	"Addis Ababa"
/tʰɔ̆k.lǎ.sɣ.sɔ̆k.lɔ̀.mǔ/	[(tʰɔ̆l.lé)(sɣ)][(sɔ̆l.lɔ̀)(mǔ)]	"Dar es Salaam"
/tʰɛ̆k.kβ.ʃʒ.tɕɔ̆.ɔ̀.pò/	[(tʰɛ̆k.kβ)(ʃʒ)][(tɕɔ̀.ɔ̀)(pò)]	"Tegucigalpa"

Notice that there is no easy way of building the foot structure in these words by placing binary feet, whether we start from the right edge or the left edge of the word.

(225) Words in which even-numbered syllables are not toneless in normal tempo

/sɔ̃ŋ.xɛ̌.ɚ.lí ŋ/	[(sɟ̌)(xɛ̀.ɚ̂)(lɟ̌)]	"monkey face"
/jɛ̌ŋ.fɔ̃ŋ.ʒ.tʰɔ̀ŋ/	[(jɛ̌)(fɟ̌.ʒ̂)(tʰɟ̌)]	"potato soup"
/tsʰɔ́.tɕɔ́.ɚ.pɔ̃ŋ/	[(tsʰɔ́)(tɕɔ́.ɚ̂)(pɟ̌)]	"sparrow spots (freckles)"
/jɔ́.tʰβ.ɚ.pʰǯ/	[(jɔ́)(tʰβ.ɚ̂)(pʰǯ)]	"wild rabbit (hare) fur"

As an alternative analysis, we assume that as the speech rate increases, the number of metrical feet in a phonological word decreases. This can be effected with a rule that deletes every unary foot flanked by two other unary feet, each dominating a head syllable, as formalized below.

(226) Normal Tempo Defooting
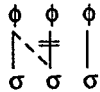
Notice that this rule requires the flanking feet to be unary, i.e. each linked to a head syllable with a straight association line. Thus, assuming this rule applies iteratively from left to right to a sequence of unary feet, only even-numbered non-final syllables lose their dominating feet, because the odd-numbered syllables are always preceded by a newly generated binary foot, not a unary foot. In addition, we can explain why the second syllable of words in (225) does not come under the weak branch of a metrical foot, since that syllable cannot undergo Normal Tempo Defooting because it is not followed by a syllable with a unary foot (the third syllable is toneless). These observations show that the foot structure in normal tempo speech must be constructed on the basis of slow tempo foot structure by applying Prosodic Defooting iteratively from left to right, as shown below.

(227) Sample derivation of foot structure in normal tempo speech
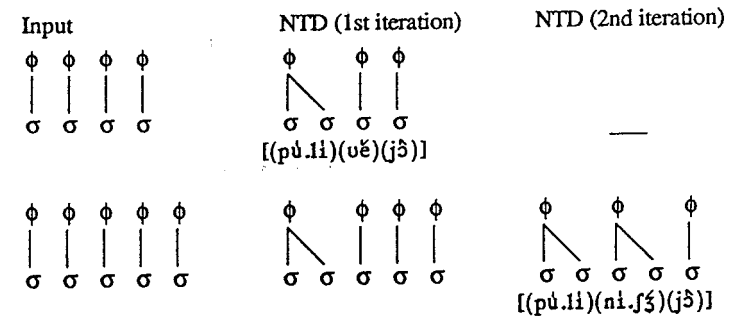
When the foot structure is complete, an unbounded right-dominant phonological word can be constructed on it, as shown below.

(228) Phonological words in normal tempo speech

[(pù.lì)(ʋɛ̌)(jɔ̃)]   [(pù.lì)(nì.ʃɔ́)(jɔ̃)]
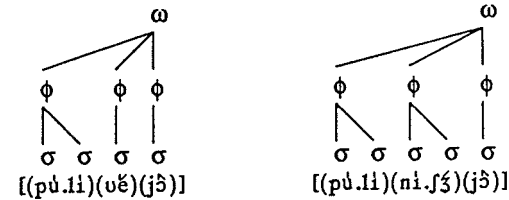
The normal tempo prosodic structure constructed above explains why rules that apply under the weak branch of a metrical foot, such as Tone Deletion and Onset Lenition, should apply in even-numbered underlyingly toned syllables in normal tempo speech as long as they are not word-final or followed by a toneless syllable. It also explains why rules that refer to word-initial or word-final syllables, e.g. Initial Register Deletion and Register Dissimilation, do not apply in the middle of a quadrisyllabic or pentasyllabic word in normal tempo speech, though they do apply in slow tempo speech (cf. (214) and (224)).

6.2.3. Metrical feet and phonological words in fast tempo

In fast tempo speech, all underlyingly toned syllables except the first and the last lose their underlying tones, as shown in the following data (cf. slow tempo data in (214) and normal tempo data in (224).

(229) Tone sandhi in polysyllabic words (fast tempo)

/pù.lĭ.ʋɛ̆.jɔ̀/	[(pú.lĭ.ʋɛ̆)(jɔ̌]]	"Bolivia"
/jɔ̌.lĭ.sòŋ.nɔ̌k/	[(jɔ̌.lĭ.sɤ̀)(nɔ́ʔ)]	"Arizona"
/pù.lĭ.nĭ.ʃǯ.jɔ̀/	[(pù.lĭ.nĭ.ʃǯ)(jɔ̌)]	"Polynesia"
/jɔ́k.xǔŋ.nɛ̆.sǯ.pɔ́/	[(jɔ́x.xǔ.nɛ̆.sǯ)(pɔ́)]	"Johannesburg"
/tɕʰĭk.kʰɛ́k.sǯ.lɔ̌k.ʃɔ̌k.kʰɛ̆k/	[(tɕʰĭk.kʰɛ́.sǯ.lɛ̆.lɔ́)(kʰɛ̆ʔ)]	"Czechoslovakia"[4]
/mɛ́.sɔ́k.pɛ́k.tʰɔ́k.mʃ.jɔ̀/	[(mɛ́.sɔ́.pɛ́.tʰɔ́.mʃ)(jɔ̌)]	"Mesopotamia"
/pɓ.ʒ.nɔ̌k.sǯ.ŋǎ.lĭ.sʒ̀/	[(pɓ.ʒ.nɔ́.sǯ.ŋǎ.lĭ)(sǯ)]	"Buenos Aires"
/fɓ.lɔ̌.tʰĭk.wɔ́k.sǯ.tʰɔ́k.kɛ́k/	[(fɓ.lɔ́.tʰĭ.wɔ́.sǯ.tʰɔ́)(kʰɛ́ʔ)]	"Vladivostok"
/ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ/	[(ɔ̀ʒ.ɔ̆ʒ.ɔ̆ʒ)(ɔ̌ʒ)]	"2-2-2-2"
/ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ/	[(ɔ̀ʒ.ɔ̆ʒ.ɔ̆ʒ.ɔ̆ʒ)(ɔ̌ʒ)]	"2-2-2-2-2"
/ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ/	[(ɔ̀ʒ.ɔ̆ʒ.ɔ̆ʒ.ɔ̆ʒ.ɔ̆ʒ)(ɔ̌ʒ)]	"2-2-2-2-2-2"
/ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ.ɔ̀ʒ/	[(ɔ̀ʒ.ɔ̆ʒ.ɔ̆ʒ.ɔ̆ʒ.ɔ̆ʒ.ɔ̆ʒ)(ɔ̌ʒ)]	"2-2-2-2-2-2-2"

Since tone deletion takes place under the weak branch of the metrical foot, the tonal patterns in the above data suggest that all syllables except the first and last underlyingly toned syllables are put under the weak branch of the metrical foot. Such a foot structure can be constructed by placing an n-ary unbounded foot on the first toned syllable and another one on the last toned syllable. However, this approach does not explain why n-ary feet instead of unary or binary feet should be constructed in fast tempo speech, and it is inconsistent with the foot construction in normal tempo speech which involves a defooting process which reflects the reduction in overall duration as a function of the increase of speech rate. A more reasonable analysis should therefore be based on the same observation as in normal tempo speech that the increase of speech rate forces the number of metrical feet in a phonological word to decrease. Thus, the foot structure in fast tempo speech can be built on the basis of slow tempo foot structure by deleting all metrical feet in a phonological word except the first and the last, with the following rule.

---

[4] Hexasyllabic words that are lexically divided into two phonological words in slow and normal tempo speech are not so divided in fast tempo speech, e.g.

/jɔ̌.tĭ.sǯ.jɔ̌.pɛ́.pɔ̀/	[(jɔ̌.rĭ.sǯ.jɔ̌.pɛ́)(pɔ̀)]	"Addis Ababa"
/tʰɔ̌k.lǎ.sǯ.sɔ́k.lɔ̌.mǔ/	[(tʰɔ́l.lɛ̆.s.sɔ́.lɔ̌)(mǔ)]	"Dar es Salaām"
/tʰɛ́k.kɓ.ʃǯ.tɕɔ̌.ɔ̆.pɔ̀/	[(tʰɛ́k.kɓ.ʃǯ.tɕɔ́.ɔ̆)(pɔ̀)]	"Tegucigalpa"

(230) Fast Tempo Defooting

This rule differs from Normal Tempo Defooting in that it does not require the flanking feet to be unary, i.e. linked to a head syllable with a straight association line. As such, it applies to every medial foot. The following shows how this rule applies.

(231) Sample derivation of foot structure in fast tempo speech
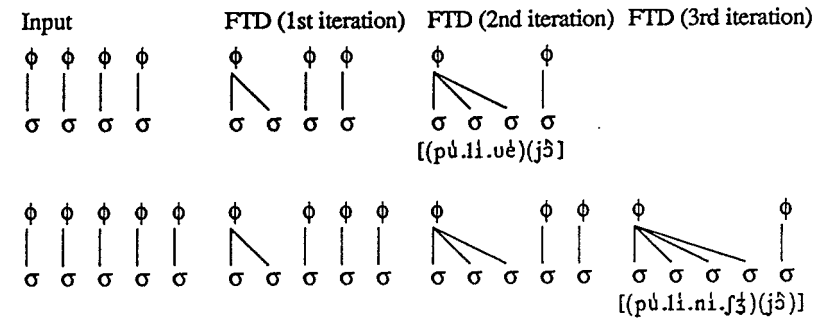
After the foot structure in fast tempo speech is constructed, placing a right-dominant word tree on the foot structure will produce the phonological word structure, as shown below.

(232) Derivation of phonological word in fast tempo speech
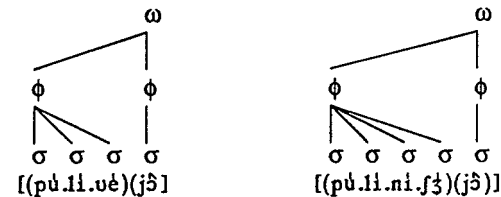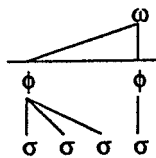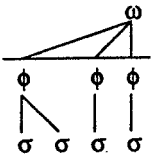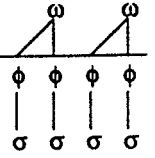
6.2.4. Segmental and tonal alternations under different prosodic structures

Once the various foot structures and word structures are constructed in different speech rates, the various rules of segmental and tonal alternations which take prosodic units as their domains of application will apply accordingly to produce the observed surface

forms. Following is a sample derivation of the three different surface forms of the word /ŋɔ̂.tʃ.lɨ́.jɔ̀/ "Australia" which we presented as the beginning of this section.

(233) Sample derivation of /ŋɔ̂.tʃ.lɨ́.jɔ̀/ "Australia" in different tempos

	Fast tempo	Normal tempo	Slow tempo
Underlying form	/(ŋɔ̂.tʃ.lɨ́)(jɔ̀)/	/(ŋɔ̂.tʃ)(lɨ́)(jɔ̀)/	/(ŋɔ̂)(tʃ)//(lɨ́)(jɔ̀)/
Tone Deletion	/(ŋɔ̂.tɔ.li)(jɔ̀)/	/(ŋɔ̂.tɔ)(lɨ́)(jɔ̀)/	—
M Ins & Reg Spread	/(ŋɔ̂.tɔ.li)(jɔ̀)]	[(ŋɔ̂.tɔ)(lɨ́)(jɔ̀)/	/(ŋɔ̂)(tʃ)//(lɨ́)(jɔ̀)/
Tonal Def & Reg Def	/(ŋɔ̂.tʃ.li)(jɔ̀)/	/(ŋɔ̂.tʃ)(lɨ́)(jɔ̀)/	—
Onset Deletion (>surface)	[(ŋɔ̂.rɔ.li)(jɔ̀)]	[(ŋɔ̂.rɔ)(lɨ́)(jɔ̀)]	[(ŋɔ̂)(tʃ)][(lɨ́)(jɔ̀)]

Thus, with the prosodic constituents metrical foot and phonological word as their domains of application, none of these rules of segmental and tonal alternations needs to directly refer to speech rate as its condition of application, since everything follows from the difference in prosodic structures dictated by different speech rates. Otherwise, the Tone Deletion rule would have to be analyzed as deleting the tonal node(s) of a syllable flanked by two underlyingly toned syllables; and this rule must be conditioned such that it applies in normal or fast tempo speech but not in slow tempo speech. Such a rule offers no explanation why any tone should be deleted when flanked by other tones, and why such a process should occur only in normal and fast tempo speech. Furthermore, without the metrical foot as their domain of application, rules like Onset Lenition, Coda Lenition, Tone Redistribution, Tone Spreading etc. would have to apply in syllables that do not have any tonal specification. However, given the framework of autosegmental phonology, it is not possible to represent the absence of some feature specification. Therefore, the prosodic domain analysis seems to be the only viable approach to rule application in this language.

6.3. Summary

In this chapter, I have justified the existence of metrical feet and phonological words. I have shown how these prosodic constituents are constructed differently in various speech rates. I argue that the behavior of various phonological processes in different speech rates is a function of the internal structures of these prosodic constituents in different speech rates. Given that these prosodic constituents define the domains of phonological rule application, it is not necessary to make phonological rules sensitive to speech rate.

CHAPTER VII   THE ROLE OF MORPHOLOGY AND SYNTAX

7.0. Introduction

There are two major schools of thought about the role of morphology and syntax in phonology. One school, represented by Chan (1980), Kaisse (1985), Chen (1987, 1990), Odden (1987b) among others, believes that phonological rules have direct access to morphological and syntactic information. The other school, represented by Selkirk (1978), Nespor and Vogel (1986), Hsiao (1991), Zhang (1992) and many others, believes that phonological rules are affected by syntax and morphology only via prosodic structure. In the previous chapter, I have shown that in polysyllabic monomorphemic words, where no morphological or syntactic information is available, prosodic constituents such as the metrical foot and the phonological word define the domain of application of various rules. What we need to find out in this chapter is how prosodic structure relates to the morphological and syntactic structures. I will show in 7.1 that in compounds, including reduplicated words, prosodic structure preserves the integrity of embedded morphemes and respects word boundaries, and that the manipulation of prosodic structure may be conditioned by lexical categories. In 7.2, I will show how prosodic structure at the phrase level generally agrees with the syntactic structure, but may also override syntactic structure by fusing certain items into a phonological word or a metrical foot even though they are separated by a word boundary.

7.1. Prosodic structure in compounds

In this section, I will show that the construction of prosodic structure generally ignores morpheme boundaries, but it preserves the integrity of non-final embedded

morphemes and respects morphological word boundaries. Unless otherwise specified, the discussion will focus on the tonal patterns of compounds in normal tempo speech, because these patterns are most complicated in normal tempo speech in polymorphemic words as well as in monomorphemic words.

7.1.1. Irrelevance of morphological structure in trisyllabic compounds

Trisyllabic compounds have the same foot structure as trisyllabic monomorphemic words, i.e. the second syllable always joins the first syllable to form a binary foot, and as such undergoes tone deletion, tone spreading and lenition rules, as long as the third syllable is toned. This foot structure is found in trisyllabic compounds with different morphological structures, e.g. [(AB)C], [A(BC)] or [ABC], as shown below, where "()" and "[]" in the literal translation indicate constituents at different levels of the morphological hierarchy.

(234) Prosodic structure of trisyllabic compounds

a. /tʰiŋ.sʅ.tʃʒ/
    [(electric view)machine]
    [(tʰi.sʅ)(tʃʒ)]
    "television set"

    /tʰβ.sβ.kuŋ/
    [(picture book)house]
    [(tʰβ.sβ)(ku)]
    "library"

    /tʰiŋ.xʷɤ.pʰβ/
    [(electric speech)book]
    [(tʰi.xʷo)(pʰβ)]
    "telephone book"

    /pʰβ.tʰɤ.tʰoŋ/
    [(grape)sugar]
    [(pʰβ.tʰo)(tʰɤ)]
    "glucose"

b. /jɛŋ.piŋ.tʰɤ/
    [foreign(flat bean)]
    [(jɛ.mi)(tʰɤ)]
    "lima bean"

    /tsʰa.sʅ.tsʰoŋ/
    [food(marketing field)]
    [(tsʰa.sʅ)(tsʰo)]
    "food market"

    /xɤŋ.sɛk.tsʰʅ/
    [red(ten character)]¹
    [(xɤŋ.sɛ)(tsʰʅ)]
    "red cross"

    /lɤ.pʰβ.tʰɤ/
    [warty(grape)]
    [(lɤ.pʰβ)(tʰɤ)]
    "balsam pear"

c. /tʰi.sʅ.ɕiŋ/
    [district city county]
    [(tʰi.sʅ)(ɕi)]
    "district, city and county"

    /sɤŋ.tsɤŋ.ɕa/
    [upper middle lower]
    [(sɤ.nzɤŋ)(ɕa)]
    "upper, middle and lower"

---

¹ The Chinese character meaning "ten" is shaped like +, hence "ten character" means the shape of the character meaning ten, i.e. the cross.

/sə̀ŋ.tsók.mě/
[pine bamboo] plum]

[(sə̀n.nzó)(mě)]
"pine, bamboo and plum"

/sè̠ŋ.ɥɪ̀ŋ.tʲɔ́/
[onset rhyme tone]

[(sɛ̠̀.ɥɪn)(tʲɔ́)]
"onset, rhyme and tone"

Since prosodic structure is constant regardless of the morphological structure of these compounds, we conclude that the construction of prosodic structure in these words is guided by the same set of rules as those responsible for monomorphemic words, i.e. a unary foot is built on every toned syllable, and Normal Tempo Defooting later deletes the second foot and reassociates the second syllable to the first foot, resulting in a binary foot followed by a unary foot. Such a foot structure allows Tone Deletion to apply in the second syllable, and Tone Spreading, Tone Redistribution or Tonal Default rules will supply the second syllable with its surface tone.

7.1.2. Morphological integrity in polysyllabic compounds

Like trisyllabic compounds, compounds with more than three syllables usually have the same foot structure as monomorphemic words with the same number of syllables, i.e. an even-numbered syllable always joins its preceding syllable to form a binary foot, and therefore becomes toneless and undergoes tone spreading and lenition rules, as long as it is not the last toned syllable or followed by a toneless syllable. For example, in all of the following quadrisyllabic compounds, the second syllable joins the first syllable to form a binary foot, even though the morphological structures of the two groups are [(AB)(CD)] and {[(AB)C]D} respectively. Again, the symbols "()", "[]" and "{}" in the literal translation indicate constituents at different levels of the morphological hierarchy.

(235) Prosodic structure of quadrisyllabic compounds

a. /tʰɪ̀ŋ.tʰə̀ŋ.wɔ̌ŋ.tɕʰʐ́/
[(electric move)(play tool)]

[(tʰɪ̀.tʰə̀ŋ).wʑ̌.tɕʰʐ́]
"electrically.powered toy"

/tʰɪ̀ŋ.xʷə̌.xʷě.ʐ̌/
[(electric speech)(meet talk)]

[(tʰɪ̀.xʷə̀).xʷě.ʐ̌]
"telephone conference"

/ʋɛ̌k.lí.çɪ̀ŋ.tɕʰě̠ŋ/
[(object law)(appear manner)]

[(ʋɛ̌l.lì).çɪ̀.tɕʰě̠ŋ]
"physical phenomenon"

b. /tʰɪ̀ŋ.sʐ̌.tʃʐ̌.tsʰóŋ/
{[(electric view)machine]factory}

[(tʰɪ̀.sʐ̌).tʃʑ̌.tsʰʑ̌]
"television factory"

/ʋǎ.tɕə̀.pʰʑ̌.tsóŋ/
{[(foreign exchange)ministry]chief}

[(ʋǎ.tɕə̀).pʰʑ̌.tsʑ̌]
"foreign minister"

/pó.lě.ʋʂ.tɕʰɔ́k/
{[(ballet)dance]drama}

[(pó.lě).ʋʂ.tɕʰɔ́ʔ]
"ballet dance drama"

Based on the foot structure in these compounds, we may conclude that the same set of rules for constructing prosodic structure in normal tempo monomorphemic words also apply to quadrisyllabic compounds. Specifically, a unary foot is placed on every toned syllable and Normal Tempo Defooting deprives the second syllable of its foot and adjoins it to the first foot.

There is a systematic exception to the account given above: if the first three syllables form a morphological constituent in which the second and third syllables form a sub-constituent, then the second and third syllables must both join the first syllable to form a ternary foot, and as such both undergo tone deletion, tone spreading and lenition rules. For example, the morphological structure of the following quadrisyllabic compounds is ((A(BC))D), and their foot structure is [(ABC)(D)].

(236) Exceptional foot structure of quadrisyllabic compounds

/xɔ̌ŋ.sɛ̌k.tsʰʑ̌.xʷě/
{[red(ten character)]association}

[(xə̀ŋ.sɛ́.tsʰʑ̌)(xʷě)]
"Red Cross Association"

/lɔ̌.pʰʂ.tʰʂ́.xʷò/
{[warty(grape)]flower}

[(lɔ̌.pʰʂ.tʰʂ́)(xʷò)]
"balsam pear flower"

/jě̠ŋ.pɪ́ŋ.tʰě.tsʑ̌/
{[foreign(flat bean)]seed}

[(jě̠.mɪ̠́.tʰé)(tsʑ̌)]
"lima bean seed"

A closer examination of all the quadrisyllabic compounds above reveals that when the foot structure is regular, the third syllable of a compound is sister either to the first syllable, or to the fourth syllable, or to a constituent that dominates the first and second syllables; but when the foot structure is irregular, none of these relationships holds. These structural differences are illustrated below.

(237) Morphological structures of quadrisyllabic compounds

(235a)   (235b)   (236)

[(tʰîŋ.tʰɔ̀ŋ)(wɔ́ŋ)(tɕʰᵹ̂)]   [(tʰî.sź) (tʃʃ́)(tsʰɡ̂)]   [(jɛ̀ . mî . tʰé) (tsź)]
"electric-powered toy"   "television set factory"   "foreign flat bean seeds"
regular   regular   irregular
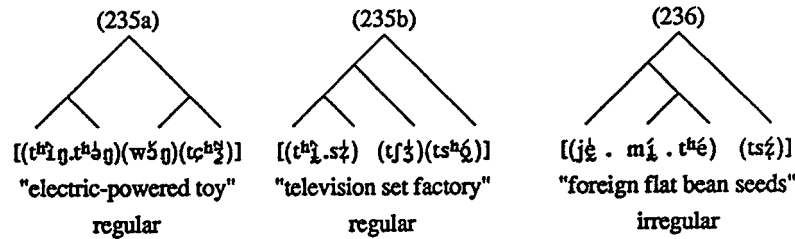
We can see from this illustration that only the compound with an irregular tonal pattern has a morphological constituent encompassing the two medial syllables. Based on this observation, I hypothesize that the failure of the third syllable to be put under a single foot when it forms a constituent with its immediately preceding syllable reflects an effort to preserve the integrity of the constituent by not splitting it into two feet. To formally state this hypothesis, we must invoke the notion of c-command, which was first proposed to describe a certain syntactic relationship, and is defined in Reinhart (1983) as follows.

(238) C-command

α c-commands β if every branching node dominating α dominates β.

By this definition, sister constituents always c-command each other, but they do not c-command their mother node or sister nodes of their mother node. Thus, if we mark the four syllables of a quadrisyllabic compound as α, β, γ and δ, then in (235a), γ does not c-command either α or β and in (235b), γ c-commands both α and β, but in the irregular case (236), γ c-commands β but not α, as shown below.

(239) C-command in quadrisyllabic compounds

(235a)   (235b)   (236)

α β γ δ α β γ δ α β γ δ
[(tʰîŋ.tʰɔ̀ŋ)(wɔ́ŋ)(tɕʰᵹ̂)]   [(tʰî.sź) (tʃʃ́)(tsʰɡ̂)]   [(jɛ̀ . mî . tʰé) (tsź)]
"electric powered toy"   "television set factory"   "foreign flat bean seeds"
regular   regular   irregular
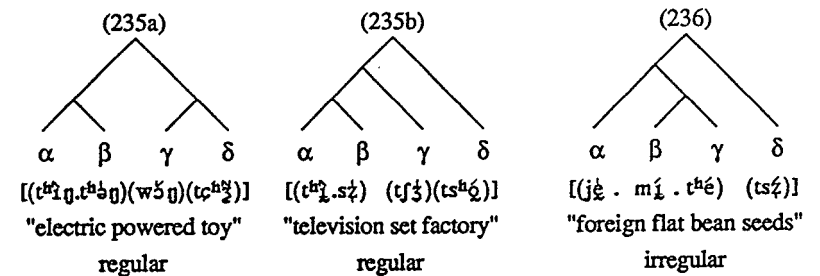
Thus, we might say that γ is part of the foot that dominates β if γ c-commands β but does not c-command α. However, such a generalization must be modified, since if γ is the final toned syllable, then it is not part of the foot that dominates β, even if it c-commands β and does not c-command α, as we can see in (234b).

Based on these observations, the hypothesis about the integrity of morphological constituents can be formally stated as follows.

(240) Morpheme Integrity Constraint (MIC)

A foot dominating α and β dominates every γ that c-commands β and does not c-command α, provided that γ precedes a footable δ.

With this MIC, the foot that dominates α and β is forced to also include γ in words like those in (236), creating a ternary foot dominating the first three syllables. This explains why in those words, both the second and the third syllables lose their underlying tones and become targets of tone spreading and lenition processes.

In fact, no matter how deep a morpheme is embedded in a morphological hierarchy, its integrity is always preserved. In the following examples, the morpheme //sɛ̌k.tsʰʑ̂// "cross" is one level more deeply embedded than it is in [(xɔ̀ŋ.sɛ́.tsʰʑ́)(xʷɛ̌)].

(240) Morpheme Integrity Constraint on more deeply embedded morphemes

ε ζ α β γ δ   ε α β γ δ

[(tsɔ̀ŋ . ŋó) (xɔ̀ŋ . sɛ́ . tsʰʑ́) (xʷě)]   [(tɕ́) (xɔ̀ŋ . sɛ́ . tsʰʑ́) (xʷě)]

"China Red Cross Association"   "Grand Red Cross Association"
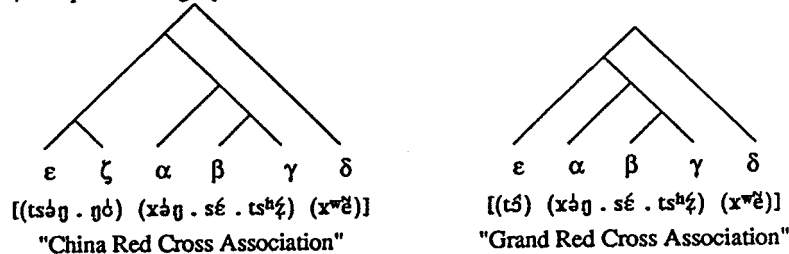
The situation is much the same in other compounds with five or more syllables. Recall that every even-numbered non-final syllable in monomorphemic words joins its preceding syllable to form a binary foot unless it is followed by a toneless syllable. The same foot structure is found in polysyllabic compounds regardless of their morphological structure, as seen in the following data. Again, "()", "[]", "{}", "‹›" and "«»" in the literal translation indicate constituents at progressively higher levels of the morphological hierarchy.

(241) Prosodic structure of compounds with five or more syllables

/nɣ̌ŋ.tʰɔ̀ŋ--ʒ̧.çɔ̃k-ỹ̆ŋ/	[(nɣ̌.tʰɔ̀ŋ)(ʒ̧.çɔ̃)(ỹ̆)]
{[Nantong][(medicine)yard]}	"Nantong Medical College"
/ʋɛ̌.xʷó--tɕɔ́-kɛ́k.mⁱŋ/	[(ʋɛ̌.xʷó)(tɕɔ́.ɣɛ̌)(mⁱŋ)]
{[culture] [big(revolution)]}	"Cultural Revolution"
/tsʰɛ̌k.tʰɔ̃-tʃʂ.ně.jɔ̀/	[(tsʰɛ̌t.tʰɔ̃)(tʃʂ.né)(jɔ̃)]
[(equator) (Guinea)]	"Equatorial Guinea"
/tsɔ̀ŋ.kók-jɛ̌ŋ.mⁱŋ--jⁱŋ.xɔ̃ŋ/	[(tsɔ̀ŋ.ŋó)(jɛ̌.mⁱŋ)(jⁱŋ)(xʑ̆)]
[(China) (people) (bank)]	"China People's Bank"
/çě.xʷě-tsβ.ʒ̃--kók-tçɔ̀/	[(çě.xʷě)(tsβ.ʑ̃)(kót)(tçɔ̃)]
{[(society)(doctrine)][country]}	"Socialist country"
/tsɔ̀ŋ.kók---çě.xʷě-kʰù.çɔ̃k-ỹ̆ŋ/	[(tsɔ̀ŋ.ŋó)(çě.xʷě)(kʰù.çɔ̃)(ỹ̆)]
‹{China} {[(society)(science)]yard}›	"Chinese Academy of Social Sciences"
/tsɔ̀ŋ.xʷó-jɛ̌.mⁱŋ--kʰɔŋ.xǔ.kók/	[(tsɔ̀ŋ.xʷó)(jɛ̌.mⁱŋ)(kʰɔ̃.xǔ)(kó?)]
{[China] [(people) (republic)]}	"Chinese People's Republic"

If the first three syllables is a constituent in which the second and third syllables form a subconstituent, then the first foot is always ternary. As a result, the third syllable loses its underlying tone, as shown below.

(242) Irregular stress and tonal patterns in compounds with five or more syllables

/xɔ̃ŋ-sɛ̌k.tsʰʑ̃--xʷě.ỹ̆ŋ/	[(xɔ̀ŋ.sɛ́.tsʰʑ́).xʷě.ʑ̆]
‹{[red(cross)]assoc.}{member}›	"Red Cross Association member"
/ʋβ-tsɛ̌ŋ.fβ--tsβ.ʒ̃/	[(ʋβ.zɛ́.fβ).tsβ.ʒ̃]
{[(no)(gov't)][doctrine]}	"anarchism"
/xɔ̃ŋ-sɛ̌k.tsʰʑ̃--xʷě.ỹ̆ŋ-tsɛ̌ŋ/	[(xɔ̀ŋ.sɛ́.tsʰʑ́)(xʷě.ʑ̆).tsɛ̃]
‹{[(red)(cross)][assoc]}{mbr}‹id››	"Red Cross Association member id"
/ʋβ-tsɛ̌ɛ.fβ--tsβ.ʒ̃-tçɛ̌ŋ/	[(ʋβ.tsɛ̃.fβ)(tsβ.ʒ̃).tçɛ̃]
‹{[(no)(gov't)][doctrine]}{person}›	"anarchist"
/xɔ̃ŋ-sɛ̌k.tsʰʑ̃--xʷě.ỹ̆ŋ-tsɛ̌ŋ.sβ/	[(xɔ̀ŋ.sɛ́.tsʰʑ́)(xʷě.ʑ̆).tsɛ̃.sβ̃]
«‹{[(red)(cross)][assoc]}{mbr}›‹certif›»	"Red Cross Association member certificate"
/ʋβ-tsɛ̌ɛ.fβ--tsβ.ʒ̃-fɛ̌ŋ.tsʑ̃/	[(ʋβ.tsɛ̃.fβ)(tsβ.ʒ̃).fɛ̃.tsʑ̃]
‹{[(no)(gov't)][doctrine]}{element}›	"anarchist (derogatory)"

The irregular foot structure of these words is also explicable with the MIC. Since the third syllable of each of the above words c-commands the second syllable but not the first syllable, it must become part of the foot that dominates the first and second syllables to avoid a violation of MIC.

7.1.3. Word boundaries in polysyllabic compounds

In 7.1.1, we concluded that the prosodic structure of a trisyllabic compound is not affected by its morphological structure, and therefore the second syllable of a trisyllabic compound is always part of a binary foot, regardless of the morphological structure of the compound. However, sometimes the second syllable of a trisyllabic compound does not lose its underlying tone, and behaves instead like a word-initial or word-final syllable, as shown below.

(243) Trisyllabic compounds split into two phonological words

a.	/ʃⁱŋ-tʰⁱŋ.sʑ̃/	[(ʃⁱŋ)][(tʰʑ̃)(sʑ̃)]
	[new(electric view)]	"new television"
cf.	/ʃⁱŋ-ʃʒ̃.lɔ̃ŋ/	[(ʃⁱŋ.ʃʒ̃)(lʑ̃)]
	[new(Zealand)]	"New Zealand"
	/tçʰỹ̌-tʰⁱŋ.sʑ̃/	[(tçʰỹ̌)][(tʰʑ̃)(sʑ̃)]
	[old(electric view)]	"old television"
cf.	/tçʰỹ̌-pɔ̃.tsʑ̃/	[(tçʰỹ̌.pɔ̃)(tsʑ̃)]
	[old(report paper)]	"old newspapers"

/tʃʰɪŋ-uʂ.tʃʰǯ/
[light(weapon)]

[(tʃʰɪŋ)][(uʂ)(tʃʰǯ)]
"light weaponry"

cf. /tʃʰɪŋ-tʃʒ̀.tɕʰèŋ/
[light(machine gun)]

[(tʃʰɪŋ.n3ʒ̀)(tɕʰɛ̌)]
"light machine gun"

b.   /kók.fóŋ-pʰɣ̌/
[(state defense)ministry]

[(kóʃ)(fɣ̌)][(pʰɣ̌)]
"defense ministry"

cf. /uǎ.tɕə̀-pʰɣ̌/
[(foreign exchange)ministry]

[(uǎ.ʐə̀)(pʰɣ̌)]
"foreign ministry"

/xǒŋ.tsè-sǯ/
[(Hangzhou)city]

[(xɣ̌)(tsè)][(sǯ)]
"Hangzhou City"

cf. /nɣ̌ŋ.tʰə̀ŋ-sǯ/
[(Nantong)city]

[(nɣ̌.tʰə̀ŋ)(sǯ)]
"Nantong City"

/ɕỹŋ.tɕʰỹŋ-tsʰò/
[(propaganda)vehicle]

[(ɕỹ)(tɕʰỹ)][(tsʰò)]
"broadcasting vehicle"

cf. /sò̀ŋ.lɛ̌ŋ-tsʰò/
[(three wheel)vehicle]

[(sɣ̌.lɛ̌)(tsʰò)]
"tricycle"

Each contrasting pair in the above data appears to have the same morphological structure and serve the same syntactic function, and are therefore both seen as compounds. There does not seem to be any phonological condition that may trigger the difference in the prosodic structures of each contrasting pair. Therefore, anything that may have caused the difference appears to be lexical. It seems that in each contrasting pair, the one split into two phonological words is less conceptualized, less familiar, less frequently used and often more recently created; and is therefore more like a string of juxtaposed words than a true compound.

Given the phonological behavior of the phrase-like compounds, it is appealing to simply treat them as syntactic phrases. However, there are good reasons not to do so. To elaborate, it is necessary to define what we mean by phrases as opposed to compound words. While it is beyond the scope of this thesis to discuss the many theoretical issues regarding wordhood in Chinese languages, the criterion we will use to identify words and phrases is based on the idea that a word is the smallest linguistic unit dominated by a non-branching syntactic constituent to which a syntactic rule can refer, while a phrase consists

of more than one of such units dominated by a branching syntactic constituent. For example, there is a common syntactic rule by which identical modifiers of conjunctive NP's can be deleted save the first one, e.g. *American men and women = American men and American women*. This rule does not apply to constituents of compound words, e.g. *seagulls and hawks ≠ seagulls and seahawks*. Thus, while *American men* and *American women* are phrases each composed of two words, *seagulls* and *seahawks* are each a single compound word. Similarly, in Nantong Chinese, a sequence of a monosyllabic adjective followed by a head noun is usually not a syntactic phrase, since it does not undergo the conjunction reduction rule. For example, in (244a), the semantic scope of the modifier *ʃɪŋ* "new" is limited to the first conjunct. In (244b), on the other hand, the semantic scope of the disyllabic modifier *ʃɪŋ.nì* "new" is ambiguous: it can modify both conjuncts.

(244) Conjunction reduction in phrases but not in compounds

a. ʃɪŋ.tʰɣ̌.sǯ xù lót.tɕʰɣ̌.tʃʒ̀   ≠   ʃɪŋ.tʰɣ̌.sǯ xù ʃɪŋ.lót.tɕʰɣ̌.tʃʒ̀
    new electric view and record image machine   new   TV   and new   VCR

b. ʃɪŋ.nì tʰɣ̌.sǯ xù lót.tɕʰɣ̌.tʃʒ̀   =   ʃɪŋ.nì tʰɣ̌.sǯ xù ʃɪŋ.nì lót.tɕʰɣ̌.tʃʒ̀
    new electric view and record image machine   new   TV   and new   VCR

I shall refer to sequences like *ʃɪŋ.tʰɣ̌.sǯ* "new television" as compound phrases, because they behave like phrases phonologically but like compounds syntactically. A compound phrase is a compound that contains word boundaries in it, while a compound word is a compound that does not contain any word boundaries. It is the presence of the word boundary that accounts for the difference in the prosodic structures of these words, as shown in the sample derivation below.

(245) Construction of prosodic structure in words with and without word boundary

	"new television"	"Hangzhou City"	"Nantong City"
	[(ʃɪŋ)][(tʰɣ̌)(sǯ)]	[(xɣ̌)(tsè)][(sǯ)]	[(nɣ̌.tʰə̀ŋ)(sǯ)]
a. Foot construction	φ φ φ | | | σ # σ σ	φ φ φ | | | σ σ # σ	φ φ φ | | | σ σ σ

b. Normal Tempo Defooting
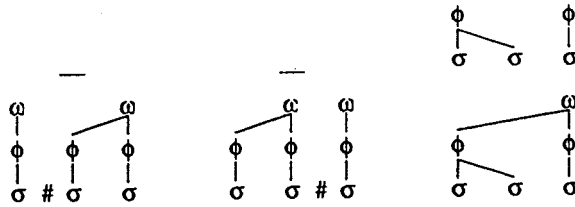
c. Word construction

The same analysis applies to similar phenomena found in compounds with four or more syllables. In quadrisyllabic compounds, the word boundary is either between the first and second syllables or between the third and the fourth syllables, but occasionally also between the second and the third syllables, as shown below.

(246) Word boundaries in quadrisyllabic compounds

a.　/ʃĩŋ # tʰĩŋ.sʅ̌.tʃʅ̌/　　　　　　[(ʃĩŋ)][(tʰĩ̥.sʅ̌)(tʃʅ̌)]
　　　[new][(electric view)machine]　"new television set"

　　　/tɕʰỹ # tʰĩŋ.sʅ̌.tʃʅ̌/　　　　　　[(tɕʰỹ)][(tʰĩ̥.sʅ̌)(tʃʅ̌)]
　　　[old][(electric view)machine]　"old television set"

　　　/tʃʰĩŋ # tsʰɜ̃ŋ.lʲɜ̆ŋ.tɕĩk/　　　[(tʃʰĩŋ)][(tsɜ̀n.lʲɜ̆)(tɕĩʔ)]
　　　[light][(heavy amount)class]　"light heavyweight"

　　　/ɕɔ́ # lɜ̀.pʰʅ̥.tʰʅ̆　　　　　　[(ɕɔ́)][(lɜ̀.pʰʅ̥)(tʰʅ̆)]
　　　[small][warty(grape)]　　　　"small balsam pear"

　　　/nɜ̆ŋ # jɜ̆ŋ.pĩŋ.tʰɜ̆/　　　　　[(nɜ̆)][(jɜ̆.mʅ̃)(tʰɜ̆)]
　　　[tender][foreign(flat beans)]　"tender lima beans"

　　　/ʃĩŋ # tʃʅ̌.nɜ̆.jɔ̀/　　　　　　[(ʃĩŋ)][(tʃʅ̌.né)(jɔ̀)]
　　　[new][Guinea]　　　　　　　　"New Guinea"

cf.　/nỹ.sʅ̌.lɔ̀.fʅ̥/　　　normal: [(nỹ.sʅ̌)(lɔ̀)(fʅ̥)] fast: [(nỹ.sʅ̌.lɔ́)(fʅ̥)]
　　　[south(Slav)]　　　　"Yugoslavia"

b.　/tʃʅ̌.nɜ̆.jɔ́ # jɜ̆ŋ/　　　　　　[(tʃʅ̌.né)(jɔ̀)][(jɜ̆)]
　　　[Guinea][person]　　　　　　"Guinean"

　　　/mɔ̆k.ʃʅ̌.kù # tsʰɜ̆ŋ/　　　　　[(mɔ́ʃ.ʃʅ̌)(kù)][(tsʰʅ̆)]
　　　[Mexico][city]　　　　　　　"Mexico City

　　　/ŋɜ̌.tʰʅ̌.lʅ̌ # wɔ̆/　　　　　　[(ŋɜ̌.tʰʅ̌)(lʅ̌)][(wɔ̆)]
　　　[Austrian][language]　　　　"Austrian"

c.　/kɔ̆k.fɔ̃ŋ # pʰʅ̥.tsɔ̆ŋ/　　　　[(kɔ́f)(fʅ̆)][(pʰʅ̥)(tsʅ̆)]
　　　[state defense][ministry chief]　"defense minister"

cf.　/uɜ̌.tɕɔ̀.pʰʅ̥.tsɔ̆ŋ/　　　　　[(uɜ̌.ʑɔ̀)(pʰʅ̥)(tsʅ̆)]
　　　[foreign exchange][ministry chief]　"foreign minister"

The fact that the second and the third syllables of words in (246a) are not separated into two prosodic units cannot be explained by MIC, because MIC does not explain why there is a word boundary between the first and the second syllables.

In compounds with five or more syllables, the word boundary is usually between the third and the fourth syllables, though sometimes it is also found between the second and the third syllables. Sometimes, there can be multiple word boundaries in a compound, which split the compound into more than two phonological words, as shown below.

(247) Word boundaries in compounds with five or more syllables

a.　/tʃʅ̌.nɜ̆.jɔ̀ # pʅ̌.sɜ̀/　　　　　[(ʅ̌.né)(jɔ̀)][(pʅ̌)(sɜ̀)]
　　　[Guinea][Bissau]　　　　　　"Guinea-Bissau"

　　　/ʅ̌.ɕɔ̆k.ỹŋ # lʅ̌.tʰɔ̆ŋ/　　　　[(ʅ̌.ɕɔ̀)(ỹ)][(lʅ̌)(tʰʅ̆)]
　　　[(medical study)court][ritual hall]　"Medical College Auditorium"

　　　/mɛ́.lʅ̌.tɕĩŋ # xɔ̆k.tsɜ̃ŋ.kɔ̆k/　[(mɛ́.lʅ̌)(tɕʅ̌)][(xɔ̆t.tsɜ̃ŋ)(kɔ̆ʔ)]
　　　[American][combine multiple states]　"American United States"

　　　/uɜ̆ŋ.xʷɔ́.kɜ̀ŋ # tʰĩŋ.jĩŋ.ỹŋ/　[(uɜ̆.xʷɔ́)(kɜ̀ŋ)][(tʰʅ̌.jĩŋ)(ỹ)]
　　　[(culture)palace][(electric image)court]　"Recreation Palace Cinema"

　　　/ʅ̌.ɕɔ̆k.ỹŋ # tsɛ̆k.kɜ̀ŋ.sɛ̆k.tʰɔ̆ŋ/　[(ʅ̌.ɕɔ̀)(ỹ)][(tsɛ̆k.kɜ̀ŋ)(sɛ́t)(tʰʅ̆)]
　　　[(med study)court][(employee)(dine hall)]　"Medical College employees' cafeteria"

　　　/tɜ̀ŋ.nỹŋ.jɔ̀ # kɔ̆k.tɕɔ̀.lʅ̃ŋ.mɜ̃ŋ/　[(tɜ̀ŋ.nỹ)(jɔ̀)][(kɔ̆t.tɕɔ̀)(lʅ̌)(mɜ̃ŋ)]
　　　[(east south)Asia][(country)(union)]　"Southeast Asia States Association"

b.　/tsʅ̌.lʅ̌ # kʰɜ̃ŋ.xû.kɔ̆k/　　　[(tsʅ̌)(lʅ̌)][(kʰɜ̃ŋ.xú)(kɔ̆ʔ)]
　　　[Chili][republic]　　　　　　"Chile Republic"

　　　/nỹŋ.tʰɜ̃ŋ # ʅ̌.ɕɔ̆k.ỹŋ/　　　[(nỹ.tʰɜ̃ŋ)][(ʅ̌.ɕɔ̀)(ỹ)]
　　　[Nantong][(medical study)court]　"Nantong Medical College"

but also　/nỹŋ.tʰɜ̃ŋ.ʅ̌.ɕɔ̆k.ỹŋ/　　[(nỹ.tʰɜ̃ŋ)(ʅ̌.ɕɔ̀)(ỹ)]
　　　{Nantong[(medical study)court]}　"Nantong Medical College"

c.　/uʅ̆ # tɕĩk.tɕʷè # tʰɜ̃ŋ.uɛk/　[(uʅ̆)][(tɕĩt)(tɕʷè)][(tʰɜ̃ŋ.uɛ̆)]
　　　[no][spine][animal]　　　　"invertebrate"

　　　/ỹŋ # tʃʅ̌.lʅ̌ # tsʰɜ̆.tsɜ̃ŋ/　　[(ỹ)][(tʃʅ̌)(lʅ̌)][(tsʰɜ̀)(tsɜ̃ŋ)]
　　　[far][distance][control]　　"remote control"

The prosodic structures of all the above polysyllabic compounds can be derived with the same analysis we use to derive the prosodic structure in trisyllabic compounds. This suggests that the construction of the prosodic structure in Nantong is post-lexical, i.e. it respects morphological word boundaries, but usually ignores morpheme boundaries.

7.1.4. Defooting in reduplicated words

Reduplication is a common process in this language. Many lexical categories may undergo reduplication, though the prosodic structures of the resulting reduplicated forms can be different in different lexical categories. In the simplest case, when an adjective is reduplicated, both tonal and segmental materials of the base are copied. For example, a monosyllabic adjective can be reduplicated to indicate a vivid description, as shown below.

(248) Monosyllabic adjectives reduplicated

/çə̀/	→	/çə̀.çə̀-ti/	[(çə̀)(çə̀.rì)]	"thin (as for paper)"
/lʃ̌/	→	/lʃ̌.lʃ̌-ti/	[(lʃ̌)(lʃ̀.rí)]	"sturdy"
/tʃín/	→	/tʃín.tʃín-ti/	[(tʃín)(tʃín.ní)]	"tight"
/ʃǯ/	→	/ʃǯ.ʃǯ-ti/	[(ʃǯ)(ʃǯ.rì)]	"thin (as for string)"
/xɛ̌/	→	/xɛ̌.xɛ̌-ti/	[(xɛ̌)(xɛ̀.rì)]	"thick (as for paper)"

Disyllabic adjectives may be reduplicated syllable by syllable, also to indicate a vivid description. In this case, the reduplicated second syllable (the fourth syllable of the surface form) heads a foot on its own, which may include the following toneless affix (e.g. -ti etc.). The reduplicated first syllable (the second syllable of the surface form), on the other hand, joins the original first syllable to form a binary foot, and therefore loses its underlying tone and undergoes tone spreading and lenition processes. Since the behavior of this syllable is entirely predictable on the basis of Normal Tempo Defooting, I assume that both syllables are copied with the tonal material as well as the segmental material. These observations are shown in the following examples.

(249) Disyllabic adjectives reduplicated

/tsɛ́ŋ.tʃʰǯ/	→	/tsɛ́ŋ.tsɛ́ŋ.tʃʰǯ.tʃʰǯ-ti/	[(tsɛ̀.nzɛ̌)(tʃʰǯ)(tʃʰǯ.rí)]	"tidy"
/řé.pʰə̌ŋ/	→	/řé.řé.pʰə̌ŋ.pʰə̌ŋ/	[(fè.fé)(pʰɡ̌)(pʰɡ̌.nì)]	"fat"
/kə̀.ʃíŋ/	→	/kə̀.kə̀.ʃíŋ.ʃíŋ-ti/	[(kə̀.ɣə̀)(ʃíŋ)(ʃíŋ.nì)]	"happy"
/jʌ̌.pá/	→	/jʌ̌.jʌ̌.pá.pá-ti/	[(jə̀.jə̌)(pá)(pá.rí)]	"shaky"

These two sets of data seem to suggest that reduplication of adjectives always involves copying of the entire syllable to be reduplicated, including its tonal and segmental specifications. However, if the adjective to be reduplicated is disyllabic but monopedal,

meaning it contains only one toned syllable, then neither syllable is copied with the tonal material, and the resulting surface form is still monopedal, as the following data show.

(250) Monopedal disyllabic adjectives reduplicated

/pʲʰɡ̌.lʲeŋ/	→	/pʲʰɡ̌.pʲʰə.lʲeŋ.lʲeŋ-ti/	[(pʲɡ̌.βʲə̀.lʲɡ̌.lʲɡ̌.nì)]	"pretty"
/xʊ̀.ʃʒ/	→	/xʊ̀.xu.ʃʒ.ʃʒ-ti/	[(xʊ̀.xʊ̀.ʃʒ̀.ʃʒ̀.rì)]	"merry"
/lǐŋ.fɔŋ/	→	/lǐŋ.lǐŋ.fɔŋ.fɔŋ-ti/	[(lìŋ.lǐŋ.fɡ̌.fɡ̌.nì)]	"clean"
/sʐ̌.tʰa/	→	/sʐ̌.sʐ.tʰa.tʰa-ti/	[(sʐ̌.sʐ̀.tʰà.tʰà.rí)]	"cozy"

The problem here is how the rule is to be formalized. We cannot say that a tone is reduplicated just in case there is a following tone, because in monosyllabic adjectives, the tone is reduplicated without a following tone. We cannot say the tone is not reduplicated when there is no following tone either, because we cannot refer to the absence of an entity in the rule. The correct analysis, I believe, is that one of the reduplication processes involves both the toned syllable and its dominating foot, as formalized below.

(251) Foot Reduplication

$$\begin{array}{ccc} \phi_i & & \phi_i \quad \phi_i \\ | & \Rightarrow & | \quad\quad | \\ \sigma_i & & \sigma_i \quad \sigma_i \end{array}$$

This rule produces an exact copy of a foot i and its head syllable i (the one dominated by the strong branch represented with the vertical line), and puts the copy right next to the original foot. In monosyllabic and disyllablic dipedal adjectives, each syllable is dominated by a unary foot. Therefore, Foot Reduplication applies to every syllable, producing a sequence of unary feet, which then undergoes Normal Tempo Defooting to yield the surface foot structure. Of course, for this rule to apply properly, we must assume that the syllables it affects are lexically marked for reduplication. Ignoring the suffix -ti, we can illustrate the application of Foot Reduplication as follows.

(252) Sample derivation of foot reduplication

a. monosyllabic monopedal

$$\begin{array}{ccc} \phi_i & & \phi_i \quad \phi_i \\ | & FR & | \quad | \\ \sigma_i & \Rightarrow & \sigma_i \quad \sigma_i \\ /\text{çà}/ & & /\text{çà}. \quad \text{çà}/ \end{array}$$

b. disyllabic dipedal

$$\begin{array}{ccc} \phi_i \quad \phi_j & & \phi_i \quad \phi_i \quad \phi_j \quad \phi_j \\ | \quad | & FR & | \quad | \quad | \quad | \\ \sigma_i \quad \sigma_j & \Rightarrow & \sigma_i \quad \sigma_i \quad \sigma_j \quad \sigma_j \\ /\text{tsɛ́ŋ.tʃʰʑ̌}/ & & /\text{tsɛ́ŋ.tsɛ́ŋ.tʃʰʑ̌.tʃʰʑ̌}/ \end{array}$$
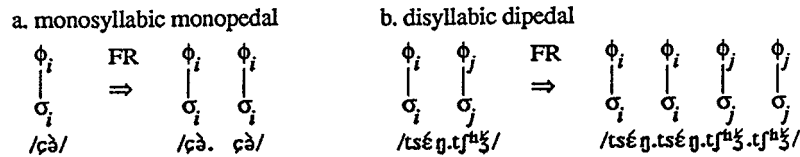
Obviously, Foot Reduplication does not account for the reduplication of toneless syllables, since these syllables never come under the strong branch of the metrical foot. Therefore, we need a rule which reduplicates a single syllable, as formalized below.

(253) Syllable Reduplication

$$\sigma_i \quad \Rightarrow \quad \sigma_i \quad \sigma_i$$

Since this rule does not refer to the prosodic status of the syllable it applies to, it is a more general rule than Foot Reduplication, and therefore must be ordered after Foot Reduplication under the elsewhere condition. Another observation about this rule is that it also accounts for the reduplication of the first syllable of a disyllabic monopedal word. This is because Foot Reduplication produces an exact copy of a base syllable under the strong branch of a metrical foot along with the dominating foot, and places this copy right next to the base syllable. This process is not possible if the base syllable is under a branching foot, because that would lead to a crossing association line violation, as shown below.

(254) Crossing association line violation resulting from Foot Reduplication

$$\begin{array}{ccc} \phi_i & FR & \phi_i \quad \phi_i \\ \diagdown & \Rightarrow & \\ \sigma_i \quad \sigma_j & & \sigma_i \quad \sigma_i \quad \sigma_j \\ /\text{sʑ̌}. \quad \text{tʰa}/ & & /\text{sʑ̌}. \quad \text{sʑ}. \quad \text{tʰa}. \quad \text{tʰa}/ \end{array}$$

To avoid such a violation, both syllables of a disyllabic dipedal word must be reduplicated by Syllable Reduplication. A foot expansion rule formalized below will then link the reduplicated and unfooted syllables to the existing foot, yielding the correct surface foot structure, as shown in the following sample derivation.

(255) Foot Expansion

$$\begin{array}{c} \phi \\ \diagdown \diagdown \\ \sigma \end{array}$$

(256) Sample derivation of reduplication in disyllabic dipedal words

Underlying Foot Reduplication Syllable Reduplication Foot Expansion

$$\begin{array}{ccccc} \phi_i & & & \phi_i & & \phi_i \\ | & & N/A & | & \Rightarrow & \diagup\diagdown\diagdown\diagdown \\ \sigma_i \quad \sigma_j & & & \sigma_i \quad \sigma_i \quad \si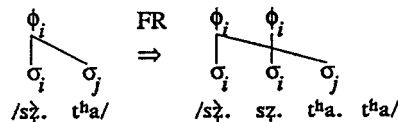gma_j \quad \sigma_j & & \sigma_i \quad \sigma_i \quad \sigma_j \quad \sigma_j \\ /\text{sʑ̌}. \quad \text{tʰa}/ & & & /\text{sʑ̌}. \quad \text{sʑ}. \quad \text{tʰa}. \quad \text{tʰa}/ & & /(\text{sʑ̌}. \quad \text{sʑ}. \quad \text{tʰa}. \quad \text{tʰa})/ \end{array}$$
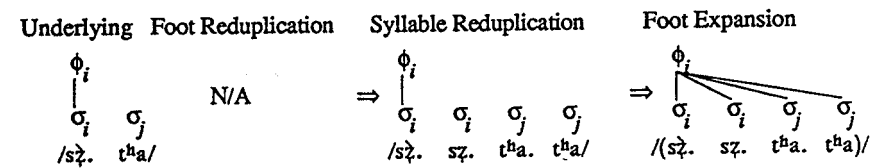
A technical detail is that syllables or feet that are to be reduplicated must be lexically marked as such, so that not all syllables or all feet undergo reduplication. In the following adjective forms each composed of a monosyllabic adjective and a suffix, only the second syllable, i.e. the suffix, is lexically marked to be reduplicated. The resulting sequence of three toned syllables then undergoes Normal Tempo Defooting so that the second syllable joins the first to form a binary foot and therefore becomes toneless.

(257) Adjectives with reduplicated suffixes

/tʃʲŋ/	→	/tʃʲŋ-pʃ́.pʃ́-ti/	[(tʃʲm.mʃ̀)(pʃ́.ɾʑ̀)] "stingy"
/xú/	→	/pʃ́.pʃ́-ti/	[(xú.ɸʃ́)(pʃ́.ɾʑ̀)] "irritable"
/xʃŋ/	→	/xʃ́ŋ-ʃʑ̌.ʃʑ̌-ti/	[(xʃ̀ŋ.ʃʑ́)(ʃʑ̌.ɾí)] "bloody"
/ɑ̃ŋ/	→	/pʰʃ̀ŋ.pʰʃ̀ŋ-ti/	[(ɑ̃.pʰʃ́)(pʰʃ̀n.nʑ̀)] "dark"
/jɛ̌ŋ/	→	/tɕʲ.tɕʲ-ti/	[(jɛ̌.nzʲ)(tɕʲ.ɾʑ̀)] "chewy"

There is evidence that Foot Reduplication is lexically conditioned, because all the reduplicated forms it produces are adjectives. The most telling evidence comes from the following, where the same morphemes are reduplicated with tonal materials in adjectives and without tonal materials in adverbs. The explanation is that these morphemes undergo Foot Reduplication to form an adjective but Syllable Reduplication to form an adverb.

(258) Adjectives and adverbs with reduplication

/xʃ́/	→	/xʃ́.xʃ́-ti/	[(xʃ́)(xʃ́.ɾí)]	*adj.* "good"
	→	/xʃ́.xʃ̀-tə/	[(xʃ́.xʃ̀.ɾʒ̀)]	*adv.* "in good manner"
/tʃʰʑ̌ŋ/	→	/tʃʰʑ̌ŋ.tʃʰʑ̌ŋ-ti/	[(tʃʰʑ̌n)(tʃʰʑ̌n.nʑ̀)]	*adj.* "light, gentle"

		→	/tʃʰɨŋ.tʃʰɨŋ-tɚ/	[(tʃʰɨn.tʃʰɨn.nɚ̀)]	adv.	"lightly, gently"
/mɔ̃ŋ/		→	/mɔ̃ŋ.mɔ̃ŋ-ti/	[(mɔ̃)(mɔ̃.nɨ̀)]	adj.	"slow"
		→	/mɔ̃ŋ.mɔ̃ŋ-tɚ/	[(mɔ̃.mɔ.rɚ̀)]	adv.	"slowly"

In other lexical categories, tonal material is never reduplicated. For example, when a monosyllabic verb[2] is reduplicated to indicate a short and tentative action, the resulting second syllable is always toneless, as shown below.

(259) Monosyllabic verbs reduplicated

/pʲə̀/	"look"	→	/pʲə̀.pʲə/	[(pʲə̀.βʲə̀)]	"take a look"
/sɔ́ŋ/	"taste"	→	/sɔ́ŋ.soŋ/	[(sɔ̀.sɔ́)]	"get a taste"
/tɛ́ŋ/	"wait"	→	/tɛ́ŋ.teŋ/	[(tɛ́.nɛ̀)]	"wait a minute"
/ʃʂ̌/	"play"	→	/ʃʂ̌.ʃʐ/	[(ʃʂ̀.ʃʐ̌)]	"play a little"
/tsʰʉ̌/	"sit"	→	/tsʰʉ̌.tsʰu/	[(tsʰʉ̀.tsʰʉ́)]	"sit for a while"

A class of nouns is formed by reduplicating a monosyllabic verb before the suffix -ɚ to indicate someone who carries out the action indicated by the verb or something with which the action is carried out. A similar construction is formed by reduplicating the last syllable of a noun or adjective before the suffix -ɚ, which indicates an object with some geometrical shape. In both cases, the reduplicated syllable is toneless. Following are some examples.

(260) Nouns formed with reduplication

a.	/tɕɔ́/	"twist"	→	/tɕɔ́.tɕə-ɚ/	[(tɕɔ́.zɔ́.ɚ̀)]	"(pencil) sharpener"
	/kʰà/	"erase"	→	/kʰà.kʰa-ɚ/	[(kʰà.kʰà.ɚ̀)]	"eraser"
	/pʰɔ́/	"pick"	→	/pʰɔ́.pʰo-ɚ/	[(pʰɔ́.pʰɔ́.ɚ̀)]	"(ear) picker"
	/tɕɔ̂/	"call"	→	/tɕɔ̂.tɕə-ɚ/	[(tɕɔ̂.zɔ̀.ɚ̀)]	"whistle"
	/tɕẙ́ŋ/	"spin"	→	/tɕẙ́ŋ.tɕyŋ-ɚ/	[(tɕẙ́.nzẙ̀.ɚ̀)]	"spinner"
	/jɔ̀/	"shake"	→	/jɔ̀.jə-ɚ/	[(jɔ̀.jɔ́.ɚ̀)]	"rattler"

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[2] Reduplication of polysyllabic (including disyllabic) verbs is extremely rare in this language. The function of reduplicated monosyllabic verbs is carried out for polysyllabic verbs by using of the suffix -xɐtsʐ, which may also be used on monosyllabic verbs, e.g.

	/çɔ̌k.tɕɨk/	*/çɔ̌k.tɕɨk.çɔ̌k.tɕɨk/	*[(çɔ́t.tɕɨç.çɔ́t.tɕɨʔ)]	
		→ /çɔ̌k.tɕɨk.xɐtsʐ/	→ [(çɔ́t.tɕɨx.xɐtsʐ̀)]	"do a study"
but	/pʲə̀/	→ /pʲə̀.pʲə/	→ [(pʲə̀.pʲə̀)]	
		→ /pʲə̀.xɐtsʐ/	→ [(pʲə̀.xɐtsʐ̀)]	"take a look"

	/tɕʷʰè/	"blow"	→	/tɕʷʰè.tɕʷʰe-ɚ/	[(tɕʷʰè.tɕʷʰè.ɚ̀)]	"noise maker"
b.	/fɔ̀ŋ/	"square"	→	/fɔ̀ŋ.foŋ-ɚ/	[(fɔ̀.fɔ̀.ɚ̀)]	"square object"
	/ẙ́ŋ/	"circle"	→	/ẙ́ŋ.yŋ-ɚ/	[(ẙ̀.ẙ́.ɚ̀)]	"circle object"
	/píŋ/	"flat"	→	/píŋ.piŋ-ɚ/	[(pí.mí.ɚ̀)]	"flat object"
	/sɔ̀ŋ.kɔ́k/	"triangle"	→	/sɔ̀ŋ.kɔ́k.kok-ɚ/	[sɔ̀.(kɔ́k.kɔ̀.ɚ̀)]	"triangular object"
	/tẙ́ŋ/	"short"	→	/tẙ́ŋ.tyŋ-ɚ/	[(tẙ̀.nẙ̀.ɚ̀)]	"short object"
	/tɕɨ̀ŋ/	"sharp"	→	/tɕɨ̀ŋ.tɕiŋ-ɚ/	[(tɕɨ̀.nzɨ̀.ɚ̀)]	"sharp object, tip"
	/wɔ̀ŋ/	"warped"	→	/wɔ̀ŋ.woŋ-ɚ/	[(wɔ̀.wɔ̀.ɚ̀)]	"warped object"

Certain classifiers, which are the unit names of certain nouns, are reduplicated to mean "every". The reduplicated syllable is also unstressed in this case, as shown in the following examples.

(261) Monosyllabic classifiers reduplicated

/tsɛ́k.tsek xá wɔ̀k.ti/	[(tsɛ́t.tsɛ̀)][xá][(wɔ́t.tí)]	"Every crab is alive"
Cl crab alive		
/kʉ̀.ku tʰɔ̃ŋ xɔ́.ti/	[(kʉ̀.yʉ̀)][tʰɔ̃][(xɔ́.rí)]	"Every egg is good"
Cl egg good		
/tʰɔ̀ jě̃ŋ.jeŋ tə tɔ̃ŋ.ti/	[tʰɔ̀] [(jɛ̀.jɛ̀.nɔ̀)][(tɔ̃n.ní)]	"He knows everything"
he Cl Part. knowledgeable		

Many kinship terms are inherently reduplicated, with the second syllable being toneless, as shown below.

(262) Reduplicated kinship terms

/tʲɔ̀.tʲɔ/	[(tʲɔ̀.rʲɔ̀)]	"grandpa, husband"
/nà.na/	[(nà.nà)]	"grandma"
/ná.na/	[(ná.nà)]	"wife"
/tɕʰẙ́.tɕʰy/	[(tɕʰẙ́.tɕʰẙ́)]	"mother's brother"
/ʂ̌.ʐ/	[(ʂ̀.ʂ́)]	"mother's younger sister"
/pɔ́k.pok/	[(pɔ́p.pɔ̀)]	"father's older brother"
/mɔ̀.mo/	[(mɔ̀.mɔ̀)]	"wife of father's older brother"
/pà.pa/	[(pà.βà)]	"father's younger brother"
/sɛ́ŋ.seŋ/	[(sɛ́.sɛ̀)]	"wife of father's younger brother"
/kʉ̀.ku/	[(kʉ̀.yʉ̀)]	"older brother"
/tɕɔ́.tɕo/	[(tɕɔ́.zɔ̀)]	"older sister"
/tʰɨ̌.tʰi/	[(tʰɨ̌.tʰɨ̀)]	"younger brother"

/mɛ̌.me/   [(mɛ̌.mɛ̀)]   "younger sister"

When parents talk to small children, they reduplicate some simple words, also with the second syllable produced by reduplication being toneless, as shown below.

(263) Reduplicated forms in motherese

/tɕɔ̌k/	"foot"	→	/tɕɔ̌k.tɕɔk/	[(tɕɔ̌t.tɕɔ̀)]	"tootsie"
/se/	"hand"	→	/sé.se/	[(sé.sɛ̀)]	"handie"
/ké/	"dog"	→	/ké.ke/	[(ké.kɛ̀)]	"doggy"[3]
/ŋɔ́.ɚ/	"kid"	→	/ŋɔ́.ŋo/	[(ŋɔ́.ŋó)]	"kiddie"
/ʊǎ/	"broken"	→	/ʊǎ.ʊa/	[(ʊǎ.ʊǎ)]	"broken"

All the reduplicated forms shown above are derived by first copying the syllable to be reduplicated with Syllable Reduplication, and then associating the new syllable with the existing foot by Foot Expansion. Therefore, the only lexical category in which Foot Reduplication may apply is adjective.

7.2. Prosodic structure in phrasal constructions

The prosodic structure of syntactic phrases including sentences reveals several facts about the relationship between prosodic structure and syntactic structure. First, the construction of metrical feet and phonological words usually takes place within morphological word boundaries. Second, because of a rule that combines two monopedal words into one bipedal word, and because of the Foot Expansion rule, a metrical foot or a phonological word may be constructed across word boundaries. Finally, prosodic constituents larger than the phonological word, i.e. the phonological phrase and the intonational phrase, do exist at syntactic phrases, but their boundaries do not necessarily correspond to those of syntactic constituents.

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[3] Instead of the expected [(ké.ɣɛ̀)], the form [(ké.kɛ̀)] is found. In general, lenition does not occur in such words in motherese, although tone spreading and tonal default rules do occur. The reason for this exception appears to be metalinguistic.

7.2.1. Phonological words bounded by morphological words

It was shown earlier in this chapter that in constructions which look like compounds but still contain word boundaries, metrical feet and phonological words are built within the morphological word boundaries. We will see in this section that this is also true in phrases that contain morphological word boundaries. In other words, the parsing of a syntactic phrase into phonological words is usually the same as its parsing into morphological words, as shown below.

(264) Parsing of syntactic phrase into phonological and morphological words

   a. /ɚ̌.mɛ̌ # sɔ̌ # mˀɔ̌.xʷɛ̌/   "Second sister goes to market"

     [(ɚ̌)(mɛ̌)][(sɔ̌)][(mˀɔ̌)(xʷɛ̌)]   slow, normal and fast tempo

     *[(ɚ̌)(mɛ̌)][(sɔ̌)(mˀɔ̌)(xʷɛ̌)]

     *[(ɚ̌.mɛ̀)(sɔ̌.mˀɔ̌)(xʷɛ̌)]

     *[(ɚ̌.mɛ́.sɔ̌.mˀɔ̌.xʷɛ̌)]

cf. b. /mɔ̌.ʃɪ́ŋ.çʷɛ̌.tsʰɔ̌.pʰɪ̌ŋ/   "chronic kidney disease"

     *[(mɔ̌)(ʃɪ́ŋ)][(çʷɛ̌)][(tsʰɔ̌)(pʰɪ̌ŋ)]

     [(mɔ̌)(ʃɪ́ŋ)][(çʷɛ̌)(tsʰɔ̌)(pʰɪ̌ŋ)]   slow tempo

     [(mɔ̌.ʃɪ́ŋ)(çʷɛ̌.tsʰɔ̌)(pʰɪ̌ŋ)]   normal tempo

     [(mɔ̌.ʃɪ́ŋ.çʷɛ̌.tsʰɔ̌.pʰɪ̌ŋ)]   fast tempo

In (264a), the third syllable /sɔ̌/ cannot be the final syllable of a word including the first three syllables, because if it were, then its lower register tone LM would trigger Register Dissimilation in the preceding syllable /mɛ̌/ and cause it to surface as [mɛ́], which is not true. This syllable cannot be the first syllable of a word including the last three syllables either, because if it were, it would undergo Initial Register and surface as [sɔ̌], which is also false. Therefore, this syllable must stand alone as a phonological word, with the preceding and following syllables forming two separate phonological words. In (264b), on the other hand, we find the same speech tempo sensitive prosodic structures as we find in polysyllabic monomorphemic words. The following narrowband spectrograms clearly show the difference in pitch contour between the pentasyllabic sentence and pentasyllabic compound shown above.

(265) Spectrograms of /ə̀.mě#sɤ̌#mʲɔ̌.xʷě/ and /mɤ̌.ʃɨ̀ŋ.ɕʷɤ̌.tsʰɤ̌.pʰʲ̌ŋ/ in normal tempo

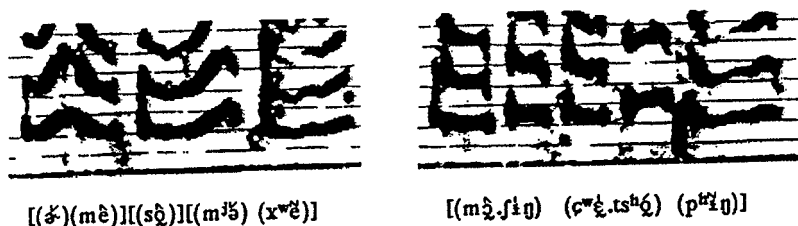[(ə̀)(mè)][(sɤ̌)][(mʲɔ̌) (xʷě)]   [(mɤ̌.ʃɨ̀ŋ) (ɕʷɤ̌.tsʰɤ̌) (pʰʲ̌ŋ)]

Figure 19 - Spectrograms of /ə̀.mě#sɤ̌#mʲɔ̌.xʷě/ and /mɤ̌.ʃɨ̀ŋ.ɕʷɤ̌.tsʰɤ̌.pʰʲ̌ŋ/

Thus, it appears that morphonological word boundaries are respected in the construction of prosodic structure in syntactic phrases as well as in compounds.

7.2.2. Merging of monopedal phonological words

If every phonological word is built within morphological word boundaries, then we expect that a morphological word boundary always coincides with a phonological word boundary. If this is true, then every syllable that precedes a morphological word boundary ought to undergo phonological rules that apply to word-final syllables. For example, a word-final LM tone syllable ought to become MLM prepausally or ML otherwise, and a word-final L tone syllable ought to become ML. However, in the following data, the LM syllables that precede a morphological word boundary often behave like a non-final syllable by undergoing Initial Register Deletion and becoming MH.

(266) Phonological words across morphological word boundaries[4]

a. V NP

/mǎ # tʰɔ̌ŋ/	[(mǎ)(tʰɔ̌)]	"sell eggs"
/mǎ.tə # tʰɔ̌ŋ/	[(mǎ.ɾə́)(tʰɔ̌)]	"sold eggs"
cf. /mǎ # tʰɔ̌ŋ.kà/	[(mǎ)][(tʰɔ̌)(kà)]	"sell egg cakes"
/xʷǒ # xʷǒ.ɚ/	[(xʷǒ)(xʷǒ.ɚ)]	"draw a picture"
/xʷǒ.tə # xʷǒ.ɚ/	[(xʷǒ.ɾə́)(xʷǒ.ɚ)]	"drew a picture"
cf. /xʷǒ # xʷǒ.tɕʰě̌ŋ/	[(xʷǒ)][(xʷǒ)(tɕʰě̌)]	"draw a portrait"

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b. V AdjP

/nɔ̌ŋ # ʋǎ.tə/	[(nɔ̌ŋ)(ʋǎ.ɾə́)]	"handled and damaged"
/jɔ̌ŋ # tɕʰy̌.tə/	[(jɔ̌ŋ)(tɕʰy̌.ɾə́)]	"was used and became old"
/mǎ # kʷǒŋ.tə/	[(mǎ)(kʷǒ.nə̀)]	"sold out"

c. V VP

| /ʋě # jɔ̌ŋ/ | [(ʋě)(jɔ̌ŋ)] | "knows how to use" |
| /ʋě # jə̌ŋ.tə/ | [(ʋě)(jə̌ŋ.ɾə́)] | "has become able to use" |

d. NP VP

/fɔ̌ŋ # ɕə̀ŋ.tə/	[(fɔ̌ŋ)(ɕə̀.nə̀)]	"meal has become smelling good"
cf. /mɤ̌.fɔ̌ŋ # ɕə̀/	[(mɤ̌)(fɔ̌ŋ)][(ɕə̀)]	"rice meal smells good"
/tʰě.ɚ # lɔ̌ŋ.tə/	[(tʰě.ɚ)(lɤ̌.nə̀)]	"beans have become rotten"
cf. /wɔ̌ŋ.tʰě # lɔ̌ŋ.tə/	[(wɤ̌)(tʰè)][(lɤ̌.nə̀)]	"soy beans have become rotten"

A closer examination of the above data reveals that a phonological word is built across a morphological word boundary just in case there is a monopedal word on each side of the word boundary. Therefore, these phonological words can be regarded as the result of a phonological process that fuses two monopedal words into a bipedal one. This process seems to reflect an effort to avoid monopedal words, and is consistent with the observation that phonological words in this language are usually binary. We can account for this process with a rule formalized as follows.

(267) Word Fusion

With this rule, we can maintain the claim that phonological words are constructed within the boundaries of morphological words, while offering a plausible explanation for the apparently exceptional phonological words across morphological word boundaries.

One should note that Word Fusion does not apply if the preceding monopedal word is focused (emphasized) or prepausal. For example, words being contrasted always are the foci of an utterance and therefore they receive more prominence and do not undergo Word Fusion, as the following examples show.

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[4] No clear evidence for this process is found in noun phrases, since whenever the modifier of a head noun is monosyllabic, it becomes part of a compound.

(268) Contrastive constructions not undergoing word fusion

/mǎ tʰɔ́ŋ pɛ́k má tʰɔ́ŋ/   [mǎ][tʰɔ̌] √ [pɛ́][má][tʰɔ̌]
"Sell eggs, not **buy** eggs."

/xʷǒ xʷǒ.ɚ pɛ́k.jɔ́ mʲɔ́ xʷǒ.ɚ/   [xʷǒ][(xʷǒ.ɚ)] √ [(pɛ́.jɔ̀)][mʲɔ́][(xʷǒ.ɚ)]
"Draw a picture, don't **trace** a picture."

/fɔ̌ŋ çèŋ tsǒk pɛ́k çèŋ/   [fɔ̌][çɛ̀] √ [(tsɔ́p.pɛ̀)][çɛ̀]
"(Rice) meal smells good, porridge does not."

7.2.3. Expansion of metrical feet across morphological word boundaries

Word fusion is one case where a prosodic constituent can cross a morphological word boundary. Another case where this can happen is the expansion of a metrical foot to include unstressed words separated by word boundaries.

Postverbal prepositions such as *la* "at", *xɔ* "to" etc. and postverbal bare classifiers such as *tɚ*, *pɕ* etc. are toneless and undergo lenition and tone spreading, just like verbal suffixes. Following are some examples.

(269) Postverbal prepositions undergo tone spreading

/fɔ̌ŋ-tə la tɕók-soŋ/
put-*Prf* at table on   [(fɔ̌.nə̀ là)][(tɕós.sɔ̀)]
"put on the table"

/fɔ̌ŋ-tə tɚ tɕʰĩŋ la tɕók-soŋ/
put-*Prf* some money at table on   [(fɔ̌.nə̀ rɚ̀)][(tɕʰḭ lá)][(tɕós.sɔ̀)]
"put some money on the table"

/nɔ̌-tə la sé-soŋ/
hold-*Prf* at hand on   [(nɔ̌.rɔ́ lá)][(sé.sɔ̀)]
"held in hand"

/nɔ̌-tə pɛŋ sᵬ la sé-soŋ/
hold-*Prf Cl* book at hand on   [(nɔ̌.rɔ́ ᵬ̀)][(sᵬ là)][(sé.sɔ̀)]
"held a book in hand"

/tɕɔ̌-tə xɔ tsòŋ.sɔ̀ŋ/
loan-*Prf* to Zon San   [(tɕɔ̌.rɔ̀ xɔ̀)][(tsɔ̀)(sɔ̀)]
"lent (it) to Zon San"

/tɕɔ̌-tə pɛŋ sᵬ xɔ ŋu/
lend-*Prf Cl* book to me   [(tɕɔ̌.rɔ̀ ᵬ̀)][(sᵬ xɔ̀ ŋù)]
"lent a book to me"

/nɔ̌-tə xɔ lĩ.sᵶ/
take-*Prf* to Li Si   [(nɔ̌.rɔ́ xɔ́)][(lḭ)(sᵶ)]
"took (it) to Li Si"

/nɔ̌-tə tɚ tɕʰĩŋ xɔ tʰo/
took-*Prf* some money to him   [(nɔ̌.rɔ́ rɚ́)][(tɕʰḭ xɔ́ tʰɔ́)]
"took some money to him"

The indefinite pronoun *tɚ* "some" is usually toneless, and so are postverbal personal pronouns *ŋú* "me", *ní* "you(sl)", *tʰǒ* "him/her/it", *ŋú.nɛn* "us", *ní.nɛn*

"you(pl)", *tʰǒ.nɛn* "ŋú "them", unless emphasized. These toneless pronouns also undergo lenition and tone spreading, as shown below.

(270) Postverbal pronouns undergo tone spreading

/tʃʰĩk-tə tɚ/
eat -*Prf* some   [(tʃʰĩt.tə̀.rɚ̀)]
"ate some"

/nɔ̌-tə tɚ/
take-*Prf* some   [(nɔ̌.rɔ́.rɚ́)]
"took some"

/pʰǒ tʰo.nɛŋ/
fear them   [(pǒ tʰǒ.nᵬ̀)]
"fear them"

/tɕʰ̌ tʰo.nɛŋ/
beg them   [(tɕʰ̌ tʰǒ.nᵬ̀)]
"beg them"

/tɕɔ̌-tə xɔ ŋu/
lend-*Prf* to me   [(tɕɔ̌.rɔ̀ xɔ̀ ŋù)]
"lent (it) to me"

/nɔ̌-tə xɔ tʰo/
took-*Prf* to him   [(nɔ̌.rɔ́ xɔ́ tʰɔ́)]
"took (it) to him"

If a personal pronoun is used as the subject of a postverbal clause, it is usually toned and therefore does not undergo tone spreading, as the following examples show.

(271) Subject personal pronouns do not undergo tone spreading

/tʰǒ jɛ̌ŋ.ue ŋú.nɛŋ pɛ́k tsʰ̌ŋ.ʃĩŋ/
he believe we not sincere   [(tʰǒ)][(jᵬ̀.uè)][(ŋú.nᵬ̀)][(pɛ́t)][(tsʰᵬ̌.ʃĩŋ)]
"He believes that we are not sincere"

/ŋú kǒk.tsʰa ní sᵶ ku xɔ́.jɛ̌ŋ/
I think you are *Cl* nice person   [(ŋú)][(kǒt.tsʰá)][(ní sᵶ yú)][(xɔ́)(jᵬ̌)]
"I think you are a nice person"

When there are toneless postverbal prepositions, classifiers and pronouns in a sentence, tone spreading crosses boundaries of major syntactic constituents, as shown in the following illustration.

(272) Tone spreading across boundaries of syntactic constituents
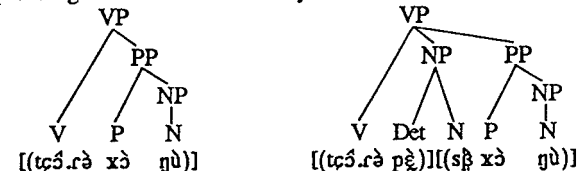
We know that tone spreading occurs within the domain of a metrical foot. We also know that the construction of prosodic structures respects morphological word boundaries. Therefore, tone spreading ought to end with the right edge of the verb or noun that

precedes a toneless word. Yet, as we can see, the domain of tone spreading in the above examples goes beyond that right edge. A natural explanation of this paradox is that in these examples, tone spreading occurs in a metrical foot which has expanded to include any number of toneless syllables that follow. No additional rules are necessary to account for this phenomenon, since the effect of foot expansion can be achieved with the same rule that associates toneless syllables produced by Syllable Reduplication to the preceding foot, as discussed in 7.1.4. What is important is that the foot expansion illustrated here exemplifies yet another case where a prosodic constituent can cross morphological word boundaries.

(273) Sample derivation of Foot Expansion across syntactic boundaries

Input	Foot Expansion	Lenition & Tone Redistr.
φ φ	φ φ	φ φ
σ σ σ σ σ σ	σ σ σ σ σ σ	σ σ σ σ σ σ
/nŏ-tə tə- tɕʰǐŋ xɔ tʰo/	/nŏ-tə tə- tɕʰǐŋ xɔ tʰo/	[(nŏ.rɔ́ rɔ́)][(tɕʰ ǐ xɔ́ tʰó)]
took-*Prf* some money to him		"took some money to him"

With the prosodic structure so constructed, lenition and tone spreading naturally occur across morphological word boundaries.

7.2.4. Intonational phrase and phonological phrase

Both the intonational phrase and phonological phrase are sequences of phonological words that serve as domains of some phonological processes. An intonatio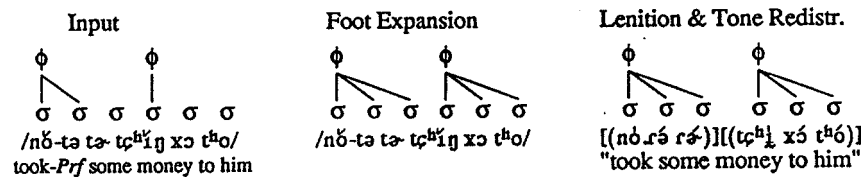nal phrase may be defined as a sequence between two pauses, and a phonological phrase is smaller than the intonational phrase.

I have shown in chapter IV that a number of rules apply in all syllables except prepausal ones. These rules include Coda Nasal Assimilation which causes the coda nasal to become homorganic with the following consonant, Coda Obstruent Assimilation which causes the coda obstruent to geminate to the following consonant, Place Feature Default which supplies the default place feature [dorsal] for placeless segments, and some others. The Foot Expansion rule discussed earlier also applies within a span of non-prepausal

syllables. If we regard this span of syllables as the intonational phrase, with the prepausal syllable as the right edge of the intonational phrase, then all the above-mentioned rules apply within the intonational phrase. In fact, no rules in this language may apply across the boundary, i.e. the pause, of such an intonational phrase.

On the other hand, there are two rules that apply with a domain which is larger than the phonological word but may be smaller than the intonational phrase. First, the Word Fusion rule we discussed earlier in this chapter does not apply if the first word is prepausal or focused (emphasized), as shown below, where boldface indicates focus and a check mark indicates a pause.

(274) Contrastive constructions that do not undergo word fusion

/mǎ tʰɔ́ŋ pɛk mǎ tʰɔ́ŋ/	[(mǎ)][(tʰɔ́)][(pɛ́)][(mǎ)][(tʰɔ́)]
sell eggs not buy eggs	"Sell eggs, not **buy** eggs."
cf. /mǎ tʰɔ́ŋ/	[(mǎ)(tʰɔ́)]
sell eggs	"Sell eggs"
/tɛ́ŋ uǎ.tə √ ŋɔ́ŋ.tʃǐŋ pɛk.tsɛŋ uǎ/	[(tɛ́)][(uǎ.rɔ́)], [(ŋɔ́.nʒǐŋ)][(pɛ́t.tsɛ́)][(uǎ)]
lamp bad *prf* eyes not *prf* bad	"Lamp has become bad, eyes have not."
cf. /tɛ́ŋ uǎ.tə/	[(tɛ́)(uǎ.rɔ́)]
lamp bad *prf*	"Lamp has become bad."
/mǎ fɔ́ŋ√ mǎ mǐŋ√ mǎ tǐŋ.ʃǐŋ/	[(mǎ)(fɔ́)][(mǎ)(mǐ)][(mǎ)(tǐ.ʃǐŋ)]
sell rice sell noodles sell snacks	"Sell rice, sell noodles, sell snacks."
/mǎ-tə tə- tʃɔ̌.tʰɔ́ŋ√ ŋɔ́k.tʰɔ́ŋ√ xu ǔ.ə-.tʰɔ́ŋ/	
buy *prf* some chicken eggs duck egges and goose eggs	

[(mǎ.rɔ́ rɔ́)][(tʃɔ̌)(tʰɔ́)], [(ŋɔ́t)(tʰɔ́)], xú [(ǔ.ɔ́)(tʰɔ́)]
"Bought some chicken eggs, duck eggs and goose eggs."

Word Fusion does apply if the second word is focused or prepausal, as the following data show.

(275) Contrastive constructions that do undergo word fusion

/mǎ tʰɔ́ŋ pɛ mǎ jǐŋ/	[(mǎ)(tʰɔ́)][pɛ́][(mǎ)(jǐ)]
sell eggs not sell salt	"Sell eggs, not sell salt."
/tɛ̌ŋ uǎ.tə √ pɛk sʐ đŋ tə/	[(tɛ̌)(uǎ.rɔ́)], [pɛ́.sʐ́][(đ.nɔ̌)]
lamp bad *prf* not is dim *prf*	"Lamp has become bad, not dim."

The seond rule that applies within a domain smaller than the intonational phrase but larger than the phonological word is the Non-Initial Decontour that we discussed in chapter

V. This rule changes a non-initial LM into L (which later becomes ML by M Insertion). Unlike most other tonal rules, which apply within the phonological word, this process can apply across a phonological word boundary (which may or may not correspond to a morphological word boundary), as we can see from the following data.

(276) LM decontour across a phonological word boundary

/tɕ.tʰɑ̌ # tsʰʐ̌.kə/	[(tɕ̌)(tʰɑ̀)][(tsʰʐ̌.ɣɔ̀)]
[treat] [self]	"treat oneself"

/tʃʰɪ́ŋ.xɤ̌ # sɛ̀ŋ.jɛ/	[(tʃʰɪ́ŋ)(xɤ̀)][(sʐ̌.jɛ̀)]
[celebrate][birthday]	"celebrate birthday"

/ɕ̌.mɛ̌ # sɤ̌ŋ # mʲɔ̌.xʷɛ̌/	[(ɕ̌)(mɛ̀)][(sʐ̌)][(mʲɔ̌)(xʷɛ̌)]
[two sister][up][market]	"Second sister goes to market"

However, if the word-final LM is prepausal or focused, it no longer undergoes the Decontour rule. Instead, it surfaces as MLM by M Insertion, as shown below.

(277) LM decontour fails to apply across a phonological word boundary

/tɕ.tʰɑ̌ # tsʰʐ̌.kə/	[(tɕ̌)(tʰɑ̌)][(tsʰʐ̌.ɣɔ̀)]
[treat] [self]	"treat oneself"

/tɕ.tʰɑ̌ √ tsʰʐ̌.kə/	[(tɕ̌)(tʰɑ̌)] √ [(tsʰʐ̌.ɣɔ̀)]
[treat] √ [self]	"treat √ oneself"

/tʃʰɪ́ŋ.xɤ̌ # sɛ̀ŋ.jɛ/	[(tʃʰɪ́ŋ)(xɤ̌)][(sʐ̌.jɛ̀)]
[celebrate][birthday]	"celebrate birthday"

/tʃʰɪ́ŋ.xɤ̌ √ sɛ̀ŋ.jɛ/	[(tʃʰɪ́ŋ)(xɤ̌)] √ [(sʐ̌.jɛ̀)]
[celebrate] √ [birthday]	"celebrate √ birthday"

/ɕ̌.mɛ̌ √ sɤ̌ŋ # mʲɔ̌.xʷɛ̌/	[(ɕ̌)(mɛ̌)] √ [(sɤ̌)][(mʲɔ̌)(xʷɛ̌)]
[two sister] √ [up][market]	"Second sister √ goes to market"

/ɕ̌.mɛ̌ √ sɤ̌ŋ √ mʲɔ̌.xʷɛ̌/	[(ɕ̌)(mɛ̌)] √ [(sɤ̌)] √ [(mʲɔ̌)(xʷɛ̌)]
[two sister] √ [up] √ [market]	"Second sister √ goes to √ market"

/ɕ̌.mɛ̌ # sɤ̌ŋ # mʲɔ̌.xʷɛ̌/	[(ɕ̌)(mɛ̌)][(sɤ̌)][(mʲɔ̌)(xʷɛ̌)]
[two sister][up][market]	"**Second sister goes to market**"

/ɕ̌.mɛ̌ # sɤ̌ŋ # mʲɔ̌.xʷɛ̌/	[(ɕ̌)(mɛ̀)][(sɤ̌)][(mʲɔ̌)(xʷɛ̌)]
[two sister][up][market]	"Second sister **goes** to market"

The behavior of Word Fusion and LM Decontout suggests that they both apply within a domain whose right edge is a focused or prepausal syllable. As this domain is larger than the phonological word but smaller than the intonational phrase, we shall refer to it as the phonological phrase.

There is no evidence that phonological phrase and intonational phrase correspond to any syntactic categories. The discourse focus that defines the right edge of a phonological phrase is usually pragmatically determined, and may be placed on words that are not at the right edge of a syntactic category. As a result, there is no correspondence between a phonological phrase and a syntactic category. In the following example, the first phonological phrase (dominated by Φ) includes only part of the first VP, and the second one includes part of the first VP and part of the second VP. Neither correspond to a single syntactic category.

(278) Phonological phrases versus syntactic categories
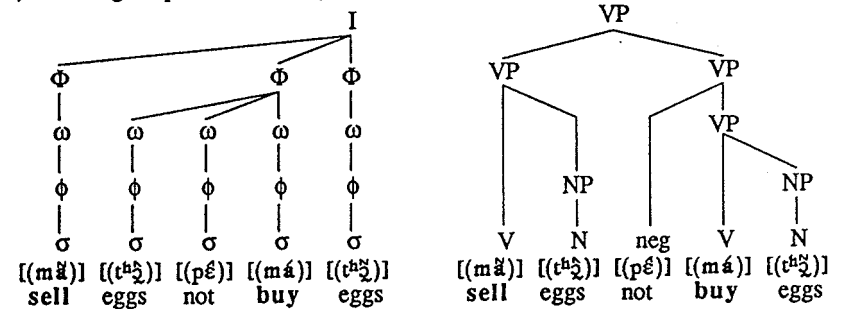
With regard to intonational phrases, it is true that their boundary, i.e. the pause, usually coincides with the boundary between syntactic constituents. However, this fact alone does not guarantee that an intonational phrase always corresponds to a syntactic category. In the example illustrated below, it is quite clear that the first and the third intonational phrases (dominated by I) both encompass materials that are not exclusively dominated by a single syntactic category.

(279) Intonational phrases versus syntactic categories

[(má.rə̀. rə́)][(tʃʒ́)(tʰʒ̃)]√[(gə́t)(tʰʒ̃)]√xù [(ù.ə́)(tʰʒ̃)]

[(má. rə̀. rə́)][(tʃʒ́)(tʰʒ̃)]√[(gə́t)(tʰʒ̃)]√xu [(ù. rə́. ə́) (tʰʒ̃)]
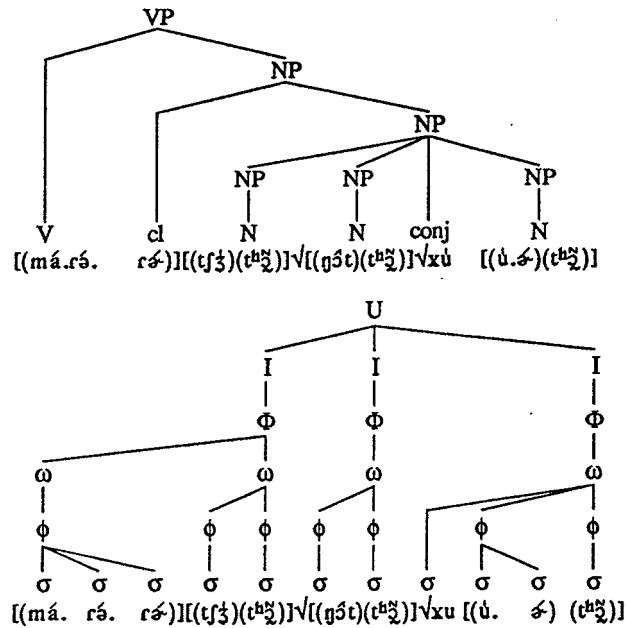
The construction of the phonological phrase and the intonational phrase in this language seems to be quite simple. After the construction of metrical feet and phonological words is complete, we build a phonological phrase on every focused or prepausal word, which is the head of the phonological phrase because it dominates the only syllable in the phonological phrase that can preserve its underlying LM contour. After that, we build an intonational phrase on the prepausal phonological phrase, which is the head of the intonational phrase because it dominates the only syllable that ends Foot Expansion and may undergo Coda Obstruent Glottalization. Following is a sample derivation of an intonational phrase.

(280) Sample derivation of intonational phrase

[(mǎ)] [(tʰʒ̃)] [(pɛ́)] [(má)] [(tʰʒ̃)]

Building metrical feet

Building phonological words

Building phonological phrase

Building intonational phrase

Applying Word Fusion
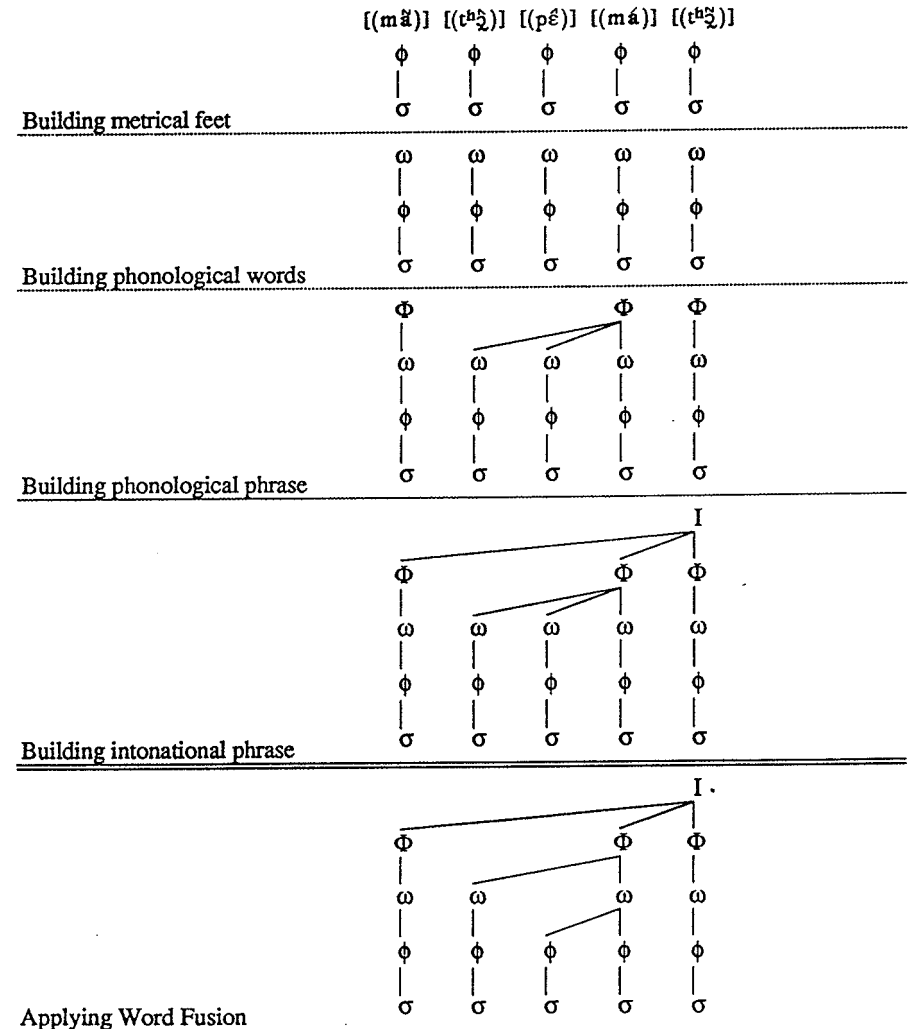
We assume that Word Fusion and Foot Expansion are both structure changing rules. They are not involved in the construction of the prosodic structure. Rather, they alter parts of the prosodic structure when it is completely built.

7.3. Summary

In the above, I have shown that prosodic consituents and morphosyntactic constituents are not isomorphic. Although metrical feet and phonological words are constructed within morphological word boundaries, there can be more than one phonological word within a morphological word, and a metrical foot or phonological word can cross a morphological word boundary due to the later rules Word Fusion and Foot Expansion which alter the prosodic structure. The phonological phrase is constructed with a focal or prepausal syllable at its right edge, and the intonational phrase is constructed with a prepausal syllable at its right edge. Neither one corresponds to a major syntactic constituent or is sensitive to some syntactic relation. With regard to the preservation of morphosyntactic information in the prosodic structure, the only clear-cut case is a constraint against splitting non-word-final embedded morphemes into two metrical feet. Another case where morphosyntactic information appears to influence phonology concerns Foot Reduplication, which only applies to adjectives, and Syllable Reduplication, which applies to all lexical categories except adjectives. Other than these two cases, no interaction is found between phonology and morphology or syntax.

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APPENDIX   A SCHEME FOR THE NANTONG PHONETIC ALPHABET

The transliteration of local personal and place names occasionally used in this study with Roman letters in lieu of the International Phonetic Alphabet is based on the following Nantong Phonetic Alphabet, which I designed to provide an easier way of transcribing local personal and place names, recording vernacular literature, helping native speakers obtain literacy, and even teaching this language to non-native speakers.

I. The Alphabet (24)

A a	B b	C c	D d	E e	F f	G g	H h	I i	J j	K k	L l
[ɔ]	[pe]	[tse]	[te]	[ə]	[fe]	[ke]	[xe]	[i]	[tɕe]	[ke]	[le]

M m	N n	O o	Q q	P p	S s	T t	U u	V v	Y y	Z z
[me]	[ne]	[o]	[ekʰu]	[pʰe]	[se]	[tʰe]	[u]	[β]	[y]	[tsʐ]

II. The Initials (35)

b	p	m	f	d	t	n	l	g	k	h	ng
[p]	[pʰ]	[m]	[f]	[t]	[tʰ]	[n]	[l]	[k]	[kʰ]	[x]	[ŋ]

j	ch	sh[1]	z	c	s	v	bi	pi	mi	di	ti
[tɕ]	[tɕʰ]	[ɕ]	[ts]	[tsʰ]	[s]	[v]	[pʲ]	[pʲʰ]	[mʲ]	[tʲ]	[tʲʰ]

ni	li	i	gu	ku	xu	u	jy	chy	shy	y
[nʲ]	[lʲ]	[j]	[kʷ]	[kʷʰ]	[xʷ]	[w]	[tɕʷ]	[tɕʷʰ]	[ɕʷ]	[ɥ]

III. The Finals (30)

a	ai	o	e	ei	i	u	y	ir	yr	z	v
[ɔ]	[a]	[o]	[ə]	[e]	[i]	[u]	[y]	[ʒ]	[ʒ]	[ʐ]	[β]

an		on	en	ein[2]	in	un	yn	ing[3]	eng	er
[ɔ̃]		[õ]	[ɛ]	[ɛ̃]	[ĩ]	[ũ]	[ỹ]	[iŋ]	[əŋ]	[ɚ]

aq	aiq	oq	eq		iq	uq	yq	irq
[ɔʔ]	[aʔ]	[oʔ]	[ɛʔ]		[iʔ]	[uʔ]	[yʔ]	[iʔ]

IV. The Tone Marks (5)[4]

low level ° [ˋ]   high rising ´ [ˊ]   high level ¯ [ˊ]   high falling ` [ˆ]   low rising ˇ [ˋ]

[1] The initials j, ch and sh are to be pronounced as [tʃ], [tʃʰ] and [ʃ] when followed by ir, yr or ing.
[2] The initials l and n are to be pronounced as [lʲ] and [nʲ] when followed by ein.
[3] The letter i in this final is omitted when preceded by jy, chy, shy or y.
[4] Tones are to be marked on the last vowel of each syllable. Toneless syllable are not marked.

V. The Syllables (400)

The table below includes all the syllables of Nantong Chinese, with tones suppressed.

a	[ɔ]	cha	[tɕʰɔ]	de	[tə]	gai	[ka]	hen	[xɛ]
ai	[a]	chaq	[tɕʰɔʔ]	dei	[te]	gaiq	[kaʔ]	heng	[xəŋ]
ba	[pɔ]	che	[tɕʰə]	den	[tɛ]	gan	[kɔ̃]	heq	[xɛʔ]
bai	[pa]	chei	[tɕʰe]	deng	[təŋ]	gaq	[kɔʔ]	ho	[xo]
baiq	[paʔ]	chein	[tɕʰɛ]	deq	[tɛʔ]	ge	[kə]	hon	[xõ]
ban	[pɔ̃]	cheng	[tɕʰəŋ]	der	[tɚ]	gei	[ke]	hoq	[xoʔ]
baq	[pɔʔ]	chin	[tɕʰʲi]	di	[ti]	gen	[kɛ]	hu	[xu]
be	[pə]	ching	[tʃʰiŋ]	dia	[tʲɔ]	geng	[kəŋ]	huai	[xʷa]
bei	[pe]	chir	[tʃʰʒ]	die	[tʲə]	geq	[kɛʔ]	huaiq	[xʷaʔ]
ben	[pɛ]	chirq	[tʃʰiʔ]	din	[tʲi]	go	[ko]	huan	[xʷɔ̃]
beng	[pəŋ]	chiq	[tɕʰiʔ]	ding	[tiŋ]	gon	[kõ]	huaq	[xʷɔʔ]
beq	[pɛʔ]	chy	[tɕʰy]	diq	[tiʔ]	goq	[koʔ]	huei	[xʷe]
bie	[pʲə]	chyei	[tɕʷʰe]	don	[tõ]	gu	[ku]	huen	[xʷɛ]
bin	[pʲi]	chyen	[tɕʷʰɛ]	doq	[toʔ]	guai	[kʷa]	hueq	[xʷɛʔ]
bing	[piŋ]	chyeq	[tɕʷʰɛʔ]	du	[tu]	guaiq	[kʷaʔ]	hun	[xɥ]
big	[piʔ]	chyn	[tɕʰy]	dv	[tβ]	guan	[kʷɔ̃]	huo	[xʷo]
bir	[pʒ]	chyng	[tɕʷʰiŋ]	dy	[ty]	guaq	[kʷɔʔ]	huon	[xʷõ]
bo	[po]	chyon	[tɕʷʰõ]	dyn	[tɣ]	guei	[kʷe]	huoq	[xʷoʔ]
bon	[põ]	chyoq	[tɕʷʰoʔ]	dyq	[tyʔ]	guen	[kʷɛ]	hv	[xβ]
boq	[poʔ]	chyq	[tɕʰyʔ]	ei	[e]	gueq	[kʷɛʔ]	ia	[jɔ]
bu	[pu]	chyr	[tʃʰʒ]	en	[ɛ]	gun	[kɥ]	iai	[ja]
bun	[pɥ]	co	[tsʰo]	eng	[əŋ]	guo	[kʷo]	iag	[jɔʔ]
bv	[pβ]	con	[tsʰõ]	er	[ɚ]	guon	[kʷõ]	ie	[jə]
cai	[tsʰa]	coq	[tsʰoʔ]	fan	[fɔ̃]	guoq	[kʷoʔ]	iei	[je]
caiq	[tsʰaʔ]	cu	[tsʰu]	faq	[fɔʔ]	guq	[kuʔ]	iein	[jɛ]
can	[tsʰɔ̃]	cv	[tsʰβ]	fei	[fe]	gv	[kβ]	ien	[jɛ]
caq	[tsʰɔʔ]	cz	[tsʰʐ]	fen	[fɛ]	ha	[xɔ]	ieng	[jəŋ]
ce	[tsʰə]	da	[tɔ]	feng	[fəŋ]	hai	[xa]	ieq	[jɛʔ]
cei	[tsʰe]	dai	[ta]	feg	[fɛʔ]	han	[xɔ̃]	in	[jʲi]
cen	[tsʰɛ]	daiq	[taʔ]	fon	[fõ]	haq	[xɔʔ]	ing	[jiŋ]
ceng	[tsʰəŋ]	dan	[tɔ̃]	foq	[foʔ]	he	[xə]	iq	[jiʔ]
ceq	[tsʰɛʔ]	daq	[tɔʔ]	fv	[fβ]	hei	[xe]	ir	[ʒ]

ja	[tɕɔ]	kuaiq	[kʷʰaʔ]	mai	[ma]	ngeq	[ŋɛʔ]	poq	[pʰoʔ]
jaq	[tɕɔʔ]	kuan	[kʷʰɔ̩]	man	[mɔ̩]	ngo	[ŋo]	pu	[pʰu]
je	[tɕə]	kuaq	[kʷʰɔʔ]	maq	[mɔʔ]	ngon	[ŋɔ̩]	pun	[pʰy̩]
jei	[tɕe]	kuei	[kʷʰe]	me	[mə]	ngoq	[ŋoʔ]	pv	[pʰβ]
jein	[tɕɛ̩]	kuen	[kʷʰɛ̩]	mei	[me]	ngu	[ŋu]	sai	[sa]
jeng	[tɕəŋ]	kun	[kʰy̩]	men	[mɛ̩]	ni	[ni]	saig	[saʔ]
jin	[tɕi̩]	kuo	[kʷʰo]	meng	[məŋ]	niaq	[nʲɔʔ]	san	[sɔ̩]
jing	[tʃiŋ]	kuon	[kʷʰɔ̩]	meq	[mɛʔ]	nie	[nʲə]	saq	[sɔʔ]
jiq	[tɕiʔ]	kuoq	[kʷʰoʔ]	miai	[mʲa]	nin	[ni̩]	se	[sə]
jir	[tʃɿ]	kv	[kʰβ]	mie	[mʲə]	niq	[niʔ]	sei	[se]
jy	[tɕy]	la	[lɔ]	min	[mi̩]	no	[no]	sen	[sɛ̩]
jyai	[tɕʷa]	lai	[la]	ming	[miŋ]	non	[nɔ̩]	seng	[səŋ]
jyei	[tɕʷe]	laiq	[laʔ]	miq	[miʔ]	noq	[noʔ]	seq	[sɛʔ]
jyen	[tɕʷɛ]	lan	[lɔ̩]	mir	[mɿ]	nu	[nu]	sha	[ɕɔ]
jyn	[tɕy]	laq	[lɔʔ]	mo	[mo]	ny	[ny]	shaq	[ɕɔʔ]
jyng	[tɕʷiŋ]	le	[lə]	mon	[mɔ̩]	nyn	[ny]	she	[ɕə]
jyo	[tɕʷo]	lei	[le]	moq	[moʔ]	nyr	[nɿ]	shei	[ɕe]
jyon	[tɕʷɔ̩]	lein	[lʲɛ̩]	mu	[mu]	o	[o]	shein	[ɕɛ̩]
jyoq	[tɕʷoʔ]	len	[lɛ̩]	mun	[my̩]	pai	[pʰa]	sheng	[ɕəŋ]
jyq	[tɕyʔ]	leng	[ləŋ]	na	[nɔ]	paiq	[pʰaʔ]	shin	[ɕi̩]
jyr	[tʃɿ]	leq	[lɛʔ]	nai	[na]	pan	[pʰɔ̩]	shing	[ʃiŋ]
kai	[kʰa]	li	[li]	nan	[nɔ̩]	paq	[pʰɔʔ]	shiq	[ɕiʔ]
kaiq	[kʰaʔ]	liaq	[lʲɔʔ]	naq	[nɔʔ]	pe	[pʰə]	shir	[ʃɿ]
kan	[kʰɔ̩]	lie	[lʲə]	ne	[nə]	pei	[pʰe]	shy	[ɕy]
kaq	[kʰɔʔ]	lin	[li̩]	nei	[ne]	pen	[pʰɛ̩]	shyai	[ɕʷa]
ke	[kʰə]	ling	[liŋ]	nein	[nʲɛ̩]	peng	[pʰəŋ]	shyan	[ɕʷɔ̩]
kei	[kʰe]	liq	[liʔ]	nen	[nɛ̩]	peq	[pʰɛʔ]	shyei	[ɕʷe]
ken	[kʰɛ̩]	lo	[lo]	neng	[nəŋ]	piai	[pʰʲa]	shyen	[ɕʷɛ̩]
keng	[kʰəŋ]	lon	[lɔ̩]	neq	[nɛʔ]	pie	[pʰʲə]	shyeq	[ɕʷɛʔ]
keq	[kʰeʔ]	loq	[loʔ]	ngai	[ŋa]	pin	[pʰi̩]	shyn	[ɕy]
ko	[kʰo]	lu	[lu]	ngan	[ŋɔ̩]	ping	[pʰiŋ]	shyng	[ɕʷiŋ]
kon	[kʰɔ̩]	lv	[lβ]	ngaq	[ŋɔʔ]	piq	[pʰiʔ]	shyon	[ɕʷɔ̩]
koq	[kʰoʔ]	ly	[ly]	nge	[ŋə]	pir	[pʰɿ]	shyoq	[ɕʷoʔ]
ku	[kʰu]	lyn	[ly]	ngei	[ŋe]	po	[pʰo]	shyq	[ɕyʔ]
kuai	[kʷʰa]	lyg	[lyʔ]	ngen	[ŋɛ̩]	pon	[pʰɔ̩]	shyr	[ʃɿ]

so	[so]	teng	[tʰəŋ]	tyq	[tʰyʔ]	y	[y]	zaiq	[tsaʔ]
son	[sɔ̩]	teq	[tʰɛʔ]	u	[u]	yei	[ye]	zan	[tsɔ̩]
soq	[soʔ]	ti	[tʰi]	uan	[wɔ̩]	yen	[ɥɛ]	zaq	[tsɔʔ]
su	[su]	tie	[tʲʰə]	uaq	[wɔʔ]	yeq	[ɥɛʔ]	ze	[tsə]
sv	[sβ]	tin	[tʰi̩]	un	[y̩]	yn	[ɥ]	zei	[tse]
sz	[sɿ]	ting	[tʰiŋ]	uo	[wo]	ynq	[ɥiŋ]	zen	[tsɛ̩]
tai	[tʰa]	tiq	[tʰiʔ]	uon	[wɔ̩]	yo	[jo]	zeng	[tsəŋ]
taiq	[tʰaʔ]	to	[tʰo]	uoq	[woʔ]	yon	[ɥɔ̩]	zeq	[tsɛʔ]
tan	[tʰɔ̩]	ton	[tʰɔ̩]	v	[vβ]	yoq	[ɥoʔ]	zo	[tso]
taq	[tʰɔʔ]	toq	[tʰoʔ]	vai	[va]	yq	[yʔ]	zon	[tsɔ̩]
te	[tʰə]	tu	[tʰu]	vei	[ve]	yr	[ʒ]	zoq	[tsoʔ]
tei	[tʰe]	tv	[tʰβ]	ven	[vɛ̩]	z	[tsɿ]	zu	[tsu]
ten	[tʰɛ̩]	tyn	[tʰy]	veq	[vɛʔ]	zai	[tsa]	zv	[tsβ]

VI. A Sample Text

V̌GUEI DA TV̀ER SAÌPÉ
[(ʋβ̞kʷè) tɔ̃ (tʰβ̞ə̀) sɑ̃ pʰɔ̃]
TURTLE WITH HARE RACE

Céngchín, ȳ zeq tv̀er hu zeq v̌guei. Tv̀er lēs kùnbecchīr v̌guei, shín to pélv̌ taì
[tsʰɔ̃ntɕʰɿ̃(ýtsɛ́)(tʰβ̞ə̀)xútsɛ́(ʋβ̞kʷè)(tβ̞ə̀)lɔ́s(kɬ̩mɛ́)tʃʰɔ̃(ʋβ̞kʷè)(ɕɬ̩tʰó)pʰɔ̃lβ̩tʰɑ̃́]
before exist cl hare and cl turtle hare always look not up turtle complain him walk too
Once upon a time, there were a hare and a turtle. The hare always looked down upon the turtle, and

mǎn. Ȳ iq ůnz, v̌guei dei tv̀er shỳq, "Sēndeq ni lēs shín ngu pélv̌ mǎn, ngū chy da ni
[mɔ̃̌(ý ji)(tʰɿ̩tsɿ̃)(ʋβ̞kʷè tè)(tʰβ̞ə̀)çɣʔ (sɛ̃nɛ́ ni)lɔ́s(ɕɬ̩ ɲú)pʰɔ̃lβ̩ mɔ̃̌(ɲú tɕʰý tɔ̃ ni)]
slow exist one day turtle to hare say save you always complain me walk slow I then with you
complained about him walking too slow. One day, the turtle said to the hare, "Since you always complain

bīr xaīz ba, kùnde lagu pédeq kuaì." Tv̀er shỳq, "Hēdisai, bīr chy bīr." To shǐng dixe
[(pɕ̃xáz β̞ɔ́)(kɬ̩nɔ̃lɔ̃yú(pʰɔ̃.ɾɛ́)kʷʰɑ̃́ (tʰβ̞ə̀)çɣʔ (xɔ̃ɾísá)(pɕ̃tɕʰý)pɕ̃ tɔ̃ (ʃi̩ŋ nixə̃)]
race once sug see which walk can fast hare say good race then race he heart under
about me walking slow, let's have a race and see who runs faster." The hare said, "Good. If you want a race,

sheīn, "Gèggu mǎntenngeí, jìngín iè da ngū bīsaì. Vēn sv̌!" Tonen chīngde héer zù
[çɛ̃̌ (kɛ̃kkù)(mɔ̃̌tʰɛ̃̌)ŋɛ́ tʃi̩ŋɿ̃ jɔ̃ tɔ̃ ɲú pɕ̃sɑ̃ ʋɛ̃̌ sβ̞ (tʰó̩nɛ̃̌)(tʃʰi̩n.nɔ̃)(xɛ̃ɔ̃)tsɑ̃]
think this slow buffalo even want with me race sure lose they asked monkey do
you have a race." He thought, "This slowpoke, how dare he race with me. He's sure to lose!" They asked