Tones in Zhangzhou:

Pitch and Beyond

Tones in Zhangzhou:

Pitch and Beyond

By

Yishan Huang

Cambridge
Scholars
Publishing

Tones in Zhangzhou: Pitch and Beyond

By Yishan Huang

This book first published 2020

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN (10): 1-5275-4421-4
ISBN (13): 978-1-5275-4421-5

Table of Contents

ACKNOWLEDGMENTS

This book is a revised version of my doctoral dissertation, which I completed at The Australian National University in 2018. I am forever indebted to my informants and the local community for their contributions during my fieldwork in Zhangzhou. They are Ruizhu Lin, Yayuan Lu, Maoyong Liu, Meiling Yang, Sumei Chen, Bingren Yan, Zhibin Huang, Yuanfa Wu, Tonglong Huang, Yueshen Huang, Jianguo Wang, Huixue Huang, Muchi Huang, Rongxia Lin, Baoqing Zhang, Jinhong Huang, Zhupen Lin, Chunhua Lin, Qiumei Huang, Yonghui Huang, Shuixuan Huang, Ronghua Huang, Hairong Yan, Jinhui Huang, Caizhu Huang, Aying Huang, Yijie Huang, Ligen Cai, Shunzhi Huang, Xianfeng Huang, Liyuan Cai, Nengzhen Chen, Xiadianmei community, and Huaqiao University.

I would like to express a deep sense of gratitude to Dr. Paul Sidwell, Dr. Mark Donohue, and Prof. Phil Rose for their constructive supervision. I would like to extend my gratitude to A/Prof. Shunichi Ishihara, Prof. Wayan Arka, Prof. Nick Evans, Dr. Julia Miller, Dr. Gwen Hyslop, Dr. Cathryn Donohue, Dr. Mark Ellison, Dr. Beth Evans, Dr. Jennifer Hendricks, Prof. Jane Simpson, Dr. Cynthia Allen, and Dr. Zhengdao Ye for their lectures, discussions, and/or seminars, which have broadened my knowledge beyond phonetics and the Sinitic language family.

I also wish to express my appreciation to numerous loving people inside and outside ANU. I am especially thankful to Dr. Siva Kalyan, Dr. Xiaoli Zhou, Ms. Chintana Sandilands, and Ms. Joanne Bushby for their assistance and encouragement during my final writing stage. I would like to extend my gratitude to Prof. Feng Shi, Prof. Yingwei Guan, Prof. Xiaonong Zhu, Prof. Xiangdong Shi, Prof. Xiaoyu Zeng, and Prof. Qibin Ran who guided me in the study of linguistics during my MA in China, and to three examiners for their feedback and suggestions for this thesis and for future research.

My deepest gratitude goes to my grandparents, parents, brother, sister-in-law, and many respected relatives. This research would not have been possible without their love, support, and encouragement. I will never be able to pay them back. I dedicate this milestone to them, and especially to my father Jinhui Huang, my ultimate role model.

ABSTRACT

This study explores the nature of Zhangzhou tones, an under-described variety of Southern Min, through the analysis of data from 21 native speakers. The realisations of Zhangzhou tones are multidimensional and the single parameter of pitch/F0 is not sufficient to characterise tonal contrasts in either monosyllabic or polysyllabic contexts in Zhangzhou. Instead, various additional parameters, including duration, vowel quality, voice quality, and syllable coda type, interact to code tonal distinctions.

Zhangzhou has eight tones, rather than the seven proposed in previous research. This finding emerged from an examination of parametrical realisations across citation, phrase-initial, and phrase-final contexts, rather than classifying tones in citation and/or in terms of the preservation of Middle Chinese tonal categories. Additionally, tonal neutralisation occurs across different contexts. As such, identifying the number of tonal contrasts based simply on the citation context is inadequate.

The tone sandhi domain is found not to be phonologically determined, but syntactically aligned; tonal alternation is only sensitive to the phrase boundary and appears irrelevant to the internal structure of syntactic phrases. Although phonologically inert, sandhi is phonetically sensitive. For example, the F0 onsets of phrase-final tones have statistically significantly diverse variants because of their predictable sensitivity to the F0 offsets of preceding tones and/or to the utterance-final depression effect.

The nature of Zhangzhou tones is morphological. Each lexical tone functions as a single morpheme with two alternating tonal allomorphs: one for sandhi (non-phrase-final) variants and another for non-sandhi (citation and phrase-final) variants, which are phonologically independent and phonetically distant. The relationship between sandhi and citation tones is morphophonemic; while the relationship between phrase-final and citation tones is allophonic.

CHAPTER ONE

INTRODUCTION

1.1. Motivations

Three major research motivations contributed to the formulation of this book.

First, the language spoken in Zhangzhou is tonally interesting, but under-described. This language, a Southern Min variety spoken in southern China, makes good use of pitch contour to distinguish lexical meanings. For example, as shown in Table 1-1, the syllabic nasal can bear five different pitch shapes (rising; low level; high falling; mid-high falling; and mid-level) to differentiate five lexical items. In utterances beyond monosyllables, the realisations of tones are dramatically alternated, and present dynamic patterns that are motivated by various morphosyntactic factors. For example, as Table 1-2 shows, tone 3 has a falling pitch [51] in citation, but the pitch is alternated to [35] at the non-rightmost position of a syntactic phrase (XP) and to [55] before the diminutive morpheme /ʔɐ51/. In the triplicated adjectives that express superlative degree, the pitches of first adjectives are shifted to a rising contour [35], regardless of whether their contour is falling (e.g., tone 3) or level (e.g., tone 7) in citation.

Table 1-1. Contrastive use of pitch in lexical distinctions in Zhangzhou

Example 1	Example 2
ʔm̩35 'to drink'	ʔi35 'he/she'
ʔm̩22 'flower bud'	ʔi22 'move'
ʔm̩51 'aunt'	ʔi51 'chair'
ʔm̩41 'affirmative'	ʔi41 'intention'
ʔm̩33 'negative'	ʔi33 'play'

Table 1-2. Pitch alternation in Zhangzhou tones across different linguistic contexts

Context	Tone 3		Tone 7	
Citation	[51]	kɐw51 'dog'	[22]	ʤjɔk22 'jade'
Non-XP-final	[35]	kɐw35.ɓɵ51 'bitch'	[32]	ʤjɔk32.tsu35 'jade bead'
Before diminutive /ʔɐ51/	[55]	kɐw55.ʔɐ51 'puppy'	[35]	ʤjɔk35.ʔɐ51 'jade'
First of triplicated adjectives	[35]	swi35.swi35.swi52 'extremely beautiful'	[35]	tit35.tit32.tit211 'extremely straight'

However, the under-described status of the language is especially true in relation to the tone sandhi. Previous studies have not quantitatively explored how individual tones are realised and how they interact in multisyllabic constructions, nor have they specified how the tone sandhi domains are constructed. An adequate theoretical explanation has not been developed to account for how tones in multisyllabic constructions are related to their citation forms. What has been documented mostly involves a brief statement that one tone changes into another for the non-final characters in terms of Middle Chinese tonal categories.[1] (e.g., Dong 1959; Lin 1992; Ma 1994; ZZG 1999; Gao 1999; Yang 2008). Lin (2017) conducted an acoustic study on the tone sandhi in four different administrative areas of Zhangzhou, but she only focused on the F0 realisations of non-stopped tones associated with sonorant-ending syllables and with one male speaker for each regional variety.

Numerous studies have provided pitch inventories for Zhangzhou citation tones (e.g., Dong 1959; Lin 1992; Ma 1994; ZZG 1999; Gao 1999; Zhou 2006; Chen 2007; Yang 2008; Guo 2014; Huang et al. 2016); however, the descriptions are somewhat inconsistent between scholars, as summarised in Table 1-3. This study, based on Huang's 2018 thesis, is the most divergent, particularly in terms of the number of tonal contrasts it presents. A few pioneering studies (Yang 2008, 2014; Yin 2009; Huang et al. 2016) have sought to explore the acoustic characteristics of Zhangzhou tones, mostly in terms of the F0 parameter; however, several problematic aspects arise with respect to their research design and analysis. For example,

[1] Tone are conventionally classified into four classes in terms of Middle Chinese tonal categories: Ping (Level); Shang (Rising); Qu (Falling); and Ru (Stopped). Each category can be further divided into two registers—Yin and Yang—depending on the voicing status of historical syllable onsets.

Yang (2008, 2014) simply compared the raw F0 values from one male speaker and one female speaker without quantification and normalisation. Yin (2009) utilised a normalisation approach, but the study only addressed the tonal F0 in unstopped syllables, while neglecting the tones in stopped syllables that are associated with obstruent codas. This book goes beyond these previous accounts, taking a more comprehensive approach based on field linguistics, acoustic phonetics, statistical testing, and linguistic theory.

Table 1-3. Pitch inventories for Zhangzhou citation tones.[2]

Author	Year	T1 (Ia)	T2 (Ib)	T3 (II)	T4 (IIIa)	T5 (IIIb)	T6 (IVa)	T7 (IVb)	T8 (IVb)
Dong	1959	24	212	53	32	33	32	13	*
Lin	1992	44	13	53	21	22	32	12	*
Ma	1994	44	12	53	21	22	32	121	*
FJG	1998	44	13	53	21	22	32	121	*
ZZG	1999	44	13	53	21	22	32	121	*
Gao	1999	45	23	53	21	33	21	121	*
Zhou	2006	44	13	53	21	22	32	121	*
Chen	2007	44	13	53	21	22	32	121	*
Yang	2008	44	13	53	21	22	32	121	*
Guo	2014	44	13	53	21	22	31	121	*
Huang et al.	2016	35	22	51	41	33	41	221	*
This study	**2019**	**35**	**22**	**51**	**41**	**33**	**41**	**221**	**22**

Second, existing interpretations of the Southern Min (SM) tone sandhi are indeterminate and controversial. While no particular theoretical work has been conducted on the Zhangzhou variety, important studies have been done on other SM varieties in Xiamen and Taiwan (see Section 1.4). However, little consensus has been reached concerning several fundamental issues, in particular:

- What is the directionality of the Southern Min tone sandhi?
- How can the Southern Min tone sandhi domain be specified?
- How can the nature of the Southern Min tone sandhi be interpreted theoretically?

[2] Due to constraints of layout: Ia = Yinping; Ib = Yangping; II = Shang; IIIa = Yinqu; IIIb = Yangqu; IVa = Yinru; IVb = Yangru.

Multiple attempts have been made to provide a unified account of the nature of Southern Min tone sandhi (known as a "tone circle") using the theories of classical generative phonology (e.g., Wang 1967); suprasegmental phonology (e.g., Yip 1980; Tsay 1991); and optimality theory (e.g., Yip 2002; Hsieh 2005; Barrie 2006; Thomas 2008). However, these phonologically-oriented proposals have been challenged by the results of several psychological experiments (e.g., Hsieh 1976; Wang 1992; Tsay & Myers 1996; Zhang et al. 2006; Chen et al. 2010), which largely falsify the full productivity of tone sandhi rules in Taiwanese Southern Min. These difficulties indicate the need for systematic phonetic study, theoretical consideration of other perspectives beyond the narrowly phonological, and the use of a large set of empirical data, to explore how SM tones are realised in utterances and to explain how the system of tone sandhi is structured abstractly. Zhangzhou, as a typical Southern Min variety, thus provides fertile ground for extending the understanding of this aspect.

Third, a sophisticated phonetic study is necessary for a better understanding of the nature of "tone" as a linguistic category. As indicated in the various definitions for tonal languages (e.g., Pike 1948; Gandour 1978; Yip 2002; Hyman 2006, 2011; Maddieson 2013), and phonological models to formally represent tones (e.g., Wang 1967; Woo 1969; Yip 1980; Bao 1990; Duanmu 1990; Chang 1992; Fu 1995; Maran 1971; Halle & Stevens 1971; Hyman 1993), summarised in Table 1-4, tone is directly related to pitch, corresponding to the fundamental frequency (F0) in acoustics and reflecting the rate of vibration of the vocal cords (e.g., Ohala 1978; Rose 1982, 1993). Thus, we find the following characterisations:

> A tone language may be defined as a language having lexically significant, contrastive, but relative pitch on each syllable.
>
> (Pike 1948: 3)

> A tone language is a language in which pitch is used to contrast individual lexical items or words.
>
> (Gandour 1978: 41)

> A language is a "tone language" if the pitch of a word can change the meaning of the word.
>
> (Yip 2002: 1)

> A language with tone is one in which an indication of pitch enters into the lexical realisation of at least some morphemes.
>
> (Hyman 2006: 229)

> Tone is the term used to describe the use of pitch patterns to distinguish individual words or the grammatical forms of words.
>
> (Maddieson 2013)

Table 1-4. Different models for the representation of tonal features

Model	Feature number	Level number	Register number	Register feature	Pitch feature
Wang 1967	7	5	1	[high], [central], [mid], [contour], [rising], [falling], [convert]	
Woo 1969	3	5	1	[high], [low], [modify]	
Maran 1971	2	3	1	[raised F0], [lowered F0]	
Halle & Stevens 1971	2	3	1	[stiff], [slack]	
Yip 1980	2	4	2	[upper]	[high]
Clements 1981	2	4	2	[high]	[low]
Yip 1989	2	4	2	[upper]	[raised]
Bao 1990	2	4	2	[stiff]	[slack]
Duanmu 1990	4	9	3	[stiff], [slack]	[above], [below]
Chang 1992	3	4/6	2	[stiff]	[constricted glottis], [spread glottis]
Hyman 1993	1/2	9	3	[high], [low]	[high], [low]
Fu 1995	2	5	3	[high], [low]	[high], [low]

The conventional understanding of tone is being challenged by an increasing number of studies of unrelated languages, which assert that, beyond differences in pitch, tonal contrasts often involve systematic differences in other parameters (see Section 1.3.). Such factors include:

- duration (e.g., Zee 1978; Kong 1987; Yu 2010; Faytak & Yu 2011)
- vowel quality (e.g., Connell 2002; Fox 2000; Whalen & Levitt 1995; Yip 1980, 2002; Ping 1995; Chan 1985; Myers & Tsay 2003; Donohue 2007, 2013)
- consonants (e.g., Halle & Stevens 1971; Hyman & Schuh 1974; Hombert 1976, 1978; Abramson & Erickson 1978; Ohala 1978; Rose 1996; Thurgood 2002; Yip 1980, 2002; Xu & Xu 2003; Lai & Jongman 2005; Francis et al. 2006; Lai et al. 2009; Ladefoged & Disner 2012)

- phonation (e.g., Andruski & Ratliff 2000; Gordon & Ladefoged 2001; Kuang 2013; Garellek & Keating 2011; Di Canio 2012; Zhu 2012; Mortensen 2013; Esposito 2012), among others

For example, tone 4 and tone 6 in Zhangzhou appear indistinguishable in terms of pitch, because both present a mid-high falling [41] contour in the data in this study. However, the two tones behave differently in other parameters, for example, length, voice quality, vowel quality, obstruent coda, and tone sandhi, as summarised in Table 1-5. This renders the conventional definition of tones, as the lexical phonemicisation of pitch distinctions, inadequate for understanding their nature. Thus, it is important that conducting a linguistic study of tones not only entails determining how many pitch contrasts exist, but also revealing and explaining how tones are realised in addition to the dimension of pitch.

Table 1-5. Multidimensional realisations of citation tones 4 and 6 in Zhangzhou

Parameter	Tone 4	Tone 6
Pitch	[41]	[41]
Length	medium	short
High vowel	breathy	creaky
Mid vowel	modal	*
Low vowel	creaky	creaky
Diphthongisation	*	high vowel diphthongisation
Coda type	sonorant	non-realised obstruent
Sandhi pitch	[63]	[65] (extra short)

1.2. Goals

Considering these three specific research motivations, this book seeks to explore and explain the nature of tones in Zhangzhou guided by five main research questions:

(1) How many tones are there in Zhangzhou?
(2) How are Zhangzhou tones realised across different linguistic contexts?
(3) How do tones interact in constructions beyond monosyllables?
(4) How are disyllabic tones related to citation tones phonologically?
(5) How are various forms of Zhangzhou tones structured abstractly?

These questions are addressed in this study using a multi-methodological approach, including: linguistic fieldwork; acoustic phonetics; statistics; and linguistic theory. Acoustic measurements and normalisations were conducted to quantify the various parameters of tonal realisations, including: F0; duration; vowel quality; voice quality; and obstruent coda, with a set of well-controlled field data from 21 speakers. These speakers offer a reasonable representation of the speech community being investigated. Comparisons were made through pairwise *t*-tests to examine how many F0 and duration levels are contrastive in a given context, and whether the tonal F0 and duration realisations are affected by their surrounding tones, across 64 disyllabic combinations. Phylogenetic methods were applied to visualise the relatedness of a set of tones in a single context (citation, phrase-initial, and phrase-final), and across different contexts, for example, how phrase-initial tones are phonologically related to citation tones. Linguistic theory was drawn upon to explain how tones are related to one another; how native speakers structure various forms of tonal realisation in their mental grammar; and how different linguistic levels interact to shape Zhangzhou tone sandhi.

The quantitative and statistical testing results allowed this study to use graphical and testable patterns to observe, describe, and generalise the nature of tonal realisations and interactions in Zhangzhou. The theoretical discussion benefits from the descriptive results of phonetics and statistics, which are expected to ensure a high level of interpretation and prediction of how the cognitive aspects of tone exist in the mental system; and how the cognitive aspects are mapped onto their phonetic parametrical spaces.

Four research goals have been fulfilled in this book. First, this study directly fills in research gaps in tonal studies of Zhangzhou using modern linguistic theory and methodology. Second, it broadens and examines the existing knowledge of the Southern Min tone sandhi based on a systematic and sophisticated phonetic investigation with a large set of field data. Third, it improves our understanding of the nature of tone as an important linguistic category. Fourth, it expands the empirical domain for typological surveys of tone in Sinitic languages.

1.3. Tonetics

Approximately 50 % (Hyman 2011: 198), and potentially as much as 60–70 % (Yip 2002: 1), of the world's spoken languages are tonal; these are largely distributed across sub-Saharan Africa, South-Central Mexico, and East and Southeast Asia (Pike 1948; Wang 1967; Yip 2002; Hyman 2011), as well as parts of Amazonia and New Guinea (Donohue 1997; Hyman 2006, 2011). As indicated in various tonological models and definitions, tonal contrasts are conventionally characterised by the perceptual dimension of pitch corresponding to the acoustic dimension of fundamental frequency (F0). However, tonal contrasts have often been reported as involving interactions between pitch/F0 and other phonetic parameters, for example, duration, vowel quality, consonant, phonation, and syllable coda type.

1.3.1. Pitch/F0 and vowel quality

Research on the interaction between pitch/F0 and vowels can be categorised into two streams. One stream concerns the intrinsic correlation between pitch/F0 and vowel height (Hombert 1978; Connell 2002; Fox 2000; Whalen & Levitt 1995; Hoole & Hu 2004), while the other considers the occurrence of the restriction of vowels with respect to different tones (Yip 1980, 2002; Ping 1995; Chan 1985; Myers & Tsay 2003; Donohue 2007, 2013; Mortensen 2013).

First, it has been attested cross-linguistically that high vowels tend to have a higher fundamental frequency than low vowels (Connell 2002; Fox 2000; Whalen & Levitt 1995). For instance, Whalen & Levitt (1995) conducted a survey of 31 languages from 11 language families to investigate the intrinsic interaction between F0 and vowel quality. The results justified the general assumption of a positive correlation between vowel height and F0 height, and indicated that the intrinsic F0 has no significant correlation with the dimension of vowel backness. In addition, the size of the intrinsic F0 is not significantly affected by the size of the vowel inventory of a natural language.

Second, vowel quality has been reported as undergoing alternation in accordance with specific tonal environments, for example, in the Mang dialect of Shuijingping (Mortensen 2013) and the Min dialect of Fuzhou (Yip 1980, 2002; Ping 1995; Chan 1985; Myers & Tsay 2003; Donohue 2007, 2013). Specifically, a vowel-raising process was found in Fuzhou with respect to higher pitched tones, as shown in Table 1-6 (Myers & Tsay 2003: 119).

Table 1-6. Vowel alternations with respect to tones in Fuzhou

Tone	Vowel alternation								
LM, LML	æ	ai	au	aγ	ei	ou	œγ	ieu	uoi
H, HL, M	ε	ei	ou	oy	i	u	y	iu	ui

In this study, the vowel quality of Zhangzhou was also found to change with respect to tonal category. For example, the high vowels were observed to undergo alternation between monophthongs and diphthongs in the stopped citation tones. This alternation of vowel quality contributes to the distinction between stopped tones and their corresponding unstopped tones, which share similar realisations in pitch.

1.3.2. Pitch/F0 and duration

The correlation between vowel duration and pitch/F0 has been studied cross-linguistically (e.g., Zee 1978; Kong 1987; Yu 2010; Faytak & Yu 2011). In general, vowels with low tones are found to have a longer duration than those with high tones, and vowels with rising tones appear longer than those with falling or level tones (Yu 2010; Faytak & Yu 2011). In other words, pitch/F0 height and duration are negatively correlated: the higher the pitch/F0, the shorter the duration; the lower the pitch/F0, the longer the duration.

Counter-examples are also found showing a positive association between pitch/F0 and duration, such as in Taiwanese (Zee 1978; Kong 1987), Cantonese (Faytak & Yu 2011), and Yucatec Maya (Faytak & Yu 2011). For example, the mid-level tone in Cantonese is observed to be longer than the mid-low level tone (Faytak & Yu 2011).

In this study, the parameter of duration is seen to play an important role in tonal realisations and distinctions in Zhangzhou. For example, level and rising pitched tones were observed to be significantly longer in statistical terms than falling-pitched tones in the citation context, but no statistically significant differences exist between the level contours (e.g., mid-level vs. low level) and between the unstopped falling contours (e.g., high falling vs. mid-high falling); this fails to support the cross-linguistic assumption of an inverse correlation between pitch height and duration.

1.3.3. Pitch/F0 and consonant

The intrinsic correlation between pitch/F0 and (prevocalic) consonants has been widely reported in the literature (e.g., Halle & Stevens 1971; Hyman & Schuh 1974; Hombert 1976, 1978; Abramson & Erickson 1978; Ohala 1978; Rose 1996; Thurgood 2002; Yip 1989, 2002; Xu & Xu 2003; Lai & Jongman 2005; Francis et al. 2006; Lai et al. 2009; Ladefoged & Disner 2012). For example, Hyman & Schuh (1974: 110) proposed a phonetic hierarchy showing continuous consonant-induced perturbative effects on tonal pitch, as shown in Figure 1-1.

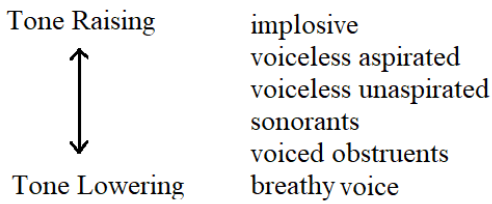

Figure 1-1. Phonetic hierarchy of consonant-induced perturbative effects on tonal pitch.

As indicated in this figure, the prevocalic voiced obstruents are treated as having a depressive effect on the pitch/F0 onset of following vowels, while their voiceless counterparts can raise the onset. This voicing-induced perturbation effect on pitch/F0, generally, has been considered to be a primary motivator of tonal development in Chinese (Yip 2002); Thai (Abramson & Erickson 1978); Vietnamese (Thurgood 2002); and many languages in the Tibetan-Burman language family, the Austronesian language family, and the Hottentot language family of South Africa (Hombert 1978: 79). Specifically, the concept of Yin and Yang register in Sinitic languages reflects the historical association between the tonal pitch and voicing status of syllable onsets; it is still commonly used to classify spontaneous tones.

In addition, aspiration (positive lag of voice onset timing) is generally considered to have the effect of raising perturbation on the pitch/F0 of following vowels in a language, regardless of whether it is tonal or not. For example, Lai et al. (2009) found that F0 is, statistically speaking, significantly higher in the aspirated than the unaspirated environment in Taiwanese. However, some languages are reported to show conflicting results (Hombert 1976, 1978). For example, the aspiration-induced perturbation effect on the F0 onset is found not to be systematic in American English and French (Hombert 1976), while Hindi has a higher F0 after voiceless, unaspirated obstruents, rather than after aspirated obstruents (Hombert 1978).

In this study, the corpus designed for the elicitation of tonal data incorporated syllable onsets with different manners and places of articulation to maximally balance the perturbative effect of prevocalic consonants on F0 realisations. Each tone is given its corresponding name in the Middle Chinese (MC) tonal categories with Yin and Yang registers, making this study comparable, both synchronically and diachronically, to previous research on Zhangzhou and studies on other Sinitic dialects and their varieties that categorise synchronic tones in accordance with conventional fashion.

1.3.4. Pitch/F0 and phonation

The function of phonation in tonal systems has received substantial cross-linguistic attention (e.g., Ladefoged 1971; Laver 1980; Huffman 1987; Andruski & Ratliff 2000; Gordon & Ladefoged 2001; Pan 2005; Garellek & Keating 2011; Esposito 2010, 2012; Di Canio 2009, 2012; Zhu 2012; Kuang 2013; Mortensen 2013). First, non-modal phonation is reported as occurring as an allophonic variant of modal phonation, depending on a specific tone, for example, in White Hmong (Esposito 2012); White and Blue Hmong (Huffman 1987); Green Hmong (Andruski & Ratliff 2000); and Itunyoso Trique (Di Canio 2012). To give a further example, in Burmese each tone is characterised by a particular type of phonation, including a low, modal-voiced tone; a high, breathy tone; a high, creaky tone; and a very high, tense-voiced tone (Mortensen 2013: 204).

Second, non-modal phonation may intersect independently with the tonal system, possibly multiplying the number of tonal contrasts. For example, Jalapa Mazatec contrasts three phonation types (breathy, modal, and laryngealised) and three level tones (low, middle, and high), independently (Garellek & Keating 2011). Another possibility is that non-modal phonation is occasionally associated with a certain tone among some speakers and for some occasions. For example, the third tone in Mandarin is produced occasionally with a creaky phonation (Kuang 2013).

In this study, the non-modal phonations—creaky, breathy, and falsetto—are observed to occur as allophonic variants of modal phonation, with a distribution conditioned by vowel quality; pitch contour; syllable coda; and/or tonal category. For example, the breathy voice is found to occur in high vowels across unstopped tones regardless of the pitch contour; while the creaky voice occurs in low vowels, but only in falling-pitched contours. The phonations are neutralised to become creaky in the stopped tones where the obstruent codas are not realised, but to become falsetto in the stopped tone 6 that occurs in the non-utterance-final context.

1.3.5. Pitch/F0 and syllable coda

In many tonal languages in East and Southeast Asia, tones are classified into the categories of unstopped and stopped depending on the type of syllable coda (e.g., Benedict 1948; Pike 1948; Leiste 1976; Gandour 1978; Ballard 1988; Chen 2002; Zhang 2007; Ratliff 2015). The presence of syllable obstruent codas is considered to constrain the number of tonal contrasts and determine which tone should appear. For example, Hyman (2012: 191) summarised the limiting effect of obstruent codas on tonal contrasts in several Sino-Tibetan languages, as shown in Figure 1-2.

Language	*classification*	*"smooth" syllables*	*stopped*	*ratio*	*codas*
Bola	Lolo-Burmese	H, L, HL	H, HL	3:2	p t k ʔ m n ŋ
Maru	Lolo-Burmese	H, M, L	H, L	3:2	p t k ʔ m n ŋ
Tangkhul	Naga	H, M, L	M, L	3:2	p t k m n ŋ r w y
Trung	Nungish	H, L, HL, LH	H	4:1	p t k ʔ m n ŋ l r
Jingpho	Jingpho	H, M, L, HL	H, L	4:2	p t k ʔ m n ŋ
Karen (Pa'o)	Karenic	H, M, L, HL	M, L	4:2	p t k ʔ m n ŋ
Xiamen	Chinese	44, 24, 22, 21, 53	4, 32	5:2	p t k ʔ m n ŋ w y
Cantonese	Chinese	53~55, 33, 22, 21, 35, 23	5, 4, 3	6:3	p t k m n ŋ w y

Figure 1-2. Limiting effect of obstruent codas on tonal contrasts.

As indicated, a full inventory of tonal contrast is preserved in "smooth" syllables that end in sonorant codas, while the number of tonal contrasts are reduced in "stopped" syllables that end in obstruent codas at the underlying level (Hyman 2012: 191). In addition, the tonal contrasts found in the stopped syllables tend to be a subset of those shown in smooth syllables.

Thus, tones appear to be asymmetrically distributed with respect to the syllable coda type. However, how the asymmetry of tonal distribution is formally accounted for can give rise to competing solutions. For example, the tonemic approach considers stopped tones and smooth tones to be two distinct categories (Sagart 1998; Chen 2000); while the allotonic approach treats stopped tones as an allotonic subset of unstopped tones (Benedict 1948; Hyman 2012).

In this study, the realisation of obstruent codas is observed to be contextually sensitive. They are found to be perceivable only in the non-utterance-final context. However, regardless of whether the codas are realised or not, a series of resulting phonetic effects are observable as impacting segmental and suprasegmental manifestations, which helps distinguish stopped tones from corresponding unstopped tones that share similar realisations in pitch. For example, as illustrated in Table 1-5, stopped tone 4 and its unstopped counterpart tone 6 are treated as two independent categories because of the differences in the realisation of other parameters.

1.4. Southern Min Tone Sandhi

The realisation of tones can be alternated when tones interact with each other in utterances beyond monosyllables. The process of contextually-triggered tonal alternation is generally referred to as *tone sandhi* in the literature (e.g., Benedict 1948; Pike 1948; Leiste 1976; Gandour 1978; Ballard 1988; Chen 2002; Zhang 2007; Ratliff 2015). For example:

> Under the circumstances appropriate to a given language, a syllable may have its normal toneme removed and a different one substituted for it.
>
> (Pike 1948: 22)

> [I]ts phonetic realisation may be influenced by the presence or type of tone on an adjacent syllable (or word). This phenomenon is referred to in linguistic literature under the name of tone sandhi.
>
> (Leiste 1976: 231)

> [T]ones change their shapes due to the effect of neighbouring tones upon one another.
>
> (Gandour 1978: 5)

> Tone sandhi describes phonetically conditioned morphotonemic alternations at the junction of words or morphemes.
>
> (Chen 2000: F37)

> Tone sandhi refers to tonal alternations conditioned by adjacent tones or by the prosodic or morphosyntactic position in which the tone occurs.
>
> (Zhang 2007: 259)

Southern Min, as a major branch of the Min language group in the Sino-Tibetan language family, has long been asserted to exhibit an intricate tone sandhi phenomenon known as the *Southern Min tone circle*, because the tonal alternation is conventionally considered to form a "musical-chair" pattern that is produced by the replacement of tone A with tone B; this in turn is replaced by tone C, and so on (Chen 2000: 42). The Southern Min tone sandhi has attracted substantial attention from different perspectives to address the following four main aspects:

- Directionality of SM tone sandhi (e.g., Tsay 1991, 1994; Hashimoto 1982).
- Definition of SM sandhi domain (e.g., Chen 1987; Lin 1994; Zhang 1993).
- Rule-based and constraint-based interpretation of SM tone circle (e.g., Wang 1967; Yip 1980; Tsay 1991; Hsieh 2005; Barrie 2006; Thomas 2008).
- Lexicon-based interpretation of SM tone sandhi (e.g., Hsieh 1976; Wang 1992; Tsay & Myers 1996; Zhang et al. 2006; Zhang et al. 2007; Chen et al. 2010).

As summarised below, various attempts have been made to account for the nature of Southern Min tone sandhi, primarily focusing on the varieties spoken in Xiamen or Taiwan; however, little agreement has been reached with regard to each aspect of the problems faced.

1.4.1. Domain of SM tone sandhi

The Southern Min tone sandhi domain is considered to be syntactically relevant (Chiu 1931; Chen 1987; Lin 1994; Zhang 1993), but conflicting opinions exist as to how the tone sandhi domain should be specified. Chiu (1931: 24, as cited in Chen 1987: 114) assumed the sandhi domain (also known as tone group) to be in a one-to-one correspondence to syntactic constituents, and that the citation tones signified the end of morphosyntactic units. Chen (1987: 147) claimed that the prosodic domain for the Southern Min tone sandhi "is circumscribed by, but not necessarily isomorphic to, surface syntactic structure." As such, he characterised the SM tone sandhi domain through marking "the right edge of every XP with #, except where XP is an adjunct c-commanding its head" (Chen 1987: 131).

Chen's definition was revised further by Zhang (1992, as cited in Zhang 1993: 302) as: "Mark the right edge of every XP with #, except where XP is an adjunct m-commanding either its head or the head of XP on the right except infl." Lin (1994: 248) defined the prosodic domain for SM tone sandhi in terms of lexical government: "$]_{Xmax}$, X^{max} not lexically governed."

As mentioned, the tone sandhi domain in Southern Min is generally considered to be aligned with syntactic phrase; however, not every XP is considered to be able to mark a prosodic group within which a sandhi process occurs. For example, Chen (1987) considered that the adjuncts within a projection of lexical categories, such as N or V, tend not to form separate tonal domains, but are subsumed under the larger XP group categorised as NP or VP.

The tone sandhi domain in Zhangzhou is also observed to be syntactically sensitive. Within a given syntactic phrase, the parametrical realisations of the tones in the non-phrase-final context undergo alternation, phonologically and phonetically. The alternations tend not to be affected by the international structures of syntactic phrases, as discussed in Chapter 7.

1.4.2. Directionality of SM tone sandhi

Two competing proposals exist with respect to the directionality of Southern Min tone sandhi. First, the direction of Southern Min tone sandhi shifts from the juncture (domain-final) to the context (the non-final) position (e.g., Wang 1967; Chen 1987; Yip 1980; Shih 1986; Zhang 1993; Yip 2002; Hsieh 2005; Barrie 2006; Thomas 2008). In other words, this proposal considers the citation/juncture form as the basis and the context/sandhi form as the derived form. The mapping between citation and sandhi forms can be schematised as follows (Chen 1987: 113):

$$T \rightarrow T'/\_T$$

(where T is the citation tone and T' is the sandhi tone).

This formula indicates that one tone's citation form is the sandhi form of another tone. The whole tone sandhi process of sonorant-ending syllables is thus considered to be circular, while the tone sandhi process of obstruent-ending syllables forms a subsystem of its own, as shown in Figure 1-3 (Chen 1987: 111–112).

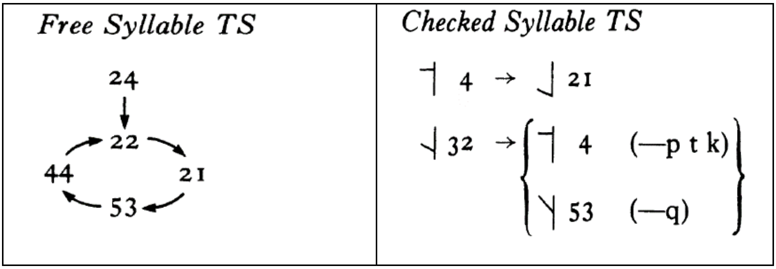

Figure 1-3. Southern Min tone circle in Xiamen (juncture to context).

Alternatively, some scholars (e.g., Hashimoto 1982; Tsay 1991, 1994) have asserted that the direction of tonal alternation is from the context form to the prejuncture form. In other words, the juncture is considered to be the conditioning environment, in which the prejuncture form is derived from the context. The derivation process is formulated as below (Tsay 1991: 83).

$$T_{con} \rightarrow T_{pre} / \_ \ \#$$

(where T_{con} is the context tone; T_{pre} is the prejuncture tone; and # is the juncture)

Similarly, the whole tone sandhi process of sonorant-ending syllables has also been reported as forming a circular process of change, as shown in Figure 1-4 (Tsay 1991: 83).

The tone alternation is given in (16).

(16) Context tone (basic) --> prejuncture tone (derived)

	T_{con}		T_{pre}
Tone I&II	Ø	-->	H
Tone III	H	-->	HL
Tone IV	HL	-->	L
Tone V	L	-->	Ø

The South Min Tone Circle now appears as in (17).

(17) The South Min Tone Circle

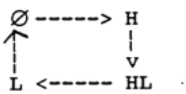

Figure 1-4. Southern Min tone circle in Taiwan (context to prejuncture).

In this study, tonal contrast neutralisation is observable as occurring across different contexts, including citation, phrase-initial, and phrase-final ones. Determining which form is basic and which form is derived is difficult. In other words, the sandhi (non-phrase-final) forms and citation forms are not in a derivational relationship in Zhangzhou. Thus, as Tsay & Myers (1996: 402) stated, the direction of the Southern Min tone sandhi appears to be indeterminate, and there seems to be "no compelling reason for choosing one of the alternating tones as underlying and the other as derived."

1.4.3. Theoretical interpretation of SM tone sandhi

1.4.3.1 Rule-based interpretation

In the paradigm of generative phonology, researchers (e.g., Wang 1967; Yip 1980; Shih 1986; Tsay 1991) have endeavoured to formulate the SM tone sandhi process in terms of rule(s), under the assumption that the tonal alternations are circular. However, the rules they formulated appear to be arbitrary and fortuitous, and therefore unsatisfactory in providing a unified and adequate explanation, as reflected in the following aspects.

First, they show little agreement with respect to how tonal features are represented, as well as how many and what rules are needed. For example, Wang (1967) asserted that each alternating process in Amoy (Xiamen) involved only one change in the specification of either the high or falling feature, thus the whole tone sandhi process could be characterised using a single alpha-switching rule, as shown in Figure 1-5 (Wang 1967: 103–104).

$$\begin{bmatrix} \alpha\ \text{HIGH} \\ \beta\ \text{FALLING} \end{bmatrix} \rightarrow \begin{bmatrix} \beta\ \text{HIGH} \\ -\alpha\ \text{FALLING} \end{bmatrix}$$

$$\begin{bmatrix} +\text{HIGH} \\ -\text{FALLING} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{HIGH} \\ -\text{FALLING} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{HIGH} \\ +\text{FALLING} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{HIGH} \\ +\text{FALLING} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{HIGH} \\ -\text{FALLING} \end{bmatrix}$$

Figure 1-5. Phonological rule for Xiamen tone sandhi in Wang's (1967) model.

Yip (1980) proposed three separate rules, including register switching, recessive deletion, and dissimilation to account for the tone sandhi process (H/LM→M→L→HL→H) in Amoy (Xiamen), as reflected in Figure 1-6 (Yip 1980: 324–326).

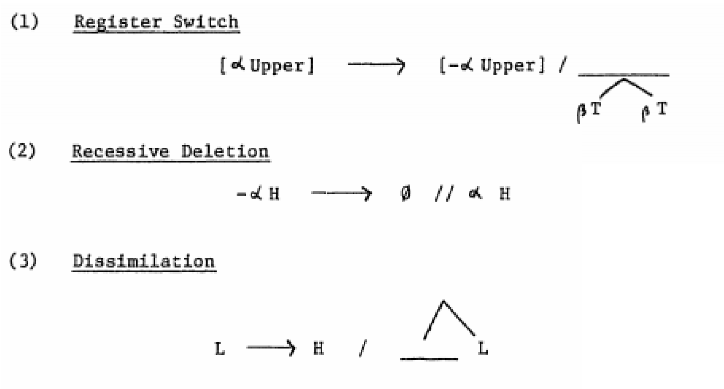

Figure 1-6. Phonological rules for Xiamen tone sandhi in Yip's (1980) model.

Shih (1986) formulated four alternation processes to account for the tone circle in Xiamen, as shown in Figure 1-7 (Shih 1986: 14). However, the proposal did not provide an exploratory statement on what mechanisms motivated tones to change in such a circular fashion.

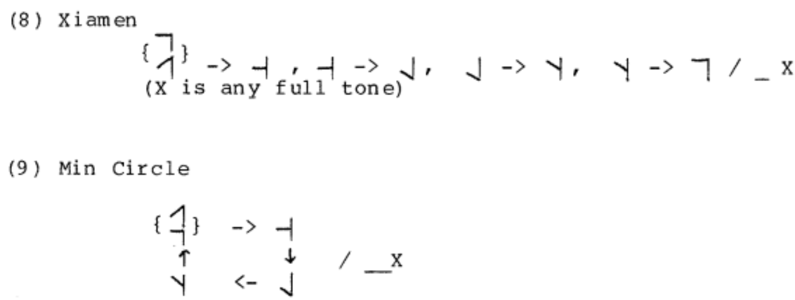

Figure 1-7. Phonological rules for Xiamen tone sandhi in Shih's (1986) model.

Tsay (1991) proposed one principle (the Contrastive Preservation Principle) and two constraints (the Rule Argument Constraint and the Rule Exchange Constraint) to generalise the process of tone sandhi (Ø→H→HL→L→Ø) in Taiwan. She asserted that, if the principle and constraints were satisfied, "the tonal alternation rule itself is simply Insert H" (Tsay 1991: 85), as shown in Figure 1-8.

Step one: apply **Contrast Preservation Principle**[9]:

```
Ø  -->  {H, HL, L}
H  -->  {Ø, HL, L}
HL -->  {Ø, H,  L}
L  -->  {Ø, H, HL}
```

Step two: apply **Rule Argument Constraint**

```
Ø  -->  {H,  L}
H  -->  {Ø, HL}
HL -->  {H,  L}
L  -->  {Ø, HL}
```

Step three: apply Taiwanese Tone Alternation Rule Ø --> H

```
Ø  -->  {H}
H  -->  {Ø, HL}
HL -->  {H,  L}
L  -->  {Ø, HL}
```

Step four: apply **Exchange Rule Constraint**

```
Ø  -->  {H }
H  -->  {HL}
HL -->  {L }
L  -->  {Ø }
```

Figure 1-8. Phonological rules for Taiwan tone sandhi in Tsay's (1991) model.

Second, they offer disjointed treatment on the directionality of the sandhi process. The rules are observed as operating in a prejunture-context direction in most proposals (e.g., Wang 1967; Shih 1986; Yip 1980), but in the opposite direction—context-prejuncture—in some others (e.g., Tsay 1991).

Third, they lack explanatory power to account for different SM varieties. The rules that they formulated tend to characterise only the sandhi pattern of the linguistic variety being investigated. However, the phonetic values of the tones vary among studies and varieties, undermining the plausibility and generalisability of the proposed models to account for varieties sharing similar patterns, but different phonetics. For example, Yip's model gave the process HL→L for Xiamen SM; while Tsay's model offered the process HL→H for Taiwan SM. Thus, the register switching rule proposed by Yip appears unable to capture Tsay's process.

1.4.3.2 Optimality theory-based interpretation

While the various rule-based approaches have been claimed to have problems characterising the nature of SM tone sandhi, phonologists (e.g., Hsieh 2005; Barrie 2006; Thomas 2008) have resorted to optimality theory (OT) for a formal interpretation under the assumption that sandhi processes are chain shifts in the direction from prejuncture (citation) to context (sandhi) tones. Thus, various extensions of classical OT have been invented (e.g., Hsieh 2005; Barrie 2006; Thomas 2008). They have also encountered theoretical difficulties in providing an adequate, unified explanation, as reflected in the following two aspects.

First, they have reached little consensus with respect to what constraints are needed and how they are ranked. For example, Hsieh (2005) asserted that the tonal chain-shifts (H→M, M→L, L→HL, HL→MH, LM→L) in SM are triggered by phonetically-based constraints on the appearance of contour and high-registered tone. He thus proposed a constraint (Max (Tone) longer-syllable) to explain why a rising tone was prohibited in the sandhi position and anti-merger constraints (e.g., *Merger (tone)) to prevent tones from being neutralised in the non-prominent context. The constraints were applied as shown in Figure 1-9 (Hsieh 2005: 109).

	*RISE	*MERGE (L)	*MERGE (H)	*MERGE (TONE)	¬ IDENT-OO-(H-REGISTER)
☞ a. H → M M → L L → F F → H LR → M				*	**
b. H → H M → M L → L F → F LR → M				*	***!

Figure 1-9. OT interpretation for Taiwan/Xiamen tone sandhi in Hsieh's (2005) model.

Barrie (2006) asserted that the SM tonal circle resulted from a preservation of the contrast between tonal features and markedness. As such, he proposed PRESERVECONTRAST output Constraints, such as PC_{out} (Register) and PC_{out} (Pitch), to penalise the output failing to maintain a contrast for a given feature; and markedness constraints (e.g., *Rise, *Contour, and *High) to penalise contour tones and, in particular, rising tones that occur in the sandhi context. The constraints are modelled as shown in Figure 1-10 (Barrie 2006: 138).

	Scenarios	*Rise	PC_{OUT} (Register)	PC_{OUT} (Pitch)	*Contour	*High
1	☞ 24→22 21 53 44			*	**	*
2	24→22 21 53 44		*!	*	**	*
3	24→22 21 53 44			*	***! (2 for /21/ and 1 for /53/)	*
4	24→22 21 53 44		*!		*** (2 for /53/ and 1 for /21/)	*
5	24→22 21 53 44			*	**	**! (1 for /53/ mapping to /44/ and 1 for /44/ mapping to itself)
6	24 22 21 53 44	*!			***	*

Figure 1-10. OT interpretation for Xiamen tone sandhi in Barrie's (2006) model.

Thomas (2008) proposed six constraints to capture the chain shifts in Xiamen tone sandhi on the basis of two fundamental assumptions: (a) tonal structures were preserved during the process; and (b) the evaluation of candidates was systemic. He thus asserted *rise as a high-ranking markedness constraint that motivates an alternation, and proposed the constraints *Merger and Differ as the factors triggering a circular change. The constraints were ranked as shown below (Thomas 2008: 427):

DIFFER, *RISE >> *MERGE >> DRAT >> Ident(Pitch) >> Ident(Shape)

Second, they also lack explanatory power in accounting for different SM varieties. Similar to the rule-based approaches, the set of constraints is formulated with respect to the phonetic properties of the variety being considered in a particular model, but it needs to be tested in the analysis of other varieties that present similar tonal shift patterns, but differ in phonetic details, to evaluate cross-linguistic relevance. For example, the constraint against rising contour (*Rise) is ranked as having the highest dominance among the proposed models for Xiamen and/or Taiwan. However, this constraint appears unattested in the Zhangzhou case, in which a falling citation contour is realised as a rising contour in the sandhi context (see Chapter 5).

1.4.3.3. Lexicon-based interpretation

While it appears phonologically challenging to offer a natural and unified explanation for the motivation of Southern Min tone sandhi, a group of researchers have conducted experiments to test the psychological reality of the SM tone sandhi rule (e.g., Hsieh 1976; Wang 1992; Tsay & Myers 1996; Zhang et al. 2006; Chen et al. 2010), the results of which largely discredit the full productivity of the tone sandhi rule in Taiwanese, and favour a lexicon-based interpretation of the relationship between sandhi and citation tones. However, these studies are somewhat controversial concerning the extent that sandhi rules are real; and systematic phonetic investigation is needed to develop a more plausible interpretation.

Hsieh (1976) asserted that some phonological rules of Taiwanese tone sandhi are unreal and that generative phonology, as a theory, has a questionable psychological reality on the basis of his experimental results. Instead, he proposed that both sandhi and non-sandhi forms be listed in the lexicon and the choice between the two alternatives should be optional. However, the explanatory power of his assertion can be considered limited because Hsieh's research only involved one female bi-dialectal speaker of coastal and inland Taiwanese, and only focused on low-rising [13] and high-falling [53] tones at the underlying level.

Wang (1992) claimed that both isolation and sandhi tones are listed in the lexicon, based on his long-term investigation of seven tones of 22 native speakers of Hsinchu Taiwanese. Contrary to Hsieh's (1976) findings, Wang asserted that "some sandhi rules are real to a certain degree, although perhaps not to the degree of being automatically generative as assumed in SPE" (125). This implies that the rules governing sandhi are organisational, rather than derivational. Thus, the difference between Wang's lexicon-based proposal and the rule-based models appears to be how generative the rules are.