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Tonal Representation of Chinese Wenzhou Dialect

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This paper centers on tonal representation of Chinese Wenzhou dialect. Tonal behaviors in Wenzhou indicate that tone is on an independent tier to the segment. Also, because of the complex of register and contour, Chinese tones have been represented with a structure of two dimensions, i.e. register and contour. However, these representations present an insolvable dilemma when analyzing the tonal behavior of Wenzhou dialect. Noticing that tone sandhi in Wenzhou is totally blind to register, we will propose that register is not an underlying feature for Wenzhou tone. We will further suggest that it is the initial consonant that carries the feature of register. This paper will conclude that the tonal representation of Wenzhou dialect has only one level, the tonal contour is formed by concatenation of level tones, and initial consonants carry the burden of meaning distinction that "tonal register" is supposed to carry.

Keywords: Southern Wu Chinese, Wenzhou dialect, tonology, representation of tone, tonal category, tonal contour

1. Introduction

This paper centers on tonal representation of Chinese Wenzhou dialect [1]. The first part of the paper is a brief review on tonal representation for Chinese languages. The second part is an introduction to the phonological system of Wenzhou. Since tone in Wenzhou is closely related to initial consonants, this paper will pay particular attention to the initials. The third part focuses on tonal representation. We will argue that it is hardly controversial that tone in Wenzhou dialect is at an auto-segmental tier. Tonal behaviors, such as floating tone, in Wenzhou indicate that tone is on an independent tier to the segment. Also, because of the complex of register and contour, Chinese tones have been represented with a structure of two dimensions, i.e. register and contour. However, these representations present an insolvable dilemma when

[1] Wenzhou is located in the southeastern area of Zhejiang Province in China; Wenzhou dialect is classified as a Southern Wu dialect.

analyzing the tonal behavior of Wenzhou dialect. Noticing that tone sandhi in Wenzhou is totally blind to register, we will propose that register is not an underlying feature for Wenzhou tone. We will further suggest that it is the initial consonant that carries the feature of register. This paper will conclude that the tonal representation of Wenzhou dialect has only one level (i.e. end node tone), the tonal contour is formed by concatenation of level tones, and initial consonants carry the burden of meaning distinction that "tonal register" is supposed to carry.

2. Tonal representation for Chinese languages

2.1 *Yin*-*Yang* registers

Traditionally, Chinese tones are classified into the *yin* and *yang* registers. Historically, the *yin* tones occur on syllables with voiceless initial obstruents, and the *yang* tones occur on syllables with voiced initial obstruents. The voiced obstruents of Middle Chinese are lost in many modern dialects, mostly of the Mandarin variety. But some dialects, particularly those spoken in Zhejiang, Jiangsu, and Hunan provinces, still maintain voicing as a distinctive feature among obstruents. From the perspective of phonetics, it is well known that voiceless consonants induce higher pitch in the following vowel, and voiced consonants induce lower pitch (Haudricourt 1954; Halle and Stevens 1971). The correlation between *yin* and *yang* on the one hand, and the pitch of tone on the other, does not present a clear pattern over modern Chinese dialects. In some dialects with voiced obstruents, notably those in the Wu dialect family, the *yin* tones are higher in pitch than their *yang* counterparts. In other dialects, such as those in the Southern Min dialect family, the situation is reversed [2]. In tonal languages, tones are not necessarily correlated with consonant voicing.

The tones are further classified into four tonal categories: *ping* "level", *shang* "rising", *qu* "departing", and *ru* "entering". Each of the four tonal categories can be realized in both the *yin* and *yang* registers, giving a total of eight tones.

(1) Traditional Classification of Tones for Chinese [3]

yin ping (=Aa)	*yin shang* (=Ba)	*yin qu* (=Ca)	*yin ru* (=Da)
yang ping (=Ab)	*yang shang* (=Bb)	*yang qu* (=Cb)	*yang ru* (=Db)

[2] For example, in Chaoyang and many other Southern Min dialects, high-pitched tones are found in syllables with voiced initials, and low-pitched tones on syllables with voiceless initials (Wang 1967).

[3] *Ping*, *shang*, *qu*, and *ru* are marked with capitalized letter *A*, *B*, *C*, and *D*. *Yin* and *yang* registers are marked with lower cased *a* and *b*.

The *ru* "entering" tones are the so-called checked tones, because they are realized on syllables ending in the voiceless stops /p, t, k, ʔ/, depending on the specific dialect. This historical classification does not give the phonetic pitch of tones. The meanings of the tonal labels are obscure at best, and we have no clear idea how the tones in classical Chinese were realized phonetically (Mei 1970; Ting 1975; Zhang 1986, 1987). According to Mei (1970), the tones in Middle Chinese can be characterized as follows.

(2) *Ping*: long, level, and low, with a higher and a lower allotone, i.e. *yin* and *yang* allotones.
Shang: short, level, and high, its lower allotone having merged with the departing tone, i.e. *qu* tone.
Qu: slightly drawn out and hence longish.
Ru: short.

These descriptions are not explicit enough to allow a precise determination of the pitch height and contour of the tones. The labels may reflect the phonetic properties of the tones at the time when they were coined, but judging by the tones of modern dialects, the names are hardly an indication of their pitch height or contour. For instance, the *yin ping* is realized as high level [4] in Beijing Mandarin, but in Tianjin, a port city about a hundred miles southeast of Beijing, the same tone is realized as low falling [5]. Both Beijing and Tianjin dialects belong to the Mandarin family. In current Chinese linguistics practice, the traditional register terms *yin* and *yang*, and the tonal labels *ping*, *shang*, *qu*, and *ru* are still employed, but only to refer to "tonal categories" of ancient Chinese. They are used for the convenience of cross-dialectal or diachronic comparison. More commonly, a tone is often described in terms of its pitch height, and the pitch shape it has over the duration of the syllable. One of the currently debated topics in Chinese tonology is the question of how to render the descriptive terms of pitch height and pitch shape into formal representation.

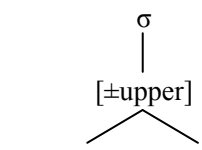
2.2 Tonal representation in non-linear phonology

In Chinese linguistics literature, tone is virtually always classified by two sets of descriptive terms: one denoting register (*yin* and *yang*, or high and low), the other pitch contour (even, rising, falling, and entering). This practice implies that tone consists of two independent, orthogonal dimensions: register and pitch contour. A

[4] Tonal value is *55* in a five-point scale notation proposed by Chao (1930).
[5] Tonal value is *21*.

musical analogy is often used to make these terms clear: register is like the key and pitch contour is like the melody. This bi-partition of tonal properties is already implicit in Wang (1967), where [high, central, mid] constitute one subset of features in contraposition to [rising, falling, concave, convex]. It is Yip (1980) who first provided the formal means to describe the internal structure of these two dimensions of tonal features.

(3) Yip's Tonal Representation



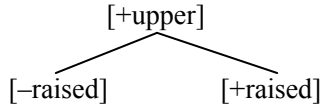
Basically, Yip first bisects the tonal space into two discrete registers: the upper ([+upper]) and the lower ([–upper]) portions of the vocal range. Within each register, the pitch is fine-tuned by the feature [±raised], yielding four possible even tones. However a tonal system contains only [H], [M], and [L] tonemes, from which the combination will yield three level tones.

(4)	+upper	+raised	[H]
		–raised	[M]
	–upper	+raised	[M]
		–raised	[L]

Contour tones are represented geometrically as a branching root node with two opposite-valued terminal nodes. Thus, a high-rising and a low-falling tone have the internal structure of (5a) and (5b), respectively.

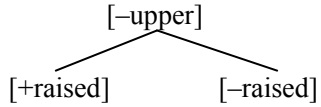
(5) Representation for Contour Tones

a. high-rising:



= MH

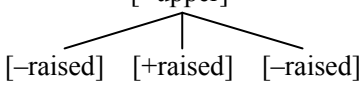
b. low-falling:



= ML

And a complex tone like MHM can be represented in like manner, as shown in (6).

(6) high rising-falling

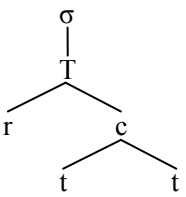


= MHM

Bao (1990) proposes an alternative geometrical configuration, where the register and the contour hang from the tone root as sister nodes, thus allowing independence between register and contour.

(7) Bao's Tonal Representation

a.

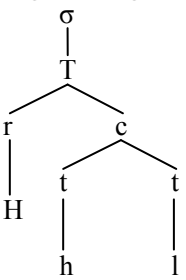


= tonal root node

= register and contour

= terminal tone segments

b. High Falling Tone in Bao's System

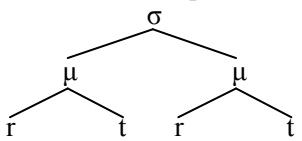


= HM

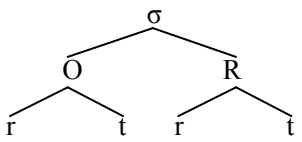
And a third proposal is that of Duanmu (1994) in which each syllable is considered bi-moraic or as consisting of onset and rhyme. Each mora (or onset and rhyme) then in turn serves as TBU.

(8) Duanmu's Tonal Representation

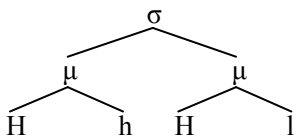
a.



b.



c.



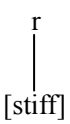
= HM

Geometrical representations like (3), (5), (6), (7), and (8) make explicit a number of empirical claims, the most important of which are: (i) tone is an auto-segment, linked to its segmental host by an association line; and (ii) register (pitch height) and contour (pitch movement, melodic shape) constitute two dimensions of tone.

2.3 Tone as laryngeal feature

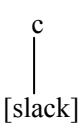
People also specify tone with laryngeal feature. In above representations, the r-node is specified by the laryngeal feature [stiff vocal cords], or [stiff] for short, proposed by Halle and Stevens (1971). Formally, it is a non-terminal node that dominates a single feature.

(9)

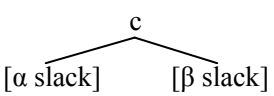


The contour node *c* is specified by the laryngeal feature [slack vocal cord], or [slack]. Following Yip (1980, 1989), the contour node may dominate a single [slack] specification, or a sequence of [slack] specifications. The c-node has two formal configurations.

(10) a.

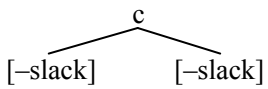


b.

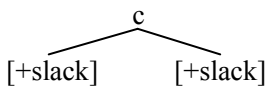


(10a) is the configuration for an even (or level) tone, and (10b) is the configuration for a contour tone. The values of the feature [slack] in any given sequence are different. It is assumed that the configurations in (10a) are conceptually equivalent to (11).

(11) a.



b.



In articulatory terms, the features provide articulatory instructions to the relevant articulators. Since the branching of the c-node is temporal, the sequences of [slack] in (11) provide the same articulatory instructions to the same laryngeal articulators over time. Similarly, in configuration (10a), the single feature [slack] provides the same articulatory instructions over time. The articulatory effect produced by the configurations in (11) and (10a) are identical. An articulatory meaningful branching structure involving a single feature must have different specifications of the feature.

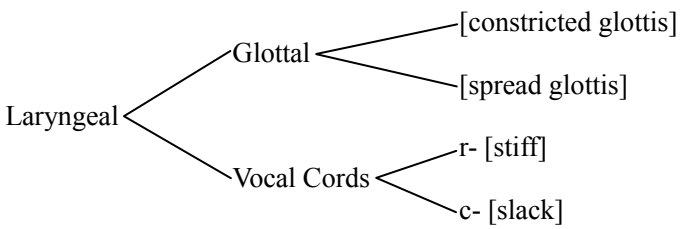
Functionally, the features [stiff] and [slack] are equivalent to [upper] and [raised] as proposed by Yip (1980, 1989).

(12)

H =	[+stiff]	([+upper])
L =	[–stiff]	([–upper])
h =	[–slack]	([+raised])
l =	[+slack]	([–raised])

Since tone is phonetically executed by the vocal cords, the geometry of tone is a substructure of the geometry of laryngeal features. Of the four laryngeal features of the Halle and Stevens (1971), two concern the tension of the vocal cords and two concern the state of the glottis. Bao proposes that these four features have the following structure.

(13)



3. Tonal representation in Wenzhou dialect

3.1 Sound system in Wenzhou

If broken down to a simple structure, a syllable in Wenzhou can be considered in terms of three parts: initial, final (with structure of V or VN) and tone. Given that tone is so closely related with initial consonants, we would like to introduce initial and tone of a syllable and leave finals out of our discussion here.

3.1.1 Initials

Among the sources that are available to us, there are two opinions on Wenzhou initials. In Qian (1992), there are 29 initials. In Yan (2000), there are 28 initials. Between Qian and Yan, there are two differences. One is that Qian has initial /ʔ/ at the position where Yan has initial /Ø/. In actual pronunciation, the zero initial does have the feature of slightly constrained glottis. So either /ʔ/ or /Ø/ is acceptable. Another difference is that Qian lists one more initial than Yan, transcribed as /ʔʊ/, which is a glottalized /v/. These two descriptions can be considered as roughly equivalent. Another description is from Zhengzhang (1964a). Zhengzhang argues that Wenzhou dialect has 36 initials. Please see the following tables for details.

(14) 29 Initials in Wenzhou Dialect Proposed by Qian (1992)

p	p^h	b	m	f	v	
t	t^h	d	n			l
ts	ts^h	dz		s	sz	
tɕ	$tɕ^h$	dʑ	ɳ	ɕ		
k	k^h	g	ŋ			
				x	ɦ	
ʔ	ʔʊ					

(15) 28 Initials in Wenzhou Dialect Proposed by Yan (2000)

p	p^h	b	m	f	v	
t	t^h	d	n			l
ts	ts^h	dz		s	z	
tɕ	$tɕ^h$	dʑ	ɳ	ɕ		
k	k^h	g	ŋ	h	ɦ	
Ø						

(16) 36 Initials in Wenzhou Dialect Proposed by Zhengzhang (1964a) [6].

		A (*yin* group)					B (*yang* group)		
		1	2	3	4	5	6	7	8
P group	p	p 報	p‘ 剖		m˗ 媽		b 袍	m 毛	
	f			f 否		ʋ (v˗) 歪			v 浮
T group		t 刀	t‘ 滔		n˗ 那	l˗ 拉	d 桃	n 惱	l 勞
Ts group		ts 資	ts‘ 溪	s 司		z˗ 永威	dz 遲		z 時
Tɕ group		tɕ 見	tɕ‘ 千	ɕ 先	ȵ˗ 黏	ǐ (j˗) 呀	dʑ 鉗	ȵ 尼	j 前
K group	k	k 高	k‘ 烤		ŋ˗ 耳		g 啣	ŋ 俄	
	h			h 好		Ø 襖			ɦ 豪

In table (16), the column represents place of articulation, and the row represents the manner of articulation. A and B represent how the initials are coupled with the tones. Initials in group A with *yin* tones and those in group B with *yang* tones.

The following table translates Zhengzhang's chart into phonetic terms.

(17) Initials in Wenzhou Dialect

	plosive	fricative	affricate	nasal	lateral	approximant
Bilabial	p, p^h, b			m, m˗		
labiodental		f, v, v˗				
Alveolar	t, t^h, d	s	ts, ts^h, dz	n, n˗	l, l˗	z, z˗
post-alveolar		ɕ	tɕ,$tɕ^h$, dʑ	ȵ, ȵ˗		j, j˗
Velar	k, k^h, g	h, ɦ		ŋ, ŋ˗		Ø

[6] Pinyin transcription and English translation of the characters in table (16):
p: bào 報 "to report", p': pōu 剖 "to cut", f: fǒu 否 "negation", m˗: mā 媽 "Mom", v˗: wāi 歪 "askew", b: páo 袍 "gown", m: máo 毛 "hair", v: fú 浮 "to float".
t: dāo 刀 "knife", t': tāo 滔 "overflow", n˗: nà 那 "that", l˗: lā 拉 "to pull", d: táo 桃 "peach", n: nǎo 惱 "to upset", l: láo 勞 "labor".
ts: zī 資 "capital", ts': xī 溪 "creek", s: sī 司 "department", z˗: wēi 威 "power", dz: chí 遲 "late", z: shí 時 "time".
tɕ: jiàn 見 "to see", tɕ': qiān 千 "thousand", ɕ: xiān 先 "in advance", ȵ˗: nián 黏 "sticky", ǐ: ya 呀 "ah", dʑ: qián 鉗 "pliers", ȵ: ní 尼 "priestess", j: qián 前 "front".
k: gāo 高 "tall", k': kǎo 烤 "to bake", h: hǎo 好 "good", ŋ˗: ěr 耳 "ear", Ø: ǎo 襖 "coat", g: xián 啣 "to hold with the mouth", ŋ: é 俄 "very soon", ɦ: háo 豪 "unrestrained".

We can see that Qian and Yan's analysis can be considered as equivalent. But where do the additional 8 initials derive from in Zhengzhang's analysis? We find from the tables that Zhengzhang lists a group of consonants denoted as [m^{-}, n^{-}, ɳ$^{-}$, ŋ$^{-}$, l^{-}, z^{-}, j^{-}, v^{-}] that are absent in Qian's and Yan's descriptions. These initials all co-occur with *yin* tones.

We adopt Zhengzhang's 36-initial-system for Wenzhou dialect. The reason for this lies in the relationship between initials and tones. Before going further into our analysis, first we would like to introduce the tonal system of Wenzhou dialect.

3.1.2 Tonal system in Wenzhou dialect

Wenzhou dialect has four tone melodies, traditionally denoted as *ping* (level), *shang* (rising), *qu* (falling), and *ru* (entering). Each melody is further divided into two pitch levels, traditionally denoted as *yin* and *yang*. This distinction in *yin* and *yang* are commonly described as high and low registers. In Wenzhou dialect, *yin* tones have a higher pitch value and normally go with voiceless initials, and *yang* tones have lower pitch value and typically go with voiced initials. Thus the Wenzhou dialect has 8 tones in total, four melodies each of which occurs at two register levels. A common practice is to denote Chinese tones with a five-point scale notation (Chao 1930). Speakers don't have an identical pitch value for each point in the five scale notation, though the relative relationship (or tonal category) between each tone is consistent. The following table is the tone system with pitch values.

(18) Tone System of Wenzhou Dialect [7]

yin ping	33	*yang ping*	31
yin shang	45	*yang shang*	34
yin qu	42	*yang qu*	11
yin ru	323	*yang ru*	212

The tonal system is also transcribed with a three-letter notation with H (high), M (mid), and L (low). The above table can be denoted as below.

(19)

yin ping	M	*yang ping*	ML
yin shang	MH	*yang shang*	MH
yin qu	HM	*yang qu*	L
yin ru	MLM	*yang ru*	MLM

[7] *5* stands for the highest pitch and *1* the lowest.

These following eight syllables illustrate the tonal values of Wenzhou dialect, shown as (20).

(20) *yin ping:*	巴	[po] M	"attached part"
yang ping:	爬	[bo] ML	"to crawl"
yin shang:	把	[po] MH	"a measure word"
yang shang:	耙	[bo] MH	"a rake"
yin qu:	霸	[po] HM	"to seize"
yang qu:	杷	[bo] L	"a kind of plant"
yin ru:	八	[po] MLM	"eight"
yang ru:	薄	[bo] MLM	"thin"

If we employ the above tonal transcription system, then the Wenzhou tone system can be reduced to only six tones: M, ML, MH, HM, L, and MLM. But since *yin* and *yang* are morphemically distinctive, the three-letter notation system will not be able to show the *yin* and *yang* register distinction of tones, especially for the *shang* tone category (*35* MH and *24* MH) and *ru* tone category (*323* MLM and *212* MLM), which have similar tone contours for both registers. Therefore the system of table 19 is not adequate. But if we look back to the features of initial consonants, we can find that minimal pairs such as 把 [po-MH] and 耙 [bo-MH] still can be differentiated through the voicing of the initial consonants, even if we cannot recognize the *yin-yang* contrast through tonal transcription. That means that we do not need to depend on *yin-yang* contrast of the tones to distinguish the morphemes in such minimal pairs as 八 [po] MLM and 薄 [bo] MLM. Thus, it may be a better solution to consider the *yin-yang* register as a feature of the initial consonants, rather than as an element of a tone. In advance of reaching a final conclusion through subsequent analysis, we will use the numerical system to transcribe the tone values.

3.2 Tonal representation of Wenzhou dialect

3.2.1 Tone as autosegmental tier

Since Goldsmith (1979) established tone as the prime example of autosegments, the autosegmental status of tone is hardly controversial. It is also true for Wenzhou tone. Some tone sandhi processes in Wenzhou dialect also support this claim. For example, the diminutive suffix of Wenzhou dialect manifests the existence and the tonal behavior of a floating tone, which is strong evidence for non-linear representation.

In Wenzhou dialect, the character 兒 [ŋ-ML] is morphologically a diminutive suffix. Phonologically, it normally consists of a velar nasal on the segmental tier and still has an independent tone. Its tone interacts with the tone of its host and follows the normal disyllabic or trisyllabic tone sandhi rule. But in some cases when the host noun itself ends with a nasal coda, the velar nasal ŋ of 兒 is deleted, while the tone remains, floating on an empty anchor. This floating tone interacts with the tone of the host syllable and follows the regular tone sandhi rules. Consider the example of a two syllable word 代人 *de zaŋ*. The base tones of these two syllables are [11] and [31] respectively. When the word means "the action of substituting someone", its surface phonological form is [*de zaŋ* (42-21)], which is in accordance with the disyllabic tone sandhi rules in Wenzhou dialect, shown as (21a). But when it means "the person in substitution" with diminutive meaning, its surface phonological form is [*de zaŋ* (43-212)], shown as (21b).

(21) a. Normal case: /de (11) + zaŋ (31)/ "the action of substituting someone"

segment:	de	+	zaŋ	
base tone:	11		31	
	↓		↓	(disyllabic tone sandhi)
sandhi tone:	42		21	(output form)

If we recover the tonal tier of the contracted suffix 兒 /ŋ/, it follows that the word will undergo the diminutive tone sandhi.

b. Diminutive case: /de (11) + zaŋ (31) + ŋ (31)/ "person in substitution"

segment:	de	+	zaŋ	+	ŋ	
base tone:	11		31		31	
	↓		↓		↓	(trisyllabic tone sandhi)
segment:	de	+	zaŋ	+	ŋ	
tone:	43		21		21	
			⎣	‖		(segment deletion)
segment:	de	+	zaŋ	+	Ø	
tone:	43		21		21	
			⎢			(floating)
segment:	de	+	zaŋ	+	Ø	
	⎢		⎣			
tone:	43		212			(output form)

(21a) and (21b) illustrate that although the segmental tier of the suffix 兒 /ŋ/ has been contracted to its host by deletion, its tone persists and interacts with the host under sandhi rules. In this case, floating tone persists and serves as an independent entity to define a tone sandhi domain.

3.2.2 One dimension of Wenzhou tone

As was mentioned earlier, register and contour constitute two dimensions of tone. The implication of this dichotomy, however, is problematic in Wenzhou dialect. Tonal representations with a register dimension are not consistent with tonal behavior in Wenzhou dialect. In our survey, tone sandhi in Wenzhou at the lexical level is blind to the register tier. In addition, a two-dimensional representation even poses difficulty for formulating tone sandhi rules to derive the grammatical surface form.

3.2.2.1 Tone sandhi at lexical level

Both Zhengzhang (1964b, 2008) and Chen (2000) divide tone sandhi in Wenzhou into two major levels according to its morpho-syntactic information, i.e. a lexical level and a phrasal level. The lexical level includes lexicalized syllable strings, ranging from disyllabic and trisyllabic, to longer strings. According to Zhengzhang (1964b, 2008), there are nine types of tone sandhi outcomes for all two syllable combinations. Since numerical tonal values are not phonologically neat, in the following discussion, we will mark *yin*-tones as Aa, Ba, Ca, and Da [8], and mark *yang*-tones as Ab, Bb, Cb, and Db [9].

These nine types of sandhi forms could be further merged phonologically, but that is not the focus of this paper. For now we will describe them following Zhengzhang (1964b, 2008) with the modification that we will use Aa, Ba, Ca, Da and Ab, Bb, Cb, Db for the input tones on the left side of the rules. Tone values on the right side of the rules are under Chao's numerical system (Chao 1930). Let's revisit the tonal system in Wenzhou using the *Aa*, *Ba*, *Ca*, *Da* and *Ab*, *Bb*, *Cb*, *Db* notations.

(22)

tone Aa: *yinping*	33	tone Ab: *yangping*	31
tone Ba: *yinshang*	45	tone Bb: *yangshang*	34
tone Ca: *yinqu*	42	tone Cb: *yangqu*	11
tone Da: *yinru*	323	tone Db: *yangru*	212

[8] *Aa*, *Ba*, *Ca*, and *Da* are for *yin-ping*, *yin-shang*, *yin-qu*, and *yin-ru*, respectively.
[9] *Ab*, *Bb*, *Cb*, and *Db* are for *yang-ping*, *yang-shang*, *yang-qu*, and *yang-ru*, respectively.

The following are the disyllabic tone sandhi types interpreted from Zhengzhang.

(23) Disyllabic Tone Sandhi Types

a. Pairs of *Aa* and *Ab* behave the same before tone *Aa* (type A)

{Aa, Ab} + Aa → [11-33]

b. Pairs of *Ba*, *Bb*, *Ca*, and *Cb* behave the same before tone *Aa* (type B)

{Ba, Bb, Ca, Cb} + Aa → [42-33]

c. Pairs of *Aa*, *Ab*, *Ca*, *Da*, and *Db* behave the same before tone *Ab* (type C)

{Aa, Ab, Ca, Da, Db} + Ab → [11-12]

d. Pairs of *Aa*, *Ab*, *Ba*, *Bb*, *Ca*, and *Cb* behave the same before tone *Ba* and *Bb* (type D)

{Aa, Ab, Ba, Bb, Ca, Cb} + {Ba, Bb} → [43-34]

e. Pairs of *Aa* and *Ab* behave the same before tone *Ca* and *Cb* (type E)

{Aa, Ab} + {Ca, Cb} → [11-53]

f. Pairs of *Ba*, *Bb*, *Ca*, and *Cb* behave the same before tone *Ca* (type F)

{Ba, Bb, Ca, Cb} + Ca → [42-21]

g. Pairs of *Ba*, *Bb*, and *Cb* behave the same before tone *Ab* (type G)

{ Ba / Bb / Cb } + Ab → [42-21]

h. Pairs of *Ba*, *Bb*, *Ca*, and *Cb* behave the same before tone *Cb* (type H)

{ Ba / Bb / Ca / Cb } + Cb → [43-11]

i. Pairs of *Aa*, *Ab*, *Ba*, *Bb*, *Ca*, and *Cb* behave the same before tone *Ca* and *Cb* (type I)

{ Aa / Ab / Ba / Bb / Ca / Cb } + { Ca / Cb } → [34-13]

j. Pairs of *Da* and *Db* behave the same before all tones except before tone *Ab* (type J)

{ Da / Db } → 01 [10] / ___ T [any tone except tone *Ab*]

Apparently, we can find in (23) that *yin* and *yang* tones behave exactly the same in disyllabic tone sandhi with only one exception; each pair of (Aa-Ab), (Ba-Bb), (Ca-Cb), and (Da-Db) has the same sandhi form when preceding the same base tone, respectively. The exception is the pair of (Ca-Cb) in sandhi types (C) and (F), in which /Ca/ + /Ab/ → [11-12] and /Cb/ + /Ab/ → [42-21]. But this exception is statistically insignificant and (Ca-Cb) pairs behave the same before all tones other than tone *Ab*. As a whole, disyllabic tone sandhi in Wenzhou is blind to *yin-yang* register distinction.

The following are a few minimal pairs of disyllabic tone sandhi forms:

(24) (a) Aa + Aa = Ab + Aa
Aa + Aa: *shang xin* (33-33) → 11-33 傷心 "sad"
Ab + Aa: *liang xin* (31-33) → 11-33 良心 "conscientiousness"

[10] "*01*" is used to transcribe a default low tone.

(b) Aa + Ab = Ab + Ab
Aa + Ab: *tian tang* (33-31) → 11-12 天堂 "heaven"
Ab + Ab: *ci tang* (31-31) → 11-12 祠堂 "memorial temple"

A similar situation is found in trisyllabic tone sandhi forms at lexical level: no register information is considered in sandhi process. (25a) clearly shows that mostly the last two tones keep their disyllabic sandhi forms, and a tone value (mostly *43*) is assigned to the antepenultimate syllable, regardless of the original register of the tone of either the antepenultimate syllable or penultimate syllable, or the register of the penultimate tone derived from disyllabic sandhi rules. (25b) shows that a *42-21-21* sandhi form is assigned to this type of trisyllabic string, regardless of the register of the antepenultimate tone or that of the penultimate, or the register of the penultimate tone after derived from disyllabic sandhi rules. (25c) also shows clear neutralization of the *yin*-entering tone and *yang*-entering tone.

(25) Trisyllabic Tone Sandhi in Wenzhou

a. $T + \left\{ \begin{matrix} A \\ B \\ C \\ D \\ E \\ H \\ I \end{matrix} \right\} \rightarrow 43 + \left\{ \begin{matrix} A \\ B \\ C \\ D \\ E \\ H \\ I \end{matrix} \right\}$

b. X + F → 42-21-21 (F: 42-21)

c. Lq + F → L + F (Lq: entering tone *323* and *212*)

In sum, lexical tone sandhi behavior in Wenzhou dialect is blind to the distinction of *yin-yang* register: no sandhi rule refers to register information during its derivation. Thus at lexical tone sandhi level, register never manifests at any level of derivation.

3.2.2.2 Phrasal level tone sandhi

Even at the phrasal level, two-dimension tonal geometry poses difficulties to some tone sandhi practices. Let's look into the three tonal representations one by one.

Yip's representation illustrates that [±upper] is the root node of the geometry and thus spreading register means spreading of the whole tone, including both register and contour. This implication contradicts some tonal processes, and is also questioned by the observation that in some dialects register spreads independently, for example,

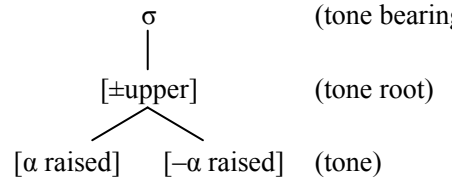
Zhenjiang dialect (Chen 2000). It also conflicts with the tonal behavior of Wenzhou dialect. The enclitics in post-tonic position assimilate to the tonal value of their host on the left via spreading (Chen 2000). See examples in (26).

(26) Spreading in Wenzhou Dialect (Chen 2000)

a.	*liang*	*GE*	"two MW" (GE is a measure word)
	MH	0	
	MH	h	(spread)
b.	*da*	*GI*	"the large one/that which is larger"
	L	0	
	L	l	(spread)

To better understand the tonal representation algorithm, here let's reexamine Yip's model and see how it fails to account for Wenzhou.

(27) Yip's Tonal Representation

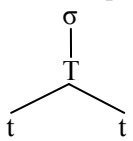


In Yip's model, there are three possible results of spreading. The first is spreading from the register node: the enclitic in (26a) would have tone **MH*. The second is spreading from the left-most tonal element, which in (26a) is either [–raised] or [+raised]. In (26a), the left-most tonal element is *H*. *H* should have the feature of [+raised]. But since the register of the host syllable does not take part in this spreading process, and the register of the enclitic syllable is empty, the feature of [+raised] alone cannot decide between the following possibilities: [+raised] + [–upper] → *M*; [+raised] + [+upper] → *H*. Given that the register is opaque in this spreading process, there is no way to rule out *M* and get *H*. Finally, option (3) is spreading from the right-most tonal element and a low register is assigned to the enclitic by default. Then the enclitic would get [+raised] + [–upper], which is **M* by Yip's approach. Thus Yip's representation doesn't the right surface form in Wenzhou, i.e. *h*, for (26a).

Duanmu's representation is also hardly applicable to Wenzhou dialect since Wenzhou is not proved to be mora-sensitive. We will not elaborate on Duanmu's approach here.

To this point, we have indicated not only that register is not necessary in an analysis of Wenzhou tone, but also that some representations with register make an explanation of Wenzhou tone sandhi impossible. Our proposal for Wenzhou tonal representation is a one-dimensional representation, in which end tonal values link directly to the root tonal node, with neither an intermediate register node as in Yip's representation, nor a dichotomy of register node and contour node (as in Bao's representation), nor a dichotomy of register node and end tonal node (as in Duanmu's representation). The tone contour is the result of concatenations of level tones.

(28) Tonal Representation for Wenzhou



If the tone did not have a *yin-yang* distinction, then we could further propose that there are only four underlying tones in Wenzhou: level tone, rising tone, falling tone and concave tone. Each tone would then have an allotone conditioned by the phonological environment of the voicing of initial consonants. Except there is still another catch: initials /m, n, ɳ, ŋ, l, z, j, v/ also have high and low tones but these initials have no voicing contrast. See below for minimal pairs:

(29) *leng*-11 令 "order"
leng-33 扔 "to throw"
ŋ-45 耳 "ear"
ŋ-34 五 "five"

4. Initials in Wenzhou

One of the conditions for a one-dimensional representation to satisfy is the fact that Wenzhou dialect has a systematic range of minimal pairs of voiced and voiceless consonants, which complementarily distribute with low and high pitches. There is no problem for obstruents. Sonorants and glides ([m, n, ɳ, ŋ, l, z, j, v]), do not contrast in voicing, although the reality is that there are minimal pairs such as [mai-11] "younger sister" and [mai-33] "little kid". If the initial does not contrast, then tone has to take this burden. Therefore, before we can claim that Wenzhou tone is one-dimensional, we have to solve the problem for syllables with this group of initial consonants.

A possible solution is to take Zhengzhang's assertion that there are 36 initial consonants in Wenzhou. Let's revisit Zhengzhang's table for Wenzhou initials.

(30) 36 Initials in Wenzhou Dialect Proposed by Zhengzhang (1964a).

		A (*yin* group)					B (*yang* group)		
		1	2	3	4	5	6	7	8
P group	p	p 報	p‘ 剖		m˗ 媽		b 袍	m 毛	
	f			f 否		ʋ (v˗) 歪			v 浮
T group		t 刀	t‘ 滔		n˗ 那	l˗ 拉	d 桃	n 惱	l 勞
Ts group		ts 資	ts‘ 溪	s 司		z˗ 永威	dz 遲		z 時
Tɕ group		tɕ 見	tɕ‘ 千	ɕ 先	ȵ˗ 黏	ǐ (j˗) 呀	dʑ 鉗	ȵ 尼	j 前
K group	k	k 高	k‘ 烤		ŋ˗ 耳		g 啣	ŋ 俄	
	h			h 好		Ø 襖			ɦ 豪

It is noticeable that Zhengzhang separates initial consonants into two groups: group A with *yin* tones and group B with *yang* tones. It is widely accepted that tones are divided into *yin* and *yang* registers, and correspondingly, certain groups of initials only co-occur with *yin* tones and others with *yang* tones. Nonetheless, Zhengzhang (1964a) points out that it is better to consider the initial consonants as having a *yin-yang* distinction. To him, not only tones have the feature of *yin-yang* distinction, but also initials. Typically, *yin* tones are found with voiceless initials and *yang* tones with voiced initials. For example, voiceless plosive [p] and [p^h] go with *yin* tones, and voiced plosive [b] goes with *yang* tones. However we also notice that there is another group of initials that can co-occur with both *yin* tones and *yang* tones. They are /m, n, ȵ, ŋ, l, z, j, v/. When they co-occur with *yang* tones, they are realized with voiced aspiration. In another word, in *yang* tones, these initials are essentially [m^h, n^h, $ȵ^h$, $ŋ^h$, $l^{ɦh}$ z^h, j^h , v^h], which are typical realizations of voiced consonants. When they occur with *yin* tones, they are still voiced consonants, but the realization is atypical: the articulation is colored by a tightened glottis (a slight glottalization) (Zhengzhang 1964a). This is why there is no strong stream of voiced airflow, and so these consonants can be considered as unaspirated. Phonetically, we would like to consider it as a laryngeal feature of [-spread gl]. Since having voiced aspiration is the typical realization of voiced consonants, it will be misleading to denote the consonants that go with *yang* tones with voiced aspiration. While voiced consonants without voiced aspiration are atypical, it is better to denote each of unaspirated voiced consonants with a raised hyphen, i.e. [m˗, n˗, ȵ˗, ŋ˗, l˗, z˗, j˗, v˗], as in Zhengzhang (1964a).

The difference in these two realizations is acoustically apparent. We have two hypotheses. One is that the feature of [±spread gl] of these segments is not phonemically distinctive, that is to say the group of [m̬, n̬, ɳ̬, ŋ̬, l̬, z̬, j̬, v̬] is a variation or allophone of group [m, n, ɳ, ŋ, l, z, j, v], and they distribute complementarily: [m̬, n̬, ɳ̬, ŋ̬, l̬, z̬, j̬, v̬] with *yin* tones, and [m, n, ɳ, ŋ, l, z, j, v] with *yang* tones. Another hypothesis is that the [±spread] feature of voiced consonants is phonemically distinctive and thus /m̬/ and /m/ are two different phonemes.

If we do not consider the *yin-yang* feature as a phonemically distinctive laryngeal feature of the initial consonant, then a syllable with [m] as its initial is not phonemically distinctive from a syllable with [m̬] as its initial, provided that the tone shapes are identical. Theoretically, [m] and [m̬] distribute complementarily: the former with *yang* tone and the latter *yin* tone. This is true in citation form of single syllables. For example, *mao* "cat" in citation form is [m̬uɔ-33] and *mao* "appearance, look" in citation form is [muɔ-11]. We can propose that the underlying forms on the segmental tier for these two syllables are the same, say /muɔ/. Then it surfaces differently under the rule (31):

(31) /m/ → [m̬] / __ σ
                    |
                [*yin* tone]

This solution works well with monosyllables in citation forms. And its advantage is that it simplifies the number of initial consonants from 36 to 29.

However, in real speech Wenzhou dialect undergoes tone sandhi. A *yin* tone and a *yang* tone can surface identically after tone sandhi. Again, take *mao* "cat" and *mao* "appearance, look" as an example. Since *mao* "cat" is pronounced [m̬uɔ-33], and *mao* "appearance" is pronounced [muɔ-11] in citation, the tone difference can distinguish the morphemes. As found in many two syllable words, the tones of these two syllables lose *yin-yang* distinction and surface to a same tone. For example, *xiongmao* "panda" /joŋ-muɔ HM-M/ surfaces to [joŋ-m̬uɔ L-M] and *rongmao* "look, appearance" /joŋ-muɔ HM-L/ also surfaces to [joŋ-muɔ L-M].

(32) a. *xiongmao* "panda": /joŋ-muɔ HM -M/ → [joŋ-m̬uɔ L-M]
b. *rongmao* "appearance": /joŋ-muɔ HM-L/ → [joŋ-muɔ L-M]

If the /m/ initials in (a) and (b) are the same phoneme, then there is no way to distinguish "panda" from "appearance" in sandhi level. The difference of laryngeal

feature in the initials is the only difference. Such minimal pairs are not rare in Wenzhou. See below for a few more examples:

(33) a.	l̬a cho /33-33/ →	[11-33]	*la che* 拉車	"to tow the car"
	la cho /31-33/ →	[11-33]	*lan che* 攔車	"to stop the car"
b.	ŋ̬ tʰo /45-45/ →	[43-34]	*er duo* 耳朵	"ear"
	ŋ tʰo /34-45/ →	[43-34]	*wu duo* 五朵	"five stalks"
c.	ɕiu va /45-45/ →	[43-34]	*shou wan* 手腕	"wrist"
	ɕiu va /45-34/ →	[43-34]	*shou fan* 首犯	"head a crime"

Since tones of *yin-yang* register are neutralized, and the initials have to take the burden for meaning distinction, it is necessary for this language to consider initials such as [l] and [l̬] as a minimal pair. Thus, group /m, n, ɳ, ŋ, l, z, j, v / and group /m̬, n̬, ɳ̬, ŋ̬, l̬, z̬, j̬, v̬/ are distinctive phonemes. This is the reason that Wenzhou dialect is best analyzed as having 36 initial consonants. One cannot reduce them to 29 with the cost that speakers lose the morpheme distinction at the sandhi level.

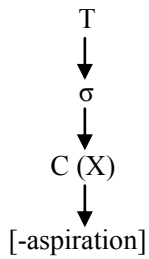
Given that consonant group /m, n, ɳ, ŋ, l, z, j, v / and group /m̬, n̬, ɳ̬, ŋ̬, l̬, z̬, j̬, v̬/ are distinctive phoneme sets in Wenzhou, we would like to claim that it is the voicing of initial consonants that takes the burden to distinguish *yin* and *yang*. Tones, however, do not have this distinction and thus are one-dimensional.

5. Conclusion

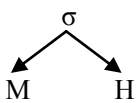
Tone in Wenzhou dialect is one-dimensional: an end node tone links directly to TBU. Tonal representation without the *yin-yang* register fits the characteristic of Wenzhou tones in its tone sandhi processes. Wenzhou dialect has 36 initial consonants and four underlying tones: level tone, rising tone, falling tone, and concave tone. Level tone and falling tone each have an allotone conditioned by the phonological environment of the voicing of the initial obstruents or of the aspiration of initial sonorant consonants (/m, n, ɳ, ŋ, l, z, j, v/). See below for a description of the four tones in Wenzhou.

(34) a. Level Tone:

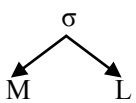
a'. Allotone Tone: L → M / ___



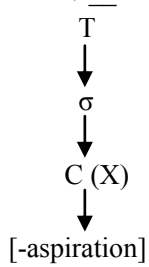
b. Rising Tone:



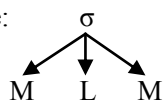
c. Falling Tone:



c'. Allotone: ML → HM / __



d. Concave Tone:



The traditional "*yin-yang*" feature is not an underlying feature of tone; it is the acoustic effect that voicing and aspiration of the initial consonants imposes on the tone. It is possible that one day, due to the fact the languages change over time, initials in Wenzhou dialect may lose voicing and leave the tone to take on the burden for meaning distinction in place of initial voicing. Only if that happens will register become part of tone in Wenzhou, just as in the case of Mandarin.

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溫州地處中國東南沿海地區，溫州方言是南部吳語的代表方言。由於溫州地處甌江流域，所以溫州方言也稱之為甌語。溫州方言的聲調性質涉及聲調學的諸多方面，本文作為對甌語聲調學的初探，只討論甌語聲調的表達形式。一般説來，雖然漢語方言的聲調普遍地分為調類（陰調和陽調）和調形兩個層次，但本文認為溫州方言的聲調底層形式只有一個層次，即終端調形層次。原來認為的聲調調類層次特徵（即陰調和陽調），本文認爲不屬於聲調；而陰和陽對詞素的辨義作用則由聲母的清濁特性和送氣特性來承擔。

關鍵詞：南部吳語、溫州方言、聲調學、聲調的表達形式、調類、調形