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The Distribution of Tone in Taiwanese[1]

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1. Introduction

The main claim of moraic theory (Hayes 1989, Hyman 1985, McCarthy & Prince 1986, 1988) is that the only real prosodic units within a syllable are moras. In this paper, I show that this claim holds for Taiwanese. In addition to moras, we also need the concept of minimal word (McCarthy and Prince 1988) and the melodic tier to account for prosodic phenomena like tone patterns and compensatory lengthening in Taiwanese. I will show that there is a constraint on the assignment of tone from the melodic tier (i.e. moras alone are not enough to account for the distribution of tone) and that the distribution of tone and the moraic structure of the syllable together provide evidence that the minimal word of Taiwanese is a bimoraic syllable.

Taiwanese, a Chinese dialect belonging to the Southern Min family, has two kinds of syllables. One ends in a sonorant segment (including vowels and sonorant consonants); the other ends in a non-sonorant segment. The former is called a "free syllable" and the latter a "checked syllable" in the traditional terminology.

There are seven surface tones in Taiwanese which can be divided into two types. One type I call "long tone" and the other "short tone" since the former is phonetically four times longer than the latter according to spectrographic analysis done by myself.

Interestingly, the free syllables always have long tone, and the checked syllables the short tone. By using moraic theory, we can account for this fact.

This paper is organized as follows. In Section 2, the tone pattern in Taiwanese is introduced. In Section 3, the syllable types are presented. In Section 4, the correlation between syllable structure and tone is demonstrated. Then, the evidence from compensatory lengthening is given in Section 5. Finally, in Section 6, the seven surface tones are reduced to five underlying tones.

2. The pattern of tones in Taiwanese

Taiwanese, like other Chinese dialects, is a monosyllabic tone language, that is, each word is one syllable and every word has a tone. The data cited in this paper are from my own dialect.

Taiwanese has seven tones: high level, rising, falling, low level, mid level, low short, and high short.[2] Following Chao (1930), I use digits to denote the Taiwanese tones; "5" denotes the highest pitch, "1" the lowest. For example, "55" is a high-level tone; "53" is a high-falling tone (a contour tone). Only one digit is used for short tones. For example, "2" is a low short tone.

The seven tones are given in (1), together with examples.[3]

(1)	I. 55 (high-level)	ts^{h}ya	55	'car'
		swa-	55	'mountain'
	II. 24 (rising)	lay	24	'come'
		i	24	'aunt'
	III. 53 (falling)	lyu	53	'button'
		ban	53	'pluck'
	IV. 11 (low-level)	p^{h}wa	11	'break'
		se	11	'small'
	V. 33 (mid-level)	bin	33	'face'
		twa	33	'large'
	VI. 2 (low-short)	pit	2	'pen'
		kut	2	'bone'
	VII. 4 (high-short)	ap	4	'box'
		kut	4	'slip'

Note that the short tones appear only with words that end with a voiceless stop, and the other tones appear with any words except those ending with a voiceless stop. We will come back to this point later.

3. The structure of Taiwanese syllables

3.1. Some generalizations

The maximal number of segments per syllable is four, with at most two prevocalic segments and one postvocalic segment. There is only one vowel per syllable. This vowel is the only segment that is obligatory within a syllable, e.g. /e/ 24 'shoe'. All consonants except /ʔ/ can appear in onset position, but only nasals and some voiceless stops (i.e. /p, t, k, ʔ/) can appear in coda position. Glides can either precede or follow the vowel, and are always adjacent to the vowel. The structure of Taiwanese syllables is summarized in (2).

(2) (C) (G) V (G)
(C) (/m, n, ng, p, t, k, ʔ/ only)

3.2. Syllable types in Taiwanese

The examples given in (3) exhaust all syllable types in Taiwanese. Syllables are classified into two major types, free and checked, according to the sonority of the last segment in the syllable. Free syllables are sonorant-final, including three subtypes: vowel-final (3a), glide-final (3b), and nasal-final (3c). Checked

syllables are stop-final, i.e. nonsonorant-final (3d).

(3) **Free syllables** -- [+son]-final syllables
a. Vowel-final syllables and syllabic nasals

e	24	'shoe'
te	11	'take'
yu	55	'worry'
m̄	33	'no'

b. Glide-final syllable

ay	11	'love'
tʰaw	24	'head'
kway	53	'cheat'

c. Nasal-final

im	11	'shade'
swan	55	'sneak'

Checked syllables -- [-son]-final syllables
d. Stop-final syllable

yap	2	'hide'
saʔ	2	'push'
kyɔk	4	'situation'
geʔ	4	'moon'
sit	4	'real'

So far, we have seen the tone pattern and the syllable structure of Taiwanese. We will see the correlation of tone and syllable structure next.

4. The correlation of tone and syllable structure

4.1. Tones in complementary distribution

As mentioned above, the short tones only appear with checked syllables. On the other hand, free syllables never have short tones. This is shown in (4).

(4) Tone	Free syllables Long Tone					Checked syl Short Tone	
	I 55	II 24	III 53	IV 11	V 33	VI 2	VII 4
Free a	e 'sift'	e 'shoe'	e 'short'	ke 'marry'	e 'able'		
Free b	taw 'home'	taw 'cast'	taw 'Chinese peck'	taw 'fare'	taw 'bean'		
Free c	tam 'taste'	tam 'wet'	tam 'scared'	tam 'nod'	tam 'mild'		
Checked d						peʔ 'eight'	peʔ 'white'

In summary, the correlation between tone and syllable structure is three-fold as shown in (5).

(5)
"Free syllable" vs. "Checked syllable"
==> [+son]-final vs. [-son]-final
==> "Long tone" vs. "Short tone"

4.2. Two hypotheses

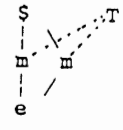
In the surface representation, there are two types of tones, long and short. Likewise, there are two types of syllables; free syllables end with a [+son] segment while checked syllable end with a [-son] segment. There are two hypotheses about this phenomenon.

4.2.1. Hypothesis I -- there are two moras in free syllables and one mora in checked syllables.

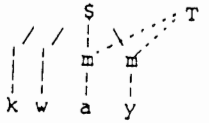
Since the checked syllables always have short tone, we may suppose that it is a light syllable which has only one mora. In other words, a nonsonorant stop in coda position is not moraic. The free syllables, then, are heavy and have two moras. This can be seen in (6) and (7).

(6) Free syllables (two moras - heavy)
(T = tone, m = mora, $ = syllable)

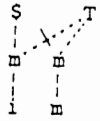
a. (3a) e 24 'shoe'



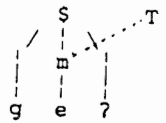
b. (3b) kway 53 'cheat'



c. (3c) im 11 'shade'



(7) Checked syllables (one mora - light)
(=(3d)) geʔ 4 'moon'



4.2.2. Hypothesis II -- all syllables have two moras.

Suppose that all syllables have two moras, that is, that the minimal word in Taiwanese is a bimoraic syllable [$ mm].

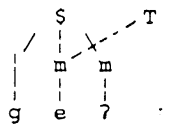
(8) Minimal Word in Taiwanese
[$ mm] wd

In other words, all consonants in coda position are moraic. Now we need to explain why checked syllables get only short tones and why free syllables never get short tones. The explanation can be obtained if we assume that moras linked up with a [-son] segment in the melodic tier cannot be linked to a tone. In other words, the checked syllables, which end with a [-son] segment, have only one mora that is linked up with the tone.

These two hypotheses give us the same results with respect to tone linking. Since in both hypotheses free syllables have two moras and the two moras are linked up with the tone, there is no distinction between them.

For checked syllables, the difference that the two hypotheses make is that there is only one mora in a checked syllable according to Hypothesis I, while there are two moras in a checked syllable according to Hypothesis II. But if we make the reasonable assumption that moras linked to a [-son] segment cannot link to a tone, the result in both hypotheses is the same: there is only one mora linked up with the tone in checked syllables. This is shown in (9) (cf. (7))

(9) Checked syllables (two moras -- but only one is linked up with the tone)
(=(3d)) ge? 4 'moon'



Since both hypotheses work equally well, how do we choose between them? Fortunately, there is an additional phenomenon that can help us make the decision, namely, compensatory lengthening.

5. Compensatory lengthening

5.1. Tone Sandhi[4]

Before discussing compensatory lengthening, we should look at the tone sandhi which accompanies it.

In Taiwanese, a base tone changes into a sandhi tone when it is not the last member within a tone group. (See Chen 1987 for detailed discussion.) The Tone Sandhi Rule is given in (10).

(10) Tone Sandhi Rule (Chen 1987)
T --> T' / ___ T [within a tone group]

Sandhi tones from my own dialect are given in (11).

(11)

	I	II	III	IV	V	VI	VII
T (Base tone)	55	24	53	11	33	2	4
T'(Sandhi tone)	33	33	55	53	11	53/4	11/2

There are alternate sandhi tones for short tones (Tone VI and Tone VII). Note that the sandhi tones of Tone IV and Tone V have the same tone values as one of the two alternate sandhi tones, i.e. 53 and 11. We will come to this later.

For checked syllables not ending with a glottal stop /ʔ/, the sandhi tones are (4) for Tone VI and (2) for Tone VII. (See (12)). (Sandhi tones are put in curly brackets to distinguish them from base tones.)

(12) a. kut 4 + tɔ: 53 ---> kut (2) tɔ: 53
'slip' 'fall' 'slip-fall'
b. kɔk 2 + ka: 55 ---> kɔk (4) ka: 55
'country' 'home' 'country'

For checked syllables ending with /ʔ/, the sandhi tones are (53) for Tone VI and (11) for Tone VII together with glottal stop deletion. (We will talk about the glottal stop deletion in next section.) That is, the sandhi tone shows up long instead of short as we would expect. Examples are given in (13).

(13) a. pe? 4 + tswa 53 --> pe: (11) tswa 53
'white' 'paper' 'white paper'
(* pe: (2) tswa 53)
b. pe? 4 + sa~ 55 --> pe: (11) sa~ 55
'white' 'clothe' 'white clothe'
(* pe: (2) sa~ 55)
c. pe? 2 + tyu~ 55 --> pe: (53) tyu~ 55
'eight' 'piece' 'eight pieces (of paper)'
(* pe: (4) tiu~ 55)
d. pe? 2 + ni~ 24 --> pe: (53) ni~ 24
'eight' 'year' 'eight years'
(* pe: (4) ni~ 24)

5.2. Compensatory lengthening

A syllable-final glottal stop is dropped when followed by another syllable, as shown in (14).

(14) ge? 4 + niu~ 24 --> ge: (11) niu~ 24
'moon' 'lady' 'moon'

The Glottal Stop Deletion Rule is given in (15).

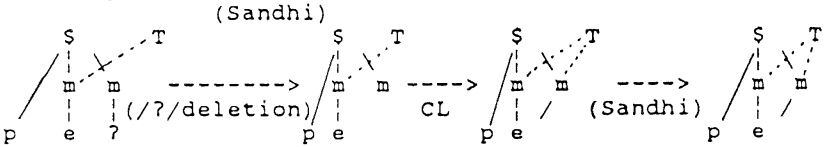
(15) Glottal Stop Deletion Rule
ʔ --> 0 / __ C$_0$ V

If nothing follows, then the final glottal stop is not dropped and the tone remains the same, as shown in (16).

(16) a. swan 11 + pe? 4 --> swan (53) pe? 4
'garlic' 'white' 'garlic sprout'
b. ɔ 55 + pe? 4 --> ɔ (33) pe? 4
'black' 'white' 'black and white'
c. te 33 + pe? 2 --> te: (11) pe? 2
'order' 'eight' 'number eight, eighth'

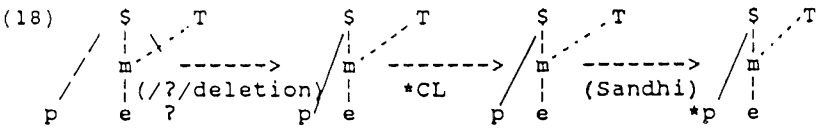
The change of a short sandhi tone to long sandhi tone in (13) can be understood as a case of compensatory lengthening (CL) if we assume that a tone linked up with two moras is long. The process is as follows : When the final glottal stop drops, it leaves a mora. The preceding vowel then spreads to that mora and gets lengthened. Since the second mora is not linked to a [-son] segment anymore, the tone can link to both moras and surfaces long. The derivation is given in (17).

(17) pe? 4 --------> pe: (11) 'white'
(Sandhi)



If there weren't two moras in the checked syllables, as is claimed in Hypothesis I, compensatory lengthening shouldn't have happened and we shouldn't have got a long tone. This is shown in (18).

(18)



Thus we conclude that Hypothesis II is more desirable than Hypothesis I. By adopting Hypothesis II, we claim that there is a constraint on tone linking, as given in (19) : a tone cannot link to a mora that dominates a [-son] segment.

By proposing this constraint, we also claim that the tonal tier is able to look down to the melodic tier.

6. Returning to tones in complementary distribution

As we recall from (11), we notice that Tone IV and Tone V are in complementary distribution with Tone VI and Tone VII, respectively.

(20) (= (11)) Sandhi tones

	I	II	III	IV	V	VI	VII
T (Base tone)	55	24	53	11	33	2	4
T'(Sandhi tone)	33	33	55	53	11	53/4	11/2

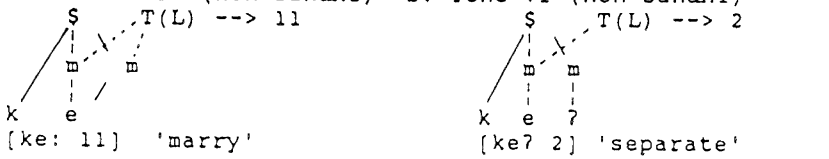
Considering the same sandhi behavior in these two groups, we may suppose that these four tones are underlyingly two tones. We can assign IV/VI as L (low) and V/VII as M (mid), as in (21).

(21)

	IV	V	VI	VII
T	11 (L)	33 (M)	2 (L)	4 (M)
T'	53	11	53 / 4	11 / 2

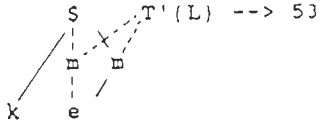
The difference between IV and VI is neither a difference in underlying tone (they are both L), nor a difference in the moraic structure of the syllables (all syllables are bimoraic, as we have argued), but rather it is a result of the Tone Linking Constraint given in (19) above. In other words, it's due to the different values of some segmental feature in the melodic tier, the feature [son]. This is supported by the fact that after the /?/ is dropped, Tone VI gets the same sandhi tone as Tone IV. In (22), it is shown that Tone IV and Tone VI have the same underlying tone L, and that the Tone Linking Constraint applies to Tone VI, not Tone IV. Thus they surface as short tone and long tone respectively.

(22) a. Tone IV (non-sandhi) b. Tone VI (non-sandhi)



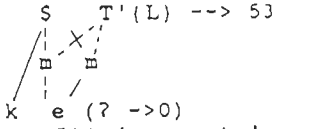
In (23) we see how these two tones get the same sandhi tone.

(23) a. Sandhi of Tone IV



(ke: 53) 'marry'
(as in **ke: 53 ts^{h}ua 33** 'marriage')

b. Sandhi of Tone VI



(ke: 53) 'separate'
(as in **ke: 53 k^{h}i 55** 'separate-open')

The same is true for Tone V and Tone VII. We thus reduce the seven surface tones to five underlying tones.[5]

(24) Underlying tone system of Taiwanese

	I	II	III	IV/VI	V/VII
Underlying	H	LH	HL	L	M
Base tone	55	24	53	11/2	33/4
Sandhi	33	33	55	53/4	11/2

7. Conclusion

I have argued that the minimal word in Taiwanese is a bimoraic syllable. This is supported by the phenomenon of compensatory lengthening. I have also shown that the seven surface tones in Taiwanese can be reduced to five underlying tones. Thus Hayes's model of compensatory lengthening (Hayes 1989) works for Taiwanese, and the concept of minimal word as proposed by McCarthy and Prince (1986, 1988) is necessary in prosodic phonology.

NOTES

[1] I would like to thank Diana Archangeli, David Basilico, Dick Demers, Rosa Garcia, Mike Hammond, Masahide Ishihara, Jorge Lemus, James Myers, Douglas Pulleyblank, Robin Schafer, and Wendy Wiswall for helpful comments on previous versions. Any errors are my responsibility.

[2] The tone values vary slightly among sub-dialects. (Ting 1970, Weingartner 1970)

[3] Phoneme Inventory of Taiwanese

a. Consonants

Labial	p	p^{h}		b	m
Dental	t	t^{h}		l	n
Alveo-palatal	ts	ts^{h}	s	dz(z)	
Velar	k	k^{h}		g	ng
Glottal	?		h		

(The alveo-palatals are palatalized when followed by /i/ or /y/. /ts/ /ts^{h}/ /dz/ are affricates. /^{h}/ marks the aspiration. /p, t, k/ are unreleased word-finally.)

b. Vowels (The vowel in an open syllable is phonetically long. However, there is no phonemic vowel length contrast in this language.)

i	e	a	u	o	ɔ
i~	e~	a~			ɔ~

c. Glides

w y

d. Syllabic consonants

m ng

[4] I thank Robin Schafer for reminding me to look at the tone sandhi data.

[5] A question can be raised about the lack of a corresponding short tone for Tone I, the high tone. This is interesting both diachronically and synchronically.

Diachronically speaking, the seven surface tones are the result of the tone split of the four tones in Middle Chinese due to the devoicing of the initial consonants. Thus :

Middle Chinese	Level I	Rising II	Falling III	Entering IV
Modern Taiwanese	I , II	III	IV , V	VI , VII

(N.B. Some Middle Chinese Tone II words changed to Modern Taiwanese Tone V.)

If Middle Chinese Tone III and Tone IV were in complementary distribution, it is not an accident that Modern Taiwanese IV/V and VI/VII are also in complementary distribution.

Synchronically speaking, Cantonese does have three short tones. I am not sure at this point if they correspond to three long tones in Cantonese.

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Arizona Regional Usage of Lexical Items: Roller Shades, Submarine Sandwich Swamp Cooler, and Arcadia Door

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Following the model of previous submarine sandwich lexical item studies done by Edwin Eames and Howard Robboy in 1967 and William Labov in 1988 in which telephone directory yellow pages were sampled, Phoenix Yellow Page directories were studied to determine usage changes and variations of four lexical items: roller shades, submarine sandwich, swamp cooler, and arcadia door.

My study begins with 1949, the year Hans Kurath first studied "roller shades," and ends with the last available directory for Phoenix, 1989. The sample years correlate as closely as possible with those of previous lexical studies on two of the items. Of the four lexical items and their variants, two of them--"roller shades" and "submarine sandwich"-- were chosen on the basis of previous studies of their transregional usage and two of them--"swamp cooler" and "arcadia door"--on the basis of their intraregional usage.

"Roller shades" and its variants have been studied in the Eastern United States by Kurath in 1949, in California by David Reed in 1952, in Colorado by Clyde Hankey in 1960, and in eight Southern states by George Wood in 1970. These studies, based on Kurath's original research, deal with dialect regions that have an influence on Arizona's dialect patterns.

"Submarine sandwich" and its variants such as "hero," "poor boy," and "hoagie," have been studied by Eames and Robboy in 1967. Their research includes 100 cities in the United States where they study not only lexical variants, but also frequency of use. Their samples come from newspaper articles, questionnaires, direct observations by local informants, and telephone directories. In 1988, Labov also studies distribution of "submarine sandwich" and its variants by direct observation, questionnaires, and Yellow Page listings. Although his research reports on such cities as San Francisco and Los Angeles, he focuses on Northeastern cities, including Philadelphia, Boston, and Pittsburgh.

Following these two models, I have used the Metropolitan Phoenix Yellow Page listings to study not only the local historical development of "roller shades," and "submarine sandwich," but also the two Southwestern items, "swamp cooler" and "arcadia door." I made follow-up telephone calls to businesses in the 1988-89 Yellow