Taiwanese Min Juncture Tones and Prosodic Boundaries

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Abstract

This study investigates the occurrence of phonemic junctures relative to (1) the IP, ip, word and syllable boundaries and (2) the lexical frequencies.

Spontaneous monologues from forty-one speakers recruited from five dialect regions in Taiwan were transcribed involving orthography, Speech Assessment Methods Phonetic Alphabet (SAMPA), phonemic tones, surface tones, syllable, segment, break, linguistic and miscellaneous tiers.

The results showed that the percentages of phonemic juncture tones increased from under 10 % before a syllable boundary, to 30% before a word boundary, 50% to 70% before an ip boundary and finally from 50% to 80% before an IP boundary. The percentage of sandhi tones decreased gradually from syllable to IP boundary. However, sandhi tones can still surface before IP boundary.

High frequency words, mostly grammatical function words and pronouns, are more likely to be produced with sandhi tones. However, low frequency lexical items can be produced with 0 % to 100 % of phonemic juncture tones. The surface realization of phonemic juncture tones can be influenced by both prosodic hierarch and lexical frequency.

Index Terms: tone sanhi group, prosodic boundary, spontaneous speech corpus, lexical frequency, lexical tone

1. Introduction

Taiwanese Min, also known as Taiwanese Hokkien, Taiwan Southern Min, or Taiwanese, belongs to the Min-Nan (Southern Min) branch of Chinese Min which is spoken by 47 million speakers in China, Taiwan, and Southeast Asia, including Burma, Indonesia, Malaysia and Singapore. In Taiwan, 15 million, approximately 70% of the population, speak the language.

1.1. Taiwanese Min lexical tones and tone sandhi rules

Being a tone language, Taiwanese Min has seven lexical tones, 55, 13, 53, 31, 33, 3 and 5 (Table 1). Following Chao's convention [1], tone numbers represent pitch height. The higher the number is, the higher the pitch becomes. Lexical tones with one tone number are shorter than lexical tones with two tone numbers.

When several tones come together in a word or phrase, the tone values may change. This phenomenon is called tone sandhi. There are at least seven tone sandhi rules (55, 13➔33 or 31➔31➔53➔55, 13➔31 and 5➔3➔5) in Taiwanese Min. Within a tone group (TSG) boundary, with the exception of the final syllable, every syllable undergoes the tone sandhi rules and carries a sandhi tone. The final syllable before a tone sandhi group does not undergo tone sandhi rules and as such carries a juncture tone that is identical to the phonemic tone.

Since every tone is involved in tone sandhi rules, each monosyllabic morpheme has two surface forms, one being the sandhi form and the other being the phonemic juncture form. For example, as shown in Table 1, /kun 55/ "gentleman" surfaces with a [33] sandhi form in the non-final position of the TSG, but with a [55] juncture form that is identical to the underlying phonemic tone at the final position of the TSG. In other words, the identification of juncture and sandhi forms can affect the lexical meanings.

Table 1: *Phonemic and sandhi forms of Taiwanese Min lexical tones .*

Segments	Phonemic Tones	Sandhi Tones	Meaning	
/kun/	/55/	[33]	Gentleman	君
/kun/	/13/	[33], [31]	Skirt	裙
/kun/	/53/	[55]	Boil	滾
/kun/	/31/	[53]	Baton	棍
/kun/	/33/	[31]	Near	近
/kut/	/5/	[3]	Plow	掘
/kut/	/3/	[5]	Bone	骨

The alternation of sandhi and juncture tones is a long debated issue. Previous theoretical studies of the effect of syntactic and phonological domains on the TSG domains involving short written texts have left many questions unanswered with respect to spontaneous speech [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12] and [13]. Generally speaking, theoretical studies claimed that the TSG domains matched up with the XP domains and juncture tones occurred before XP boundaries.

Experimental articulatory, acoustical and perceptual studies involving speech produced in laboratory conditions found that (a) juncture and sandhi tones are not fully neutralized; (b) the TSG boundary does not fit into the prosodic hierarchy and (c) the TSG is distinctively different from the intonation phrase (IP), intermediate phrase (ip) and word boundaries [14], [15], [16], [17] and [18].

1.2. Research questions

This study investigates the occurrence of phonemic junctures relative to (1) the IP, ip, word and syllable boundaries and (2) the lexical frequencies. We intended to show that both phonemic juncture and sandhi tones can occur before ip and IP boundaries. Moreover, sandhi tone is the more prevalent form, especially among high frequency words.
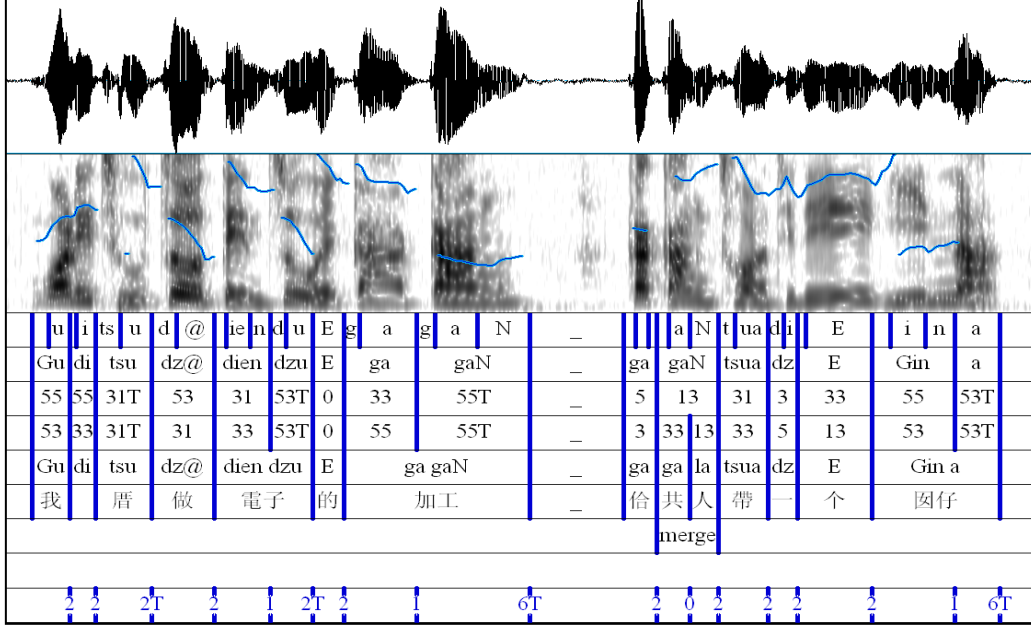
u	i	ts	u	d	@	ie	n	d	u	E	g	a	g	a	N	_	a	N	t	ua	d	i	E	i	n	a
Gu	di	tsu	dz@		dien		dzu			E	ga		gaN			_	ga	gaN	tsua		dz		E	Gin		a
55	55	31T	53		31		53T			0	33		55T			_	5	13	31		3		33	55		53T
53	33	31T	31		33		53T			0	55		55T			_	3	33	13		33		5	13		53T
Gu	di	tsu	dz@		dien		dzu			E	ga gaN					_	ga	ga	la	tsua		dz	E	Gin	a	
我		厝	做		電子		的			加工						_	佮	共	人	帶		一		个	囡仔	
																	merge									
2	2	2T	2		1		2T	2		1	6T						2	0	2		2	2		2	1	6T

Figure 1: *Example of data transcription "I work on electronic parts and babysit at home."*

2. Method

2.1. Speakers

Forty-one native Taiwan Min speakers participated in the experiments. Their background information is listed in Table 2. These speakers were pre-screened for the languages spoken at home and were required to be able to read a newspaper in Taiwan Min before they are qualified to participate in the experiment.

Table 2: *Speakers' backgrounds.*

	Above 40		Under 30	
	Male	Female	Male	Female
Northern Zhanzhou	2	2	2	1
Northern Quanzhou	2	2	2	2
Central Zhangzhou	2	2	2	2
Central Quanzhou	3	2	2	1
Southern Mixed	2	2	2	2
East Yilan	--	--	--	2

2.2. Corpus

Taiwanese Min Spontaneous Speech (TaiMinSS, www.taimin.tw) contains thirty minutes monologues elicited from forty-one speakers recruited from six dialect regions in Taiwan, including Northern Zhangzhou, Northern Quanzhou, Central Zhangzhou, Central Quanzhou, Southern Mixed and Yilan. Within each dialect region, there were males and females over 40 years of age and under 30 years of age. A background dictionary containing more than 35,000 lexical entries, including 2,2479 lexicons from an online dictionary built by Ministry of Education (MOE) [19], 1,1238 lexicons from National Chung Cheng University radio broadcasting [20], and Childes corpora [21], and around 3,000 lexical entries from TaiMinSS and TV Taiwanese Min news was used.

As shown in Figure 1, the corpus was transcribed at nine tiers, including orthography, words tier, underlying phonemic tones, surface tones, syllable, phone segment, break, miscellaneous, and linguistic tiers. Both the orthography and lexical parsing follow the convention of MOE dictionary. Programs were written to automatically generate the words tier containing SAMPA symbols and the underlying tone tier containing the phonemic tones according to MOE dictionary. EasyAling [22], and [23] was used to force align the SAMPA symbols and generate the syllables in syllable tier and segments in phone tier. Surface tone tier was automatically generated following the tone sandhi rules, 13, 55, ➔ 33 ➔ 31 ➔51 ➔55, and 5 ➔3➔ 5, and manually checked to mark the location of TSG boundaries. We also manually checked for the surface tone values of each syllable and corrected the SAMPA symbols in syllable and phones tiers to reflect the actual pronunciation. In this study, the focus was on underlying tones, surface tone and break tiers.

The break indices, 0 stands for syllable merging, 1 stands for syllable boundary, 2 stands for word boundary, 3 stands for sentence internal pause, 4 stands for unfinished sentences, 5 stands for intermediate phrase, 6 stands for intonation phrase. Break indices were placed at the end of the syllable preceding the boundaries.

2.3. Data analysis

The preliminary data of four speakers were shown here. To analyze the effect of boundary on the occurrence of phonemic juncture tones, syllables were further divided according to their dictionary phonemic tone values and the following break indices.

To explore the effect of lexical frequencies, the percentages of phonemic juncture tones produced for each lexical item were plotted against the lexical frequency of the lexical item within the TaiMinSS corpus.

3. Results

3.1. Juncture and sandhi tones versus boundary

Figure 2 showed the percentage of non-juncture and phonemic juncture tones before syllable, word, ip and IP boundaries. As the boundary strengths increased, there was a trend for percentage of non-juncture tones to decrease and percentage of phonemic juncture tones to increase. In two speakers' data, the number of non-juncture tones increased before IP boundaries. Since the non-juncture tones contained neutral tones, by eliminating the neutral tones, more consistent pattern should be revealed.
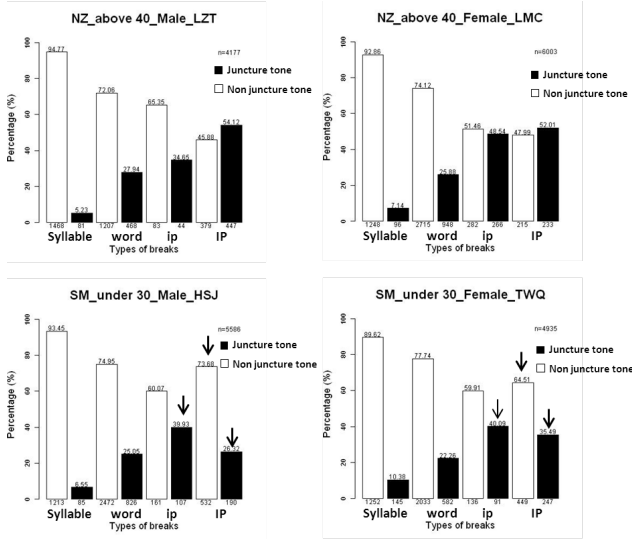
Figure 2: *Percentages of juncture and non-juncture tones before syllable, word, intermediate phrase (ip) and intonation phrase (IP) boundaries.*

After excluding the neutral tones, as shown in Figure 3, we found that as the boundary strength increased, the percentages of sandhi tones decreased, whereas the percentages of juncture tones also increased.
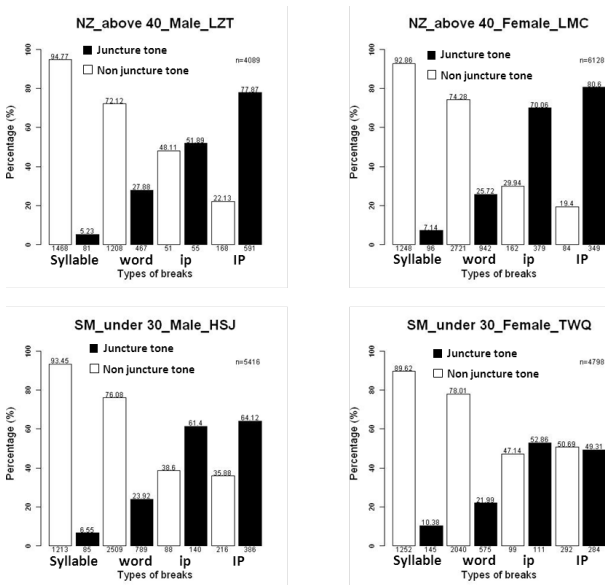

Figure 3: *Percentages of juncture tones (black bar) and non-juncture and non-neutral tones (white bars) before syllable, word, ip and IP boundaries.*

Even after the elimination of neutral tones, non-juncture tones can still be found before ip and IP boundaries (Figure 3). We further divided the non-juncture tones according to their underlying phonemic tone values and surface tone values and it was found that sandhi tones can still occur before ip and IP boundaries. In other words, neither XP nor prosodic boundary can solely determine the occurrence of phonemic juncture tones or sandhi tones.

Table 3: *Number of phonemic tones produced as various surface tones. Sandhi tones are in bold face.*

	s55	s33	s31	s13	s53
ip & IP final position , N=671					
u55	--	**77**	2	1	3
u33	1	--	**286**	10	3
u31	2	3	--	2	**41**
u13	2	**111**	**32**	--	3
u53	75	5	12	2	--

In sum, the percentage of sandhi tones decreased and percentage of phonemic juncture tones increased as the following boundary strength increased. However, sandhi tones can still appear before ip and IP boundaries and phonemic juncture tones can still occur before syllable boundaries. It is proposed that there are other factors determining the realization of juncture and sandhi tones.. Next we would like to explore the effect of lexical frequency on the surface realization of phonemic juncture and sandhi tones.

3.2. Phonemic juncture and sandhi tones versus lexical frequencies

As shown in Figurer 4, among the 6272 lexical items produced by the four speakers, high frequency words (> 1000) were produced with less than 20% of phonemic juncture tones. However, low frequency words (< 50) are produced with 0 to 100 % of phonemic juncture tones. To further explore the occurrence of phonemic juncture tones among low frequency words, factors such neighborhood density and prosodic focus should be taken into considerations.
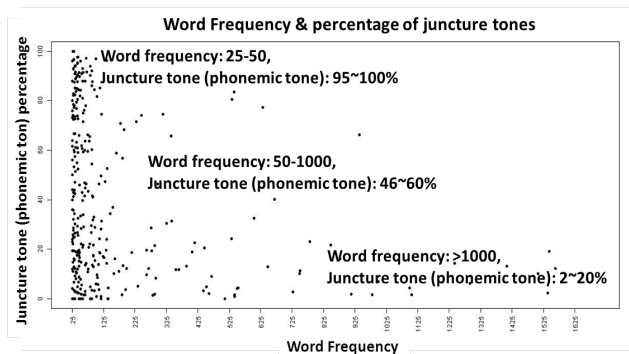
Figure 4: *Percentage of juncture tones and lexical frequency for each lexical item.*

4. Discussion

As the strengths of boundaries increased, the preceding syllables tended to be produced with phonemic juncture tones. However, sandhi tones can still occur before IP boundaries. Unlike the traditional theoretical studies claiming that TSG boundary coincided with XP boundary, here in spontaneous speech, the occurrence of phonemic juncture tones is more flexible. Lexical frequency also contributes to the occurrence phonemic juncture tones.

The optional surface of phonemic juncture tones before ip and IP boundaries suggested that phonemic juncture tone might be a prosodic marker of IP boundary, just like duration final lengthening, f0 final lowering, anacrusis and pitch reset. Further researches are necessary to explore the effect of phonological neighborhood density and function load on the occurrence of the surface realization of phonemic tones.

5. Acknowledgements

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