THE OCCURRENCE OF TAIWANESE MIN JUNCTURE TONES BEFORE PROSODIC BOUNDARIES AND MODIFICATION MARKER

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ABSTRACT

This study explores how prosodic boundaries and morpho-syntactic modification marker [ε 0] determine the occurrence of Taiwanese Min sandhi and juncture tones. Juncture and sandhi tones from a TaiMinSS corpus were investigated involving forty female and male speakers above forty or under thirty years of age from six dialect regions. Unlike the syntactic approach which claims that only juncture tones occur before modification marker [ε 0], the results in this study confirmed that both sandhi and juncture tones occur before [ε 0]. More juncture than sandhi tones before [ε 0] were found. However, there were more juncture tones than sandhi tones before a strong prosodic boundary, including ip and iP boundaries, but more sandhi tones than juncture tones before lower level of boundaries, including syllable and word boundaries in the prosodic hierarchy. In short, the interface between morpho-syntax and prosody determines juncture tone production.

Keywords: tone sandhi rules, Taiwanese Min, spontaneous speech corpus, prosodic boundary.

1. INTRODUCTION

Adult speech segmentation relies on rhythm [1], syntactic structure and function words. A tone sandhi group (TSG) is a language-specific rhythmic unit observed in Taiwanese Min and, to date, its prosodic nature has not been investigated fully.

In Taiwanese Min, the domains of tone TSG are signalled by juncture tones. Juncture tones surface at the domain-final position preceding a TSG boundary. Moreover, juncture tones are identical to the underlying phonemic tones, thus juncture tones are assumed to be the canonical forms.

When several tones come together in a word or a phrase, the surface tone may change, this is identified as tone sandhi. At the non-final position of a TSG, sandhi tones surface according to the chain shift sandhi rules: 55, 13 → 33 →31 → 53 → 55, 3 → 5 → 3, and 55, 53 →13 →31. For example, in /pɛʔ5 tsai31 lɔ53/ [pɛʔ3 tsai31 lɔ53] "cabbage stew,"白菜滷, the syllable /tsai31/ [tsai53] surfaces with a sandhi tone, whereas the syllable /lɔ53/ [lɔ53] surfaces with a juncture tone. However, in /lɔ53 pɛʔ5 tsai31/ [lɔ55 pɛʔ3 tsai31] "stew cabbage," 滷白菜, the syllables /lɔ53/ and /tsai31/ and surface with sandhi tone [lɔ55] and juncture tone [tsai31] and, respectively. The production of juncture and sandhi tones is determined by TSG domains. The surface tone values may change according to the syllable positions in a TSG domain.

1.1. Morpho-syntactic modification marker [ε 0]

Previous studies have explored the occurrence of juncture tones before TSG domains using a syntactic approach based on short written sentences. These studies have proposed that juncture tones occur at the right edges of XP's, which act as arguments or adjuncts [8, 9, 10, 11]. Moreover, only juncture tones were found to occur before morpho-syntactic attribute marker "的" [ε 0] in a nominal phrase [XP ε YP] [11]. The number "0" represents a neutral tone. For example, the noun /hai53 bĩ55/ "seashore" 海邊 followed by the modification marker [ε 0] 的 modify the following noun / tsʰu 31/ "house' 厝 to form /hai53 bĩ55 ε0 tsʰu31/ [hai55 bĩ55 ε0 tsʰu31] "beach house."海邊的厝

However, these syntactic theories were not supported by the spontaneous corpus of children. It is found that children are tuned to language-specific rhythm early in life [12] and may use a preliminary syntactic structure, along with phrasal prosody, to initiate the crucial segmentation process. The spontaneous production of two two-year olds in the Taiwanese Child Language Corpus revealed discrepancies between the XP domains proposed in existing syntactic theories [13]. Since there were no adult spontaneous speech corpora available at the time, it is unclear whether the discrepancies were due to the limitation of syntactic theories or to the incomplete acquisition of the tone sandhi group domain by children.

1.2. Prosodic boundary and juncture tone

Since morpho-syntactic theory cannot explain the occurrence of juncture tones in the spontaneous corpus, some experimental studies were conducted. Results of these experimental studies have found that (a) juncture and sandhi tones are not fully neutralized, (b) TSG boundaries differ from syllable, word,

intermediate phrase (ip) and intonation phrase (IP) boundaries, and (c) a TSG boundary is not part of the prosodic hierarchy [2, 3, 4, 5, 6].

Previous prosodic studies have shown that canonical forms tend to occur before or after strong prosodic boundaries [2, 4, 7]. Following the assumption that the juncture tone is the canonical form, this study investigated whether a juncture tone occurs more often than a sandhi tone before stronger prosodic boundaries, including ip and IP boundaries, and whether sandhi tone occurs more often before syllable and word boundaries.

Since Taiwanese Min under the influence of its lingua franca, Taiwan Mandarin, is undergoing many sound changes, this study also attempted to determine whether or not juncture tone production before a morpho-syntactic marker and prosodic boundaries varies according to age, gender and dialect regions.

In summary, by using an adult spontaneous speech corpus involving Taiwanese Min (TaiMinSS, www.taimin.tw), this study sought to explore the effect of modification marker [ε 0] and prosodic boundary on juncture tone occurrence.

2. METHOD

2.1. Speakers and data recording

Spontaneous monologues were elicited from forty speakers from six dialect regions in Taiwan: Northern Zhangzhou (NZ), Northern Quanzhou (NQ), Central Zhangzhou (CZ), Central Quanzhou (CQ), Southern Mixed (SM) and Yilan (YL) (Table 1).

Table 1: Speaker backgrounds.

		F		M	
		>40	<30	>40	<30
Area	NZ	2	1	2	2
	NQ	2	2	2	2
	CZ	1	2	2	2
	CQ	2	1	3	2
	SM	2	2	2	2
	YL		2		

During a thirty-minute recording, speakers introduced their home town, profession, hobby, and favorite food. The recordings were conducted either in the phonetic lab at National Chiao Tung University or in quite rooms in the homes or offices of the subjects. A TEV Tm-728 II microphone was used along with a Korg MR-1000 digital recorder to capture the speakers at 16 bits and 44.1kHz. The digital sound files were then transferred from the digital recorder to servers and further divided into seven or eight small sound files for speech annotation using Praat.

2.2. Corpus

The spontaneous monologues were transcribed using Praat at nine interval tiers: an utterance tier with SAMPA symbols for each syllable; an orthography tier with Chinese characters according to a dictionary [14] ; a word tier with SAMPA symbols parsed for each word; an underlying tone tier with dictionary tones; a surface tone tier with actual tones produced; a syllable tier reflecting the actual segmental pronunciations; and a segment tier with vowel and consonants individually aligned to the wave forms and spectrograms.

There was also a linguistic tier tagging of the code switches, loan words, and syllable contractions. In the miscellaneous tiers information such as disfluency, laughing, coughing, throat clearing, and ambient noises were tagged.

In the break tier, there were seven types of break indices:‘0’ for syllable contractions; ‘1’ for syllable boundaries;‘2’ for word boundaries; ‘3’ for sentence internal pauses with neither final lengthening nor f0 lowering or f0 rest; ‘4’ for truncated sentences with neither final lengthening nor f0 lowering before the pause, but f0 reset after the pause; ‘5’ for ip boundaries; and ‘6’ for IP boundaries.

In total, there were 37,589 utterances containing 164,782 words. Among the three manually checked tiers, more than half (65.47%) of the surface tones and 52.52% of the breaks were tagged by two transcribers. The inter-transcriber agreement rate was 89.81 % for the surface tone tier and 95.66 % for the break tier.

2.3. Data analysis

After removing the syllables with disfluency, laughter, coughs, throat clearings, ambient noises, code switches, syllable contractions and loan words, there were 182,472 syllables carrying sandhi, juncture and neutral tones.

The number of sandhi, juncture, and neutral tones before syllable, word, ip and IP boundaries were analysed. Logistic mixed effect regression models were conducted to analyse any impact of age, gender and dialect region on the juncture to sandhi tone ratios before syllable, word, ip and IP boundaries.

Furthermore, the numbers of sandhi and juncture tones before syntactic modification marker “的” [ε 0] were analysed, as well as the juncture and sandhi tone ratios before modification marker “的” [ε 0] followed by syllable, word, ip and IP boundaries.

3. RESULT

3.1. Juncture tones and prosodic boundaries

The results of a Chi square analysis found that prosodic boundaries had a significant effect on the

number of juncture tones (p< .001). Thus, the data were further divided according to prosodic boundaries.

As shown in Figure 1, there were more sandhi tones than juncture tones before syllable and word boundaries. There were more juncture than sandhi tones before ip and IP boundaries. Using the juncture to sandhi tone ratio before syllabic boundary as the baseline data, the logistic mixed effect regression models (boundary) revealed that the juncture to sandhi tone ratios increased significantly from word boundary (β=1.555, p< .001) to ip boundary (β=3.097, p< .001) and finally to IP (β= 2.729, p< .001) boundaries (Table 2).

Figure 1: Numbers of sandhi, juncture and neutral tones before syllable, word, ip and IP boundaries.

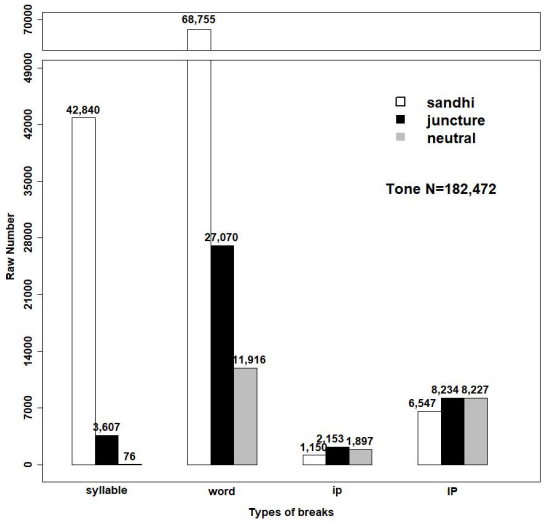

Table 2: Results of a logistic mixed effect regression model (prosodic boundary) on the sandhi and juncture tone ratios before syllable, word, ip and IP boundaries.

Boundary	β	Std.Error	Z	P
Syllable	-2.483	0.031	-79.96	<.001
Word	1.555	0.019	82.65	<.001
ip	3.097	0.041	76.16	<.001
IP	2.729	0.024	113.02	<.001

In order to explore how juncture / sandhi ratios vary according to age, gender and dialect region, the relative importance of their impact was assessed by comparing the full model to a smaller model using Chi-squared statistics and p-values to determine which model provided the better fit (Baayen, 2008). The results of the four Chi-squared statistics for syllable, word, ip and IP boundaries found the inclusion of age, gender and dialect region did not show a better fit before word and ip boundaries. However, before a syllable and ip boundaries, the model including age and dialect region did reveal a better fit. Following the results of the Chi-square analysis, two further logistic mixed effect models with speakers as a random factor were used to explore the effect of age and dialect region on the juncture/sandhi tone ratios before syllabic and IP boundaries. The results revealed that before a syllabic boundary, the Southern Mixed speakers and speakers over forty years of age produced significantly fewer juncture tones. However, before an IP boundary, the Northern Zhangzhou speakers above forty years of age produced significantly more juncture tones than sandhi tones. In other words, the Northern Zhangzhou and Southern Mixed dialect speakers over forty years of age produced more sandhi tones before a syllable boundary and produced more juncture tones than sandhi tones before an IP boundary than the other speakers in this study.

In sum, the number of juncture tones were significantly higher than sandhi tones before strong prosodic boundaries, including ip and IP. However, before lower level boundaries such as syllable and word boundaries, there were fewer juncture tones than sandhi tones. It is proposed, therefore, that prosodic boundary affects juncture tone production.

3.2. Modification Marker [ɛ 0]

Lin [10] has proposed that juncture tones occur before morpho-syntactic modification marker [ɛ 0]. This study investigated the spontaneous monologues in TaiMinSS with regards to this proposition.

In total there were 4, 756 tokens of [ɛ 0], including no [ɛ 0] before a syllable boundary, 3644 tokens of [ɛ 0] before word boundary, 205 tokens of [ɛ 0] before ip boundary and 907 tokens of [ɛ 0] before IP boundary. The results of a Chi square analysis found a significant effect of prosodic boundary on the number of juncture tones (p< .001). Thus, the data were further divided according to prosodic boundaries.

As shown in Figure 2, there were significantly more juncture tones before word, ip and IP boundaries. According to results of logistic mixed effect regression models (boundary) with speakers as the random effect and the juncture to sandhi ratios before word boundary as the baseline data, the juncture to sandhi ratios increase significantly before ip (β= .443, p< .05) and IP (β= .281, p< .01) boundaries (Table 3).

Figure 2: Numbers of sandhi and juncture tones before modification marker [ɛ 0] followed by syllable, word, ip and IP boundaries.

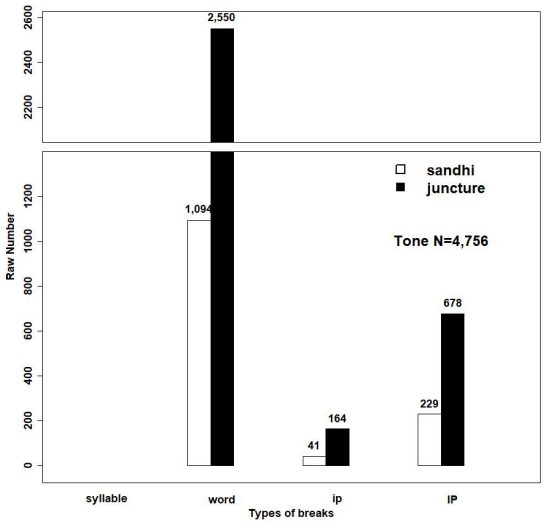

Table 3: Results of logistic mixed effect regression model (prosodic boundary) on the sandhi and juncture tone ratios before modification marker [ε 0] followed by syllable, word, ip and IP boundaries.

Boundary	β	Std.Error	Z	P
Word	.855	0.076	11.307	<.001
ip	.443	0.181	2.446	<.05
IP	.281	0.087	3.218	<.01

To explore the effect of age, gender and dialect region on the juncture to sandhi tone ratios before word, ip and IP boundaries, three logistic mixed effect regression models were used. The results reveal that speakers over forty years of age produced significantly more juncture tones than sandhi tones preceding modification marker [ε 0] followed by word ($p< .001$), ip ($p< .05$) and IP ($p< .05$) boundaries. Furthermore, male speakers produced significantly more juncture tones than sandhi tones before an IP boundary ($p< .01$). In other words, speakers over forty years of age produced significantly more juncture tones before modification marker [ε 0].

In summary, there were significantly more juncture tones than sandhi tones before modification marker [ε 0] across word, ip and IP boundaries. An effect of the modification marker on juncture production was also found. Therefore, the current findings contradict the syntactic theory which claims that only juncture tones can occur before modification marker [ε 0].

4. DISCUSSION

Based on the spontaneous monologues in the TaiMinSS corpus, this study found significant effects of prosodic boundaries and modification marker [ε 0] on the occurrence of juncture tones. It is proposed that prosodic boundary and morpho-syntactic modification marker [ε 0] interact to determine juncture tone production.

The occurrence of juncture tones increases as the strength of the prosodic boundaries increases. With reference to morpho-syntactic effects, there were significantly more juncture tones than sandhi tones before [ε 0] followed by word, ip and IP boundaries. Both juncture and sandhi tones were found to occur before modification marker [ε 0].

4.1. Sound changes in sandhi and juncture tones

However, a comparison across all speaker groups of different ages, genders and dialect regions revealed that the occurrence of juncture tones produced by younger speakers is less likely to be influenced by either prosodic boundaries or modification markers. It is, therefore, on the basis of the 25.659% of juncture in the current study, proposed that the predominant occurrence of sandhi tones (74.392 %) in the non-final positions of tone sandhi groups would yield more exemplars of the sandhi forms of the same morpheme. Taiwanese Min maybe undergoing a period of sound change during which young speakers are producing more sandhi forms across prosodic boundaries and before modification marker [ε 0].

4.2. Prosodic and Morpho-syntactic interface

Both prosodic boundaries and morpho-syntactic medication markers [ε 0] influence the occurrence of juncture tones to a certain extent. However, neither of these factors can fully account for the occurrence of juncture tones. Moreover, since the morpho-syntactic marker [ε 0] carries a neutral tone, future studies need to examine more syntactic particles or markers with neutral tones before one can conclude whether it is the neutral tone or the morpho-syntactic property that determines juncture tone production.

5. CONCLUSION

This study used a new corpus data to access a morpho-syntactic theory on the occurrence of juncture and sandhi tones. The fact that juncture tones did not always occur before modification marker [ε 0], suggests that syntax cannot fully determine the occurrence of juncture tones. Instead, there appears to be an interaction between prosody and the morpho-syntactic marker that affects juncture tone production. Future studies need to explore juncture tone production before other syntactic markers or particles with neutral tones in order to determine whether or not it is the prosodic neutral tone or the syntactic property that determines juncture tone production.

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