

[Forum]

## Morpho-Syntactic Effects on Tone Sandhi Variants in Shanghai Chinese

YASUNORI TAKAHASHI

*Kobe University*

**Abstract:** This paper examines effects of morpho-syntax on tone sandhi variants in Shanghai Chinese. In Shanghai Chinese, “(broad) tone sandhi” occurs in a polysyllabic phrase in which the overall pitch of the phrase is solely determined by the tone of the initial syllable. When this rule applies to a quadrisyllabic phrase whose initial tone is T5 (*yangru*), two sandhi variants appear that differ in their tonal representations. Previous work has suggested several interpretations of the relationship between the sandhi variants but they have not been supported by any objective data.

This study closely observes the distribution of sandhi variants in Shanghai Chinese from a morpho-syntactic perspective. The investigation reveals the following two findings: 1) Three, not two, sandhi variants are found; and 2) two of these sandhi variants (“Second Association” and the “2+2 Variant”) occur only in compounds that consist of two disyllabic nouns (“2+2 compounds”). The second finding clearly indicates that the distribution of the sandhi variants is affected by the morpho-syntactic structures of the phrases.

This paper further discusses why two of the sandhi variants occur only in 2+2 compounds. The occurrence of the 2+2 Variant can be attributed to the difference of a foot (or sandhi domain) construction among the morpho-syntactic structures, and the occurrence of Second Association can be explained by the historical relationship among the sandhi variants.\*

**Key words:** Shanghai Chinese, phonology, tone sandhi, variation, morpho-syntax

### 1. Introduction

In Shanghai Chinese, a quadrisyllabic phrase has two tone sandhi variants when its initial syllable has a particular tone. Although previous studies have suggested several interpretations of the relationship of the variants, their distribution has not been investigated in detail. This study examines whether morpho-syntax is

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involved in the distribution of the sandhi variants. The results of the quantitative investigation reveal that three, not two, sandhi variants are attested in quadrisyllabic phrases, and that their distribution is clearly skewed according to the morpho-syntactic structures of the phrases. The distribution can be explained in terms of metrical rules and the historical relationship of the tone sandhi variants.

This paper is organized as follows: Section 1.1 summarizes the tone sandhi system of Shanghai Chinese. Section 1.2 discusses the sandhi variants observed in quadrisyllabic phrases. Next, Section 2 describes the methods and results of the investigation. Section 3 addresses why the distribution of the sandhi variants is skewed according to morpho-syntax. Section 4 concludes this paper.

### 1.1. Tones and tone sandhi in Shanghai Chinese

Shanghai Chinese, which belongs to the Wu dialects, is a regional Chinese dialect spoken in Shanghai, China. According to Xu et al. (1988: 7), it has three varieties: Old, Middle, and New Shanghai, which are spoken by the old, middle, and young generations, respectively. While Old Shanghai has a rather different tone system than those of the other two varieties (cf. Shen 1981), it appears that Middle and New Shanghai share the same tone system (cf. Xu et al. 1988, Qian 2003). Like most previous studies, this paper focuses on New Shanghai. Henceforth, I will refer to this variety simply as Shanghai Chinese.

There are five citation tones in Shanghai Chinese, labeled from T1 to T5 in this paper. T1, T2, and T3 are called “smooth tones,” and they occur in open syllables or those with a nasal coda. T4 and T5 are called “checked tones,” and they appear in syllables with a glottal stop in the coda (Chen 2000: 14–16).

Table 1. Citation tones in Shanghai Chinese (Xu et al. 1988: 8, Selkirk and Shen 1990: 314)

	T1	T2	T3	T4	T5
Chinese name	<i>yinping</i>	<i>yinqu</i>	<i>yangqu</i>	<i>yinru</i>	<i>yangru</i>
Pitch value <sup>1</sup>	[53]	[34]	[23]	[ <u>55</u> ]	[ <u>12</u> ]
Underlying tone <sup>2</sup>	/HL/	/MH/	/LH/	/MH/	/LH/

In polysyllabic phrases (or words), the overall pitch values are determined solely by the initial tone. This phenomenon has been traditionally called “broad tone sandhi” (we will simply call it “tone sandhi”).<sup>3</sup> Since the late 1970s, research-

<sup>1</sup> The tonal notation of Chinese divides the pitch range into five levels, with 1 as the lowest and 5 as the highest (Yip 2002: 19–20). Underlined values mean “checked tone.”

<sup>2</sup> Selkirk and Shen suggest underlying tones of Shanghai Chinese for analyzing tone sandhi efficiently; therefore, the underlying tones do not necessarily correspond to their pitch values. In contrast, Chen (2000: 221) shows underlying tones of the language that do accurately reflect their pitch values, but it is difficult to analyze Shanghai tone sandhi assuming such underlying tones.

<sup>3</sup> Xu et al. (1988: 42) argue that broad tone sandhi can apply to almost all types of word or phrasal structures. However, it tends not to apply to verb + object, verb + complement and

ers have analyzed this tone sandhi in terms of Autosegmental Phonology (Zee and Maddieson 1979, Yip 1980, among others). These autosegmental analyses are summarized by Chen (2000: 220, 223) as “tone-deletion-cum-spread analysis,” which consists of two phonological operations: tone deletion and tone spread (or, more accurately, tone re-association). Tone deletion eliminates all tonal features except for those of the initial syllable, and tone spread re-associates the tonal features of the initial syllable with the syllables in a left-to-right, one-to-one fashion. A number of previous works on tone spread (e.g., Zee and Maddieson 1979, Duanmu 1995, Takahashi 2011, among others) have further argued that there are several ways in which the tonal features of an initial syllable are re-associated with the following syllables. For example, Duanmu (1995: 228) and Takahashi (2011: 143–144) suggest two rules of tone spread: 1) The tonal features of an initial syllable are re-associated with a first and second syllable, or 2) they are re-associated with a first and last syllable. This paper calls the former “Second Association” and the latter “Final Association.” Examples of each are given in (1).

(1) Examples of two types of tone spread (cf. Duanmu 1995: 228, Takahashi 2011: 143–144)

a. Second Association (DL: default low tone)

e.g., T3 sandhi [dɛ (T3). ts<sup>h</sup>ɔ (T2). vɛ (T3)] ‘egg fried rice’ (lit., ‘egg-fry-rice’)

σ	σ	σ	→	σ	σ	σ	→	σ	σ	σ	→	σ	σ	σ
LH	MH	LH		LH				L	H			L	H	DL
underlying tones				tone deletion				tone spread				insertion of a DL		

b. Final Association

e.g., T5 sandhi [bəʔ (T5). kɛ (T1). sɿ (T2)] ‘hot water’ (lit., ‘white-boil-water’)

σ	σ	σ	→	σ	σ	σ	→	σ	σ	σ
LH	HL	MH		LH				L		H
underlying tones				tone deletion				tone spread		

In these examples, tone deletion removes all tones except the initial ones. In Second Association (1a), the tonal features of the initial syllable re-associate with the first and second syllables, and a default low tone (DL) is inserted into the third syllable (Zee and Maddieson 1979: 120). In Final Association (1b), on the other hand, the tonal features of the initial syllable re-associate with the first and last syllables, and the pitch value of the intermediate syllable (i.e., the second syllable) is determined by interpolation between the first low tone and the final high tone. Table 2 shows pitch values of disyllabic to quadrisyllabic phrases and the distribution of Second Association and Final Association in the tone sandhi system of Shanghai Chinese.

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subject + predicate structures because another type of tone sandhi applies to them instead.

Table 2. Pitch values and distribution of tone spread types in Shanghai tone sandhi (Xu et al. 1988: 24)

Initial tone	Disyllabic phrase	Trisyllabic phrase	Quadrissyllabic phrase
T1 [53] /HL/ <sup>4</sup>	[55. 21]	[55. 33. 21]	[55. 33. 33. 21]
T2 [34] /MH/	[33. 44]	[33. 55. 21]	[33. 55. 33. 21]
T3 [23] /LH/	[22. 44]	[22. 55. 21]	[22. 55. 33. 21]
T4 [55] /MH/	[33. 44]	[33. 55. 21]	[33. 55. 33. 21]
T5 [12] /LH/	[11. 23]	[11. 22. 23]	a. [22. 55. 33. 21] b. [11. 22. 22. 23]

*Note.* Gray cells: Second Association, White cells: Final Association, Underlined tones: checked tones

### 1.2. Two variants of quadrissyllabic T5 sandhi

In Table 2, it is noted that only quadrissyllabic T5 sandhi possesses two sandhi variants that reflect Second Association and Final Association, respectively. For example, Xu et al. (1988: 33) report that a quadrissyllabic idiom [zoʔ. mən. zoʔ. lu] ‘be familiar with (a place)’ (lit., ‘familiar-gate-familiar-road’) has [22. 55. 33. 21] (i.e., Second Association) and [11. 22. 22. 23] (i.e., Final Association).

How do previous studies interpret the relationship between these two variants in quadrissyllabic T5 sandhi? Xu et al. (1988: 25) argue that Second Association and Final Association are in free variation because the former can be substituted for the latter and vice versa. This interpretation is followed by many other studies (Shen 1985, Jin 1995, Qian 2003, among others). In contrast, Zee (1988: 347) regards Final Association as the only correct sandhi pattern in quadrissyllabic T5 sandhi, and Sato (2011) points out that the distribution of the sandhi variants is related to the internal structure of noun phrases: Disyllabic + disyllabic noun phrases have both variants (i.e., Second Association and Final Association) while trisyllabic + monosyllabic and monosyllabic + trisyllabic noun phrases only have Final Association. However, Sato (2011) does not present the detailed results of his research, and his interpretation has not been supported by any quantitative data.<sup>5</sup> In addition, the scope of his investigation is limited to morphology, though it has been reported that syntax is also involved in the application of tone sandhi in various Chinese dialects (for details, see Chapter 9–11 of Chen 2000 and Bao 2004).

Taking account of the results and problems described in Sato (2011), this paper investigates the quantitative distribution of the sandhi variants in various morpho-syntactic constructions.

<sup>4</sup> I regard T1 sandhi as Second Association. Takahashi (2013: 111–114) reports that the F0 contours of polysyllabic words whose initial tone is T1 always fall drastically in the second syllable, which indicates that L of initial T1 /HL/ is associated with the second syllable.

<sup>5</sup> Sato’s data seem to be collected from only one native speaker of Shanghai Chinese.

## 2. Methods and Results

### 2.1. Participants

Seven native speakers of Shanghai Chinese, four males and three females aged 27 to 31, participated in the experiment. All the participants had lived in the urban area of Shanghai (called *shiqu* ‘市區’) since childhood. They were studying at various universities in Tokyo, where the experiment was conducted.

### 2.2. Stimuli

Four types of morpho-syntactic structures were used to test whether they are involved in the distribution of the sandhi variants in T5 sandhi. Only noun compounds (with a sentence-final particle attached) were investigated because “broad tone sandhi” must apply to them.<sup>6</sup> The target phrases of each structure used in the experiment are listed in Table 3.<sup>7</sup>  $[2+2]_N$  and  $[3+1]_N$  are noun compounds:  $[2+2]_N$  consists of a disyllabic place name plus a disyllabic noun [da. fiəʔ] ‘university,’ and  $[3+1]_N$  consists of a trisyllabic place name and monosyllabic noun [lu] ‘road.’  $[[2+1]_N+1]_S$  comprises a compound (which consists of a disyllabic place name plus the monosyllabic noun [lu] ‘road’), followed by a sentence-final particle [ləʔ] indicating a change of state, and  $[[3]_N+1]_S$  consists of a trisyllabic place name noun followed by the same sentence-final particle.

<sup>6</sup> In contrast, another tone sandhi (i.e., “narrow tone sandhi”) tends to apply to other types of phrases (e.g., verb phrases).

<sup>7</sup> I excluded other morpho-syntactic structures from the experiment because we do not have enough examples. For instance, there are only a handful of adjectives that have T5 tone (e.g., [laʔ] ‘hot (taste),’ [baʔ] ‘white,’ [loʔ] ‘green’), and they cannot modify trisyllabic nouns (e.g., \*[laʔ. məʔ. ɕi. ku] ‘hot Mexico’). Therefore, it is quite difficult to systematically examine the distribution of the sandhi variants in the  $[1+3]_N$  structure (i.e., a monosyllabic adjective + a trisyllabic noun).

Table 3. Target phrases in the experiment

a. [2+2] <sub>N</sub> AB [da. fiəʔ] 'AB University'	b. [3+1] <sub>N</sub> XYZ [lu] 'XYZ Road'	c. [[2+1] <sub>N</sub> +1] <sub>S</sub> AB [lu. ləʔ] 'AB Road' + SFP	d. [[3] <sub>N</sub> +1] <sub>S</sub> XYZ [ləʔ] 'XYZ' + SFP
[loʔ. jā. da. fiəʔ] 'Luoyang Univ.'	[məʔ. ei. ku. lu] 'Mexico Road'	[loʔ. jā. lu. ləʔ] 'Luoyang Road' + SFP	[məʔ. ei. ku. ləʔ] 'Mexico' + SFP
[ŋəʔ. jā. da. fiəʔ] 'Yueyang Univ.'	[məʔ. ʃ. k <sup>h</sup> u. lu] 'Moscow Road'	[ŋəʔ. jā. lu. ləʔ] 'Yueyang Road' + SFP	[məʔ. ʃ. k <sup>h</sup> u. ləʔ] 'Moscow' + SFP
[vəʔ. sɛ. da. fiəʔ] 'Foshan Univ.'	[məʔ. ə. pən. lu] 'Melbourne Road'	[vəʔ. sɛ. lu. ləʔ] 'Foshan Road' + SFP	[məʔ. ə. pən. ləʔ] 'Melbourne' + SFP
[loʔ. sɛ. da. fiəʔ] 'Leshan Univ.'	[loʔ. sɛ. tɛi. lu] 'Los Angeles Road'	[loʔ. sɛ. lu. ləʔ] 'Leshan Road' + SFP	[loʔ. sɛ. tɛi. ləʔ] 'Los Angeles' + SFP
[daʔ. tsɿ. da. fiəʔ] 'Dezhou Univ.'	[liiʔ. dɔ. uɛ. lu] 'Lithuania Road'	[daʔ. tsɿ. lu. ləʔ] 'Dezhou Road' + SFP	[liiʔ. dɔ. uɛ. ləʔ] 'Lithuania' + SFP
[loʔ. fəŋ. da. fiəʔ] 'Lufeng Univ.'	[daʔ. ɲi. ʃ. lu] 'Tunisia Road'	[loʔ. fəŋ. lu. ləʔ] 'Lufeng Road' + SFP	[daʔ. ɲi. ʃ. ləʔ] 'Tunisia' + SFP
[loʔ. ts <sup>h</sup> ä. da. fiəʔ] 'Lechang Univ.'	[miiʔ. su. li. lu] 'Missouri Road'	[loʔ. ts <sup>h</sup> ä. lu. ləʔ] 'Lechang Road' + SFP	[miiʔ. su. li. ləʔ] 'Missouri' + SFP
[ɲioʔ. lin. da. fiəʔ] 'Yulin Univ.'	[miiʔ. ei. kən. lu] 'Michigan Road'	[ɲioʔ. lin. lu. ləʔ] 'Yulin Road' + SFP	[miiʔ. ei. kən. ləʔ] 'Michigan' + SFP

Note. N: noun, S: sentence, SFP: sentence-final particle

In addition to the target phrases, three dummy phrases were selected for each morpho-syntactic structure; these are listed in Table 4. In all dummy phrases, T3 sandhi occurs because T3 is the initial tone. The target and dummy phrases were inserted in X position of a frame sentence [i fiɛz huəei X] 'He now likes X' (i: 'he,' fiɛz: 'now,' huəei: 'like'). In the frame sentence, [2+2]<sub>N</sub> and [3+1]<sub>N</sub> function as the object, while [[2+1]<sub>N</sub>+1]<sub>S</sub> and [[3]<sub>N</sub>+1]<sub>S</sub> have two syntactic roles: object and sentence-final particle.

Table 4. Dummy phrases in the experiment

a. [2+2] <sub>N</sub> AB [da. fiəʔ] 'AB University'	b. [3+1] <sub>N</sub> XYZ [lu] 'XYZ Road'	c. [[2+1] <sub>N</sub> +1] <sub>S</sub> AB [lu. ləʔ] 'AB Road' + SFP	d. [[3] <sub>N</sub> +1] <sub>S</sub> XYZ [ləʔ] 'XYZ' + SFP
[jā. tsɿ. da. fiəʔ] 'Yangzhou Univ.'	[ɔ. di. li. lu] 'Austria Road'	[jā. tsɿ. lu. ləʔ] 'Yangzhou Road' + SFP	[ɔ. di. li. ləʔ] 'Austria' + SFP
[lɛ. tsɿ. da. fiəʔ] 'Lanzhou Univ.'	[ŋu. lu. ʃ. lu] 'Russia Road'	[lɛ. tsɿ. lu. ləʔ] 'Lanzhou Road' + SFP	[ŋu. lu. ʃ. ləʔ] 'Russia' + SFP
[nø. tɛin. da. fiəʔ] 'Nanjing Univ.'	[ja. ka. daʔ. lu] 'Jakarta Road'	[nø. tɛin. lu. ləʔ] 'Nanjing Road' + SFP	[ja. ka. daʔ. ləʔ] 'Jakarta' + SFP

### 2.3. Procedure

Recording was conducted in a sound-treated booth in the Phonetic Laboratory at Tokyo University of Foreign Studies. The recording was made with a 44.1 kHz sampling rate using an AKG C444 microphone and Marantz PMD660 recorder and saved onto a compact flash memory card. The target sentences were presented in Chinese at random. Each participant read all the sentences twice.<sup>8</sup> They were instructed to read the target sentences at a normal speech rate. The sandhi pattern of each token was checked by analyzing the recording material with F0 tracking in Praat ver. 5.1.44 (Boersma and Weenink 1992–2014).

### 2.4. Results

In the experiment, three, not two, sandhi variants were found, as shown in (2).

- (2) Three sandhi variants found in the experiment
- |                       |                          |                |
|-----------------------|--------------------------|----------------|
| a. Second Association | b. Final Association     | c. 2+2 Variant |
| σ   σ   σ   σ         | σ   σ   σ   σ            | σ   σ   σ   σ  |
| (L   H   L   L)       | (L                    H) | (L H) (L H)    |

In Second Association (2a), where an initial LH tone re-associates with the first and second syllables and a default low tone is inserted into the following syllables, pitch rises to the second syllable, then falls. In Final Association (2b), where an initial LH tone re-associates with the first and final syllables and the pitch values of the intermediate syllables are determined by interpolation between the first low tone and final high tone, gradual pitch-rise occurs over the quadrisyllabic phrase. Second Association and Final Association can be called “quadrisyllabic sandhi” because they have only one sandhi domain that corresponds to the whole quadrisyllabic phrase.

On the other hand, the third type of sandhi variant (2c), which we will call the “2+2 Variant,” cannot be classified as quadrisyllabic sandhi because it has two sandhi domains: The first and second syllables constitute one disyllabic sandhi, and the third and fourth syllables constitute another. In the 2+2 Variant, it is impossible to detect whether the initial tone of each sandhi domain re-associates with the second or the final syllable: As the second syllable is equivalent to the final syllable in the disyllabic domain, the two rules of tone re-association would predict the same pitch representation [L.H.L.H].

Table 5 shows the distribution of the sandhi variants for each morpho-syntactic structure. In the table, “Error token” includes mispronunciations that can be attributed to the participants’ confusion with the tone system of Mandarin, the official language of China.<sup>9</sup>

<sup>8</sup> All participants used one variant for each phrase.

<sup>9</sup> For example, [daʔ. ɲi. sɿ. lu] ‘Tunisia Road’ and [daʔ. ɲi. sɿ. ləʔ] ‘Tunisia’ + SFP were pronounced with T1 sandhi by five participants. In Mandarin, the tone category of the initial [daʔ] belongs to *yinping*; therefore, the participants might misrecognize it as *yinping* (T1) even in Shanghai Chinese.

Table 5. Distribution of the sandhi variants in the four morpho-syntactic structures

	a. [2+2] <sub>N</sub>	b. [3+1] <sub>N</sub>	c. [[2+1] <sub>N</sub> +1] <sub>S</sub>	d. [[3] <sub>N</sub> +1] <sub>S</sub>
Second Association	33 (59%)	0	0	0
Final Association	13 (23%)	51 (91%)	55 (98%)	51 (91%)
2+2 Variant	9 (16%)	0	0	0
Error token	1 (2%)	5 (9%)	1 (2%)	5 (9%)

It was found that all sandhi variants appeared in [2+2]<sub>N</sub> (henceforth, we will call this morpho-syntactic structure “2+2 compounds”), while only Final Association, except for error tokens, occurred in the other morpho-syntactic structures, (b) to (d) in Table 5. In other words, Second Association and the 2+2 Variant occurred only in 2+2 compounds. A chi-square test of independence was conducted to assess the relationship between morpho-syntactic structure and sandhi variant. The result was significant at the 0.01% level ( $\chi = 158.89, p < 0.001$ ), which indicates that there was a statistical association between morpho-syntactic structure and sandhi variant.

In 2+2 compounds, where all variants were attested, the distribution of the variants (see Table 6) was different in each word. In Table 6, ‘Foshan University’ [vəʔ. sɛ. da. fiəʔ] and ‘Leshan University’ [loʔ. sɛ. da. fiəʔ] did not have the 2+2 Variant, while the other compounds had all sandhi variants.

Table 6. Distribution of the sandhi variants in 2+2 compounds

	SA	FA	2+2	E		SA	FA	2+2	E
‘Luoyang Univ.’	4	2	1	0	‘Dezhou Univ.’	3	1	2	1
‘Yueyang Univ.’	4	1	2	0	‘Lufeng Univ.’	4	2	1	0
‘Foshan Univ.’	5	2	0	0	‘Lechang Univ.’	4	1	2	0
‘Leshan Univ.’	4	3	0	0	‘Yulin Univ.’	5	1	1	0

*Note.* SA: Second Association, FA: Final Association, 2+2: 2+2 Variant, E: Error token

### 3. Why Do the 2+2 Variant and Second Association Occur Only in 2+2 Compounds?

In the experiment, Final Association occurred in all four morpho-syntactic structures while Second Association and the 2+2 Variant occurred only in 2+2 compounds. These results show that the distribution of the sandhi variants is greatly skewed to the morpho-syntactic structures of the phrases, which means that they are not completely in free variation. Here, we will consider why the 2+2 Variant and Second Association occurred only in 2+2 compounds.

#### 3.1. Occurrence of the 2+2 Variant: A metrical approach

First, we will address the occurrence of the 2+2 Variant. The difference between this variant and the other sandhi variants lies in the construction of their sandhi domains: The 2+2 Variant contains two disyllabic sandhi domains, while Second



Association and Final Association each have a quadrisyllabic sandhi domain (see Section 2.4). Thus, in order to account for the skewed distribution of the 2+2 Variant, it is necessary to understand how a sandhi domain is created in each morpho-syntactic structure.

Since the 1980s, a number of studies have discussed which prosodic constituent corresponds to a sandhi domain of Shanghai Chinese. Yip (1980: 164) suggests that a sandhi domain of the language is a trochaic foot because the pitch value of Shanghai tone sandhi is solely determined by the tone of the initial syllable. Selkirk and Shen (1990: 318–319), on the other hand, claim that tone sandhi occurs within a phonological word rather than a foot. Duanmu (1993: 20–21) points out that Selkirk and Shen’s analysis cannot explain the sandhi domain in noun compounds, and alternatively elaborates a metrical approach to Shanghai tone sandhi. Bao (2004: 881–883) argues against Duanmu’s interpretation, but he does not propose an alternative.

In Chinese phonology, feet have been proposed as sandhi domains of various dialects (for details, see Chen 2000), but they have a different nature from those in stress languages. For example, tri- and quadrisyllabic feet, which are too big from a universal viewpoint,<sup>10</sup> are often tolerated in various Chinese dialects because it is normal for the scope of tone sandhi to exceed three syllables (e.g., Yip 1980, Duanmu 1993, Chen 2000). In this study, I will follow Duanmu’s metrical interpretation because it can account for the formation of the sandhi domain in Shanghai Chinese, and there are no other alternatives. However, I want to emphasize that the foot of the language is not entirely consistent with that of stress languages.

Duanmu (1993) and Chen (2000) propose metrical (or stress assignment) rules of Shanghai Chinese. I rewrite the relevant rules in terms of foot formation in (3) and show how metrical feet are formed in the target four morpho-syntactic structures in Table 7.

- (3) Metrical rules of Shanghai Chinese (cf. Duanmu 1993: 26, Chen 2000: 307–308)
- a. A trochaic foot is assigned from left to right.
  - b. Foot formation takes place cyclically from the word level to phrase level.
  - c. A stray monosyllable (or a degenerate foot) is adjoined to the left (or preceding) foot.
  - d. Multiple feet in a phrase can be optionally combined into one foot (“Foot Reduction”).

<sup>10</sup> An anonymous reviewer points out this problem.

Table 7. Foot formation in the four morpho-syntactic structures<sup>11</sup>

	a. $[2+2]_N$ $\sigma \sigma + \sigma \sigma$	b. $[3+1]_N$ $\sigma \sigma \sigma + \sigma$	c. $[[2+1]_N+1]_S$ $\sigma \sigma + \sigma + \sigma$	d. $[[3]_N+1]_S$ $\sigma \sigma \sigma + \sigma$
Word level 1	$(\sigma \sigma) + (\sigma \sigma)$	$(\sigma \sigma \sigma) + \sigma$	$(\sigma \sigma) + \sigma + \sigma$	$(\sigma \sigma \sigma) + \sigma$
Word level 2	—————	$(\sigma \sigma \sigma + \sigma)$	$(\sigma \sigma + \sigma) + \sigma$	—————
Phrase level	—————	—————	$(\sigma \sigma + \sigma + \sigma)$	$(\sigma \sigma \sigma + \sigma)$
Foot Reduction	$(\sigma \sigma + \sigma \sigma)$	—————	—————	—————

In 2+2 compounds, shown in column (a) of Table 7, it is possible to create two kinds of foot constructions: two disyllabic feet and a quadrisyllabic foot. The latter can be formed if Foot Reduction (3d) is optionally applied to the phrase. In the other morpho-syntactic structures (columns b to d of Table 7), on the other hand, only a quadrisyllabic foot can be formed; since a stray monosyllable must be adjoined to the preceding foot, a trisyllabic foot is created in the first element at Word level 1 in columns (b) and (d). Subsequently, the fourth syllable is combined with the preceding trisyllabic foot at Word level 2 in column (b) or Phrase level in column (d). Similarly, in column (c), the third and fourth syllables are adjoined to the preceding foot at Word level 2 and Phrase level, respectively, which consequently results in a quadrisyllabic foot.

Provided that a sandhi domain corresponds to a metrical foot, as suggested by Duanmu and Chen, the 2+2 Variant can occur in two disyllabic feet because it contains two disyllabic sandhi domains. Therefore, in the experiment above, it can occur only in 2+2 compounds because this is the only morpho-syntactic structure that can contain two disyllabic feet.<sup>12</sup>

### 3.2. Occurrence of Second Association: A diachronic hypothesis

Next, we will consider why Second Association occurred only in 2+2 compounds. Since Second Association and Final Association are considered quadrisyllabic sandhi, they should occur in the same foot construction—i.e., a quadrisyllabic foot—which means that the metrical analyses proposed by Duanmu (1993) and Chen (2000) cannot address this problem; that is, they cannot predict which sandhi variant appears in the same foot construction.

To resolve this problem, I will focus on the historical relationship between Second Association and Final Association. It is suggested that the latter variant retains the older sandhi pattern more so than the former does. Qian (1995: 323) argues that the old sandhi pattern (i.e., Final Association) has been retained only in T5 sandhi, and the new sandhi pattern (i.e., Second Association) has developed

<sup>11</sup> An anonymous reviewer points out the correct way of foot formation in Table 7.

<sup>12</sup> This conclusion predicts that the 2+2 Variant never occurs in morpho-syntactic structures where two disyllabic feet cannot be formed. Takahashi (2013: 73–74) preliminarily investigated other structures, and the data support the conclusion here.

in T1 to T4 sandhi. Takahashi (2011) also points out that in T5 sandhi, Final Association is attested in Old Shanghai, whereas Second Association developed later. Based on these historical analyses and the results of the experiment above, it is assumed that in quadrisyllabic T5 sandhi, the historical change from Final Association to Second Association has been occurring only in 2+2 compounds, not in the other morpho-syntactic structures.<sup>13</sup>

Following these historical assumptions, this study proposes a historical scenario that accounts for the skewed distribution of Second Association in quadrisyllabic T5 sandhi. In this scenario, Second Association, which has already developed in T1 to T4 sandhi, might extend to T5 sandhi, which has retained the original Final Association (see Figure 1).

T5 sandhi	Final Association	2+2 Variant	
e.g., [loʔ. jã. da. fioʔ]	[L... H] ~	[L.H] [L.H]	
‘Luoyang Univ.’	<b>【Stage 1】</b>		<b>【Stage 2】</b>
T3 sandhi	Second Association	2+2 Variant	Second Association
e.g., [jã. tsɿ. da. fioʔ]	[L.H.L.L] ~	[L.H] [L.H]	[L.H.L.L]
‘Yangzhou Univ.’			

Figure 1. Historical change of sandhi variants in T5 sandhi

This scenario comprises two historical stages<sup>14</sup>: In Stage 1, Final Association was retained in T5 sandhi, while Second Association had already developed in the other sandhi (e.g., T3 sandhi). In 2+2 compounds, the 2+2 Variant optionally occurred since they could be parsed into two disyllabic feet<sup>15</sup> (see Table 7 in Section 3.1). In this situation, speakers of Shanghai Chinese could not distinguish the pattern of T5 sandhi (i.e., Final Association) from that of T3 sandhi (i.e., Second Association) because T5 and T3 sandhi took the same tonal representation, [L.H][L.H], in the 2+2 Variant.

Then, in Stage 2, because Second Association had already occurred in all tone sandhi except T5 sandhi (see Table 2 in Section 1.1), speakers regarded Second Association as the “unmarked” sandhi variant in Shanghai Chinese and began extending it to T5 sandhi. Consequently, they began to produce Second Association even in T5 sandhi.

The most important point of this scenario is that the historical change from

<sup>13</sup>It seems that this historical change is not finished yet, as a quarter of the 2+2 compound tokens retained Final Association in the experiment (see Table 5).

<sup>14</sup>An anonymous reviewer points out the correct process of this historical change.

<sup>15</sup>This is the case even for dummy words in the experiment above: 2+2 compounds (e.g., [jã. tsɿ. da. fioʔ] ‘Yangzhou Univ.’) had the 2+2 Variant as well as Second Association while only the latter variant occurred in the other structures.

Final Association to Second Association could occur only in phrases that could be parsed into two disyllabic feet, because the speakers' confusion of the sandhi variants was caused by use of the 2+2 Variant. Therefore, it is predicted that within the four morpho-syntactic structures investigated above, this historical change would happen only in 2+2 compounds, since they can be parsed into two disyllabic feet as well as into a quadrisyllabic foot (see Table 7 in Section 3.1). This prediction is consistent with the results of the experiment: Second Association occurred only in 2+2 compounds, never in the other morpho-syntactic structures (see Table 5 in Section 2.4).

#### 4. Conclusion

This study has revealed that in Shanghai Chinese, the distribution of three kinds of variants found in quadrisyllabic T5 sandhi is greatly skewed to the morpho-syntactic structures of phrases: The 2+2 Variant and Second Association occur only in compounds that consist of two disyllabic nouns (2+2 compounds), and other morpho-syntactic structures only have Final Association. To correctly understand the occurrence of the 2+2 Variant in 2+2 compounds, I have paid attention to the difference of foot formation among the morpho-syntactic structures: Two disyllabic feet can be formed only in the 2+2 compound, which leads to the occurrence of the 2+2 Variant in this morpho-syntactic structure. To account for the occurrence of Second Association in 2+2 compounds, I have considered the historical relationship between Second Association and Final Association. The historical scenario I propose correctly predicts that Second Association can occur only in 2+2 compounds because the historical change from Final Association to Second Association has happened through the 2+2 Variant.

The results of this study clearly indicate that morpho-syntax as well as phonology may play a crucial role in the application of tone sandhi in Shanghai Chinese. Thus far, previous tonological work on Shanghai Chinese (except Selkirk and Shen 1990 and Sato 2011) has not seriously considered interactions of non-phonological factors (such as morpho-syntax) with tonal phenomena. However, it is necessary to take morpho-syntax into account in order to fully understand the attributes of tone sandhi of the language.

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*Author's contact information:*

School of Languages and Communication, Kobe University  
1-2-1 Tsurukabuto, Nada, Kobe, Hyogo 657-8501, Japan  
e-mail: ytakahashi@port.kobe-u.ac.jp

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【要旨】

上海語のトーンサンディー変種に働く形態統語論の影響

高橋 康德

神戸大学

第1音節の声調が語全体のピッチを決定する上海語では、陽入声が初頭にくる4音節語でのみ2種類のピッチ変種が観察されるが、これらの変種がどのような関係にあるのかは未解決の問題であった。本稿では形態統語構造に注目して変種の出現分布を調査し、従来の報告にあった2種類に加えてもう1種類の変種が存在すること、変種の出現分布は形態統語構造の影響を大きく受け、特に2+2変種と第2音節連結変種は「2音節名詞+2音節名詞」の環境でしか出現しないことを示す。さらに本稿では、なぜ上記2変種が「2音節名詞+2音節名詞」でしか出現しないのかを考察する。2+2変種では形態統語構造によるフット形成方法の違い、第2音節連結変種では上海語のトーンサンディーの通時変化プロセスに注目することで出現分布を説明できる。