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Research Article

Structure-dependent tone sandhi in real and nonce disyllables in Shanghai Wu

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ABSTRACT

Disyllabic sequences in Shanghai Wu undergo different types of tone sandhi depending on their structure: phonological words (e.g., modifier–nouns) spread the initial tone across the disyllable, while phrases (e.g., non-lexicalized verb–nouns) maintain the final tone and level the contour of the nonfinal tone. We investigated the productivity of the two tone sandhi types through 48 speakers' productions of real and nonce disyllables. Our results show that (a) the word-level tone sandhi in Shanghai indeed involves tone spreading, while the phrase-level sandhi is better interpreted as phonetic contour reduction, (b) the spreading sandhi generally applies productively to nonce words, but there are some differences in tone production between real and nonce words that are attributable to both categorical non-application and gradient application of the sandhi in nonce words, and (c) the structure dependency of Shanghai tone sandhi is also productive, as the speakers produced qualitatively different *f*0 patterns in modifier–noun nonce words and verb–noun nonce phrases. These results indicate that in order to arrive at a full picture of tone sandhi patterning, experimental data that shed light on the generalizations that speakers make from the speech input are necessary.

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1. Introduction

1.1. Tone and tone sandhi in Shanghai Wu

Shanghai is a Northern Wu dialect of Chinese spoken in a major metropolis in eastern China with a population of 23.5 million (2010 census data, from http://www.stats-sh.gov.cn/). Like other dialects of Chinese, Shanghai Wu is tonal, but two properties of Shanghai differentiate its tone system from the more familiar four-tone system of Mandarin. First, Shanghai has retained the historical checked syllables (syllables closed by a stop, realized in Shanghai as CV?) that Mandarin has lost. These syllables have considerably shorter duration than open or sonorant-closed syllables and a reduced tonal inventory: there are three tones on open or sonorant-closed syllables, transcribed by Xu, Tang, and Qian (1981) in Chao numbers (Chao 1948, 1968) as 53 (T1), 34 (T2), and 13 (T3); but on CV? syllables, there are only two phonetic tones 55 (T4) and 12 (T5).[1] Second, Shanghai, like many Wu dialects of Chinese, has maintained the historical voicing/phonation distinction in syllable onsets, and the cooccurrence restriction between voicing/phonation and *f*0, which led to the *yin-yang* tone split in many Chinese dialects (Karlgren, 1915–1926; Haudricourt, 1954; Pulleyblank, 1978; Yip, 1990, among many others), is still synchronically relevant for Shanghai: the higher tones 53, 34, and 55 (the historical *yin* tones in Chinese) only occur after voiceless obstruents and modal sonorants and the lower tones 13 and 12 (the historical *yang* tones) only occur after voiced obstruents and murmured sonorants.[2]

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[1] In Chao numbers, a speaker's tonal range from low to high is represented by a numerical scale from "1" to "5." Contour tones are denoted by number concatenations; e.g., "13" indicates a rising tone in the low range (Chao, 1948, 1968). In the tradition of Chinese dialectology, we also use an underline to indicate tones that occur on syllables closed by an obstruent coda, in the case of Shanghai, a glottal stop ?.

[2] Phonetically, the "voiced" stops in Shanghai are not realized with typical closure voicing, but were described as "voiceless with voiced aspiration" by Chao (1967). More recent studies showed that the voiced category has acoustic properties of breathy phonation such as higher H1–H2 (Cao & Maddieson, 1992; Ren, 1992; Chen, 2011; Gao, Hallé, Honda, Maeda, & Toda, 2011) as well as a shorter closure duration than the voiceless category (Shen & Wang, 1995; Wang, 2011). On fricatives, the voicing distinction is truly reflected in voicing. On

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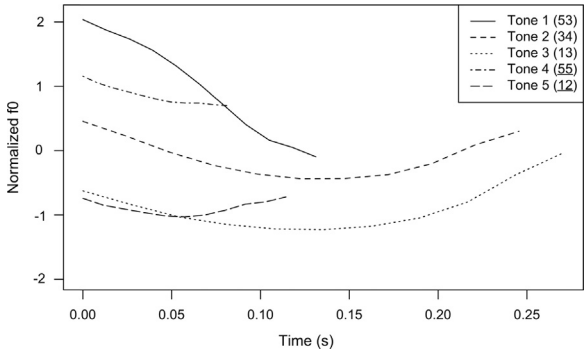

Fig. 1. The five phonetic tones in Shanghai. Each tone is exemplified by the average *f*0 of eight monosyllabic morphemes read in isolation by a female native speaker. The numbers after each tone reflect Xu et al.'s (1981) transcriptions in Chao numbers. Tone 1 (53), Tone 2 (34), and Tone 3 (13) occur on open or sonorant-closed syllables, and Tone 4 (55) and Tone 5 (12) occur on ʔ-closed syllables. Tones 1, 2, and 4 occur after voiceless/modal onsets, and Tones 3 and 5 occur after voiced/murmured onsets.

Fig. 1 illustrates the five phonetic tones in Shanghai and their cooccurrence with syllable types and onsets. The data came from one female speaker, who read eight monosyllabic morphemes for each tone one time in isolation. The *f*0 values of the tones were measured using the ProsodyPro script (Xu, 2005–2011) in Praat (Boersma & Weenink, 2009), and the values in Hz were first converted into semi-tone, and then *z*-score transformed. For more details of the stimuli and data analysis, see Section 2.

Like in the majority of Chinese dialects, tones in Shanghai participate in tone sandhi depending on the context in which they appear. Comprehensive descriptions of Shanghai tone sandhi in disyllables appeared in Sherard (1972), Zee and Maddieson (1980), Shen (1981), Xu et al. (1981), Xu & Tang (1988), and Zhu (1999, 2006). Two properties of Shanghai tone sandhi are particularly noteworthy. First, the sandhi pattern that occurs in compounds is the so-called "left-dominant sandhi" (Yue-Hashimoto, 1987; Chen, 2000; Zhang, 2007, 2014), which spreads the tone of the initial syllable across the entire word. Examples (1a) and (1b) show that the surface tones of the compounds "to catch a cold" and "popsicle," 55-31 and 22-44, are derived by spreading the base tones of the initial syllables, 53 and 13, over the disyllables, respectively. This is a notably different pattern from the more familiar third tone sandhi in Mandarin whereby a T3 (213) changes into a T2 (35) before another T3.[3] Yue-Hashimoto (1987) and Zhang (2007) termed the Mandarin-type tone sandhi "last-syllable dominant" and "right-dominant," respectively, and showed from typological data that there is an asymmetry in how the sandhi behaves based on directionality, in that left-dominant sandhi tends to involve the extension of the initial tone rightward, while right-dominant sandhi tends to involve local or paradigmatic tone change. Shanghai and Mandarin, therefore, represent a typical pattern in their respective sandhi directionality.

(1)	Shanghai tone sandhi examples:		
	a.	sɑ̃^{53}	"to hurt"
		foŋ^{53}	"wind"
		/sɑ̃^{53}-foŋ^{53}/→[sɑ̃^{55}-foŋ^{31}]	"to catch a cold" (Xu et al., 1981: p. 151)
	b.	bɑ̃^{13}	"stick"
		pin^{53}	"ice"
		/bɑ̃^{13}-pin^{53}/→[bɑ̃^{22}-pin^{44}]	"popsicle" (Xu et al., 1981: p. 153)

Second, tone sandhi in Shanghai is sensitive to the morphosyntactic structure of the disyllabic sequence. According to Xu et al. (1981) and Xu and Tang (1988), modifier–noun combinations are invariably compounds and can *only* undergo left-dominant sandhi. Verb–noun, verb-modifier, subject–predicate combinations and coordinate structures that are less lexicalized and have lower frequency of occurrence, however, can undergo right-dominant sandhi, which retains the tone of the final syllable and reduces the tonal contour of the nonfinal syllable. The effects of syntactic structure and frequency of occurrence on Shanghai tone sandhi are illustrated by the examples in (2). In (2a), the same morphemes for "to fry" and "rice", when concatenated as a modifier–noun compound "fried rice," undergo left-dominant contour extension, but when concatenated as a verb–noun phrase "to fry rice", may undergo either left-dominant contour extension or right-dominant contour reduction. In (2b), the verb "to pull" is concatenated with three different nouns – "river", "grass", and "tree", which form an idiomatic expression for "tug-of-war", a commonly used phrase "to pull out grass; to weed", and a rarely used phrase "to pull out a tree", respectively, and the tone sandhi patterns for these three concatenations are left-dominant only, variable left-dominant or right-dominant, and right-dominant only, respectively.

(*footnote continued*)
sonorants, the modal-murmured distinction, which corresponds to the voiceless-voiced distinction in obstruents, is only reported by a subset of the resources, e.g., Xu and Tang (1988) and Zhu (1999), who transcribed the sonorant distinction as ʔC∼ɦC and qC∼C, respectively. We use this transcription practice here.

[3] Acoustically, the third tone sandhi in Mandarin does not involve complete neutralization (Peng, 2000; Yuan & Chen, 2014; among others). But the small acoustic difference between a sandhi T3 and a base T2 cannot be reliably perceived by native speakers (Peng, 2000).

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