Morphological Effects on the Access of Mandarin Sandhi Syllables

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Mandarin tone 3 sandhi, in which a Tone 3 (T3) syllable changes to a Tone 2 (T2) when followed by another T3 syllable, poses challenge to lexical and phonological processing as language users need to sort through the deviant surface forms (i.e., T2s and T3s) to arrive at the abstract phonemic representations of words. Previous studies have investigated how Mandarin T3 sandhi words are represented and processed by native speakers on the word-level (i.e., compounds; Zhou & Marslen-Wilson, 1997; Chien et al., 2016); however, few studies have taken into account how morphological information (i.e., reduplication) and sentential contexts are deployed by native speakers in accessing the underlying and the surface representations of sandhi syllables. This study compares the processing of the Mandarin T3 sandhi words induced by two different morphological processes—verb reduplication with a T3 stem (i.e., T3-RED), and compounds that are underlyingly /T3-T3/ (i.e., T3-COM). Non-sandhi verb reduplication with a T2 stem (i.e., T2-RED) was included as the baseline (Table 1). While disyllabic compounds are stored as lexical units in the mental lexicon (Zhou & Marslen-Wilson, 1995), it is unclear how the sandhi syllables of compounds and reduplicated verbs are represented and processed. This study aims at investigating how morphological processes interact with phonological processes.

We conducted a *cross-modal syllable-morpheme matching experiment*. Target words were embedded in carrier sentences at the sentence-final position, and sentences were visually presented 2 characters at a time (equivalent to the size of disyllabic words in Chinese) on a computer monitor in a rapid serial visual presentation mode (programmed using E-Prime 2.0; Figure 1). A monosyllabic audio was played at the onset of the target word, and participants were asked to judge whether the audio matches the red-color coded first character by pressing the yes-no keys on a response box. For each of the three conditions in Table 1, three types of audio stimuli minimally contrasted by tones were used, including T2, which is the underlying and surface tone of the non-sandhi syllable in T2-RED and the surface tone of the sandhi syllable in T3-RED and T3-COM, T3, which is the underlying tone of the sandhi conditions in T3-RED and T3-COM, and a control tone T1 (the high-level tone in Mandarin), which is not related to the surface or the underlying tones of the stimuli. The audio stimuli were presented in a Latin-square design.

Both responses (Yes/No; Figure 2) and RTs (Figures 3 and 4) were recorded for analysis. The Yes responses to the underlying-matching audios (T2 in T2-RED; T3 in T3-RED and T3-COM) almost all reached ceiling, suggesting that subjects were highly accurate in accessing the underlying tonal representation. By contrast, the Yes percentages of the surface-matching audios (T2) of the sandhi compounds were higher than that of the sandhi reduplication, suggesting that association with the surface tone was stronger in compounds than in reduplications. RT results were consistent with the response patterns. First, the underlying tone of sandhi reduplications induced significantly longer RTs than that of non-sandhi reduplications (Figure 3), corroborating previous findings that sandhi words are more effortful to process than non-sandhi words (Zhang et al., 2015). Second, subjects showed distinct processing patterns matching the surface-matching audios with the sandhi syllables: whereas the surface tone was easier to be mapped onto the sandhi syllable of compounds, it was harder to be accepted in reduplication. It suggests that the surface tonal representation was highly activated in lexical compounds but exerted a minimal role in processing sandhi reduplications.

The current study sheds light on how tone sandhi representation could help us understand the processing mechanisms of the higher-level (i.e., reduplication) and the lower-level (i.e., compounding) compositions. Both the underlying tone and the surface tone of a sandhi syllable are activated in the mental lexicon; however, lexical compounds and reduplicated structure demonstrate different strengths of associations with these representations. Mandarin tone sandhi occurs in the word level for compounds, thus the surface T2 representation is strongly associated with the word-level representation; whereas for reduplicated structure, tone sandhi occurs in supra-lexical level, therefore, it is the underlying T3, instead of the surface T2 representation, which is represented in the word level. According to our results that the underlying T3 was strongly represented in both structures, while the surface T2 was only activated in compounds but not reduplication, we propose that the word-level representation is salient during morphological processing and higher-level construction yields morphological decomposition.

Table 1: Three Mandarin constructions and examples

Phonological rules	**T2-RED**	**T3-RED**	**T3-COM**
underlying form	/T2/ + /T2/	/T3/ + /T3/	/T3 + T3/
tone sandhi	×	**T2** + T3	**T2** + T3
tone neutralization	T2 + **T0**	**T2** + **T0**	×
surface form	[T2 + **T0**]	[**T2** + **T0**]	[**T2** + T3]
Example	*tán2* → *tán2-**tan0*** ‘talk (for a little bit)’	*xiǎng3* → ***xiáng2-xiang0*** ‘think (for a while)’	*lǐ3-jiě3* → ***lí2**-jiě3* ‘understand’

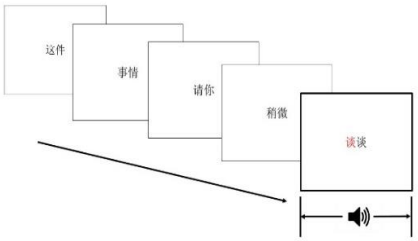

Figure. 1 *Cross-modal syllable-morpheme matching* experiment research paradigm

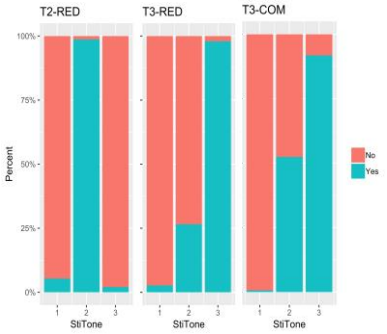

Figure. 2 Percentages of response types (Yes/No) across three constructions (T2-RED, T3-RED, T3-COM)

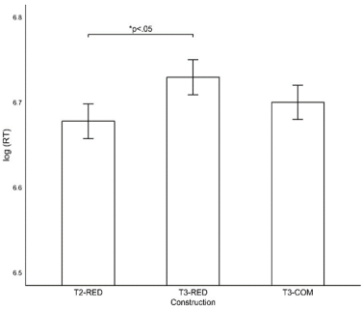

Figure. 3 RTs towards the T3 stimuli processing across three constructions (T2-RED, T3-RED, T3-COM)

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