Tonal Processing in Mandarin Reduplication: Morphological and Lexical Effects

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Introduction. Prosodic alternations such as tonal changes create a challenge to language processing, as language users need to sort through deviant surface forms to arrive at the correct underlying representation. In Mandarin, Tone 3 (T3) sandhi is a well-known example of grammaticalized tonal alternation where a low tone T3 obligatorily becomes a rising tone (T2) when it is followed by another T3. Therefore, T3 sandhi produces a surface sequence of T2-T3 that is underlyingly T3-T3. Such a process is both grammaticalized (therefore productive) and lexicalized. Recent studies found that Chinese words involving tone sandhi are more effortful to process than non-sandhi sequences and that the underlying T3 of the sandhi syllable is activated even though it surfaces as a T2 (Chien et al. 2016, Zhang et al. 2015).

The current study. Research on sandhi processing has so far focused exclusively on words. The current study investigates the processing and representation of sandhi tones that are derived from morphological processes such as reduplication. Two types of T3-T3 sequences that involve T3 sandhi are compared: verbal reduplications like *jiang(T3)-jiang(T3)* 'speak for a little bit', which add diminished meaning to its base *jiang(T3)* 'speak' (Basciano & Melloni 2017; Packard 1997, 2000) and existing disyllabic words like *li(T3)-jie(T3)* 'to understand'. Note that the morphological reduplication produces an intermediate representation of T2-T3, which further undergoes tone deletion on the second syllable, leading to a surface output of T2-T0 (e.g., *jiang(T2)-jiang(T0)*) while lexicalized sandhi simply surfaces as T2-T3 (e.g., *li(T2)-jie(T3)*). Our goal is to untangle whether and how the underlying tone (T3) in these sandhi syllables is accessible and to look at the interactions between morphological and phonological processes. Table 1 illustrates the three Mandarin constructions being contrasted: (A) reduplication with a T2 stem, which serves as a baseline that involves tonal deletion on the second syllable but not sandhi, (B) reduplication with a T3 stem which involves both sandhi and tone deletion, and (C) lexicalized T3 sequence, which involves sandhi but not tone deletion.

Research method. Thirty native speakers of the northern variety of Standard Mandarin (19-36 years old) participated in 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). A monosyllabic audio was played at the onset of the target word, and participants were asked to judge whether the audio matches the red-coded character of the target word (i.e., the bold-faced red-coded syllables in Table 1) 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 A and the surface tone of the sandhi syllable in B and C, T3, which is the underlying tone of the sandhi conditions in B and C, 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.

Results. Both reaction times (RT) and response types (YES or NO) were analyzed. The percentages of saying yes to the underlying tones (A: T2, B: T3, C: T3) were higher than those of the surface tones (B: T2, C: T2) (Figure 1). Figure 2 showed longer RTs for saying yes to B than A (sandhi vs non-sandhi), which corroborates the cost of accessing the underlying representation of a sandhi syllable. Regarding the responses to T2 (Figure 3), we analyze the Yes and No responses

separately: 1) for the participants who responded YES to T2, condition B takes longer than A ($p<0.001$) and C ($p<0.05$); 2) for the no responses to T2, the RT of C was longer than B ($p<0.05$), and both longer than processing the T1s (baseline) within their own group (B: $p<0.01$, C: $p<0.001$). Both findings suggest that the surface tone of a morphologically complex form like reduplication is less accessible and easier to reject.

Discussion. Matching the underlying tone with the target word is shown to be preferred in all three constructions, including both sandhi conditions B and C (reduplication vs non-reduplication), suggesting equal availability of the underlying representations in morphologically complex sequences and in words. The main difference was found in responses to the surface tone T2. For the participants who matched the target words with the surface tones (Figure 3-left the yes responses), for example, reduplicated sequences were more costly than the lexicalized sequences, suggesting that the reduplicative sandhi sequences take more effort to be parsed as a sandhi word, as opposed to the non-reduplicative sandhi sequences. On the other hand, the underlying phonological representations have a greater influence in reduplicated structure and serve as stronger competitors for the surface tones. Morphological reduplications enhance the underlying tone of the stem and make the surface tones easier to reject.

Conclusion. In our current study, we found a construction-specific effect in processing the Mandarin T3 sandhi words. Verbal reduplications, although being opaque and morphologically complex, retains stronger access to the underlying tone of the sandhi syllables than the non-reduplicative lexicalized constructions. We also show that phonological processes such as tone sandhi are active in both morphologically complex expressions and lexicalized items (i.e., words). This study shows that sandhi is an active process both at the lexical level and at the post-lexical level and that both surface and underlying forms remain in competition in sentence processing.

Table 1: Three Mandarin constructions and examples

Construction	Tonal representation	Sandhi	Deletion	Example
A	/T2-T2/→[T2-T0]	×	✓	***tán*-*tan*** ‘talk (for a little bit)’
B	/T3-T3/→[T2-T0]	✓	✓	***xiáng*-*xiang*** ‘think (for a little bit)’
C	/T3-T3/→[T2-T3]	✓	×	***lí*-*jiě*** ‘understand’

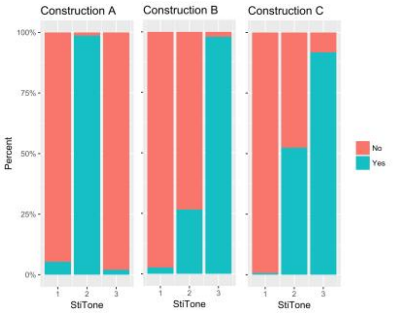

Fig. 1 Percentage of response types

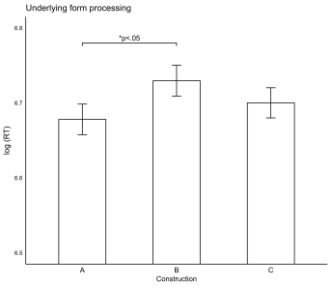

Fig. 2 RTs for saying yes to the underlying tone

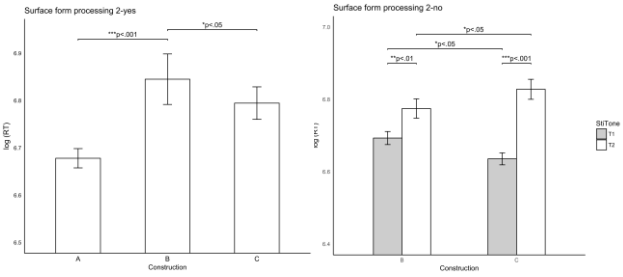

Fig. 3 RTs of responses to the surface T2-YES (left), NO (right)

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