

# Sandhi Sans Derivation: Third Tone Patterns in Mandarin Chinese

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## 1 Introduction

The tonal inventory of Mandarin Chinese consists of four lexical tones. T1 is characterized by a high-level pitch, T2 is a rising tone that sweeps from the middle of the pitch register to its peak, T3 is a low-dipping tone marked by low-falling contour followed by a rise, and T4 is a falling tone that spans both the upper and lower limits of the pitch register. Using numerical values to represent possible values along the pitch register continuum, with “1” representing the lowest possible pitch and “5” representing the highest (Chao, 1948, 1968), the four lexical tones of Mandarin Chinese can be represented as follows:

- (1) a. T1: (55)
- b. T2: (35)
- c. T3: (214)
- d. T4: (51)

These tones participate in a number of sandhi processes that have been thoroughly investigated along both descriptive and theoretical channels. The focus of this paper is the phenomenon of third tone sandhi, which itself subdivides into at least two distinct processes.

Canonical T3 sandhi (henceforth T3S) is traditionally described as a phonological rule that affects two adjacent T3s, the first of which undergoes a categorical tone change yielding a surface T2. Third tone sandhi, however, does not always output rising tones (i.e. T2s). As Chen (2000) and others have pointed out, Mandarin T3 sandhi also includes a rule of “half sandhi” (HT3S hereafter), in which T3s become low-falling or level at prosodic boundaries and elsewhere. In the literature, most analyses of the third tone center on the characterization of the canonical sandhi pattern. The majority of these accounts are derivational:  $T3 \rightarrow T2 / \_ T3$  (cf. Chen, 2000 and references therein). The advantage of a derivational approach is that it affords a relatively simple mechanism for deriving multiple applications of the sandhi rule. Allowing the rule to apply cyclically over binary domains, surface tone patterns are readily derived:  $(T3T3)T3 \rightarrow T2(T3T3) \rightarrow T2T2T3$ .

In this paper, we offer a new perspective on third tone patterns in Mandarin Chinese. We argue that third tone sandhi (both T3S and HT3S) does not involve categorical tone change, but rather the simplification of tonal contours by way of toneme deletion. In this way, we are able to derive T3 sandhi patterns non-derivationally in Optimality Theoretic terms, appealing exclusively to independently motivated constraints. Our approach is grounded entirely in the  $F_0$  patterns of five native speakers we recorded and measured. This appeal to  $F_0$  measurement and analysis rarely plays a central role in studies of Mandarin sandhi. As a result, we are not only able to directly establish and confirm T3 sandhi patterns, we are also equipped to bring new observations to the fore. With respect to the latter, we point out that third tones do not undergo sandhi (either T3S or HT3S) in prosodically prominent environments. Furthermore, our methodology affords us the ability to present supporting evidence in favor of the hypothesis that Mandarin sandhi domains largely coincide with syntactic constituents (Shih, 1986; Chen, 2000; and Duanmu, 2004, among others).

This paper has a bipartite organization. In the remaining section, we establish a number of empirical generalizations and motivate our analysis. We consider T3 patterns in two-word utterances in section 2.1, followed by a variety of three-word utterances with varying syntactic structures in section 2.2. We then briefly examine sandhi patterns in longer structures in section 2.3, pointing out that our analysis successfully generalizes over utterances of varying lengths.

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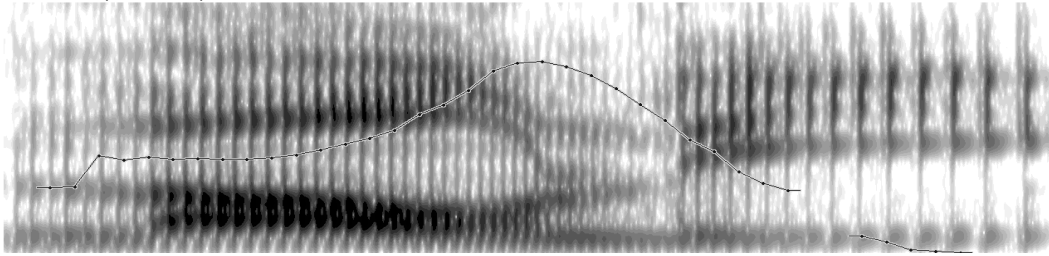
\*We thank our native speaker consultants, without whose involvement this project would not have been possible: Shizhe Huang, Xiaorong Li, Xianghua Tu, Jiahong Yuan and Changchun Zhang. Thanks also to Adam Albright, Joan Chen-Main, Masayuki Gibson, David Harrison, Rolf Noyer, Keren Rice and Jie Zhang for valuable input and to Dorothy Kunzig for tireless assistance.

## 2 Analysis

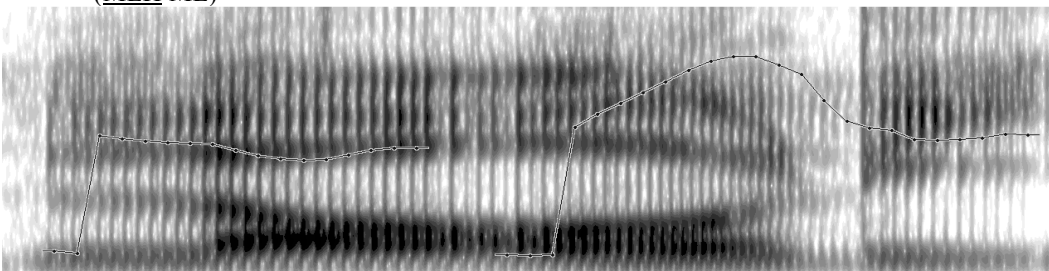
### 2.1 T3S in Two-word Structures

We begin by investigating T3 patterns in simple two-word utterances as a way of establishing our basic analysis. Consider the following data.<sup>1</sup> (In what follows, the diacritic ˇ marks an underlying T3, while caps/underscore denote contrastively stressed elements. Surface tone transcriptions are provided below each pinyin representation by way of Roman characters rather than Chao numbers: L(ow), M(id), H(igh).)

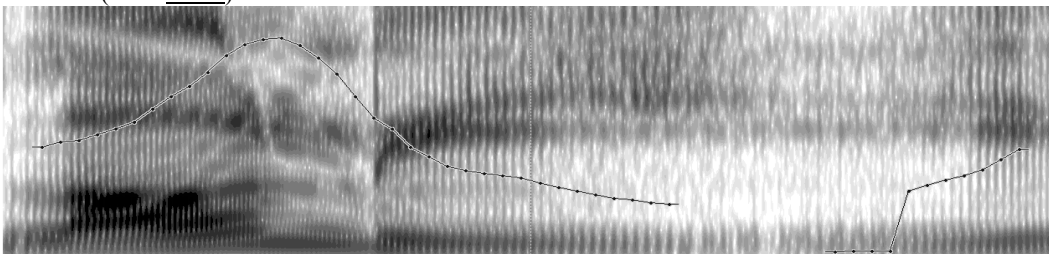
(2) a. Lǎo Lǐ                    ‘Old Li’  
(MH ML)



b. LǎO Lǐ                    ‘OLD Li’  
(MLH ML)



c. Lǎo Lǐˇ                    ‘Old LI’  
(MH MLH)

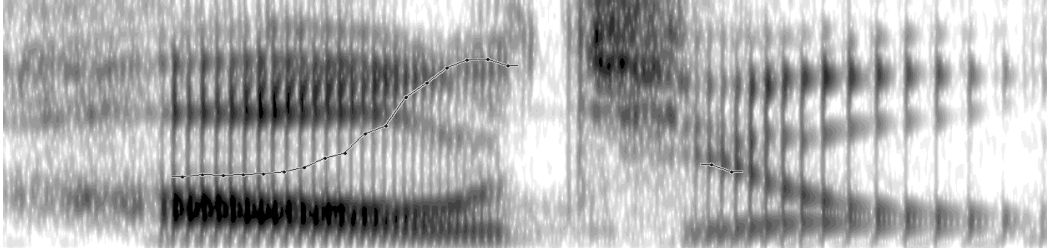


(2a) illustrates both T3S and HT3S. The underlying lexical T3 on *Lao* surfaces as a rising tone in virtue of preceding another lexical T3 (cf. T3S), while the underlying T3 on *Li* is realized as a low–falling tone, a consequence of its alignment with a prosodic boundary (cf. HT3S). In (2b) and (2c) there is contrastive stress on one of the words. As the pitch-tracks clearly show, stress-bearing words do not undergo sandhi, but rather surface with fully preserved dipping T3 contours (cf. (1c)). When the first word is stressed, as in (2b), the second word undergoes HT3S. When the second

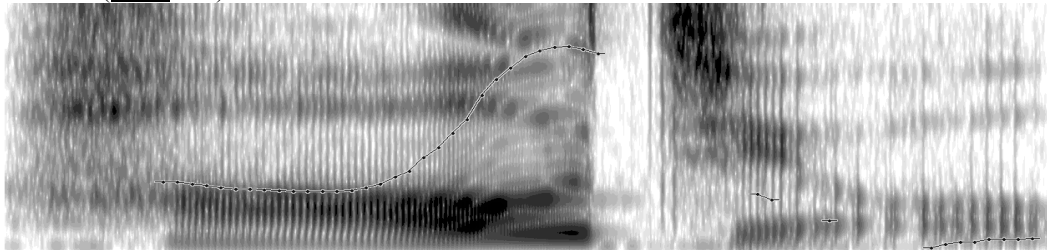
<sup>1</sup>We elicited data from five native speakers, four of whom we recorded using Praat (Boersma and Weenink 2007). In what follows, pitch-tracks from different speakers are often presented within a given paradigm. This decision was based on presentational considerations relating to pitch-track legibility rather than inconsistent tonal patterns.

word is stressed, T3S applies to the first word, as in (2c). These tonal patterns are fully general. The facts are replicated below with a different example. Although the dip of the fully preserved T3 on the first word in (3b) is not as pronounced as that in (2b), it is clearly perceivable, certainly in comparison with the non-dipping contours on the first words in (3a) and (3c).

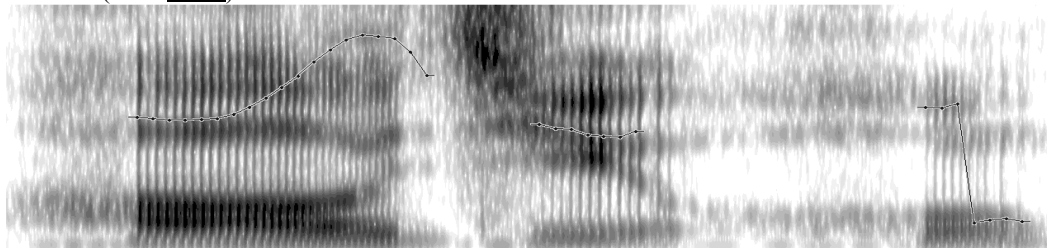
- (3) a. Hǎo jǐu                    ‘Good wine’  
(MH ML)



- b. HǎO jǐu                    ‘GOOD wine’  
(MLH ML)



- c. Hǎo JǐU                    ‘Good WINE’  
(MH MLH)



To account for these facts, we propose that a variety of interacting constraints trigger the deletion of one of T3’s constituent tonemes as a function of the prosodic environment. As such, we claim that the underlying form of the Mandarin third tone is its complex citation form: /MLH/ (cf. Lin, 1993; Chen, 2000; and Yin, 2003), contra Yip (1980, 2000), who motivates an analysis of third tones as underlyingly low tones. Our proposal is that canonical third tone sandhi involves the deletion of a medial L toneme, which in turn yields a high–rising tonal sequence [MH] rather than a true categorical tone change. Because the magnitude of  $F_0$  rise in these cases is lower than in true T2s (Chen and Yuan, 2007; Lin, 2007), our deletion analysis is supported on empirical grounds. In a similar fashion, we analyze HT3S as a case of final-H deletion. This yields [ML] sequences that are perceived as either low–falling or level tones. Our proposal is illustrated schematically below.

- (4) a. T3S: /MLH/ → [MH] / \_\_ MLH  
b. HT3S: /MLH/ → [ML] / \_\_ ]<sub>PROSODIC DOMAIN</sub> and elsewhere

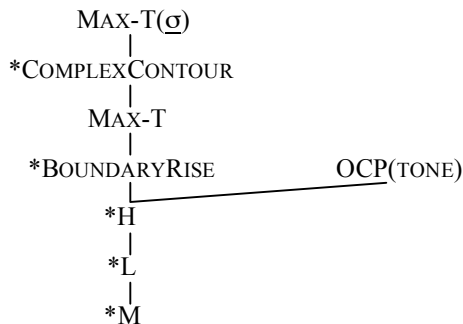
We analyze toneme deletion and preservation as triggered by the interaction of the following constraints.

## (5) Constraints:

- a. MAX-T( $\sigma$ )
- b. MAX-T
- c. \*COMPLEXCONTOUR
- d. \*BOUNDARYRISE
- e. OCP(TONE)
- f. \*H >> \*L >> \*M

The first constraint, MAX-T( $\sigma$ ), is a positional faithfulness constraint that guards against toneme deletion in prosodically prominent (i.e. stressed) positions. In order to derive the observed sandhi freezing effects under stress (cf. (2b–c), (3b–c)), this constraint must be undominated. The next constraint, MAX-T, is a general faithfulness constraint that protects tonemes from deletion in general. Constraint \*COMPLEXCONTOUR is violated whenever more than two tonemes are sequenced. As such, the constraint forces the reduction of triple toneme contours like T3s. This constraint must dominate MAX-T, otherwise the derivation of high–rising tonal sequences [MH] from underlying MLH sequences would not obtain. The fourth constraint we employ is \*BOUNDARYRISE, which militates against a tonal rise at the end of a prosodic domain. Similar constraints have been independently motivated in the literature. See, for example, Zhang’s (2007) \*RISE-FINAL. This constraint is responsible for the derivation of HT3S. In order to avoid violating the constraint, the final H toneme of a T3 must be deleted when aligned with the right edge of a prosodic boundary. The fifth active constraint is OCP(TONE), which we interpret in a more specific way than traditional OCP accounts. This constraint, we claim, prohibits identical toneme sequences (consisting of two or more tonemes) within a prosodic domain. Under this interpretation, (ML MLH) sequences, for example, would violate the constraint as a consequence of the (ML ML...) subsequence. Both \*BOUNDARYRISE and OCP(TONE) can be satisfied by minimal violations of the higher–ranking MAX-T. They are crucially unranked with respect to one another. The last suite of constraints we appeal to are the individual tonal markedness constraints. We assume the ranking \*H >> \*L >> \*M, which essentially recapitulates the independently motivated tonal markedness hierarchy proposed by Pulleyblank (1986) and Akinlabi (1997) for languages with three lexical tonemes. According to this hierarchy, M is the least marked tone. Thus, if a tone is to be deleted for whatever reason, the tone most likely to delete will be H, followed by L. Recall that under our toneme deletion analysis, half T3 sandhi, which occurs robustly in the language as the elsewhere case, is a consequence of H deletion, while canonical T3 sandhi, which applies in fewer contexts, is driven by L deletion. In order to rule out (ML MH) and (ML ML) outputs in neutral two-word utterances, it must be the case that \*BOUNDARYRISE and OCP(TONE) both outrank the tonal markedness constraints (cf. tableaux (7a–b)). The Hasse diagram in (6) below summarizes the constraint ranking we are envisioning. The tableaux in (7) provide additional ranking arguments and formalize our non–derivational deletion analysis of T3 sandhi.

## (6) Ranking:



(7) a.

| / (MLH MLH) /            | *COMPLEX CONTOUR | MAX-T | *BOUNDARYRISE | OCP(TONE) | *H | *L  | *M |
|--------------------------|------------------|-------|---------------|-----------|----|-----|----|
| a. (MLH MLH)             | *!*              |       | *             | *         | ** | **  | ** |
| b. (MH M)                |                  | ***!  |               |           | *  |     | ** |
| c. (ML MH)               |                  | **    | *!            |           | *  | *   | ** |
| d. (ML ML)               |                  | **    |               | *!        |    | **  | ** |
| e. (LH ML)               |                  | **    |               |           | *  | **! | *  |
| f. $\varnothing$ (MH ML) |                  | **    |               |           | *  | *   | ** |

b.

| / (MLH MLH) /             | MAX-T( $\sigma$ ) | *COMPLEX CONTOUR | MAX-T | *BOUNDARYRISE | OCP(TONE) | *H | *L | *M |
|---------------------------|-------------------|------------------|-------|---------------|-----------|----|----|----|
| a. (MH M)                 | *!                |                  | ***   |               |           | *  |    | ** |
| b. (ML MH)                | *!                |                  | **    | *             |           | *  | *  | ** |
| c. (ML ML)                | *!                |                  | **    |               | *         |    | ** | ** |
| d. (LH ML)                | *!                |                  | **    |               |           | *  | ** | *  |
| e. (MH ML)                | *!                |                  | **    |               |           | *  | *  | ** |
| f. (MLH MLH)              |                   | **!              |       | *             | *         | ** | ** | ** |
| g. (MLH MH)               |                   | *                | *     | *!            |           | ** | *  | ** |
| h. (MLH LH)               |                   | *                | *     | *!            | *         | ** | ** | *  |
| i. $\varnothing$ (MLH ML) |                   | *                | *     |               |           | *  | ** | ** |

c.

| / (MLH MLH) /             | MAX-T( $\sigma$ ) | *COMPLEX CONTOUR | MAX-T | *BOUNDARYRISE | OCP(TONE) | *H | *L  | *M |
|---------------------------|-------------------|------------------|-------|---------------|-----------|----|-----|----|
| a. (MH M)                 | *!*               |                  | ***   |               |           | *  |     | ** |
| b. (ML MH)                | *!                |                  | **    | *             |           | *  | *   | ** |
| c. (ML ML)                | *!                |                  | **    |               | *         |    | **  | ** |
| d. (LH ML)                | *!                |                  | **    |               |           | *  | **  | *  |
| e. (MH ML)                | *!                |                  | **    |               |           | *  | *   | ** |
| f. (MLH MLH)              |                   | **!              |       | *             | *         | ** | **  | ** |
| g. (ML MLH)               |                   | *                | *     | *             | *!        | *  | **  | ** |
| h. (LH MLH)               |                   | *                | *     | *             |           | ** | **! | *  |
| i. $\varnothing$ (MH MLH) |                   | *                | *     | *             |           | ** | *   | ** |

In this way, we capture T3S and HT3S patterns in both neutral and contrastive two-word utterances.

Tableau (7a) provides the following ranking arguments: \*COMPLEXCONTOUR >> MAX-T; MAX-T >> {\*H, \*L, \*M}; {\*BOUNDARYRISE, OCP(TONE)} >> {\*H, \*M}; \*H >> \*M; \*L >> \*M. Tableau (7b) argues that both \*BOUNDARYRISE and OCP(TONE) outrank \*L and \*M, while tableaux (7b–c) illustrate that MAX-T( $\sigma$ ) is undominated. Although our analysis of T3 sandhi in two-word utterances does not provide a ranking argument for MAX-T >> \*BOUNDARYRISE, these constraints must be ranked as such because, otherwise, a lexical T2 (MH) at the right edge of a prosodic domain would lose its rise.

(8)

| / ...MH) /        | *BOUNDARYRISE | MAX-T |
|-------------------|---------------|-------|
| a. ...M)          |               | *     |
| b. ...H)          |               | *     |
| c. $\odot$ ...MH) | *!            |       |

For non-complex (i.e. two-toneme) contours, then, underlying toneme preservation must be more important than avoidance of a boundary-final rise.

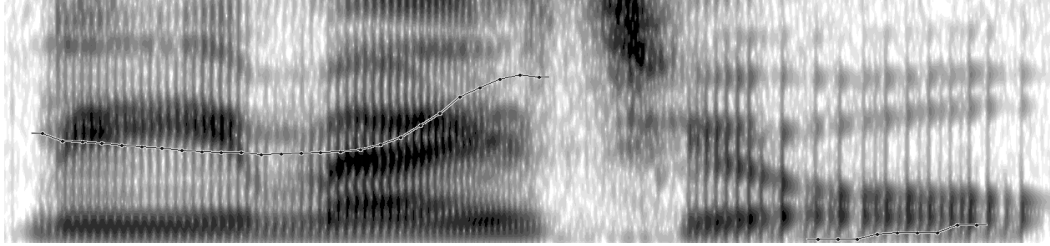
## 2.2 T3S in Three-word Structures

When three underlying T3s are sequenced, the sandhi patterns depend on the syntactic structure of the utterance. Here there are two relevant syntactic configurations to consider: [N]<sub>NP</sub> [V [N]<sub>NP</sub>]<sub>VP</sub> (i.e. non-branching subject + transitive VP) and [Adj N]<sub>NP</sub> [V]<sub>VP</sub> (i.e. complex subject + intransi-

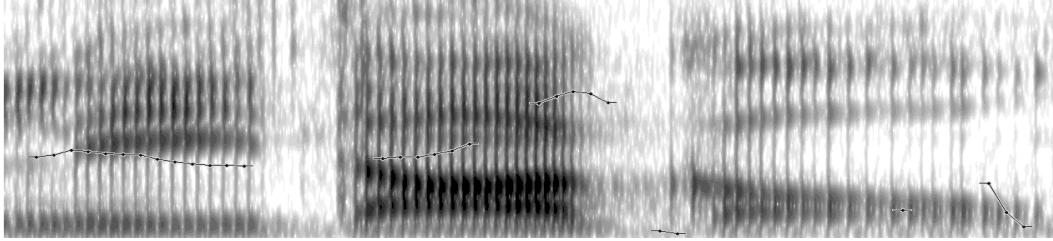
tive VP). When the structure is of the former variety, the sandhi domains are organized into unary domains followed by binary domains. Structures of the latter type are mapped onto binary domains followed by unary domains. In short, sandhi domains largely coincide with syntactic constituents (cf. Shih, 1986; Chen, 2000; and Duanmu, 2004).<sup>2</sup>

When an unstressed T3-bearing subject constituent is syntactically non-branching, it will undergo HT3S as a consequence of its prosodic edge orientation. The verb in the following domain will undergo canonical T3 sandhi and the T3-bearing object that follows it will predictably surface with a falling tone (i.e. HT3S). These patterns are illustrated below.

- (9) a. Lǐ mǎi jǐu. 'Li buys wine.'  
(ML) (MH ML)



- b. Lǐ dǎ gǒu. 'Li beats the dog.'  
(ML) (MH ML)



Our constraint ranking successfully accounts for these tonal patterns.

(10)

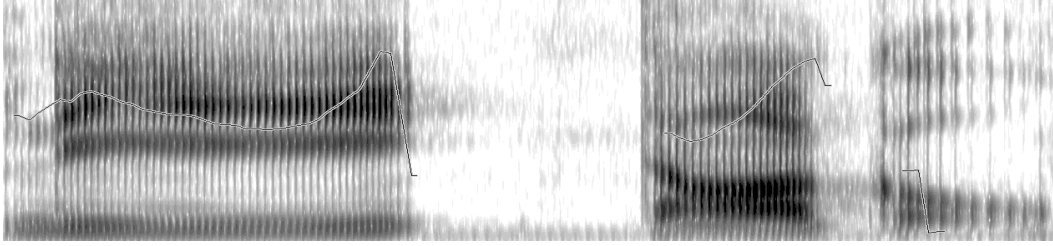
| /(MLH) (MLH MLH)/           | *COMPLEXCONTOUR | MAX-T | *BOUNDARYRISE | OCP(TONE) | *H  | *L   | *M  |
|-----------------------------|-----------------|-------|---------------|-----------|-----|------|-----|
| a. (MLH) (MLH MLH)          | *!***           |       | **            | *         | *** | ***  | *** |
| b. (MH) (MH ML)             |                 | ***   | *!            |           | **  | *    | *** |
| c. (MH) (ML ML)             |                 | ***   | *!            | *         | *   | **   | *** |
| d. (ML) (MH MH)             |                 | ***   | *!            | *         | **  | *    | *** |
| e. (MH) (ML MH)             |                 | ***   | *!*           |           | **  | *    | *** |
| f. (ML) (ML MH)             |                 | ***   | *!            |           | *   | **   | *** |
| g. (MH) (LH ML)             |                 | ***   | *!            |           | **  | **   | **  |
| h. (ML) (ML ML)             |                 | ***   |               | *!        |     | ***  | *** |
| i. (ML) (LH ML)             |                 | ***   |               |           | *   | ***! | *** |
| j. $\emptyset$ (ML) (MH ML) |                 | ***   |               |           | *   | **   | *** |

And as previously established, T3S is suspended when a word is contrastively stressed. The data below support this claim and the tableau in (11d) formalizes the emergence of this pattern. (Note that the tableaux for (11b–c) would resemble our tableaux for stressed two-word utterances (cf. (7b–c)). That is to say, MAX-T( $\sigma$ ) preserves the full underlying contour of T3 regardless of the number of words in the utterance.)

<sup>2</sup>Two-word utterances consisting of elements that do not form sub-sentential constituents, e.g., [N]<sub>NP</sub> [V]<sub>VP</sub>, are obligatorily parsed into single sandhi domains. It seems that Mandarin sandhi domains must be binary if possible.

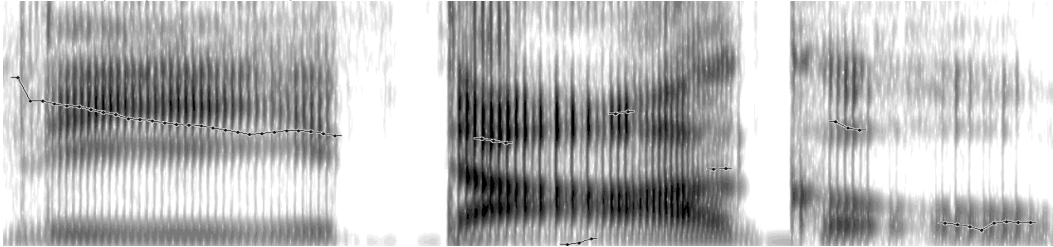
(11) a. Lǐ dǎ gǒu.  
(MLH) (MH ML)

‘Li beats the dog.’



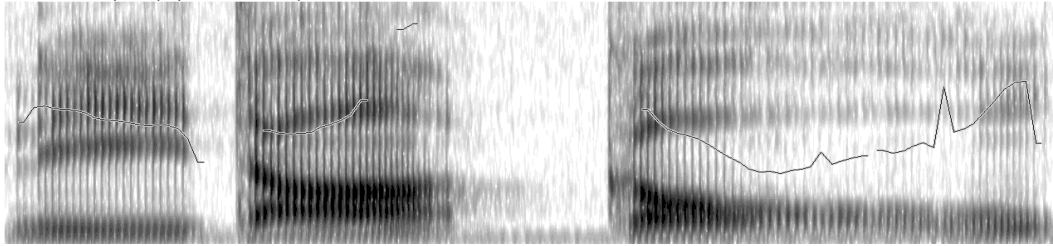
b. Lǐ Dǎ gǒu.  
(ML) (MLH ML)

‘Li BEATS the dog.’



c. Lǐ dǎ Gǒu.  
(ML) (MH MLH)

‘Li beats THE DOG.’

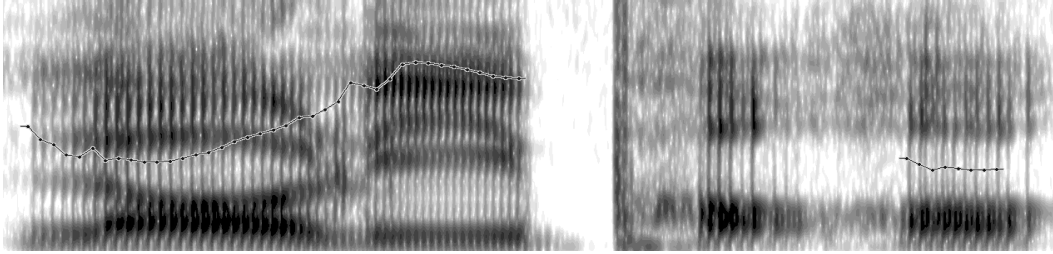


d.

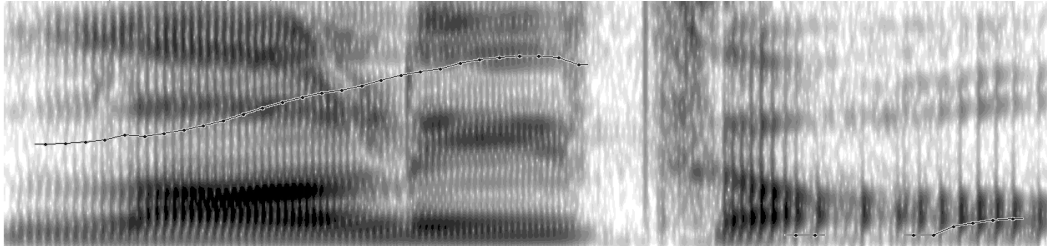
| /( <u>MLH</u> )(MLH MLH)/   | MAX-T(σ) | *COMPLEX CONTOUR | MAX-T | *BOUNDARY RISE | OCP (TONE) | *H  | *L   | *M  |
|-----------------------------|----------|------------------|-------|----------------|------------|-----|------|-----|
| a. ( <u>MH</u> ) (MH ML)    | *!       |                  | ***   | *              |            | **  | *    | *** |
| b. ( <u>ML</u> ) (MH ML)    | *!       |                  | ***   |                |            | *   | **   | *** |
| c. ( <u>MLH</u> ) (MLH MLH) |          | **!*             |       | **             | *          | *** | ***  | *** |
| d. ( <u>MLH</u> ) (ML MH)   |          | *                | **    | **!            |            | **  | **   | *** |
| e. ( <u>MLH</u> ) (ML ML)   |          | *                | **    | *              | *!         | *   | ***  | *** |
| f. ( <u>MLH</u> ) (LH ML)   |          | *                | **    | *              |            | **  | ***! | **  |
| g. σ( <u>MLH</u> ) (MH ML)  |          | *                | **    | *              |            | **  | **   | *** |

The tonal patterns of the other relevant three-word configuration (i.e., [Adj N]<sub>NP</sub> [V]<sub>VP</sub>) surface as expected. The realization of the binary subject constituent mirrors the tonal realization observed in two-word utterances: T3S and HT3S apply to the modifier and noun respectively (cf. (2a) and (3a)). Because the verb occupies a unary sandhi domain, HT3S applies in the absence of contrastive stress. These patterns are illustrated below.

- (12) a. Lǎo Lǐ pǎo. ‘Old Li runs.’  
(MH ML) (ML)



- b. Lǎo Lǐ zǒu. ‘Old Li walks.’  
(MH ML) (ML)



What we label as ML (in the data above and below), the result of HT3S, can be realized in different ways by different speakers (e.g., as ML, HM or even as a level tone<sup>3</sup>), but it crucially never surfaces as a dipping tone as in a T3 or as a steady rising tone as in a true lexical/derived T2. Note that although the second word *Li*'s  $F_0$  is marked by a brief initial rise in (12a–b), its overall  $F_0$  trend is either falling or level. This makes the tonal contours of these words fundamentally different from those of true T2s, which rise steadily throughout their production (e.g., compare the  $F_0$  contours of the first two words in (12a–b)). For this reason, we transcribed *Li* in (12a–b) as ML (i.e., as a half T3), rather than MH. Again, our constraint ranking successfully accounts for these tonal patterns.

(13)

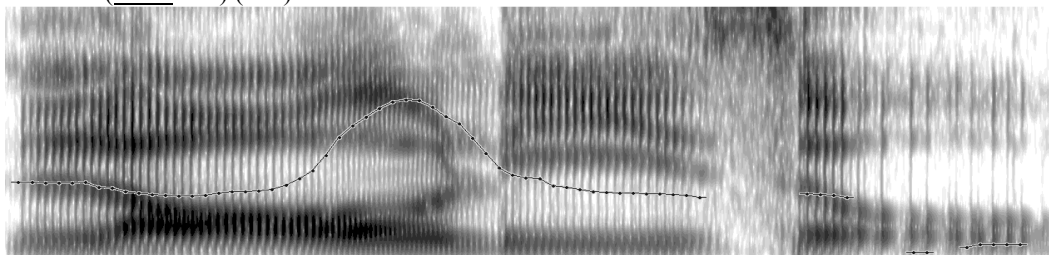
| /(MLH MLH) (MLH)/             | *COMPLEXCONTOUR | MAX-T | *BOUNDARYRISE | OCP(TONE) | *H  | *L  | *M  |
|-------------------------------|-----------------|-------|---------------|-----------|-----|-----|-----|
| a. (MLH MLH) (MLH)            | *!*             |       | **            | *         | *** | *** | *** |
| b. (MH MH) (ML)               |                 | ***   | *!            | *         | **  | *   | *** |
| c. (MH ML) (MH)               |                 | ***   | *!            |           | **  | *   | *** |
| d. (ML MH) (ML)               |                 | ***   | *!            |           | *   | **  | *** |
| e. (ML MH) (MH)               |                 | ***   | *!*           |           | **  | *   | *** |
| f. (ML ML) (ML)               |                 | ***   |               | *!        |     | *** | *** |
| g. $\varnothing$ (MH ML) (ML) |                 | ***   |               |           | *   | **  | *** |

As before, tone is preserved under contrastive stress in these constructions. Supporting data are provided in (14a–c) below. The tableaux for these data are comparable to (11d) and are thus omitted to conserve space.

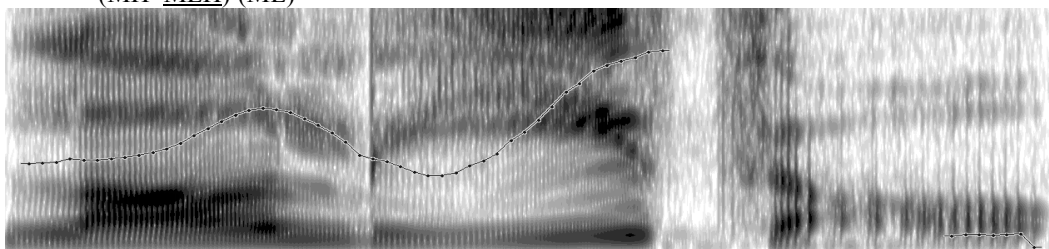
<sup>3</sup>One could argue that the tonal realization of what we label ML on *Li* in (12b) is really HH so that the surface tonal realization of the sentence, for example, is (MH HH ML). This would be consistent with a derivational approach, according to which two applications of canonical T3S are followed by a single application of T2S. Ternary domains such as these, which are not isomorphic with the internal syntactic structure, could either be the result of a collapse of two prosodic domains into one due to speech rate (Yip and Kuo, 2003) or may in fact represent the default prosodic structure in [Adj N]<sub>NP</sub> [V]<sub>VP</sub> constructions. This tonal patterning, if correct, is currently not derivable under the proposed ranking in (6).



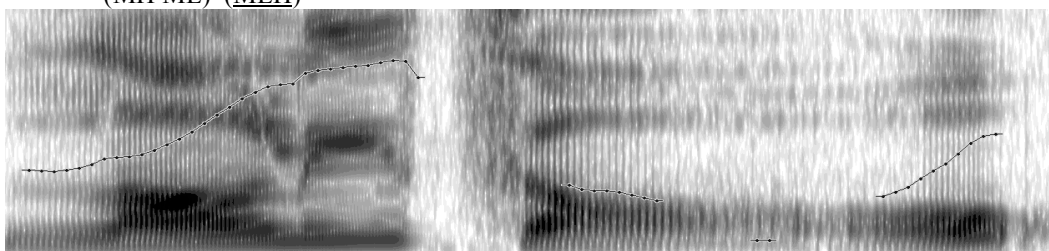
- (14) a. LǎO Lǐ zǒu.                   ‘OLD Li walks.’  
           (MLH ML) (ML)



- b. Lǎo Lǐ zǒu.                   ‘Old LI walks.’  
           (MH MLH) (ML)



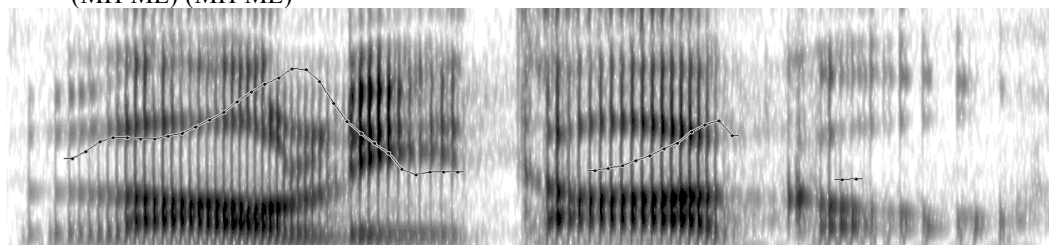
- c. Lǎo Lǐ Zǒu.                   ‘Old Li WALKS.’  
           (MH ML) (MLH)



### 2.3 T3S in Longer Structures

Four-word utterances consisting of binary subjects and predicates built entirely from lexical T3-bearing words pattern exactly as predicted by our analysis. In both domains, T3S and HT3S apply.

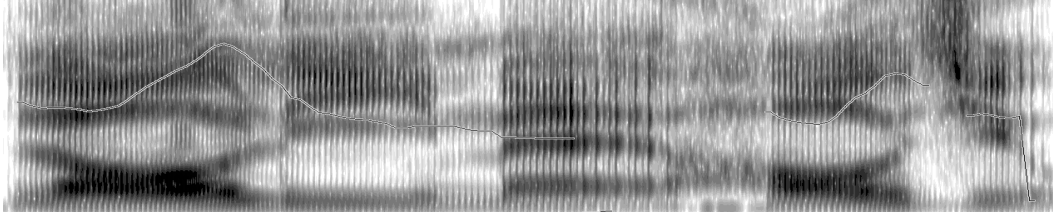
- (15) Lǎo Lǐ dǎ gǒu.               ‘Old Li beats the dog.’  
           (MH ML) (MH ML)



Again, stressed words retain their underlying dipping contours. For space reasons, illustrative pitch-tracks are omitted. The tableau for (15) would be comparable to (7a).

The T3 pattern that surfaces in the oft-cited five-word sentence in (16) below, pronounced naturally (i.e. not overly careful or slow), is also predicted by our analysis.

- (16) Lǎo Lǐ mǎi hǎo jiǔ. 'Old Li buys good wine.'  
 (MH ML) (ML) (MH ML)



Here we assume that the modifier + nominal structures are each mapped into binary domains and that within the verb phrase, the predicate 'buys' forms a separate unary domain. The resulting tonal pattern shown in (16) is consistent with this bracketing. The tableaux in (7a) and (10) are subparts of the larger tableau outputting the winning tonal pattern in (16). For this reason, no OT calculation is shown. Our analysis thus successfully generalizes over structures of varying length and complexity.

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