

# WHAT SPREADS, AND HOW? TONAL RIGHTWARD SPREADING ON SHANGHAI DISYLLABIC COMPOUNDS

*Xiaonong Sean Zhu*

Linguistics Department, Faculties, Australian National University

## ABSTRACT

The present paper examines what kinds of Shanghai disyllabic lexical tone sandhi undergoes, especially in what sense and to what extent a disyllabic tone can be claimed to result from rightward spreading of the corresponding citation tone. It will be shown that F0 spreading occurs in the Long tone domains while Contour element spreading mainly in the Short tone domains.

## 1. INTRODUCTION

Tone sandhi in Wu Chinese is recognised as having more types than that in other Chinese dialect groups (Chao 1976:39), and is probably the most complex in the world's tonal languages (Rose 1990:1). A great deal of work concerning tone sandhi in Wu has been done since Kennedy (1953) first found, in a northern Wu dialect spoken in a small town about 150 kilometres south-west of Shanghai, two basic patterns of tone sandhi in terms of direction and sensitivity to morpho-syntactic boundaries: left-dominant sandhi at the lexical level and right-dominant sandhi at the phrase level. The present paper examines what kinds of Shanghai disyllabic lexical tone (henceforth ditone) sandhi undergoes, especially in what sense and to what extent a ditone can be claimed to result from rightward spreading of the corresponding citation tone.

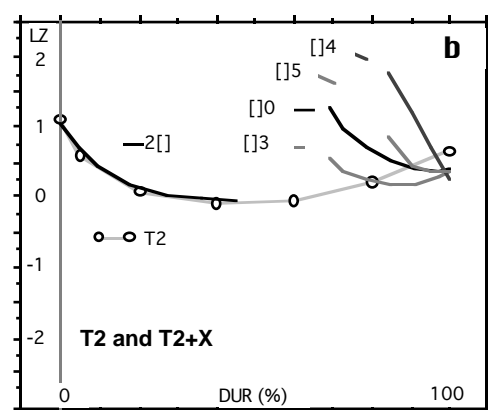
Shanghai has five citation tones (marked as T1 to T5) and five ditone classes defined by the first syllable tone. Their phonetic values, in Chao's five-point scale with 5 being the highest and underscores indicating shortness, and phonological representations are given in Table 1. Upper and Lower Registers are associated with clear voiceless and murmur voiceless respectively in the citation case, and with voiceless and voiced in the ditone case. The letters 'h' and 'l' are referred to as Contour elements.

Citation	T1	T2	T3	T4	T5
Pitch	51/541	34	14/113	44	14/113
Register	Upper	Upper	Lower	Upper	Lower
Truncation	Long	Long	Long	Short	Short
Contour	hl	lh	lh	lh	lh
Ditones	T1+X	T2+X	T3+X	T4+X	T5+X
Pitch	55+31	33+44	22+44	33+44	11+14
Register	Upper	Upper	Lower	Upper	Lower
Stress	s w	s w	s w	s w	w s
Contour	h+l	l+h	l+h	l+h	l+lh

**Table 1:** Phonetic and phonological representations for Shanghai citation and ditones.

Three of the citation tones have two allotones each. T1 can be either straight falling [51] or delayed falling [541]. Both T3 and T5 have a rising version [14/14] and a dipping version [113/113]. While only T1 is falling or Lo-targeted, the remaining four are all rising or Hi-targeted (Zhu 1995). The first three ditones are Long tone domains, while the remaining two Short tone domains. The first four ditones have an [s w] stress pattern, while the last one (T5+X) [w s] (Zhu 1995, 1996).

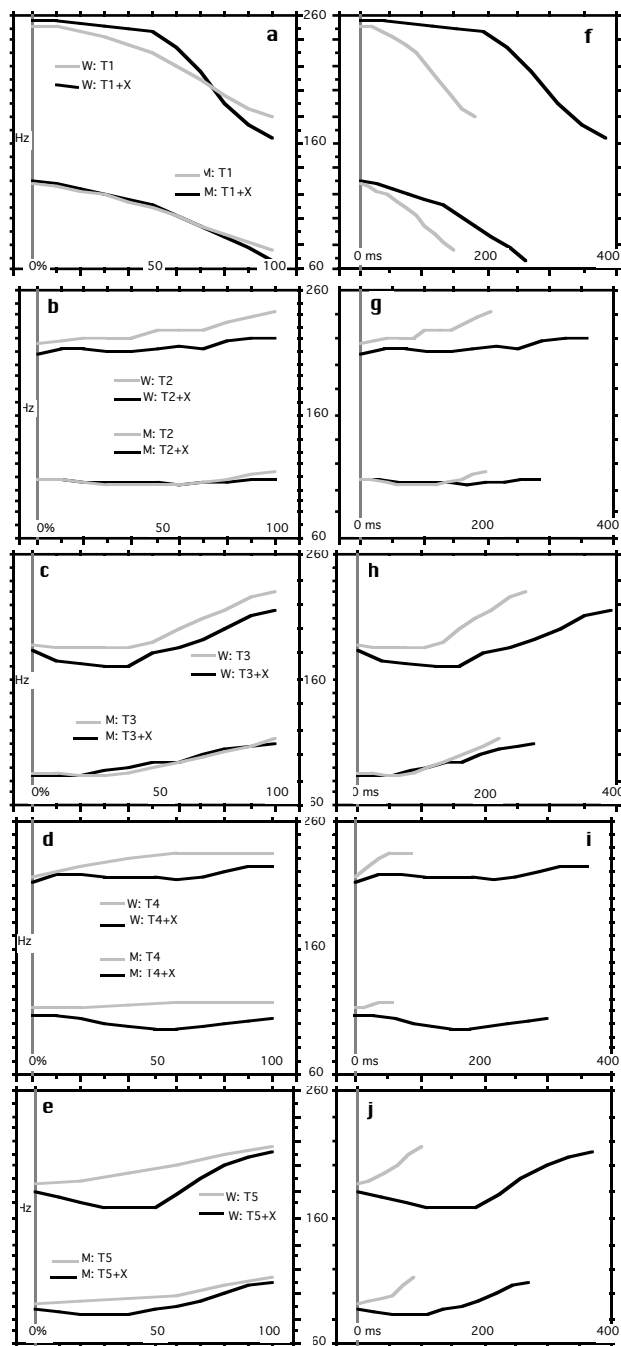
The ditone sandhi in Shanghai is characterised as 'rightward spreading'. What spreads, however, can be phonological features (Sherard 1980:47) or phonetic contours (Zee and Maddieson 1980:60), or either, as distinguished in Rose (1990:34). In fact, the rightward spreading in Shanghai differs from tone to tone, conditioned by the intervocalic consonant (C2) voicing, Truncation or phonological length of the second syllable tone, the F0 height of the first syllable tone, and the stress assignment (Zhu 1998). Moreover the claimed rightward spreading in Shanghai can hardly be recognised when test words contain a C2 which brings about F0 perturbation on the second syllable. Figure 1 shows that none of the four S2 contours after T2 has a rising shape. That means T2+X cannot be taken as rightward spreading in phonetic terms since T2 is rising towards the offset. Note there is a C2 in the testing words, so the F0 shape of S2 is inevitably influenced. Data like that do not allow us to say whether we have phonetic spreading or not because we cannot assess the effect of C2. This motivated an experiment using disyllables without a C2, which gave a continuous F0 contour without disruption.



**Figure 1** (from Figure 10.21b in Zhu 1995): Logarithmic z-score normalised citation T2 and corresponding ditones with T2 on S1 (2[]) plotted against equalised duration. [0] stands for the neutralised T1 and T2 on S2.

## 2. PROCEDURE AND RESULTS

A man M and a woman W of New variety II of Shanghai were recorded in this experiment. Both speakers have a delayed falling T1, a dipping T3 and a rising T5.

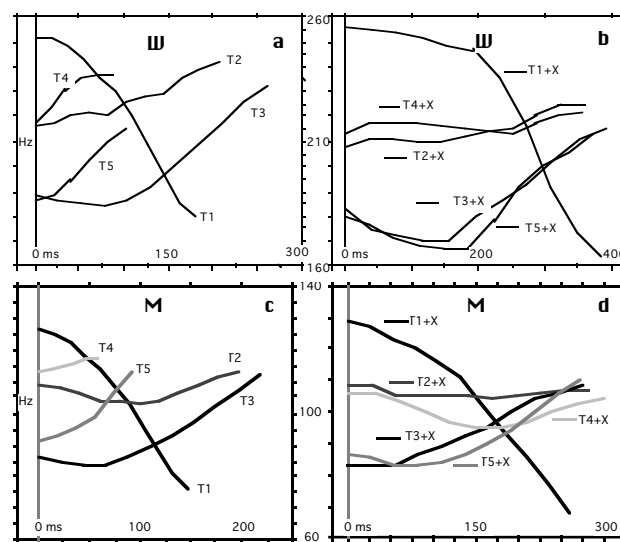


**Figure 2:** F0 contours of Shanghai citation tones and corresponding ditones plotted against equalised duration (a-e), and mean absolute duration (f-i) for two speakers.

Used in the experiment were five monosyllables with different tones (T1 *saè* 'three', T2 *pu* 'cloth', T3 *bi* 'leather', T4 *iq* 'one', T5 *luq* 'six') and five disyllabic compounds,

with the first syllable the same as the monosyllables and the second being zero-initial (T1+X *saèxao* 'number three', T2+X *puxa* 'cloth shoes', T3+X *bixa* 'leather shoes', T4+X *iqxao* 'number one', T5+X *luqxao* 'number six'). I avoided the compounds with T4 or T5 on S2 because they are still short and truncated by a glottal stop. It does not matter whether T1, T2 or T3 is on S2 since they are neutralised when S2 has a non-obstruent-initial. In the current word list the S2 tones in the five disyllables are all T3. The testing syllables, mixed with dummy ones, were written in Chinese characters on two pieces of A4-size paper. I did not use a carrier sentence so as to avoid sandhi effect and intonational effect. Both speakers read the list six times with a short break after each time. The recording was made at night in a quiet room. F0 was extracted digitally using the API procedure of ILS software (Interactive Laboratory System by Signal Technology Inc). The F0 data were obtained from sampling points at intervals of 10 percent of the duration except for T4 and T5, which were sampled at every 20 percent point. The measurement procedures used to extract F0 were basically that described in Rose (1990). The F0 and duration data are graphically presented in Figure 2. In Figure 2a are four F0 contours. The light lines are the two contours for citation T1, and the dark lines for the disyllabic T1+X. The top two contours are for the female, and the bottom two for the male. The duration scale is set equalised. In panel (f), next to (a), are the same four contours plotted as functions of mean absolute duration. And so also for the other four pairs of citation and ditones in the next eight panels.

Figure 3 plots these mean F0 values in another way which shows the paradigmatic relationships between the F0 shapes for the same speaker. In panel (a) are the five citation tones for W, and in (b) her five ditones. M's citation and ditone contours are respectively plotted in panels (c) and (d).



**FIGURE 3:** F0 contours of citation tones (a, c) and corresponding ditones (b, d) plotted against mean absolute duration for speakers W (a, b) and M (c, d).

### 3. DISCUSSION

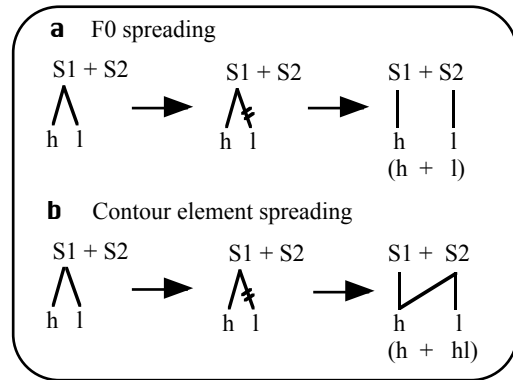
Generally speaking, the two speakers differ in two respects. Firstly, for the male speaker, the three ditones with a Long tone on S1 in Figure 2a-c are almost perfectly congruent with their citation counterparts, with the offset of ditones being slightly lower by 4 to 8 Hz. By contrast, the three pairs of Long contours for the female do not match well; the details will be discussed later. Secondly, the two contours of length-paired Hi-target ditones for W in Figure 3b resemble each other (Upper T2+X resembling T4+X, and Lower T3+X resembling T5+X), with an average difference of 4 Hz for each pair. That means the S1 Register is conditioning the ditone F0 shape, but Truncation is not. On the other hand, these two pairs of contours for M in panel (d) differ to some extent.

The same F0 declination is found for both speakers: all the ditones offset lower than their citation counterparts. Moreover, the amount of the F0 declination is smallest and negligible in T5+X: 2 Hz for W and 3 Hz for M. I interpret this as the F0 declination of a ditone being more obvious in the [s w] combination than in the [w s] combination, supposing the ditone has the same offset target as its citation counterpart, because the stress of S2 raises F0.

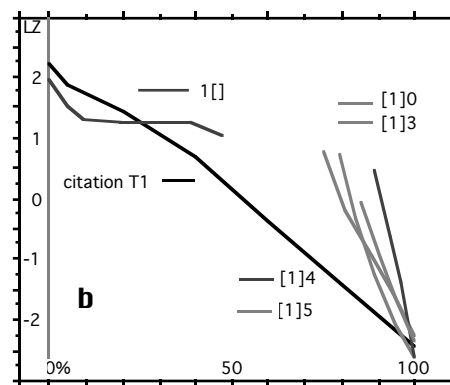
Below I will discuss the sandhi details of the five pairs of citation and ditones separately, and offer a brief phonological account for each of the pairs.

*Lo-target T1 and T1+X.* This is the most frequently discussed ditone class concerning rightward spreading. It was suggested (e.g. Zee and Maddieson 1980, Jin 1985) that the Contour elements /h/ of citation T1 spread to the ditone T1+X as /h+l/. Figure 4a shows these phonological processes: first delink the /l/ element from S1, and then associate it with S2. Toda (1990) challenges the accepted view and argues that the phonetic rightward spreading of a falling tone should be two successive half falling contours (51>53+31) and that T1+X in Shanghai (51>55+31) can only be considered phonological spreading as formularised in Figure 4b. What Toda said about the Shanghai phonological or Contour element spreading does exist for the straight falling allotone (cf. Figure 5). Her suggestion, however, needs supplementing since F0 spreading is also found in Shanghai for the delayed falling allotone. I will use 'F0/element spreading' rather than 'phonetic/phonological spreading' because 1) both types have phonetic explanations (see below); and 2) when the spreading types in phonetic terms (e.g. [53+31]) are discussed, they will be confused with 'phonetic spreading'.

Now look at Figure 2a. The two speakers' ditone shapes are of the two types, corresponding to the two spreading types just discussed. W's T1+X is composed of a level contour over the first half of the duration, with a declination of 9 Hz at the 50% point compared with the onset, and a falling contour over the last half. This can be considered element spreading. On the other hand, M's T1+X is perfectly congruent with his T1 contour. This is a good example for the F0 spreading in falling shape. Recall that both speakers have the same delayed falling [541] for their citation T1. So the same phonetic as well as phonological input results in different implementations.



**Figure 4:** Phonological processes for the two types of rightward spreading from a falling tone.

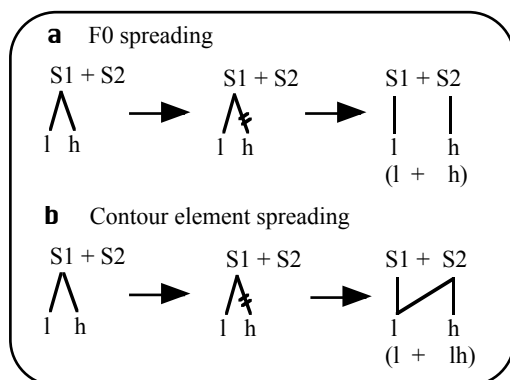


**Figure 5** (from Figure 10.25b in Zhu 1995): Logarithmic z-score transformed F0 contours for the straight falling T1 and corresponding ditones, averaged from three male speakers. The duration scale is set equalised.

Note an interesting geometry for the two types of spreading in Figure 2. For the F0 spreading, it is obvious that the paired citation and ditone contours for M are similar on the equalised duration scale (panel a). But they have different F0 derivatives along the absolute duration (f). For the element spreading, on the other hand, W's paired contours onset about the same, but differ from each other in shape, when plotted against the equalised duration (a). However in panel (f) with the absolute duration scale, the later part of her ditone contour has effectively the same F0 derivative as its citation counterpart. The second half of W's T1+X contour looks just like a horizontal shift to the right of her citation T1. So from the viewpoint of geometry, the F0 spreading results from a curve stretch along the time dimension. The element spreading results from a rightward shift of the citation curve along the time dimension. A locus is left during the shift by the citation onset with an F0 declination. With these geometrical images in mind, both spreading types can be phonetically accounted for: the F0 spreading is a procedure of **contour stretch**, and the element spreading **contour shift**.

*T2 and T3 and corresponding ditones.* Figure 2b-c show that M's ditone contours are perfectly congruent with their citation contours, with an F0 declination of 4-6 Hz at the

ditone offset with respect to the citation offset. These are therefore excellent examples for F0 spreading in both high and low rising shapes. W's ditone contours in the same panels have the same F0 shapes as their citation counterparts, but at a lower level by an average of 13 Hz for both pairs. It can be concluded that in the case of Hi-target Long tone domains, the first-syllable F0 shape spreads over the disyllable, but the F0 height may be a little lower. The phonological processes for these two Long tone domains are shown in Figure 6a: /lh/ > /l+h/. The geometrical images in Figure 2b-c and g-h show the sandhi type over the disyllables with T2 or T3 on S1 is of the **contour stretch**.



**Figure 6:** Phonological processes for the two types of rightward spreading from a rising tone.

*T4 and T4+X.* The F0 curves of T4+X in Figure 2d cannot at all be considered F0 spreading of citation T4. But note the geometrical images in 2i. The last one third of W's ditone contour looks like a rightward shifted citation T4 with an F0 declination. The first two thirds of her ditone contour is like the F0 locus of the citation onset left during the shift. And the same is true for M, with a larger F0 declination with respect to his F0 range and height. The above observation characterises the Contour element spreading for the T4 domain. So the phonological process for the T4 domain should be represented like that in Figure 6b: /lh/ > /l+lh/. The geometrical images in Figures 2d and 2i show the sandhi type of the disyllables with T4 on S1 is of the **contour shift**. The S1 contour shifts to the right, the onset creating an F0 locus with a declination.

*T5 and T5+X.* The speakers' citation T5 contours in Figure 2e rise like T3, but the two ditone contours are quasi-level or slightly falling over the first half of duration and rise to effectively the same height as their citation counterparts at offset with only 2-3 Hz difference. They do not match each other as well as T3(+X) did. So we can say the spreading mechanism for the T5 domain differs from that for the Long tone domains of T2 and T3. It is the Contour element spreading that occurs on the T5 domain. The phonological process for T5 spreading is presented in Figure 6b: /lh/ > /l+lh/. The geometrical images in Figures 2e and 2j show the sandhi type of the disyllables with T5 on S1 is of the **contour shift**.

## 4. SUMMARY

In sum, the rightward spreading overwhelmingly occurs in Shanghai ditone sandhi. F0 spreading or contour stretch is found in the Hi-target Long tone domains of T2 and T3. Contour element spreading or contour shift is found in the Hi-target Short tone domains of T4 and T5. The Lo-target T1+X has both F0 and Contour element spreading for different speakers.

## 5. REFERENCES

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