

# Bidirectional Tone Sandhi in Tianjin Dialect: Problem and Analysis

Qiuwu MA

School of Foreign Languages, Tongji University, China

mqw@tongji.edu.cn

## Abstract

The paradoxical problem of Tianjin tone sandhi, first recognized by Chen (1986)[1], has ever been a challenge to current phonological theories. The present paper demonstrates what reasons underlie it and then discusses what problems still exist in the application of some current theories or models in Tianjin tone sandhi.

**Index Terms:** tone sandhi, bidirectionality, derivational path

## 1. Tones and tone sandhi in Tianjin dialect

Tianjin dialect is a Chinese Mandarin dialect spoken in a metropolis located 30 miles southeast of Beijing. There are four tones in this dialect and they are called *yinping*, *yangping*, *shangsheng* and *qusheng*. The pitch value of each tone reported by some of empirical studies and experiments are given in (1), where “1” indicates the lowest pitch level and “5” indicates the highest.

(1)	Tone A	Tone B	Tone C	Tone D
Li (1956) [4]	11	55	(214)	(51)
Davison (1982) [3]	21/11	45	24	53
Li & Liu (1985) [5]	21	34	213	53
Shi (1987) [12]	21	45	13	53

There are some slight discrepancies in the pitch value descriptions of different tones. But the tone patterns of the four can be basically confirmed respectively as low, high, rising and falling, phonologically represented here as LL, HH, LH and HL.

It has been widely acknowledged that when two tones are juxtaposed, there are four tone combinations that undergo sandhi, as listed below. See Li & Liu (1985)[5], Tan (1986) [13], Shi (1987)[12], Chen (1986, 2000)[1][2], Wang (2002) [14] and etc.

(2) sandhi rule	examples <sup>①</sup>	meaning
a. A→C/_A	bing <sup>LL</sup> .gao <sup>LL</sup> → bing <sup>LH</sup> .gao <sup>LL</sup>	冰糕
b. C→B/_C	shui <sup>LH</sup> .guo <sup>LH</sup> → shui <sup>HH</sup> .guo <sup>LH</sup>	水果
c. D→A/_D	dian <sup>HL</sup> .che <sup>HL</sup> → dian <sup>LL</sup> .che <sup>HL</sup>	电车
d. D→B/_A	lu <sup>HL</sup> .yin <sup>LL</sup> → lu <sup>HH</sup> .yin <sup>LL</sup>	录音

The rules above are considered as the four basic rules for Tianjin tone sandhi, as the tone sandhi of more than two syllables are simply the application of these four rules (Li & Liu 1985)[5].

Problems arise when these four sandhi rules apply in the trisyllabic combinations. According to Li & Liu (1985)[5] and Chen (2000)[2], among the 64 (4×4×4) trisyllabic combinations of the four tones, 27 undergo tone sandhi, 20 out of 27 combinations apply one rule from (2) once only, and the rest apply or possibly apply twice or more of the rules.

(3)

Attested form	Unattested form
a. DDA→ <u>ADA</u> → <u>ABA</u>	DDA→DAD
b. CCC→ <u>BCC</u> → <u>BBC</u>	CCC→CBC
c. DAA→ <u>DCA</u>	DAA→BAA→BCA
d. AAA→ <u>ACA</u>	AAA→CAA→CCA→BCA
e. CAA→ <u>CCA</u> → <u>BCA</u>	
f. ADD→ <u>AAD</u> → <u>CAD</u>	
g. DDD→ <u>DAD</u> → <u>BAD</u>	DDD→ADD→AAD→CAD

## 2. The problem

As seen from the seven trisyllabic sequences listed in (3), sandhi rules apply either from left to right (as shown in 4) or from right to left (as shown in 5) to derive the attested surface forms.

(4) Rightward tone sandhi

dian <sup>HL</sup>	shi <sup>HL</sup>	ji <sup>LL</sup>	a TV set
D	D	A	UR
A			D→A/_D
	B		D→B/_A
A	B	A	PR

(5) Leftward tone sandhi

ting <sup>LH</sup>	guan <sup>LL</sup>	xin <sup>LL</sup>	very concerned about
C	A	A	UR
	C		A→C/_A
B			C→B/_C
B	C	A	PR

Studies have shown that the directionality of tone sandhi in Tianjin dialect does not obviously relate to its morpho-syntactic structure.

(6) [[bao<sup>LH</sup>wen<sup>LL</sup>]bei<sup>LL</sup>] thermos bottle  
 bao<sup>LH</sup>[wen<sup>LH</sup>]bei<sup>LL</sup>] → [bao<sup>HH</sup>wen<sup>LH</sup>]bei<sup>LL</sup>

Then, what are the reasons that underlie the bidirectional tone sandhi in this dialect? And in what way can the bidirectional tone sandhi be accounted for?

As is known, for the disyllabic sequences in Tianjin dialect, tone sandhi rules will change the tonal category of the first tone but not of the second; for the trisyllabic sequences, the rightmost tone remains unchanged. Now the problem is: which tone, the leftmost or the medial one in a trisyllabic sequence, will change first if both change? If the leftmost in trisyllabic string changes first, the medial one may possibly change thereafter; if the medial tone changes first, the medial sandhi tone may bleed or feed the sandhi process of the leftmost tone. In the former case, rightward tone sandhi will result if the leftmost and the medial one changes successively. And in the later case, leftward tone sandhi will result if the leftmost tone changes after the medial one. The examples in

<sup>①</sup> Examples are given here in *pinyin* transcription.

(3) clearly show that bidirectional tone sandhi exist in Tianjin dialect.

Chen (1986)[1] first recognized the tough problem concerning the tone sandhi of trisyllabic sequences in Tianjin dialect and claimed that “the phenomenon in Tianjin dialect severely drains the descriptive and explanatory capability of any current linguistic theory”. “The paradox of Tianjin tone sandhi”, which Chen was first to use to describe such problem, has aroused wide attention among the linguists around the world, and many solutions to this problem have been advanced thereafter, but none of them so far has been satisfactory.

### 3. Analysis

#### 3.1. Trigger of bidirectional tone sandhi

For the trisyllabic sequences, rightward tone sandhi starts from the initial tone to the medial tone. As is pointed out above, the four basic tone sandhi rules in Tianjin dialect are all context sensitive rules in which the change of the initial tone is triggered by its following tone. For the rightward tone sandhi, the medial tone triggers the change of the initial tone and then is caused to change by the leftmost tone. Each of these two tone sandhis does not affect the change of its own context. But it is not the case for leftward tone sandhi. Leftward tone sandhi starts from the medial tone to the initial tone. The medial tone sandhi will absolutely affect the application of the initial tone sandhi in two ways: either to feed (see 7a) or to bleed (see 7b) the application of the initial tone sandhi.

- (7) a. Feeding order  
 da<sup>LH</sup>guan<sup>LL</sup>qiang<sup>LL</sup> talk like a bureaucrat  
 CAA → CCA → BCA  
 b. Bleeding order  
 ji<sup>LL</sup>guan<sup>LL</sup>qiang<sup>LL</sup> machine gun  
 AAA → ACA

It is obvious that for rightward tone sandhi the initial tone is easier to change than the medial one and the medial one is easier to change than the final one. Among the three tones, the final tone is most faithful to its input form, the medial tone is less faithful and the initial one is the least faithful. As for leftward tone sandhi, the final tone is most faithful and remains unchanged while the medial one is likely to change as much as the initial one. If the initial and the medial can both change, it is wiser or more economical for the medial one to change first for the reason that the change of the medial tone imposes no requirements on the initial tone while the change of the initial tone is ensured on the condition that the medial one do not change simultaneously. These two directional tone sandhi can be illustrated respectively as follows:

- (8) a. right tone sandhi
- |                |                |                |
|----------------|----------------|----------------|
| T <sub>1</sub> | T <sub>2</sub> | T <sub>3</sub> |
| √              | √              | √              |
|                | √              | √              |
|                |                | √              |
- b. leftward tone sandhi
- |                |                |                |
|----------------|----------------|----------------|
| T <sub>1</sub> | T <sub>2</sub> | T <sub>3</sub> |
| √              | √              | √              |
|                |                | √              |
|                |                | √              |

Based on this way of classification, we relegate all the seven trisyllabic tone sandhi listed in (3) into the following two groups (Ma 2005)[6][7]:

- (9) Rightward tone sandhi  
 a. DDA → ADA → ABA  
 b. CCC → BCC → BBC
- Leftward tone sandhi  
 c. DAA → DCA  
 d. AAA → ACA  
 e. CAA → CCA → BCA  
 f. ADD → AAD → CAD  
 g. DDD → DAD → BAD

For the tone sandhi in (9a) and (9b), what triggers the tonal change of the leftmost tone is the falling tone (Tone D) and the rising tone (Tone C) in the medial syllable. Of the four tone system of Tianjin dialect, Tone C and Tone D are the only contour tones. Comparing with (9c), (9d) and (9e), we find that Tones C and D are different from the medial tone of these three trisyllabic sequences in that the former two tones are contour tones while the latter is a level tone. Now we might as well make an assumption: leftward tone sandhi applies when the medial tone is a low level tone, while rightward tone sandhi applies when the medial is a contour tone.

Leftward and rightward tone sandhi co-exist in Tianjin dialect and thus bring about the bidirectional tone sandhi phenomena.

#### 3.2. Role of the teleological well-formedness

For the trisyllabic sequences, rightward tone sandhi starts from the initial tone to the medial tone while leftward tone sandhi from the medial tone to the initial tone. Both rightward and leftward rule application co-exist in Tianjin dialect. As is pointed out above, whether the medial tone in a trisyllabic sequence is a contour tone or a level one can be taken as the trigger of different directional rule application in Tianjin dialect. Specifically speaking, rightward tone sandhi applies when the medial tone is a contour. It is true to the trisyllabic tone sandhi in (9a) and (9b) but not for (9f) and (9g). Why do (9f) and (9g) take the leftward mode of rule application but not the rightward one even if the medial tone is a contour tone?

As for (9f), the initial disyllabic sequence is AD and AD never changes wherever it occurs. It has no way but to apply tone sandhi rules to the last two syllables DD and produce the changed disyllabic tone sequence AD. Such a change creates the environment that causes the initial tone A to change into C. And thus leftward mode of rule application is resulted. In short, (9f) has no choice in terms of the direction of tone sandhi application and the contour tone in the medial position then has no effect in selecting the way of rule application.

As for (9g), the medial tone (Tone D) is a contour tone and, as is pointed out above, rightward tone sandhi should apply. However the fact is the opposite. What are the reasons then that underlie this unpredicted direction of tone sandhi rule application?

- (10) a. rightward mode of rule application
- |            |        |
|------------|--------|
|            | D D D  |
| D → A/___D | A      |
| D → A/___D | A      |
| A → C/___A | C      |
|            | *C A D |

b. leftward mode of rule application

	D D D
D→A/___D	A
D→B/___A	B
	B A D

In (10a), as predicted, rightward mode of rule application is taken, which result in the output of AAD after two passes. However the output AAD is an illegal surface form of tone combination in Tianjin Dialect. Thus two choices will certainly happen when an illegal surface form appears due to the rightward tone sandhi triggered by a medial contour tone. One is that tone sandhi will apply iteratively in order to meet the requirement of well-formed surface of tone combination; the other is that reverse tone sandhi will be triggered. As for (10a), the illegal output AAD will either apply tone sandhi rule (2a) again, so as to derive an unattested form CAD, or trigger the leftward mode of rule application, which lead to the attested form BAD as shown in (10b).

Then which one should be the best choice? It is obvious that the differences between (10a) and (10b) are the number of times the tone sandhi rules apply and the outputs that the different number of derivational passes has produced. Such differences lie in the derivational path that the rule application takes. In other words, different paths result in different number of derivational passes needed and different surface forms as well. (10a) takes the rightward mode of rule application and thus requires at least three passes to derive the form CAD; (10b) takes the leftward mode of rule application and thus needs only two passes to derive the form BAD. To compare these different surface forms that the two different paths lead to, we can easily find that BAD is simpler in tonal shape than CAD. Less passes and simpler tonal shape of the surface form come together to influence the choice of the derivational path eventually (Ma 2012)[8].

#### 4. Discussion

From the analysis above, we can find that the teleological well-formedness plays an important role in the selection of the derivational path and the derivational path then decides how many passes the derivation undergoes. Now the question is: in what way can the bidirectional tone sandhi be accounted for?

Classical generative phonology is derivationally based and has been proved to be difficult to account for the tonal phenomenon of Tianjin dialect. Classical OT is teleological non-derivational phonological theory and also fails to solve the bidirectionality problem. McCarthy (2007, 2008, 2010) [9][10][11] develops a new derivational model of Optimality Theory --- Harmonic Serialism. Is this theory feasible and applicable to Tianjin tonal sandhi problem? In terms of Tianjin tonal phenomenon, HS is faced with at least some of the following questions:

- Sometimes different paths may converge to the same surface form after several passes, which lead to no problems in choosing the paths. But sometimes different paths may diverge into different surface forms like shown in Tianjin tone sandhi. In other words, different paths may produce different outputs. In this case, it is important for HS to define the derivational path of the tonal mappings from input to output. Then what technical devices are now available for HS to define the derivational path?

- Faithfulness constraints or markedness constraints? Or something else? As I have demonstrated above, the natural class of contour/level tones may be the trigger of the bidirectional tone sandhi. Within the framework of sympathy theory, I argue to use positional faithfulness to delineate the bidirectional tone sandhi in Tianjin dialect. Then how do we incorporate the positional faithfulness constraints into the analytical system of Harmonic Serialism?
- Further more, even if HS can find an effective way to account for the bidirectional tone sandhi triggered by the natural class of contour/level tones, exceptions may appear as for (9g). Actually in Tianjin dialect, other factors including less passes and simpler tonal shape of the surface forms may also have an impact on the choice of the derivational path. How does HS react to this impact of the teleological forces on its choice of derivational path?
- As we have mentioned above, the natural class of contour/level tones may be the trigger of the bidirectional tone sandhi, which points the way in the choice of the derivational path. However once the derivational path or the direction of rule application is decided, is this choice of direction unalterable in any cases? As for the case like (9g), its derivational path deviates from the original one due to the effect of the teleological forces --- less passes and simpler tonal shape of the surface forms. The deviation in terms of the path selection has set a challenge for Harmonic Serialism with respect to the choice of derivational path. Within a particular language, HS must make a choice anytime and anywhere between rightward tone sandhi and leftward one. And the choice is made clearly under the influence of the number of the derivational passes and the complexity of the surface tonal shape.

In summary, Harmonic Serialism is seemingly incapable of the paradoxical problem in Tianjin tone sandhi either in defining the derivational path or in handling the violability in the choice of the derivational path.

#### 5. Conclusions

It can be easily seen from the analysis above that the complexity of Tianjin trisyllabic tone sandhi lies in (1) the choice of derivational path, (2) the co-existence of leftward and rightward rule application or, in other words, the bidirectionality of Tianjin trisyllabic tone sandhi, (3) the deviation of derivational path due to the effect of less passes and simpler tonal shape.

In this paper, I demonstrated what reasons underlie this paradoxical problem in Tianjin tone sandhi and then discussed what problems still exist in the application of some current theories or models in Tianjin tone sandhi. In brief:

- (1) In the trisyllabic sequences, the natural class of contour /level tones is the trigger of the bidirectional tone sandhi in Tianjin dialect. Leftward tone sandhi applies when the medial tone is a low level tone, while rightward tone sandhi applies when the medial is a (LH or HL) contour tone.
- (2) Different paths result in different number of derivational passes needed and different surface forms as well. In other words, the teleological forces will have an impact on the choice of derivational path and at the same time

will decide how many passes the derivation undergoes. Less passes and simpler tonal shape of the surface forms will lead to the deviation in terms of the path selection.

- (3) Classical generative phonology and Classical OT have been proved to be difficult to give a satisfactory solution to the paradoxical problem of tone sandhi in Tianjin dialect. Harmonic Serialism, a newly advanced derivational model of Optimality Theory, also faces some problems in terms of the bidirectionality of Tianjin trisyllabic tone sandhi.

To sum up, we still have to find some effective technical devices available for HS to define the derivational path, and incorporate the positional faithfulness constraints into the analytical system of HS. Moreover, the deviation in terms of the path selection has also set a challenge for Harmonic Serialism with respect to the choice of derivational path. Accounting for the paradoxical problem of tone sandhi in Tianjin dialect, Harmonic Serialism still has a long way to go.

## 6. References

- [1] Chen, M. Y., "The paradox of Tianjin tone sandhi", Proceedings from the Annual Meeting of the Chicago Linguistic Society (CLS22), 98- 154,1986.
- [2] Chen, M. Y., "Tone Sandhi Patterns across Chinese Dialects", Cambridge: Cambridge University Press, 2000.
- [3] Davison D. S., "The Analysis of Retroflexible Onset in Tianjin Dialect", 15<sup>th</sup> International Conference Sino-tibetan Languages and Linguistics,1982.
- [4] Li, S. Y., "Shuo Tianjinhua de Ren Zenyang Xuexi Putonghua", Studies of the Chinese Language, Vol.4,1956.
- [5] Li, X. J. and Liu, X. S., "The tone sandhi in Tianjin Dialect", Studies of the Chinese Language, Vol.4: 76-80, 1985.
- [6] Ma, Q. W., "An OT solution to the paradox of Tianjin tone sandhi", Zhongguo Yuwen, Vol.6: 561-568, 2005.
- [7] Ma, Q. W., "More on the paradox of Tianjin tone sandhi", Contemporary Linguistics, Vol.2: 97-106, 2005.
- [8] Ma, Q. W., "More remarks on the paradox of Tianjin tone sandhi", Contemporary Linguistics, Vol.1: 12-23, 2012.
- [9] McCarthy, J. J., "Hidden Generalizations: Phonological Opacity in Optimality Theory", London: Equinox Publishing, 2007.
- [10] McCarthy, J. J., "Doing Optimality Theory: Application Theory to Data", Oxford: Basil Blackwell, 2008.
- [11] McCarthy, J. J., "An introduction to harmonic serialism", Language and Linguistics, 4(10): 1001-18, 2010.
- [12] Shi, F., "An analysis on the monosyllabic tone in Tianjin Dialect", Essays on Liguistic Study, Vol.4, 1987.
- [13] Tan, F., "Ye Tan Tianjin Fangyan de Liandu Biandiao", Studies of the Chinese Language, Vol.6: 447-450, 1986.
- [14] Wang, J. L., "Optimality Theory and the Tone Sandhi and Neutral Tone in Tianjin Dialect", Studies of the Chinese Language, Vol.4: 363-372, 2002.