

NEUTRAL TONE REALIZATION IN TIANJIN MANDARIN

Qian Li & Yiya Chen

Leiden University Centre for Linguistics, Leiden University, the Netherlands

q.li@hum.leidenuniv.nl; yiya.chen@hum.leidenuniv.nl

ABSTRACT

This study examines the acoustic realization of neutral tone in Tianjin Mandarin, which shows great variability in the f_0 patterns. Previous studies, mainly with impressionistic data, have proposed that the neutral tone in Tianjin Mandarin has different underlying tonal targets depending on the tonal contexts, in particular the following tone. This presents a great challenge to the cross-dialectal understanding of neutral tone realization in the Mandarin family. With well-controlled laboratory speech, we show that the f_0 contours over the neutral tone syllable can be predicted from the neighboring lexical tones and much of the f_0 variation can be explained by factors that are known to affect lexical tone realization, namely, tone sandhi, focus, and tonal coarticulation.

Keywords: neutral-tone, Tianjin, tone-sandhi, focus

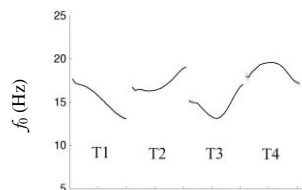
1. INTRODUCTION

Chinese dialects are known for their rich inventory of lexical tones and complex patterns of tone sandhi changes [2]. Much less, however, is known about the so-called neutral tone, whose f_0 realization shows greatly varied patterns. It has been proposed that the neutral tone variability is due to its different underlying tonal targets [8, 9]. With data from Tianjin Mandarin, we argue that much of the variation can be explained by factors that are known to affect lexical tone realization in connected speech, namely tone sandhi, focus, and tonal coarticulation.

Tianjin Mandarin has four lexical tones. Fig. 1 illustrates the f_0 realization of the lexical tones uttered in isolation. In addition, Tianjin also has syllables which do not surface with any of the lexical tones, commonly known as neutral tone syllables. Like in Beijing Mandarin, these syllables appear in bisyllabic items following a lexical tone or are grammatical morphemes (e.g., the aspect marker *zhe* and the possessive marker *de*) [9]. In most cases, the f_0 realization of Tianjin neutral tone is similar to that of Beijing Mandarin where the

preceding syllable shows a significant effect [7]. What is different in Tianjin is that when the following tone is T1, it seems to affect the f_0 realization of the neutral tone, leading to the proposal that Tianjin neutral tone has special tonal targets in specific tonal contexts [9]. This poses a great challenge to our understanding of the cross-dialectal realization of neutral tone in the Mandarin family. The goal of this study is therefore to examine whether the neutral tone realization in Tianjin is indeed influenced by the following tone. Furthermore, we will explore how factors that are known to introduce tonal variation might explain the neutral tone variability in Tianjin. Specifically, we will investigate the effects of tone sandhi, focus, and tonal co-articulation.

Figure 1: Four lexical tones in Tianjin Mandarin, produced in isolation. Normalized time.



Tone sandhi refers to the change of lexical tones when syllables are combined [2]. For bisyllabic constituents, previous studies in Tianjin have suggested four sandhi rules [2, 6, 9]:

- a. T1→T3/_T1 b. T3→T2/_T3
c. T4→T1/_T4 d. T4→T2/_T1

Three patterns (a-c) have been attributed to the Obligatory Contour Principle (OCP). In a sequence of two identical tones, the first one has been argued to undergo dissimilatory changes, similar to the Mandarin Low tone sandhi. One additional pattern (d) is the change of T4 into T2, when the following tone is T1. Note that we see a parallel case here to the neutral tone pattern described earlier: in a similar tonal context (i.e., before T1), neutral tone is realized with a high-level or rising f_0 contour. This raises the question of whether the high-level or rising f_0 over the neutral tone before T1 is related to the sandhi pattern or due to its own special target.

It is well-known that the information status of a word (e.g., old vs. new or contrastive information) can have a significant effect on the way the lexical tone of a word is realized [3, 4]. Focus has been shown to affect the f_0 realization of neutral tone in Beijing Mandarin [5]. Based upon impressionistic observations, [6] proposes that focus blocks tone sandhi in Tianjin Mandarin in a bisyllabic phrase. When the following syllable is focused, the sandhi pattern remains; when the preceding syllable is focused, however, tone sandhi no longer applies. If tone sandhi indeed plays a role on neutral tone realization, we may expect different f_0 contours of neutral tone when its neighboring tones are uttered with different focus conditions.

In addition to tone sandhi and focus, we know that adjacent tones usually coarticulate in connected speech, where both carryover and anticipatory effects are observed. Neutral tone syllables are in prosodically weak positions and in Beijing Mandarin, neutral tone has been shown to be less capable in overcoming the influence from the neighboring lexical tones [5]. So, it is also important to control the neighboring lexical tones for better understanding of their coarticulatory effects on the neutral tone realization.

By carefully controlling these factors on tonal realization, we hope to reveal the nature of the neutral tone realization in Tianjin Mandarin and contribute further to cross-linguistic comparisons of neutral tone realization among Chinese dialects.

2. METHOD

2.1. Materials

The stimuli included trisyllabic phrases with one neutral tone syllable (*de*, *zhe*) embedded in the middle. To examine the effect of tone sandhi, bisyllabic phrases without neutral tone were also included and elicited in isolation. For the effect of focus, two focus conditions were elicited via different preceding questions, as in (1) and (2). Bolded syllables were uttered with focus. We also varied the preceding and following tones for possible tonal coarticulatory effects.

- | | | |
|-----|-----------------------------------|-------------------------------------------------------------------------------------------------------|
| (1) | Focus on
Preceding
Syllable | Question: Shuí de mā ? (' WHOSE mother?')
Answer: Tā de mā . (' HIS mother.') |
| (2) | Focus on
Following
Syllable | Question: Tā de shuí? ('His WHAT ?')
Answer: Tā de mā . ('His MOTHER .') |

2.2. Subjects

Seven speakers (three males and four females) participated in the experiment. All were in their twenties, born and raised in the urban areas of Tianjin. They were paid for their participation but naive of the purpose of the experiment.

2.3. Recording

Recordings were conducted in a sound-treated booth (four speakers at Beijing Language and Culture University, and three at Nankai University). Subjects followed the same procedure. Question and answer pairs were presented on a computer screen. Subjects were grouped into pairs with one reading the questions and the other the answers and then switched their roles after one round of recording. In total, 896 trisyllabic phrases (4 preceding tones * 4 following tones * 2 neutral tone syllables * 2 focus conditions * 2 repetitions * 7 subjects) and 224 bisyllabic phrases (4 preceding tones * 4 following tones * 2 repetitions * 7 subjects) were elicited.

2.4. f_0 Extraction

The data were manually segmented in Praat [1]. A custom-written script was used for f_0 extraction and smoothing. f_0 contours were obtained by taking 20 points (in Hertz) in the lexical tone syllables and 10 points in the neutral tone syllables, at even intervals from each syllable and averaged across two repetitions of the same rendition. The different number of points taken also shows approximately the durational contrast observed over neutral tone syllables vs. lexical tone syllables. The data were averaged across speakers after being transformed into semitones with the formula in (1):

$$(1) \quad st = 12 \times \log_2(f_0 / f_{ref})$$

(*st*: semitone; f_0 : raw f_0 value in Hz; f_{ref} : the reference frequency with 100 Hz for females and 50 Hz for males)

3. RESULTS

Fig. 2 displays mean f_0 contours of the four sandhi patterns. This figure confirms earlier observations that in the combination of T1+T1 (Fig. 2A), the preceding T1 is changed into a dipping f_0 pattern, comparable to T3; and in T4+T1 (Fig. 2D), the preceding T4 is changed into a high rising f_0 pattern, more comparable to T2. It is, however, less clear whether tone sandhi has applied in Figs.

2B and 2C. On the one hand, the first T3 in Fig. 2B and the first T4 in Fig. 2C seem to be realized with f_0 contours that are more comparable to that of T2 and T1 uttered in isolation (Fig. 1). On the other hand, their f_0 contours are also comparable to the realization of T3 and T4 respectively in non-sandhi contexts in connected speech, as we have observed in a different data set of ours.

Figure 2: Sandhi patterns in Tianjin Mandarin. Solid lines indicate mean f_0 ; gray areas stand for ± 1 standard error of mean (also in **Figure 3**). Normalized time.

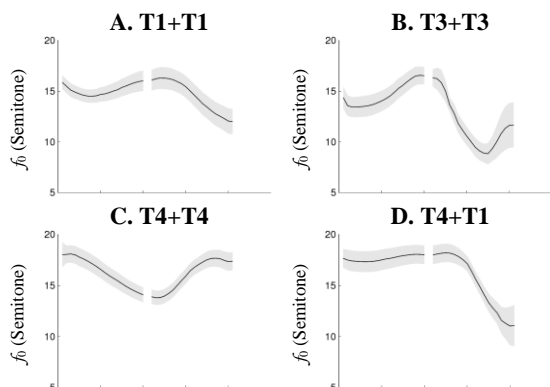
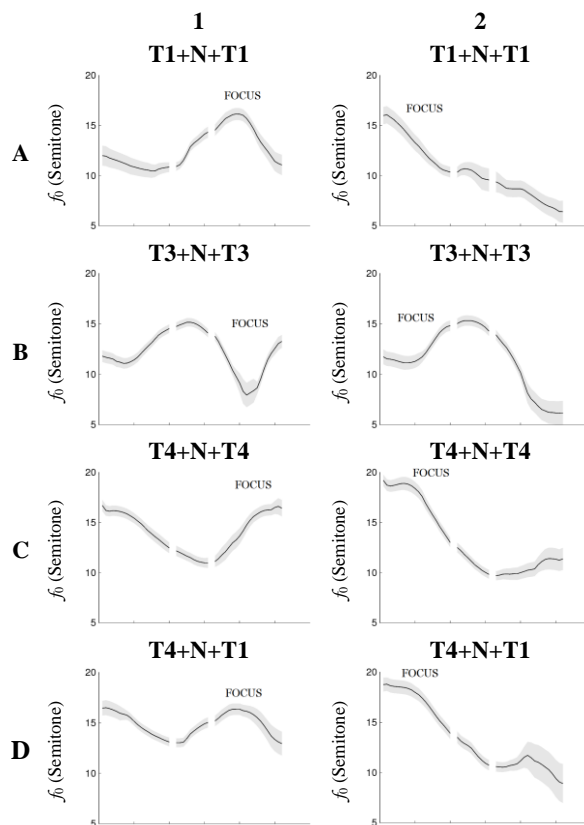


Fig. 3 shows the f_0 contours of neutral tone syllables embedded in lexical tonal contexts, comparable to those in Fig. 2. Those on the left (Figs. 3A-D, 1) were uttered with focus on the following lexical tone syllable while those on the right (Figs. 3A-D, 2) with focus on the preceding syllable. When focus was on the following tone, the f_0 contours are rather comparable to those in Fig. 2. The neutral tone syllable seems to form a constituent with the preceding syllable and they together serve as the bearing unit of the preceding lexical tone. Over this larger domain, the preceding tone also seems to be realized with a more exaggerated tonal gesture, particularly in Fig. 3D-1. When the preceding syllable was focused, the f_0 contours are a bit different from those in Fig. 2, in particular the realization of the preceding T1 (Fig. 3A, 2) and T4 (Fig. 3D, 2), both of which were realized a clear falling f_0 contour. One possibility is that focus on the preceding syllable blocked the application of tone sandhi and enforced the realization of the underlying lexical tonal target for T1 and T4 so that their f_0 contours resemble more their respective realizations in isolation (Fig. 1). The neutral tone syllable again seems to form a constituent with the preceding syllable.

Tonal coarticulation also had an influence on neutral tone realization. In all tonal contexts, the f_0 contour of neutral tone is greatly influenced by the

preceding tone, suggesting a greater carryover effect. Little anticipatory effect can be found in the data. Comparing further the two columns in Fig. 3, we see lexical tones under focus were generally realized with an exaggerated tonal gesture (Figs. 3A-D). In T1+N+T1 (Fig. 3A) and T4+N+T1 (Fig. 3D), when the following lexical tone was focused, neutral tone shows a rising pattern; while when the preceding lexical tone was focused, neutral tone shows a declining f_0 pattern. The effect of focus is not that salient in the other two combinations (Figs. 3C & 3B).

Figure 3: f_0 of neutral tone intervening sandhi patterns. Column 1 stands for the following lexical-tone focused condition; Column 2 the preceding lexical-tone focused condition. Row A is the pattern T1+N+T1; Row B is T3+N+T3; Row C is T4+N+T4; Row D is T4+N+T1. Normalized time.



4. DISCUSSION AND CONCLUSION

Results of this study showed that neutral tone in Tianjin Mandarin does not have any special pitch target as proposed in [9]. Rather, when there is only one neutral tone in a sentence, the f_0 contour over the neutral tone syllable can be predicted from the neighboring lexical tones and the discourse context in which they are produced.

Tone sandhi, together with focus, showed a conspicuous effect on neutral tone realization in certain tonal contexts. When the following lexical tone was focused, the f_0 contours of “preceding lexical tone syllable + neutral tone syllable” sequences in tri-syllabic phrases showed very similar patterns to that of the preceding tone syllable in bi-syllabic phrases (Figs. 2-3). The neutral-tone syllable preceding T1 showed a rising pattern (Figs. 3A-1 and 3D-1). This pattern fits the description in [9]. While [9] attributes the rising f_0 to a special target of the neutral tone before T1, our data suggest that this rising f_0 is better explained as being influenced by the preceding T1 and T4, which have undergone sandhi changes when followed by T1 (Figs. 2A and 2D), despite the fact that there is an intervening neutral tone. Specifically, in T1+T1 and T4+T1, both the preceding T1 and T4 are realized with rising f_0 contours, due to tone sandhi (Figs. 2A and 2D). In the trisyllabic combinations, neutral tone does not block sandhi (Fig. 3A-1 & 3D-1). Rather, it seems to become part of the bearing unit for the sandhi-derived rising tone for the underlying T1 and T4. As mentioned earlier, the existing literature suggests that tone sandhi also applies in T3+T3 and T4+T4 sequences. The fact that T3 and T2 are both rising tones and T1 and T4 are both falling tones (although with different rising or falling gestures) makes it difficult to ascertain whether tone sandhi has been applied or not. What is clear is that in these two sequences, the f_0 contour of the neutral tone syllable is also clearly influenced by the preceding lexical tone, suggesting a great carry-over effect, just like the f_0 realization of the neutral tone syllables in Beijing Mandarin.

When the preceding tone was focused, there is no evidence for the application of tone sandhi. [6] reported, with impressionistic data, that focus blocks tone sandhi in bisyllabic constituents. Our results thus confirm and extend the observation to tri-syllabic phrases. As shown in Figs. 3A-2 and 3D-2, focus on the preceding T1/T4 blocks tone sandhi, and consequently, their following neutral tone syllable shows a falling f_0 contour. We also observed phonetic effects of focus on tonal realization, particularly in the case of T4+N+T4 (Fig. 3C), where lexical tones were realized with more magnified tonal gestures under focus, which subsequently affected the neutral tone realization. The effect of focus on the neutral tone in T3+N+T3 (Fig. 3B), however, was not observed.

One may argue that the f_0 realization of the neutral tone syllables in Tianjin Mandarin is a simple interpolation of its preceding and following lexical tones. While we agree that this account is plausible when there is only one neutral tone syllable, further studies with longer stretch of neutral tone syllables are certainly needed to verify this possibility. Chen & Xu [5] show that in Beijing Mandarin, only when there is a sequence of three neutral tone syllables, there is clear evidence for the existence of a weak low tonal target over the neutral tone syllable. Whether Tianjin Mandarin has a similar neutral tone target will be addressed in our follow-up study.

What we have shown in this study is that Tianjin Mandarin does not have various neutral tone targets as proposed by previous studies. Rather, the f_0 patterns of the neutral tone syllables can be predicted from the neighboring lexical tones, and the variation in neutral tone f_0 realization can be explained by factors that are known to affect lexical tone realization, namely, tone sandhi, focus, and tonal coarticulation.

5. ACKNOWLEDGEMENTS

We thank the support from the Chinese Scholarship Council to QL as well as the support from the NWO (016084338) and the European Research Council (206198) to YC. We would also like to thank Wen Cao and Feng Shi for making the sound-booth recordings possible.

6. REFERENCES

- [1] Boersma, P., Weenink, D. 2010. Praat: Doing phonetics by computer. <http://www.praat.org/>
- [2] Chen, M. 2000. *Tone Sandhi: Patterns across Chinese Dialects*. New York: Cambridge University.
- [3] Chen, Y. 2010. Post-focus f_0 Compression – Now you see it, now you don't. *J. of Phonetics* 38, 517-525.
- [4] Chen, Y., Gussenhoven, C. 2008. Emphasis and tonal implementation in Standard Chinese. *J. of Phonetics* 36, 724-746.
- [5] Chen, Y., Xu, Y. 2006. Production of weak elements in speech – Evidence from F0 patterns of neutral tone in Standard Chinese. *Phonetica* 63, 47-75.
- [6] Li, X., Liu, S. 1985. Tianjin fangyan de liandu biandiao. *Zhongguo Yuwen* 1, 76-80.
- [7] Shi, F. 1986. Tianjin fangyan shuangzizu shengdiao fenxi. *Yuyan Yanjiu* 1, 77-90.
- [8] Wang, J. 1997. The representation of neutral tone in Chinese Putonghua. In Wang, J., Smith, N. (eds.), *Studies in Chinese Phonology*. Berlin: Mouton de Gruyter, 157-183.
- [9] Wang, J. 2002. Youxuanlun he tanjinhua de liandu biandiao ji qingsheng. *Zhongguo Yuwen* 4, 363-383.