PITCH PATTERNS OF PROSODIC WORDS IN SUZHOU CHINESE

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ABSTRACT

The pitch patterns of prosodic words in Suzhou Chinese are investigated in connected speech. The results show that the non initial syllables in prosodic words have constant pitch targets. However the pitch targets are mid level of tonal range instead of low level as suggested in previous studies.

Keywords: pitch, tone sandhi, Chinese

1. INTRODUCTION

There are seven distinctive citation tones in Suzhou Chinese (Chao [1]). They are high level tone (T1), low falling and rising tone (T2), high falling tone (T3), high falling and rising tone (T4), low rising and falling tone (T5), high short tone (T6) and low short tone (T7). Many studies (for example: Qian & Shi [3], Wang [5], Ye [6] etc.) show that the prosodic words in Suzhou can form a big tone sandhi domain, which is similar to the tone sandhi forms in Shanghai Chinese as described in Zee & Maddieson [7]. Despite of the different descriptions in tone value among the past studies, they all agree that (i) the tone patterns on the prosodic words are a result of the rightward spreading of the citation tone on word initial syllable to the entire word, with the deletion of the citation tone on the following syllables, (ii) the tone pattern of the domain is similar to the shape of the citation tone of the word initial syllable, (iii) the height of the posterior part of the domain falls to a low position with the number of syllable increasing. Table 1 gives a description in five point scale of the citation tones on the word-initial syllables and the tone patterns on the prosodic words in Suzhou Chinese.

However, all these results are only concerned with the tone pattern of the prosodic word in isolation form. One problem may arise that the isolation form is usually a declarative sentence containing only one word actually. With the increasing of the number of the syllable in the prosodic word, the effect of the intonation grows. Another fact is that there is a clear trend in many languages that F0 values tend to drift down in an utterance, which is called "declination". Thus, the falling at the end of the prosodic words in Suzhou may be the result of the sentence declination instead of the intrinsic pitch target of the tone sandhi domain.

In Mandarin Chinese, there are so called "neutral tone" syllables whose F0 have been believed to be completely dependent on the tone of the preceding syllables. They are often treated as similar phenomenon of the rightward tone spreading as the tone sandhi in Suzhou Chinese Shi [4]. Experimental studies Chen & Xu [2] have proved that the F0 curve of neutral tone goes to a mid level of the tonal pitch range with the number of neutral tone increasing in connecting speech. The finding also reminds us that the falling of later part of prosodic word in Suzhou Chinese may also change in speech.

2. METHODOLOGY

As shown in Table 1, there are more variations for the sandhi form of the two short tones than other long tones. In this paper, only the sandhi forms of the five long tones are investigated. There are two factors are considered in the design of the test material. First, the syllable numbers of the prosodic words can influence the pitch of the later part of word. According to the previous description, the tone value in five point scale fall to 1 from the third syllable for all the five sandhi forms. Trisyllabic, quadrisyllabic and quintesyllabic words are used. Second there may be some contextual effect from the following syllable tones. Here two carrier sentences are designed. One contains a high tone (T1) and another, a low tone (T2).

To minimize the effect of declination, the test words are formed prosodic phrases with the following words, thus they are only placed before lowest prosodic boundaries.

The carrier sentences are as follows:

A 住勒 _____老[læ44]师明朝去上海。
(The teacher who lives in ____ will go to Shanghai tomorrow.)

B 住勒 _____老[læ21]板明朝去上海。
(The boss who lives in ___ will go to Shanghai tomorrow.)

Table 1: The citation tones on the word-initial syllables and the tone patterns on the prosodic words in Suzhou Chinese.

Initial syllable		Tone sandhi patterns			
Tone type	Citation tones	Bisyllabic words	Trisyllabic words	Quadrisyllabic words	Quintesyllabic words
T1	44	44-21/4-44	4-4-21	4-4-3-21	4-4-3-2-1
T2	213	21-4	21-4-21	21-4-3-21	21-4-3-2-1
T3	52	52-1	52-2-1	52-2-2-1	52-2-2-2-1
T4	231	23-1	23-3-1	23-3-2-1	23-3-2-2-1
T5	523	52-3	52-3-1	52-3-2-1	52-3-3-2-1
T6	5	5-23	5-23-1	5-23-3-1	5-23-3-2-1
		5-52	5-52-1	5-53-2-1	5-53-3-2-1
		5-5	5-5-1	5-5-5-1	5-5-5-3-1
T7	23	23-52	23-52-1	23-53--2-1	23-53-3-2-1
		2-5	2-5-21	2-5-3-1	2-5-3-2-1
		23-5	23-5-1	23-5-5-21	23-5-4-2-1

The test words are as follows:

T1	苏州葛	苏州路葛	苏州新村葛
	Suzhou	Suzhou Rd.	Suzhou new estate
T2	常州葛	常州路葛	常州新村葛
	Changzhou	Changzhou Rd.	Changzhou new estate
T3	九号葛	九号路葛	九号新村葛
	No 9	No 9 Road	No 9 new estate
T4	广州葛	广州路葛	广州新村葛
	Guangzhou	Guangzhou Rd.	Guangzhou new estate
T5	两号葛	两号路葛	两号新村葛
	No 2	No 2 Road	No 2 new estate

Three native Suzhou speakers participated in the experiment (2 male and 1 female). Recording was conducted in a quiet room, using AKG C520 microphone and Shure X2U interface. All the subjects repeated all the test sentences three times.

Praat was used in pitch extraction. The vocal period were marked automatically first. Then all the marks were checked manually in the help of narrow band spectrograph. Segmental boundaries were hand-labeled. F0 curves were smoothed to eliminate the irregular pitch points around the syllable edge.

For ease of data analysis, tone feature points (for the first syllable, they are starting and end points; for other syllables, they are turning point and end point) of each syllable were labeled by hand.

After all the F0 values of the feature points were obtained, all the values are transformed into semitone using the following formula.

$$St=12*\ln(x/x0)/\ln2 \quad (1)$$

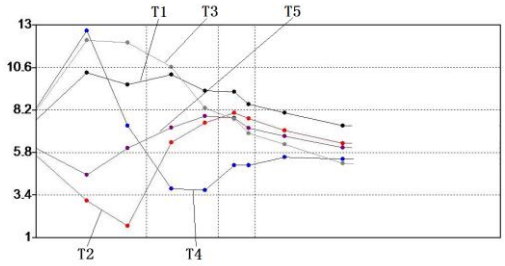
x is original F0 value. x0 is the mean F0 value of the end points of the low tone that followed the test words for each subject.

3. RESULTS

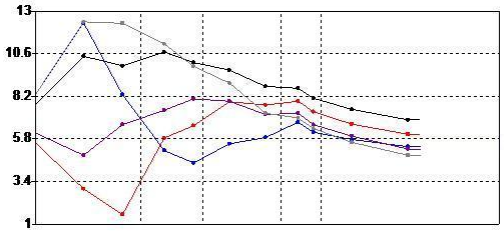
As shown in Figure 1, the pitch curves can be classified into three types. First type included T1 and T3. The pitch curves of the entire prosodic words show declining patterns. T1 fall gradually, the pitch decrease nearly 3 St from the beginning to the end. T3 fall rapidly: the beginnings are almost the highest, and the ends are the lowest. Second type is T4. The pitch curves fall rapidly in the first syllable, but fall gradually in the second syllable. In the third syllable, the pitch curves change the direction and begin to rise. The third type included T2 and T5. After the first syllable, the pitch curves begin to rise, and get to the peak around the boundary between second and third syllables, then fall down gradually.

Figure 1: Mean pitch (in Semitone) contours of words in different tonal contexts. Each curve in a graph is an average of 9 repetitions by 3 subjects, and each vertical dash line indicates a syllable boundary. The five curves in each graph differ in the first full tone, as indicated by T1(black), T2(red), T3(grey), T4(blue) and T5(purple). The three rows differ in the number of syllables. The two columns differ in the tone of the followed syllable, left column is high tone, right column is low tone.

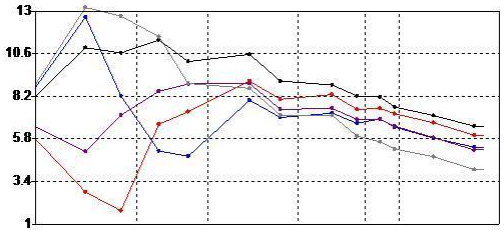
Trisyllabic words (last syllable is a high tone)



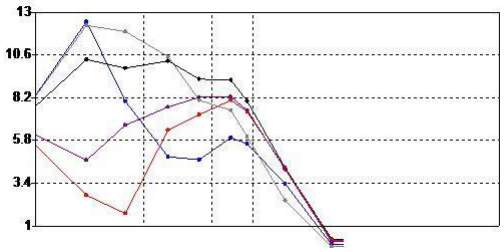
Quadrisyllabic words (last syllable is a high tone)



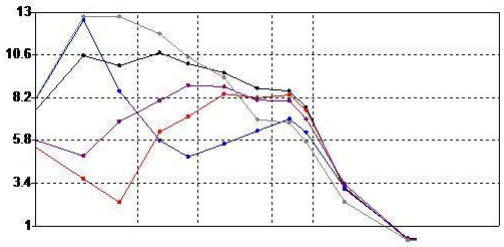
Quintesyllabic words (last syllable is a high tone)



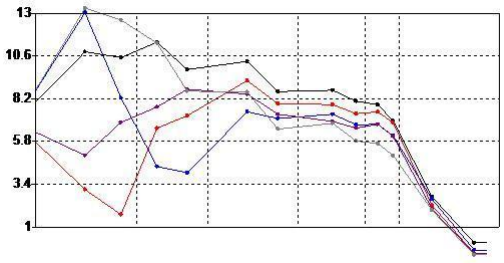
Trisyllabic words (last syllable is a low tone)



Quadrisyllabic words (last syllable is a low tone)



Quintesyllabic words (last syllable is a low tone)



The means (and Std. Deviation) of pitch for the starting and end points of the non-initial syllables in trisyllabic words are 7.8 (3.5), 7.4 (3.2); 7.7 (2.8), 7.0 (2.6) respectively. Those for Quadrisyllabic words are 8.3 (3.6), 8.1 (3.5); 8.2 (3.3), 7.5 (3.3); 7.6 (3.0), 6.9 (2.8). And those for quintesyllabic words are 8.5 (3.8), 7.9 (3.3);8.9 (2.9), 7.6 (2.3); 7.7 (2.4), 7.0 (2.7); 7.0 (2.6), 6.4 (2.5). Thus, the means of pitch decrease gradually in the prosodic words. The standard deviations of pitch decrease as well, which shows a tendency of concentration. Therefore, although the pitch curves of the five sandhi tones are different, all the pitch curves concentrated at a mid pitch range finally in spite of the number of syllables in the prosodic words and the large pitch variations of the first syllables. The concentration cannot be explained by the coarticulation of the following tones, because the pitch curve goes to the mid range even before low tone as shown in the right column. This pitch pattern is different from the previous description for isolated prosodic words in Suzhou Chinese.

4. DISCUSSION

The tails of the prosodic words in Suzhou concentrate at a mid pitch range rather than a low pitch range as suggested in the previous descriptions. The results of this study are similar to the case of neutral tones in Mandarin which tend to concentrate around the mid level of the tonal pitch range Chen & Xu [2]. Both of them cannot be derived from tone spreading from the preceding tone or linear interpolation between adjacent full tones.

F0 is falling throughout the initial syllable of T2 and the offset is the lowest. But the following syllable always rises first. Thus the pitch curves of T2 in Suzhou are similar to those of post-L F0 Raising in Mandarin. Chen & Xu [2] explained that it might be due to a tendency for F0 to 'bounce' back after reaching an extremely low value. However, the pattern for pitch curves of T4 is also falling rising and falling as shown in Figure 1, which cannot be explained by extremely low pitch because the offset of the initial syllable in T4 is much higher than that of T2. As the citation tone patterns for T2 and T4 are both falling and rising, the difference between them is onset pitch, I prefer to explain the pitch curves for T2 and T4 by the final rise of the two tones in isolation.

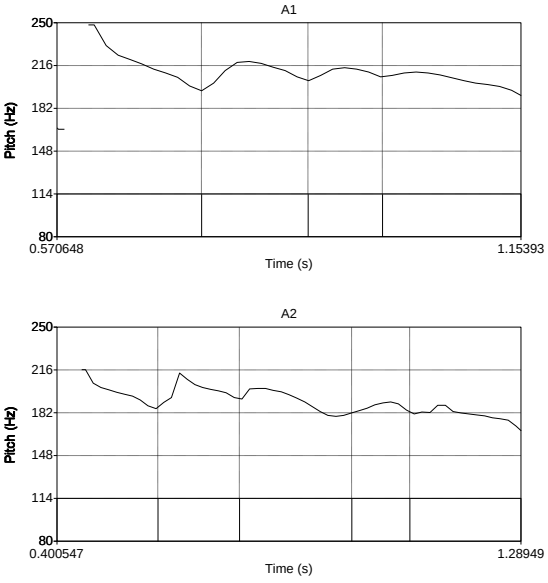
There are some differences in this study from the results in Chen & Xu [2]. Based on the figures in Chen & Xu [2], we found that the pitch of the last neutral tone in Mandarin is always lower than that of the peak of the following F tone. But in our results, the last syllables of the prosodic words are

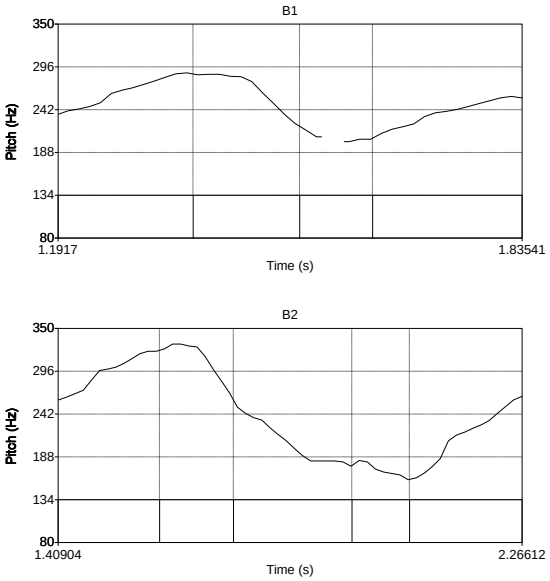
always higher than the peak the following tones. The right boundaries of the test words in Chen & Xu [2] are boundaries of prosodic phrases, while in this study those of the test words are inside prosodic phrases. For comparison, we recorded some Mandarin sentences using the similar structure of the sentences of this study.

Due to condition limit, only one female Mandarin speaker participated the recording by now. Because her speech patterns are constant no matter how many times she read the sentences. Her results can be used for a brief comparison. Further recording will be done later.

Figure 2 shows the pitch curves 3-syllable and 4-syllable Suzhou prosodic words and 3-syllable and 4-syllable Mandarin neutral tone words. The tones of the first syllable and the syllable followed the test words are all high level tones. (The Mandarin sentences are "妈妈的妈妈 mother's mother" and "妈妈们的妈妈 mothers' mother") We can see that there are no obvious valleys on the pitch curves in Suzhou, while the neutral tones are located at the valleys on the pitch curves in Mandarin. This comparison supports that different dialects may have neutral-tone targets specified with different F0 values from that in Standard Chinese (Chen & Xu [2]). Of course, more data are needed.

Figure 2: F0 curves of two female speakers. A is a Suzhou speaker, B is a Mandarin speaker. A1 and A2 are 3-syllable and 4-syllable T1 words followed by a high tone respectively. B1 and B2 are 3-syllable and 4-syllable neutral tone words initialed and followed by high tones.





5. CONCLUSIONS

The previous tone values descriptions for prosodic words in Suzhou only reflect the pitch curves of the prosodic words in isolation. Although the tone sandhi forms of the prosodic words are results of tone spreading. The falling pitch at the posterior part of the prosodic words may be due to the intonational declination instead of intrinsic pitch target.

As shown in our results, the pitch targets of the non initial syllables of prosodic words are the mid level of the tonal pitch range in Suzhou Chinese. However, the target may be language-specific, and be higher than that of the neutral tone in Mandarin.

6. REFERENCES

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