

Phonation Type and Tone Sandhi as Evidence of Chinese Stress in Longquan Wu

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Abstract

Disyllabic lexical tone sandhi for the Wu (Chinese) variety of Longquan 龙泉 is described for one male speaker. The tone sandhi described is typologically more similar to that of Northern Min varieties than Wu varieties. It is argued that the retention of creaky tonation on the second syllable is a marker of stress – a phonological phenomenon hitherto not yet described for Chinese.

1. Introduction

The acoustic correlates of stress (i.e. linguistically significant prominence) have been generally well researched, and include intensity, duration and, most of all, F0 (Lehiste 1970:132). However, the acoustic reflexes of stress have proven to be difficult to identify in varieties of Chinese.

In Chinese varieties, the acoustic reflexes of stress are interwoven with those of tone, and are much more difficult to separate (Coster and Kratochvil, 1984). Moreover, native Chinese speakers and listeners do not seem to be so aware of stress patterns. This means that stress patterns are usually inferred from tonological activity (Ballard 1984), rather than from measured phenomena, or native speaker judgements, but see Coster and Kratochvil (1984).

Using this approach, it is easily shown that there is a distinction between weak-strong and strong-weak patterns in many Chinese varieties (Chen 2000:295-306). An example of this is the distinction between compound nouns and verb-object constructions in Tangxi:

- /tsaoHL.vaeLH/ > /x.LH/ ‘to fry rice’ (1)
> /H.L/ ‘fried rice’ (2)
(Chen 2000:299)

The neutralisation of the first syllable’s tone in (1) shows a weak-strong status, while the spread of the first syllable’s tone across both syllables in (2) shows a strong-weak status. It is not clear, however, whether this distinction between strong-weak and weak-strong patterns is the same thing as stress.

This paper will describe a dialect where variation in phonation type as a function of tone sandhi is a key to showing stress and metrical structure.

From Shanghai, south along the coast of China, through Zhejiang, Fujian and into northern Guangdong province, the local varieties of Chinese exhibit tone sandhi phenomena (Norman 1988:202). Tone sandhi occurs when a tone is changed or affected by another tone, especially within a word. These changes may be quite simple, as in the well-known third tone-tone sandhi in Mandarin Chinese (demonstrated in Zee 1980), or more complex systems, such as the Amoy tone circle (Chen 2000:20, 82-3) or Wenzhou tone sandhi (Rose 2001, 2002, 2004). The tone sandhi patterns of many varieties within the tone sandhi areas have been studied in detail; however, the dialect to be described in this paper - Longquan - and the surrounding areas of Chuqu Wu have been little studied, especially with regards to tone sandhi.

Tone	Example	Character	Gloss
Creaky	/təŋ 313/	东	‘east’
High Falling	/təŋ 52/	懂	‘know’
Low Falling	/təŋ 31/	同	‘same’
High Rising	/təŋ 435/	冻	‘freeze’
Low Rising	/təŋ 324/	洞	‘cave’
High Stopped	/təw? 5/	竹	‘bamboo’
Low Stopped	/təw? 23/	毒	‘poison’

Table 1. *Minimal tone set for Longquan citation tones.*

Longquan (龙泉), in southern Zhejiang province of China, is a variety of Wu. Wu is the name for a group of Chinese dialects, usually differentiated from other dialects by their use of voiced and voiceless phonemes in separate registers and its complex tone sandhi. Longquan is from the southern area of Wu, in the Chuqu or Lishui subgroup. The Chuqu subgroup is mutually unintelligible with the northern varieties.

The tone sandhi variation across the Wu spectrum vary from simple neutralisation patterns, such as Lanqi (Rickard 2004) to highly complex patterns of interaction and contour variation rules, such as those of Wenzhou (Rose 2002, 2004). The tone sandhi patterns of Longquan lie somewhere inbetween.

In single syllables, there are seven tones in Longquan (for sub-minimal septuplet, see Table 1). The term tone is used here to mean a concept analogous to ‘phone’, an audibly distinguishable pitch and duration shape that can be considered as realisations of a morphemic sound shape (Rose p.c) Six of these form high/low range pairs: high and low falling, high and low rising, and high and low stopped.

The seventh tone is remarkable, and distinguished by creaky tonation (phonation type as a tonal property has been usefully dubbed tonation (Bradley 1982:10)). Figure 1 shows the tonal acoustics. Note how the F0 on the creaky tone resembles a low dipping tone. For a full description of the Longquan citation tones, see Steed (2005).

2. Procedure

The data for this study was collected from a single speaker (WWB), a young man from Longquan town. The recordings were made by W. L. Ballard in 1988 onto cassette. The recordings are of 250 one- and two-syllable expressions read from a list, repeated three times. The two-syllable

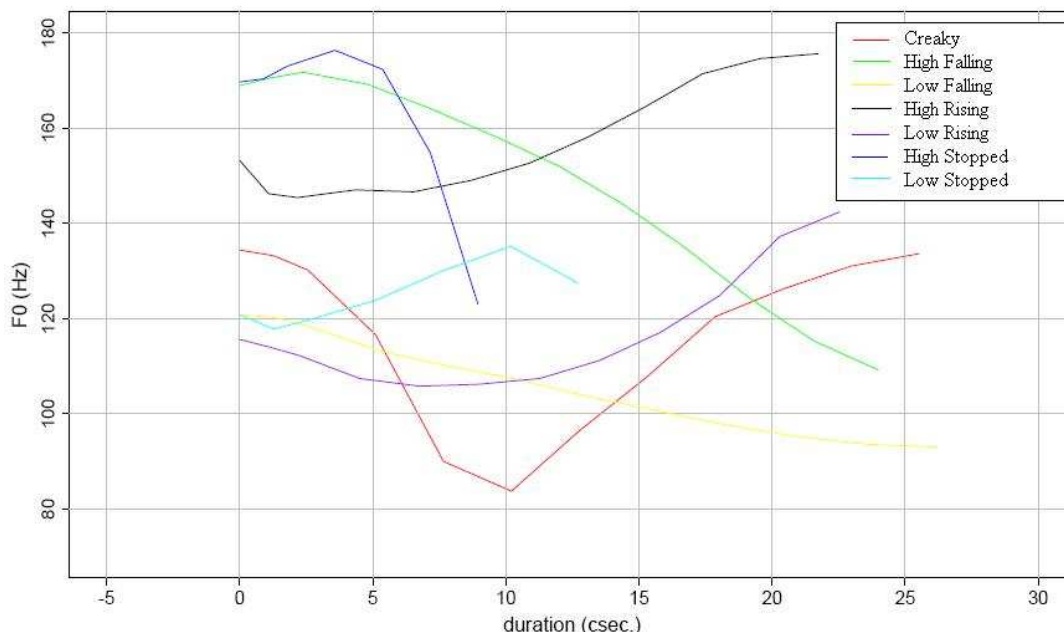


Figure 1. Mean F0 contours of the citation tones of a speaker of Longquan as a function of absolute duration (from Steed 2005).

Measuring points
0% of rhyme duration
10% of rhyme duration
20% of rhyme duration
40% of rhyme duration
60% of rhyme duration
80% of rhyme duration
100% of rhyme duration

Table 2. Measuring points for each syllable rhyme in the data

each word was recorded, as well as the duration of the intervocalic consonant.

The mean values of F0 and rhyme duration and the standard deviation for each combination of tones (creaky+high rise, creaky+low rise etc.) was calculated and plotted using Matlab. From these plots the contour of each token was quantized into a five point scale to correspond roughly to Chao tone-letters (where 1 = lowest pitch and 5 = highest pitch).

3. Results

The results can be seen in Table 3 and Figure 2. Table 3

S1	S2	Creaky	H.Fall	L.Fall	H.Rise	L.Rise	H.Stop	L.Stop
Creaky	33		35	52	35		33	
L.Fall					33		33	5
H.Rise	35					35		35
H.Fall	31	313	31	42	31	31	31	31
L.Rise							4	
H.Stop	32		32		32		32	32
L.Stop								23

Table 3. The 49 possible combinations of tones in Longquan and their contour realizations using Chao tone letters. 1 = low pitch, 5 = high pitch. Underlined numbers have short duration. A tilde represents creaky phonation.

expressions are words. Only the first replicate was used. The recordings were digitized using Cool-Edit at 16k with 16-bit quantization. The one-syllable expressions were analysed in Steed (2005). This study presents a description and analysis of the tone sandhi in the two-syllable words.

The F0 of each token was measured at 7 places along the rhyme of each syllable (see Table 2). The F0 values of these measurements show the contour of the F0 of the rhyme sufficiently to give a tonal contour analysis. The extra measurement at 10% allows for the perturbatory effects of the syllable onset on the F0 onset of the contour. The duration of the rhyme of the first and second syllable of

shows the pitch contour of all 49 possible combinations of tones on Longquan two-syllable words in Chao tone letters. So for example it can be seen that a word consisting of a low falling tone followed by a high rising tone has a pitch shape of 33.435, a mid level tone, followed by a high rising tone. Figure 2 shows the mean F0 contours as a function of absolute duration for a high rising tone followed by each tone, with an arbitrary gap in duration to allow for easier comparison of the tones' F0 contour. Table 4 shows examples of the combinations shown in Figure 2.

Tone	Mean Citation duration (from Steed 2005)	Mean 1 st syllable duration	Mean 2 nd syllable duration
Creaky	25.5 (3.21)	15.9 (2.16)	22.6 (1.52)
High Falling	26.2 (3.81)	16.5 (1.83)	20.9 (2.26)
Low Falling	24.0 (3.21)	15.8 (1.57)	17.8 (1.56)
High Rising	21.7 (2.84)	15.7 (1.04)	18.0 (1.13)
Low Rising	22.5 (1.43)	16.8 (1.94)	20.9 (2.98)
High Stopped	9.0 (0.40)	11.9 (1.49)	9.9 (0.41)
Low Stopped	12.7 (1.77)	12.5 (1.93)	13.5 (0.9)

Table 4. Mean durations (in csecs.) of syllables in the three recorded positions (bracketed numbers indicate standard deviations).

Figure 3 shows normalised contours of the citation and second syllable data. It shows that the second syllable contours for Longquan are all very similar to those of the citation, or single syllable reading. Phonemically, they can

mean duration of the second syllable stopped tones is slightly longer than its citation tone counterpart. It is not enough of a difference in duration to be linguistically significant.

The range of the second syllable tokens is slightly greater than that of the single syllable tokens. This greater range is approximately 10Hz added to the top of the range. This extra 10Hz is occupied by the high stopped tone, whose mean onset is higher than its single syllable counterpart.

The second syllable tones themselves are often affected by the first syllable tone. If the first syllable is a low falling contour, for example, the onset of a following high falling contour is visibly lower on an F0 graph. This can be seen in Figure 4. The higher F0s on the second syllable contours follow those with a high offset on the first syllable; the lower onset second syllable contours follow those with a low offset on the first syllable.

The most important feature of Table 2 for this paper is

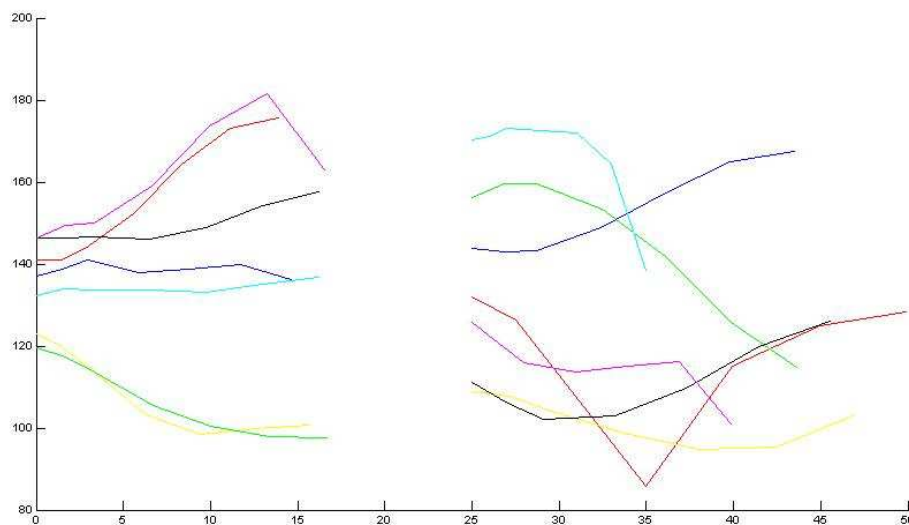


Figure 2. F0 variation of two syllable words with an initial high rising tone. Mean duration of the tones is shown for both syllables, but the second syllables' onset time is artificial to demonstrate their contours evenly.

Token	Example	Characters	Gloss
high rising+creaky	/k ^h wa.tj ^h wo 35.313/	(red) 快车	express
high rising+high falling	/te.pi 31.52/	(green) 对比	contrast
high rising+low falling	/t ^h a.jan 31.31/	(yellow) 太阳	sun
high rising+high rising	/ci.ka 33.35/	(blue) 世界	world
high rising+low rising	/t ^h a.təw 34.213/	(black) 态度	attitude
high rising+high stopped	/e.kwo? 33.5/	(cyan) 爱国	patriotism
high rising+high stopped	/sz.li? 35.32/	(magenta) 势力	influence

Table 5. Examples of first syllable tone variation in Longquan

be regarded as identical. Phonetically, however, there are a few differences.

The mean duration of the second syllable tokens is shorter than the citation tone duration by as much as seven centiseconds for the unstopped tones, that is the tones that do not have a final glottal stop (see Table 4). However,

the presence of the creaky tone on the second syllable, and its complete absence on the first syllable. The creaky phonation characteristic of the creaky tone is retained on the second syllable. When a creaky tone occurs on the first syllable, there is never creaky phonation. Some of the stopped tones

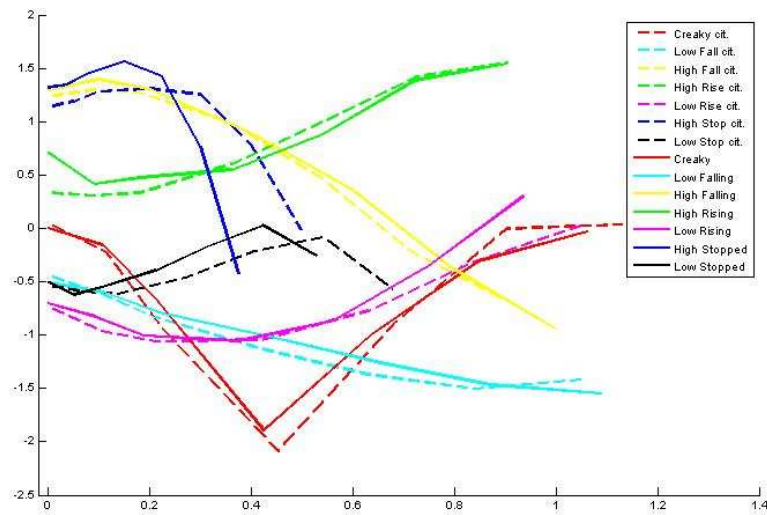


Figure 3. Comparison of Longquan's citation and second syllable tone contours using normalised data. The citation tones have dotted lines.

have creaky phonated offsets on the first syllable in place of a glottal stop.

The first syllable tokens form four contours: high rising, mid level and two similar low falling contours. The falling contours are distinguished by the presence or absence of a final glottal stop; the difference is almost entirely in the shorter duration (12.2csecs compared to 16.3csecs).

The falling and rising contours are similar in shape to the falling and rising contours that appear in the second syllable and citation tokens. Figure 5 shows a comparison of the first and second syllable contours. There are some differences in the range of the rises and falls in the data; for example, the high rises have a larger range before a contour with a higher pitch onset compared to those followed by a lower pitch onset (see figure 5).

The mid-level contour is not similar to any of the surface forms of Longquan's tones. However, it may be similar to the contour that would arise if the creaky tone is uttered without the creaky phonation (Steed 2005:27). If this is the case, then the first syllable contours can be mapped onto existing Longquan tones. The result of this is that the tone sandhi may be described as a phonemic category shift rather than a phonetic shift.

For unstopped tones, the mean duration of the first syllable tokens is a lot shorter than the second syllable and citation tone durations (see Table 2). Also, the variation in the length of the first syllable duration between tones is much smaller. The mean durations of the stopped tones are similar to or slightly longer than the duration of the second syllable and citation forms.

4. Analysis

The results yield three main features that show characteristics of a weak-strong syllable pattern in Longquan: duration, tone sandhi and tonation behaviour.

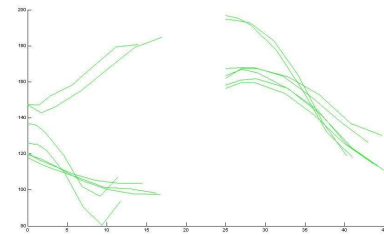


Figure 4. The disyllabic F0 contours of tone sandhi combinations finishing with a high falling tone. The intervocalic gap is artificial to allow for easier comparison. Note the different heights of the falling tones.

Duration is not a good measure of prominence because it is influenced by other factors, such as phrase final lengthening.

Tone sandhi behaviour gives some evidence of weak-strong patterning. This is reinforced by the evidence provided by the behaviour of the creaky tonation.

The complexities of Longquan's tone sandhi patterns can be resolved into a set of rules that give a transformation from the citation (single syllable) form of the tone to the two syllable form. This is made simpler by the fact that the second syllable form of each tone is phonetically very similar to the citation form, and phonemically identical, that is, it has the same geometry of features. Because of this, only first syllable rules need to be given.

There are three possible results for the transformation into first syllable form: a high rise, a mid level and a low fall. These can be interpreted as having an intermediary form of high (H), mid (M) or low (L). These forms are realised as the corresponding surface forms.

The rules for transforming a citation form into a first syllable form are as follows:

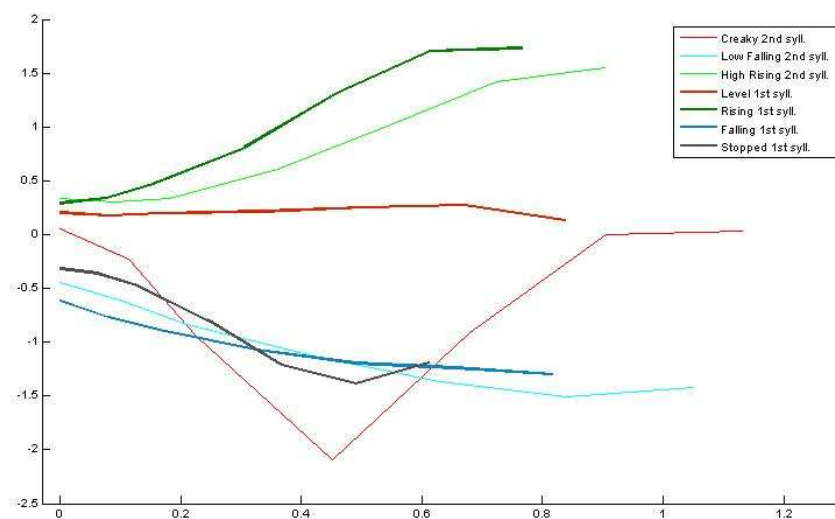


Figure 5. Comparison of first syllable and second syllable F0 contours, using normalised data. The thicker lines are the first syllable contours.

- Creaky, low fall > H / __ low fall, low stopped,
 high fall > M / else (3)
- High fall, low rise, all stopped > L (4)
- High rise > M / __ all rising, high stop
 > L / __ high fall, low fall
 > H / else (creak, low stop) (5)

The transformation rules 3-5 between citation and first syllable form are not necessarily phonological. This is because the rules assume that either the citation form or the first syllable form is the underlying contour of the toneme. The underlying contour is not necessarily easy to derive and must often be inferred rather than measured. In Longquan the underlying form is likely to be very similar to the citation or second syllable form. This is based on two pieces of evidence.

The first is the similarity of the second syllable form to the citation form. Because this form arises consistently in both the one syllable and two syllable examples, this is a good indication that the underlying contour of the tonemes is also something similar to these forms.

The second piece of evidence is the lack of complexity in the first syllable forms. The first syllable forms in the data are not as complex as the other forms, having only four variants, high rising, low falling, mid level and low falling stopped. These four reflexes, if they were the underlying forms would have to result in seven surface forms for the other forms. While this is possible, given environmental derivatives, this does not apply to Longquan, as there is no environmental feature to warrant these changes, nor is there the distribution necessary to result in such transformations.

The retention of the tonal phonology on the second syllable and its partial neutralisation on the first syllable imply a weak-strong prominence pattern. A strong syllable retains its features, while a weak syllable is more likely to have features neutralised or modified.

The retention of creaky voicing on the second syllable form is phonemically important. Chen (2000:285) says that 'despite its pivotal role in determining tonal behavior, stress [in Chinese] has proven to be frustratingly elusive

acoustically and perceptually.' Although it is clear that stress is related to neutralisation and tone sandhi, there is little evidence outside of tone sandhi that shows predictable stress. In Longquan this is not a problem. The retention of the creaky phonation on the second syllable, and its absence on the first, shows that the stressed syllable within the data is on the second syllable of a two syllable expression. A variety with initial disyllabic stress would not neutralise such a salient feature as creaky phonation on a stressed syllable. A variety without phonemic stress would not likely neutralise the creaky phonation one syllable only; it would neutralise on both or neither of the two syllables.

The implication of this is that Longquan is definitely a right-dominant, weak-strong variety, where the rightmost syllable is the syllable which has the most input with regards to neutralisation of the final contour of the word, with regards to both tone and phonation. This evidence is supported by the strong resemblance of the second syllable F0 contours to the citation tone F0 contours.

5. Conclusion

The tone sandhi of the Longquan variety is governed by a set of rules. The second syllable and the citation tone F0 contours represent the underlying tone contours, while the first syllable F0 contours are determined by contour neutralisation and the combination of tonemes.

The most important result here, however, is the use of tonation as a feature of syllable prominence. The behaviour of the creaky tone and the nature of the tone sandhi behaviour give us evidence of the existence of a weak-strong patterning in a Chinese variety. This evidence improves the link between tonation, tone sandhi behaviour and stress patterns.

A feature that is not resolved here is the relationship between stress and weak/strong syllables. In this paper, they are treated as referring to the same concept, but their exact relationship is yet to be determined.

6. Acknowledgements

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