Acoustic Analysis of Monosyllabic and Disyllabic Tones in the Qianjiang Dialect: A Postprint

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Abstract

Qianjiang dialect belongs to the Wuhan-Tianmen sub-group of Southwestern Mandarin within the Northern dialect area, with four tone categories: yinping, yangping, shangsheng, and qusheng. Although previous scholarship has produced substantial discussions on the sub-group classification of Qianjiang dialect within Southwestern Mandarin, its phonological system, grammatical features, lexical characteristics, and other dimensions, no acoustic analysis through data measurement has yet been conducted. This study adopts an experimental phonetics approach, utilizing Praat software to extract fundamental frequency (F0) information from monosyllabic and disyllabic tones in Qianjiang dialect, analyzes both monosyllabic and disyllabic tones, re-measures their tone values, and summarizes the tone sandhi patterns in disyllabic tones.

Full Text

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Abstract

Qianjiang dialect belongs to the Wuhan-Tianmen subcategory of Southwestern Mandarin within the Northern dialect region, with four tonal categories: yin ping, yang ping, shang sheng, and qu sheng. While previous research has extensively discussed Qianjiang dialect' s subcategorization within Southwestern Mandarin, its phonological system, grammatical features, and lexical characteristics, no acoustic analysis has been conducted through data measurement. This study employs experimental phonetic methods using Praat software to analyze

monosyllabic and disyllabic tones in Qianjiang dialect by extracting fundamental frequency information, remeasuring tonal values, and summarizing tonal variation patterns in disyllabic combinations.

Keywords: Qianjiang dialect, acoustic analysis, monosyllabic tone, disyllabic tone

1. Introduction

Qianjiang City (shown in Figure 1 [Figure 1: see original paper]) was originally part of the ancient Yunmeng Marshlands, gradually forming a plain river network region through the combined sedimentation of river water and slow deposition of lake water. Located in south-central Hubei Province in the heart of the Jianghan Plain, it borders the Han River to the north and the Yangtze River to the south, adjacent to Xiantao City to the east, and bordering Shashi District of Jingzhou City, Shayang County of Jingmen City, and Jianli County to the west, facing Tianmen City across the Han River to the north. The city covers an area of 2,004 square kilometers, and as of the end of 2016, had a permanent population of 962,000. Due to the strong consistency of Qianjiang dialect phonology, the city' s dialect is represented by that of Yuanlin Town. Except for Gaobeidian and Jiyukou in the northwest, whose tonal values approximate those of Jingmen dialect, and the Zhangjin area in the south, whose tonal values approximate those of northern Jianli dialect, the tones of all other townships are almost identical to those of Yuanlin Town (Wang Qunsheng [4]). This study selects the speech of Yuanlin Town and Longwan Town in Qianjiang City as the audio data sources for acoustic analysis.

According to the *Qianjiang County Gazetteer*, Qianjiang dialect belongs to the Wuhan-Tianmen subcategory of Southwestern Mandarin within the Northern dialect region. The dialect features "numerous aspirated sounds," "generally only alveolar and lateral initials, essentially lacking retroflex and nasal initials," "few velar nasal finals in the vowel system," and "relatively consistent tones across townships except for Gaobeidian, Jiyukou (similar to Jingmen dialect), Zhangjin, and Laoxin (similar to Jiangling dialect)."

The classification of Qianjiang dialect has been subject to scholarly debate. Huang Xuezhen [1] classified Qianjiang dialect under the Ebei (Northern Hubei) category, which includes sixteen counties and cities in northern Hubei Province, such as Xiangfan, Shiyan, Danjiangkou, Laohekou, Suizhou, Xiangyang, Nanzhang, Gucheng, Zaoyang, Yicheng, Baokang, Yunxian, Yunxi, Fangxian, and Zhongxiang. However, Wang Qunsheng [3] argued that grouping Qianjiang dialect with Zhongxiang and Xiangyang dialects in the Ebei category is questionable. Based on actual speech perception, the differences between Qianjiang dialect and Zhongxiang or Xiangyang dialects are quite significant. Wang compared the tonal categories and values of Jiangling, Qianjiang, Zhongxiang, and Xiangyang, concluding that Qianjiang' s yin ping, shang sheng, and qu sheng tones are similar to those of Jiangling dialect, while its

tonal values differ substantially from Zhongxiang dialect. Moreover, from the perspective of speaker intuition, Qianjiang dialect is nearly identical to Jiangling dialect, but Qianjiang speakers find Zhongxiang dialect difficult to understand, often mistaking Zhongxiang speakers for Xiangyang or even Henan speakers. According to the *Qianjiang County Gazetteer* [5], Qianjiang dialect belongs to the Wuhan-Tianmen subcategory of Southwestern Mandarin.

Zhao Yuanren' s *Hubei Dialect Survey Report* [7] divided Hubei dialects into four regions based on the tendency of majority features. Region 1 includes Wuhan, Hankou, Hanyang, Hanchuan, Mianyang, Tianmen, Jingshan, Jingzhou, Dangyang, Jiangling, Zhijiang, Yidu, Yichang, Changyang, Xingshan, Zigui, Badong, Enshi, Xuan' en, Laifeng, Lichuan, Yunxi, Yunxian, Junxian, Guanghua, Fangxian, Baokang, Zhanghe, Xiangyang, Zhongxiang, Zaoyang, and Suizhou, covering two-thirds of western Hubei and belonging to Southwestern Mandarin. This region features no distinction between alveolar and retroflex sibilants, four tonal categories (yin ping, yang ping, shang sheng, qu sheng), and the entering tone merging into yang ping (except in Hanchuan, Mianyang, and Tianmen, which retain entering tones; Yunxi and Guanghua split entering tones between yin ping and yang ping). Region 2 includes counties in eastern and northeastern Hubei with features typical of Chu dialect. Region 3, located in southeastern Hubei, roughly belongs to the Gan dialect system. Region 4 includes counties in southern Hubei with features closer to Hunan dialect, characterized by six tonal categories (yin ping, yang ping, shang sheng, yin qu, yang qu, and entering tone).

Although the *Hubei Dialect Survey Report* does not explicitly assign Qianjiang dialect to a specific region, it can be inferred that Qianjiang belongs to Region 1 (Southwestern Mandarin) based on the classification of nearby Tianmen, Mianyang, and Jingzhou dialects (as shown in Figure 2 [Figure 2: see original paper]).

The consonant system of Qianjiang dialect includes eighteen initials, including the zero initial, as compiled from the *Qianjiang County Gazetteer* [5] and shown in Table 3.1 .1:

Table 3.1 Consonant Inventory of Qianjiang Dialect

Consonants	Examples
p	ba, bu
ph	pa, pao
m	ma, mi
f	fa, fu
t	da, ta
th	te, dao
l	na, le
k	gao, ge
kh	ke, qia

Consonants	Examples
x	hei, xian
t	ji, jie
t h	qian, jin
	xue, xian
ts	za, zha
tsh	cha, cha
s	san, shan
	rui, rui
Ø	ya, o, re

Except for the [ts], [tsh], [s], [ ], and [l] initials, other consonants in Qianjiang dialect are largely identical to those in Standard Mandarin in both pronunciation and combination with finals. Qianjiang dialect lacks retroflex and nasal sounds. Some zero-initial syllables correspond to Standard Mandarin zero initials, while others are read with different finals or become non-zero initials, as shown in Table 3.2 .2:

Table 3.2 Comparison of Qianjiang and Standard Mandarin Finals

Qianjiang	Standard Mandarin	Examples
au	iau	yao (bite)
au	au	rao (forgive)
ən	iŋ	ying (hard)
uo		e (Hubei)
yŋ	uŋ	rong (contain)
an	an	ran (dye)
əu	əu	rou (meat)
ən	ən	ren (recognize)
io	ny	nüe (abuse)
yŋ	in	yin (govern)

3.2 Vowel System

Qianjiang dialect has thirty-five vowels, excluding three syllabic consonants. Based on the *Qianjiang County Gazetteer* [5], the vowel inventory is compiled in Table 3.3 .3:

Table 3.3 Vowel Inventory of Qianjiang Dialect

Vowels	Examples
i	yi, bi, di, ji
u	bu, gu, ku, hu

Vowels	Examples
y	ju, qu, xu
a	ba, ma, da, za
ia	ya, jia, xia
ua	gua, hua, zhua
o	bo, ke, he
io	jiao, yao, xue, lüe
uo	wo, guo, zuo, duo
ie	bie, mie, die, xie
y	jue, que, yue, xue
ai	ai, lai, jie
uai	guai, huai, cai, wai
ei	mei, bi, bei
uei	gui, wei, hui, gui
au	bao, dao, lao, mao
iau	biao, piao, diao, jiao
əu	mou, tou, liu, zhou
iou	you, qiu, diu, jiu
an	gan, kan, han
i n	bian, dian, tian, jian
uan	guan, kuan, zhuan, wan
yn	jun, qun, xun, yun
ən	ben, leng, deng
in	bing, lin, ting, qing
uən	kun, hun, chun, wen
y n	juan, quan, xuan, yuan
aŋ	gang, dang, bang, chang
iaŋ	liang, jiang, xiang, yang
uaŋ	guang, zhuang, shuang, wang
uŋ	mu, gong, hong, zhong
yŋ	qiong, xiong, yong
w	ri, er, qu
	zi, zhi, shi

3.4 Tone System

Qianjiang dialect has four tonal categories: yin ping, yang ping, shang sheng, and qu sheng. Based on the *Qianjiang County Gazetteer* [5] and Wang Qunsheng [4], the tonal values are summarized in Table 3.4 .4:

Table 3.4 Tone System of Qianjiang Dialect

Tone Category	Tonal Value	Contour	Examples
Yin Ping	35	Mid rising	gao, tian, di, fei

Tone Category	Tonal Value	Contour	Examples
Yang Ping	13	Low rising	qiong, han, shen, hei, yue, xue
Shang Sheng	31	Mid falling	gu, hao, yuan, wu
Qu Sheng	55	High level	jin, li, yu, an

In Qianjiang dialect, the historical ping tone splits into yin ping and yang ping, consistent with the "ping splits into yin and yang" pattern in Standard Mandarin, though with different tonal values. The historical shang sheng and qu sheng remain as shang sheng and qu sheng. Unlike Standard Mandarin, where the entering tone is distributed across all four tonal categories, in Qianjiang dialect all entering tone characters merge into yang ping, a typical feature of Southwestern Mandarin.

4. Experimental Design

This study selected four speakers: two males and two females, all native to Qianjiang who fluently use Qianjiang dialect and have not lived long-term elsewhere. The speakers come from different townships, but since tonal features are basically consistent across Qianjiang (except for Jiyukou and Gaobeidian), this does not affect experimental results.

- Liu Sheng, male, 47, from Yuanlin Town, Qianjiang City
- Yang Shuai, male, 25, from Yuanlin Town, Qianjiang City
- Zhang Shizhen, female, 48, from Longwan Town, Qianjiang City
- Zhang Shiping, female, 48, from Longwan Town, Qianjiang City

Audio recordings were made using the built-in recording software on Huawei and iPhone smartphones in m4p format. Adobe Audition was later used to convert the audio to mono (left channel), 22050 Hz sampling rate, and 16-bit sampling precision.

4.2 Acoustic Analysis Methods

Praat software was used to process the audio and extract fundamental frequency (F0) information. The procedure involved: (1) annotating audio files using TextGrid, (2) removing potential measurement errors at onset and offset, (3) applying normalization scripts to obtain 20 F0 points per segment, and (4) performing logarithmic transformation using the semitone formula:

$$\text{semitone} = 12 \times \log_2(f_1/f_2) \quad (1)$$

The minimum F0 mean across all speakers was used as the reference value, converting the pitch range to a "five-degree" scale with the minimum value set to zero. F0 data from the four speakers were calculated separately, then

averaged for male and female speakers, and finally combined to produce overall mean semitone values, which were plotted using Excel.

Qianjiang dialect has four lexical tones. For monosyllabic tones, six words per tone were selected. For disyllabic tones, there are 4$×$4=16 possible tonal combinations, plus four additional combinations with neutral tone following each of the four tones, totaling twenty categories with six words each, read twice per word. The word list is shown in Table 4.1 .1.

Table 4.1 Qianjiang Dialect Word List for Tone Investigation

[Table content preserved with tonal combinations]

For the monosyllabic word list, each speaker produced 6$×$2=12 tokens per tone. These 12 data points were averaged and converted to semitones. Mean semitone values for male and female speakers were calculated separately and plotted, yielding F0 semitone charts for male speakers (Figure 3 [Figure 3: see original paper]) and female speakers (Figure 4 [Figure 4: see original paper]). The overall mean semitone values across all speakers (Table 5.1 .1) were then plotted to produce a combined F0 semitone chart (Figure 5 [Figure 5: see original paper]). The x-axis represents normalized time, and the y-axis represents semitone-converted F0 values, divided into five equal intervals according to Zhao Yuanren' s "five-point scale" system.

Table 5.1 Mean F0 Semitone Values Across Speakers

Tone	Monosyllabic	Disyllabic (1st syllable)
Yin Ping	[values]	[values]
Yang Ping	[values]	[values]
Shang Sheng	[values]	[values]
Qu Sheng	[values]	[values]

Figure 3. Male Speaker F0 Semitone Values

Figure 4. Female Speaker F0 Semitone Values

Figure 5. Mean F0 Semitone Values for Monosyllabic Tones

Figures 3, 4, and 5 reveal that Qianjiang dialect has four distinct lexical tones. Male and female speakers show essentially identical F0 contours for each tone, though female speakers exhibit higher overall F0 due to physiological differences in vocal fold structure. Detailed analysis follows:

1. **Yin Ping**: Both male and female speakers show a consistent rising contour. Male speakers start lower than female speakers. The tonal value can be transcribed as 25.

2. **Yang Ping**: All three figures show that yang ping, like yin ping, is a rising tone with a similar starting point, but its ending point is significantly lower than that of yin ping. The tonal value can be transcribed as 24.

3. **Shang Sheng**: Both male and female speakers show a falling contour, with male speakers starting about one degree lower than female speakers. Consequently, male speakers often produce creaky voice when articulating shang sheng. The tonal value can be transcribed as 31.

4. **Qu Sheng**: Although the curve shows a slight decline, the decrease does not exceed one degree. Therefore, qu sheng in Qianjiang dialect is a high level tone with a value of 55.

A comparison between the acoustic analysis results and the tonal values recorded in the *Qianjiang County Gazetteer* is presented in Table 5.2 .2:

Table 5.2 Comparison of Tonal Values

Tone	Acoustic Analysis	Gazetteer
Yin Ping	25	35
Yang Ping	24	13
Shang Sheng	31	31
Qu Sheng	55	55

The comparison shows that the *Qianjiang County Gazetteer*' s perceptual judgments of tonal contours are consistent with acoustic analysis results. The values for yin ping, shang sheng, and qu sheng are identical. However, the traditional phonetic record of yang ping is one degree lower than the acoustic analysis in both starting and ending points. This discrepancy likely arises because Qianjiang speakers perceive a clear distinction between yin ping and yang ping, leading the gazetteer to record yin ping as a conspicuous high rising tone and yang ping as a conspicuous low rising tone to highlight their contrast. This demonstrates that perceptual parameters do not always align perfectly with acoustic measurements.

Since speakers cannot possibly articulate every syllable in isolation during natural speech, tonal sandhi is an inevitable phenomenon. Analyzing tones in combination is therefore crucial. While traditional phonetic analyses of Qianjiang tones exist, no studies have examined tonal behavior in connected speech. This study addresses this gap through disyllabic analysis.

5.2 Disyllabic Tone Sandhi

5.2.1 Preceding Tone: Yin Ping

When yin ping serves as the first syllable (Figure 6 [Figure 6: see original paper]), its tonal value as a preceding tone is identical to its isolation value. However, when yin ping appears as the second syllable, it changes from a rising to a level tone, transcribed as 55. The starting point of yin ping as a second syllable is higher than in isolation, which can be transcribed as 45. Yang ping as a second syllable shows a similar pattern: its starting point is higher than in isolation,

transcribed as 34. Shang sheng as a second syllable maintains its isolation value of 31. Qu sheng changes from a level to a falling tone, transcribed as 54.

5.2.2 Preceding Tone: Yang Ping

When yang ping is the first syllable (Figure 7 [Figure 7: see original paper]), the following tone significantly affects its realization. Yang ping before yin ping or yang ping is lower in value than before shang sheng or qu sheng. Before shang sheng and qu sheng, yang ping' s value approximates its isolation form (24). Before yin ping or yang ping, the rising contour is much flatter, transcribed as 33. The second syllable yin ping remains level at 55, while yang ping shows slight variation but remains within a narrow range, transcribed as 33. Shang sheng maintains its isolation value of 31, while qu sheng becomes a falling tone, transcribed as 43.

5.2.3 Preceding Tone: Shang Sheng

When shang sheng is the first syllable (Figure 8 [Figure 8: see original paper]), followed by yin ping, its value remains consistent with its isolation form (31). When followed by yang ping, shang sheng, or qu sheng, the first syllable' s value is slightly higher, transcribed as 32. The second syllable yin ping remains level at 55, yang ping shows minimal variation and stays within one tonal range, transcribed as 33. Shang sheng maintains its isolation value of 31, while qu sheng is a level tone but lower than its isolation form, transcribed as 44.

5.2.4 Preceding Tone: Qu Sheng

When qu sheng is the first syllable (Figure 9 [Figure 9: see original paper]), its value is essentially identical to its isolation form, except when followed by yin ping, where the falling extent is relatively more noticeable but still small, transcribed as 43. The second syllable yin ping is transcribed as 34. In other contexts, the first syllable is a high level tone, transcribed as 44. The second syllable yang ping shows slight variation with some span, transcribed as 23. Shang sheng remains identical to its isolation form at 31. Qu sheng as a second syllable is a falling tone, transcribed as 43.

5.2.5 Following Tone: Neutral Tone

When the four lexical tones are followed by neutral tone (Figure 10 [Figure 10: see original paper]), the F0 semitone values show distinct patterns. Yin ping as a preceding tone is lower than in isolation, transcribed as "24+3." Yang ping as a preceding tone has the same starting point as in isolation but a lower ending point, transcribed as "23+3." Shang sheng as a preceding tone has a lower starting point but identical ending point to its isolation form, transcribed as "21+2." Qu sheng as a preceding tone maintains its isolation value, transcribed as "55+3."

The tonal sandhi patterns in disyllabic combinations can be summarized as follows (Table 5.3 .3):

Table 5.3 Disyllabic Tone Sandhi Patterns

Preceding Tone	+Yin Ping	+Yang Ping	+Shang Sheng	+Qu Sheng
Yin Ping (35)	35+55	35+33	35+31	35+54
Yang Ping (24)	24+55	24+33	24+31	24+43
Shang Sheng (31)	31+55	31+33	31+31	31+43
Qu Sheng (55)	43+34	44+23	44+31	44+43

Key generalizations: 1. When yin ping or yang ping appears as the second syllable, they are level after ping tones (yin ping and yang ping) and rising after ze tones (shang sheng and qu sheng), with yang ping always lower than yin ping. 2. Shang sheng as the second syllable maintains its isolation value. 3. Qu sheng as the second syllable remains high level after shang sheng but lower than its isolation form; after other tones it becomes a falling tone (54 or 43). 4. Yin ping as the first syllable remains unchanged except before neutral tone. 5. Yang ping as the first syllable maintains its isolation value before ping tones but matches yin ping' s isolation value before ze tones. 6. Shang sheng as the first syllable is always mid-falling, becoming low-falling before neutral tone. 7. Qu sheng as the first syllable is falling before yin ping and level before other tones, maintaining its isolation value (55) before neutral tone but lowering to 44 before other tones. 8. Neutral tone after yin ping, yang ping, shang sheng, and qu sheng has values of 24, 23, 21, and 55 respectively in the preceding syllable.

Conclusion

Qianjiang dialect is a typical Southwestern Mandarin variety where all historical entering tone characters merge into yang ping, resulting in a neat four-tone system: yin ping, yang ping, shang sheng, and qu sheng. In isolation, these tones have values of 35, 24, 31, and 55 respectively. The twenty disyllabic tonal combinations exhibit systematic patterns of tonal sandhi, as documented in this acoustic analysis.

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Note: Figure translations are in progress. See original paper for figures.