The Experimental Research of Suzhou Dialect's Monosyllabic Tones in Gansu Province

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Abstract: The Suzhou dialect belongs to the Lanyin Mandarin's Hexi corridor part. There have been few studies on the Suzhou dialect of Jiuquan. Based on the previous research of Suzhou dialect, this paper uses the experimental phonetic method to study the monosyllabic of Suzhou dialect. It is concluded that there are three monosyllabic tones in Suzhou dialect: Yinping 33, Yangping and Shangsheng merged into Yangping Shang 51, Qusheng 213.

1. Introduction

The Suzhou dialect belongs to the Lanyin Mandarin's Hexi corridor part. The characteristic of Lanyin mandarin is that voiceless consonant and secondary voiced consonant of Rusheng words are read as Qusheng today. Lanyin Mandarin includes Jincheng part and Hexi corridor part. According to the tone evolution, the Hexi corridor can be divided into Gutian and Wuzhangjiu two parts. The characteristic of Wuzhangjiu part where Suzhou dialect belongs is that Yangping and Shangsheng merged but Qusheng is individual.

Up to now, few studies have been made on Suzhou dialect. The systematic and in-depth study is *the Study of Jiuquan Dialect* by Zhanao Sun and Shengping Liu. The book makes a comprehensive exploration of Jiuquan dialect's formation, development, the rhythm, the main vocabulary, and grammatical phenomena. In the second chapter of the Jiuquan dialect phonology, the consonants, vowels, tones and pitch value are described. It is mainly based on the dialect of Suzhou District where the city of Jiuquan is located, considering Jinta County, Yumen City, Guazhou County, and other places. The Yinping of single word tone is 44, the Yangping is 53, and the Qusheng is 213. These conclusions are obtained through listening, and no acoustic experiments have been conducted on the tone. To make up for this deficiency, this paper uses the acoustic experiment method to analyze the monosyllabic tones from the perspective of the fundamental frequency, to verify and supplement the existing research results.

2. Experimental Description

2.1 Pronunciation word list.

Pronunciation word list was determined according to the tone questionnaire in the Chinese language resource survey manual. Based on the four ancient tones of Ping, Shang, Qu, and Ru, every tone is divided into four categories which are voiceless, secondary voiceless, secondary voiced, and voiced. There is a total of 66 examples.

<p align="center">Table. 1 Pronunciation Words</p>

Ancient tone type	Voiceless and voiced	Examples	Ancient tone type	Voiceless and voiced	Examples
Ping	Voiceless	东 该 灯 风	Qu	Voiceless	冻 怪 半 四
	Secondary voiceless	通 开 天 春		Secondary voiceless	痛 快 寸 去
	Secondary voiced	门 龙 牛 油		Secondary voiced	卖 路 硬 乱
	Voiced	铜 皮 糖 红		Voiced	洞 地 饭 树
Shang	Voiceless	懂 古 鬼 九	Ru	Voiceless	谷 百 搭 节 急
	Secondary voiceless	统 苦 讨 草		Secondary voiceless	哭 拍 塔 切 刻
	Secondary voiced	买 老 五 有		Secondary voiced	六 麦 叶 月
	Voiced	动 罪 近 后		Voiced	毒 白 盒 罚

2.2 Selection of speakers.

The speaker is a middle-aged male born in 1965. He is from Suzhou, Jiuquan City, Gansu Province. Both his parents and spouse are from Suzhou, Jiuquan City. They are born and raised in the local area. They have no long time to go out. He can speak native dialect and recognize each pronunciation word. The recording was done in a quiet room.

2.3 Experimental tools and analysis software.

The experiment used a laptop computer, an external sound card, a mixer, and a clip-on microphone. The analysis software mainly includes Praat5.0, Microsoft Excel2010, and MATLAB.

2.4 Experimental process

2.4.1 Sound recording.

The words are recorded by a software named Language protection camera in a quiet room, and the sample words are automatically segmented. The speaker would be familiar with the example words listed in the pronunciation list in advance of communication. Make sure he can pronounce words in native. The pronunciation partner read each example word twice and record the mistakes in time during the formal recording.

2.4.2 Data extraction and processing.

Extracting fundamental frequency data in Praat are listed in the Excel, regardless of the onset-section and offset-section. In MATLAB, the script is used to normalize the fundamental frequency data and the T-value method is used to convert the five-degree value. The formula is $T = \left[\left(\lg f_0 - \lg \min \right) / \left(\lg \max - \lg \min \right) \right] \times 5$ .Where f_0 is the average fundamental frequency of the measurement point, min is the lower limit and max is the upper limit of the modulation domain. The value calculated by this method ranges from 0 to 5.

3. Results and discussion

3.1 Analysis of fundamental frequency.

The fundamental frequency is the most common and important distinguishing factor in any tone system. The fundamental frequency data are extracted to compare the starting point average, the middle average, the endpoint average, the maximum and the minimum of each group.

<p align="center">Table. 2 Pingsheng Fundamental Frequency Parameters of Suzhou Dialect</p>

Fundamental Frequency(Hz)	Voiceless	Secondary Voiceless	Secondary Voiced	Voiced
Starting point average	115.3	115.8	135.7	164.7
Middle average	114.9	114.6	111.6	113.8
Endpoint average	110.2	109.9	79.4	76.0
Maximum	121.5	125.1	140.3	178.5
Minimum	103.8	103.2	76.9	72.4

Based on the initial, Pingsheng can be divided into Yin and Yang, in which the voiceless consonant is classified as Yin and the voiced consonant is classified as Yang. It can be seen from table 2 that the maximum fundamental frequency of Yinping is 125.1Hz, the minimum is 103.2Hz. The voice range is 103.2Hz-125.1Hz and the domain width is 21.9Hz. The maximum fundamental frequency of Yangping is 178.5Hz, the minimum is 72.4Hz. The voice range is 78.3Hz-187Hz and the range width is 106.1Hz. From the data, we can see that the fundamental frequency of voiceless and secondary voiceless is flat and the fundamental frequency of secondary voiced and voiced is obviously reduced. It is indicated that Pingsheng is divided into Yin and Yang, in which Yinping is flat and Yangping is down in the Suzhou dialect.

Table. 3 Shangsheng Fundamental Frequency Parameters of Suzhou Dialect

Fundamental Frequency(Hz)	Voiceless	Secondary Voiceless	Secondary Voiced	Voiced
Starting point average	149.5	154.2	147.9	101.5
Middle average	112.5	111.9	110.4	96.3
Endpoint average	75.7	78.2	72.4	109.6
Maximum	170.3	168.1	159.2	121.1
Minimum	70.6	74.5	69.8	91.7

It can be seen from table 3 that the maximum fundamental frequency of Shangsheng is 170.3Hz, the minimum is 69.8Hz. The voice range is 69.8Hz-170.3Hz and the domain width is 100.5Hz. From the data, we can see that the fundamental frequency of Voiceless, secondary voiceless, and secondary voiced in the Shangsheng is obviously reduced, which is the falling tone. The fundamental frequency of voiced decreases first and then rises, which is the fall-rise tone.

Table. 4 Qusheng Fundamental Frequency Parameters of Suzhou Dialect

Fundamental frequency(Hz)	Voiceless	Secondary Voiceless	Secondary Voiced	Voiced
Starting point average	101.2	109.4	98.0	100.3
Middle average	91.3	101.9	92.3	92.1
Endpoint average	109.4	124.7	107.1	108.5
Maximum	121.3	155.8	118.4	115.4
Minimum	85.0	86.1	81.0	83.0

It can be seen from table 4 that the maximum fundamental frequency of Qusheng is 155.8Hz, the minimum is 81.0Hz. The voice range is 81.0Hz-155.8Hz and the domain width is 74.8Hz. From the data, we can see that the fundamental frequency of Voiceless, secondary voiceless, secondary voiced, and voiced in the Qusheng decreases first and then rises, which is the fall-rise tone.

Table. 5 Rusheng Fundamental Frequency Parameters of Suzhou Dialect

Fundamental frequency(Hz)	Voiceless	Secondary Voiceless	Secondary Voiced	Voiced
Starting point average	102.5	93.9	99.5	140.3
Middle average	90.7	86.8	93.6	106.0
Endpoint average	95.8	102.8	104.4	76.7
Maximum	135.6	115.5	110.4	145.5
Minimum	74.0	79.8	87.3	73.8

It can be seen from table 5 that the maximum fundamental frequency of Rusheng is 145.5Hz, the minimum is 73.8Hz. The voice range is 73.8Hz-145.5Hz and the domain width is 71.7Hz. From the data, we can see that the fundamental frequency of voiceless, secondary voiceless, secondary voiced in the Rusheng decreases first and then rises, which is the fall-rise tone. The fundamental frequency of voiced is obviously reduced, which is the falling tone.

3.2 Five-degree value.

According to the converted five-degree value, T-value curves can be drawn respectively in MATLAB.
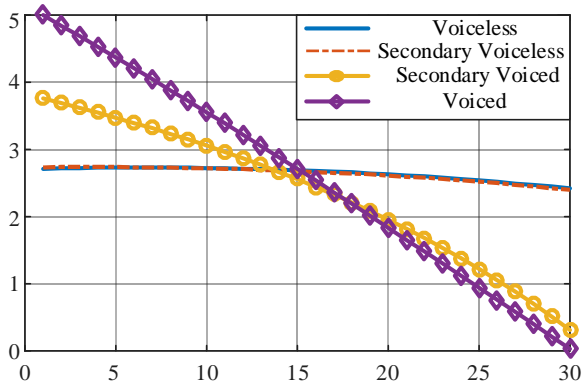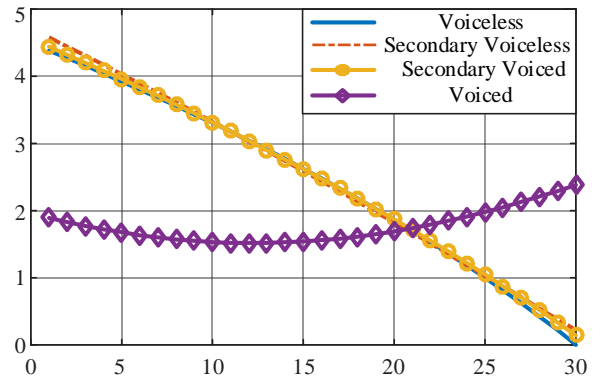
Fig. 1 T-value curve of Pingsheng
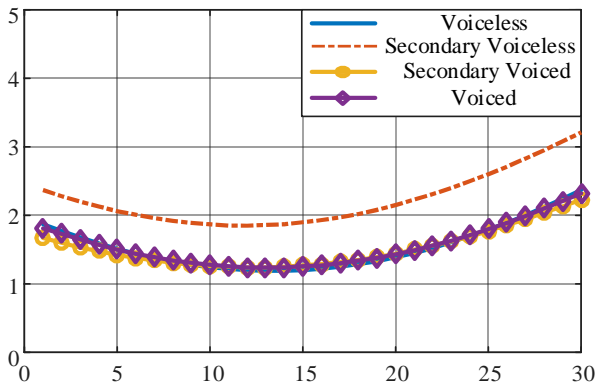

Fig. 2 T-value curve of Shangsheng
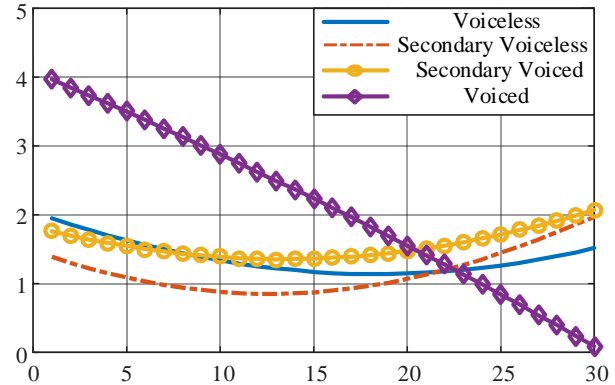

Fig. 3 T-value curve of Qusheng

Fig. 4 T-value curve of Rusheng

In Fig.1 the T-value curve trend of voiceless and secondary voiceless Pingsheng is the same, and it is Yinping. Although the starting point of voiced curve is higher than that of secondary voiced, both show a downward trend, and it is Yangping. In Fig.2 the T-value curves of voiceless, secondary voiceless, and secondary voiced Shangsheng all show a downward trend, so they can be classified as Yangping and named Yangpingshang. While the curve of voiced Rusheng also shows a downward trend in Fig. 4, it can be assigned to Yangping Shang. There are several same trend curves that decrease first and then rise which belongs to Qusheng, including Voiceless, secondary voiceless, secondary voiced and voiced Qusheng in Fig.3, voiceless, secondary voiceless and secondary voiced Rusheng in Fig.4 and Voiced Shangsheng in Fig.2.
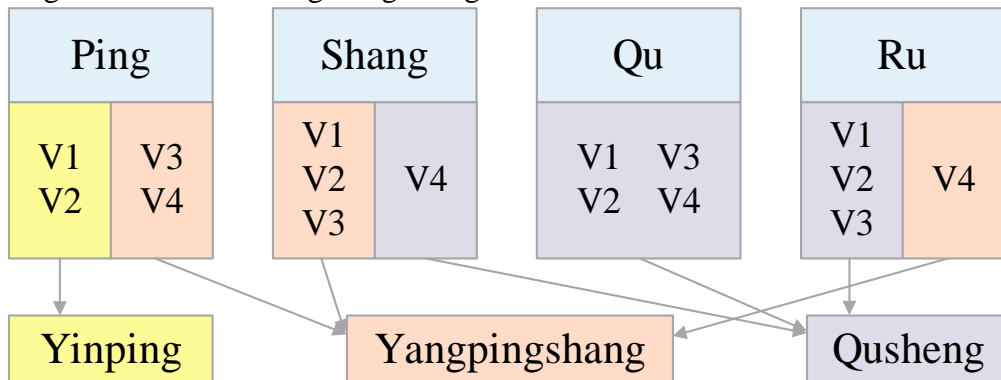
(V1：Voiceless, V2：Secondary Voiceless, V3：Secondary Voiced, V4: Voiced)

Fig. 5 Tone evolution of Suzhou Dialect

Finally, according to the tone category, the T-value curve of the Suzhou dialect can be drawn, in which the abscissa is the number of tone points and the ordinate is the T value, to visually reflecting the rise and fall of each tone.
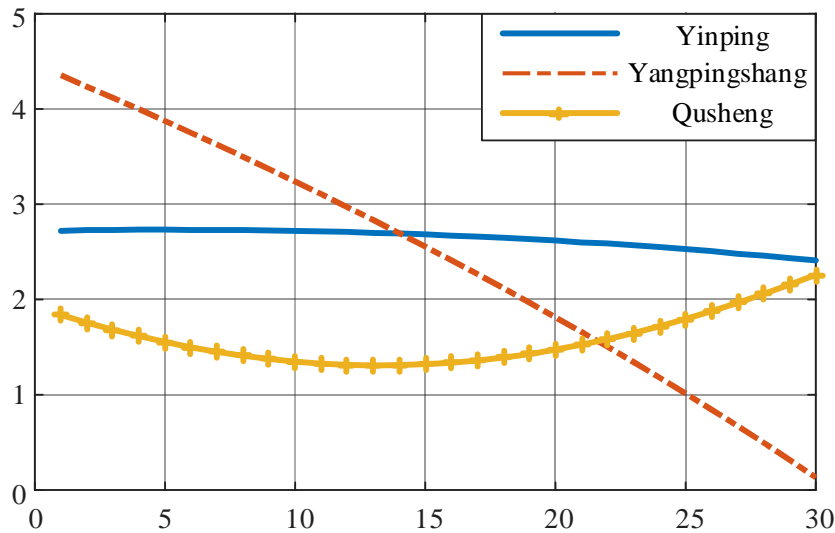
Fig. 6 Curve of monosyllabic tones in Suzhou dialect

4. Summary

Through the acoustic analysis and data statistics of the monosyllabic tone in Suzhou dialect, the experimental results are as follows. There are three monosyllabic tones, in which Yinping is a middle flat tone with a value of 33, Yangpingshang is a high-falling tone with a value of 51, Qusheng falls first and then rises obviously, so the tone value is recorded as 213.

Comparison with research results of the existing Suzhou dialect, tone category and tone trend is consistent, but the specific tone value differs slightly. In this analysis, only one speaker was selected, and then more objective and effective data can be obtained through the comparative study of multiple speakers.

Table 6 Comparison of the Five-degree Value of Suzhou Dialect

Tone category	Yinping	Yangpingshang	Qusheng
Traditional T-value	44	53	213
Experimental T-value	33	51	213

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