

## Experimental Study on the Monosyllabic Tones of Lixian Dialect

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**Abstract:** This paper mainly study the monosyllabic tones of Lixian dialect, and makes a quantitative analysis of it with the method of experimental phonetics. Through the experiment, it concludes that the dialect has four tones: yinping (41), yangping (34), shang (51) and qu (44). Lixian dialect belongs to Qinlong piece of zhongyuan Mandarin, and its tone development is in line with the evolution rule of zhongyuan Mandarin. The duration mode of the four monosyllabic tones is T1>T2>T4>T3.

### 1. Introduction

Lixian belongs to Longnan city of Gansu Province. According to the Chinese language atlas, Lixian dialect belongs to Qinlong section of the Zhongyuan Mandarin. Li Rong (1985a) pointed out when classifying the Chinese dialects that the most striking feature of the zhongyuan Mandarin is that ancient secondary voiced of Ru sound as Yinping now, which are distinguished from the other six dialects. Influenced by the dialects of surrounding areas, Lixian dialect has a great internal divergence in pronunciation.

The former research methods of Lixian dialect are mainly the traditional linguistic research methods. This paper takes Chengguan town in Lixian as the research object and use the method of experimental phonetics to quantitatively study the monosyllabic tones and the evolution of them.

### 2. Experimental method

#### 2.1 Pronunciation List

The pronunciation list of this article mainly uses the tone part of the phonology table in the handbook of Chinese dialect survey.

Table. 1 Pronunciation List

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

## 2.2 Articulators

There are two articulators in this experiment, who are born and raised in Lixian. They live in Chengguan Town of Lixian all year round and seldom go out. They have a certain level of education and have no throat disease.

## 2.3 Sound recording

The recording equipment includes the clip microphone, the mixer and the computer. The recording software is Audition 3.0 and the sampling frequency is 44100Hz. The monophonic recording is carried out with the sampling accuracy of 16 digits. When recording, the speaker is required to read all the example words in the pronunciation list with natural intonation and speed. Each word is read three times and saved as.wav format.

## 2.4 Collection and processing of experimental data

### 2.4.1 Duration and fundamental frequency data

The fundamental frequency and duration data were extracted in Praat.

The first step is to determine the tone load section. Abramson et al. pointed out that "the tone starts at the beginning of the vowel and on the diagram starts at the second pulse of the vowel." When determining the end point, it is mainly to see whether the amplitude in the sonogram drop significantly and whether the second formant in the wideband graph is clear. If the amplitude drops significantly or the second formant becomes blurred, it can be considered as the end of the tone.

After the duration of the tone is determined, the duration is divided into 10 equal parts to obtain the fundamental frequency data on the equal points, a total of 11. Save these data in an Excel sheet.

### 2.4.2 Data processing

Data processing includes normalization and transformation of five degree value.

The LZ normalization method is adopted in this article. The specific steps include calculating the mean value of the fundamental frequency, converting the mean value into logarithm, calculating the mean value and standard deviation of the logarithm value, and z-score normalization. The normalized formula is  $Z_i = (x_i - \mu) / \sigma$ , where  $\mu$  is the mean,  $\sigma$  is standard deviation,  $X_i$  is the logarithm of the fundamental frequency, and  $Z_i$  is the normalized lz-score after normalizing. Finally the average value was calculated and converted into the value of five degrees to determine the specific tone value of this dialect.

## 3. The Experimental Results

### 3.1 The Fundamental Frequency Analysis

The purpose of analyzing the data of pitch is to determine the evolution of Lixian dialect.

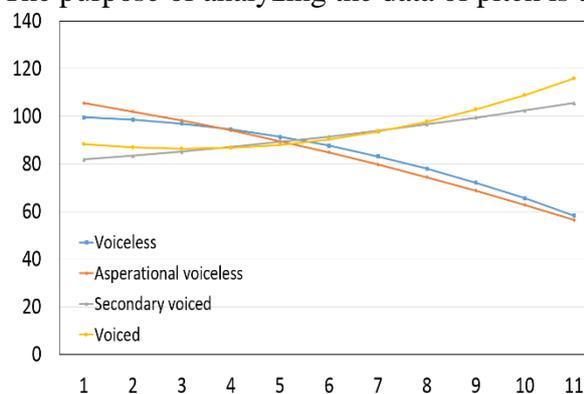


Fig. 1 Fundamental frequency curve of Ping

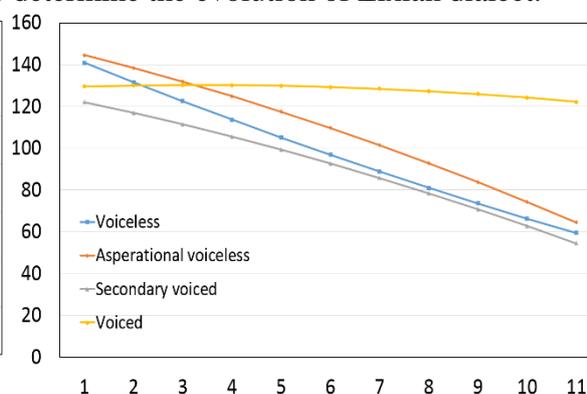


Fig. 2 Fundamental frequency curve of Shang

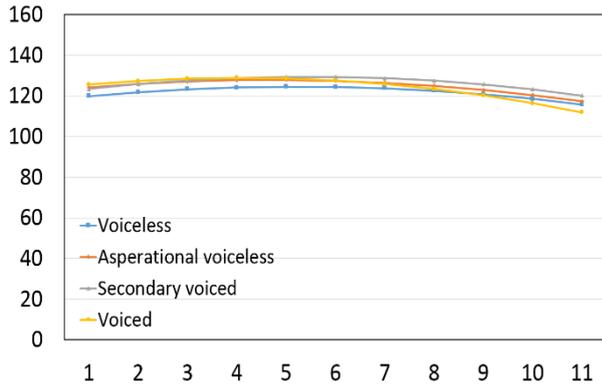


Fig. 3 Fundamental frequency curve of Qu

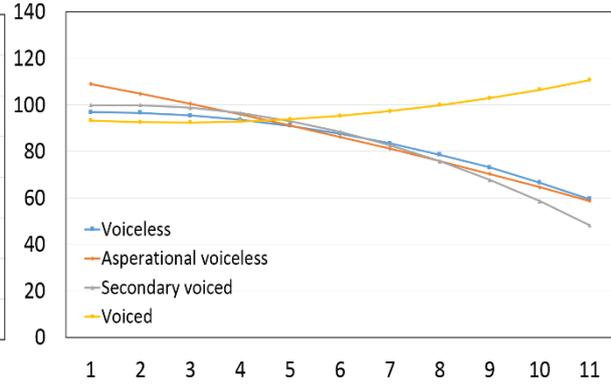


Fig. 4 Fundamental frequency curve of Ru

Figure 1 to Fig 4 are the fundamental frequency curves of Ping, Shang, Qu and Ru. It can be seen that Ping has divided into two tones: the voiceless and asperational voiceless are changed into a falling tone, the secondary voiced and voiced are changed into a rising tone. The first one named Yinping, its domain width is 55.3Hz. The second one is named Yangping, its domain width is 44.8Hz. Shang has developed into two tones, too. The voiceless, asperational voiceless and secondary voiced became a falling tone and the domain width is 98.3Hz. The voiced of Shang became a level tone and its domain width is 28.2Hz. Different with Ping and Shang, Qu does not differentiate. It is a level tone and the domain width is 41.1Hz. However, Ru has some changed. Same with Shang, its voiceless, asperational voiceless and secondary voiced changed into a falling tone and the domain width is 68.6Hz. But the voiced of it became a rising tone and the domain width is 30.6Hz.

By comparison the fundamental frequencies, we find that Ping, Shang and Ru all produced differentiation. At the same time, by compared their maximum value, the minimum value and domain width, we found that some of them can be merged into a tone.

We found that, in Lixian dialect, there are four tones now. Yinping, it is a falling tone, Yangping is a rising tone, Shang is a falling tone and Qu is a level tone. Their name are same with the tones in ancient, but the tone types are different.

In addition, according to the determination principle of the tone load section, the mean length of four tones was obtained. The Figure 5 is the average pronunciation times of four tones.

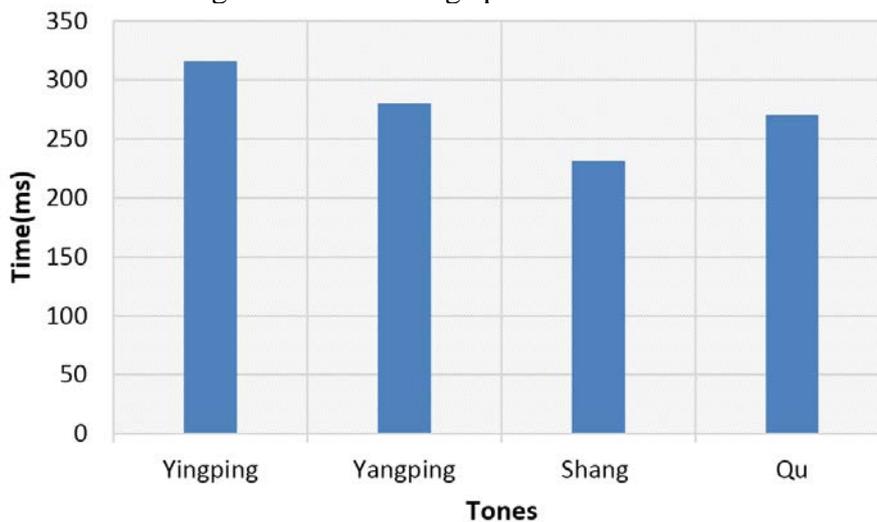


Fig. 5 The average pronunciation times

### 3.2 The Five Degree Calculation

This part mainly calculates the logarithm of the fundamental frequency of the four tones and carries on the normalizing, then obtains the specific tone value of these tones. T1, T2, T3 and T4 respectively represent Yinping, Yangping, Shang and Qu.

Table. 2 Log of mean fundamental frequency

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
T1	2.01	2.00	1.99	1.98	1.96	1.94	1.91	1.88	1.85	1.80	1.75
T2	1.94	1.94	1.95	1.95	1.96	1.97	1.98	1.99	2.01	2.02	2.04
T3	2.14	2.12	2.09	2.05	2.02	1.99	1.95	1.91	1.87	1.82	1.77
T4	2.09	2.10	2.10	2.11	2.11	2.10	2.10	2.10	2.09	2.08	2.07

Table 2 is the logarithm value of the mean fundamental frequency of the four tones. Not all values in table 2 should be used when calculating the mean and standard deviation. The value of each tone at 0% and the value of the falling tone at 100% should be discard. About the logarithm values, the mean  $\mu$  is 2, the standard deviation  $\sigma$  is 0.09. Then, the values in table 3 were normalized with z-score to obtain the LZ value. Finally, combined with their values of time to get the tone figure.

Table. 3 LZ values of four tones

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
T1	0.16	0.05	-0.08	-0.25	-0.45	-0.69	-0.97	-1.31	-1.70	-2.17	-2.73
T2	-0.63	-0.63	-0.61	-0.55	-0.47	-0.37	-0.24	-0.09	0.08	0.26	0.46
T3	1.60	1.28	0.95	0.60	0.23	-0.16	-0.57	-1.01	-1.48	-1.98	-2.53
T4	1.05	1.11	1.15	1.18	1.18	1.16	1.13	1.07	0.99	-0.89	0.76

Table. 4 Relative time (ms)

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
T1	0	31	63	94	126	158	189	221	253	284	316
T2	0	28	56	84	112	140	168	196	224	252	280
T3	0	23	46	69	92	115	138	161	185	208	231
T4	0	27	54	81	108	135	162	189	216	243	270

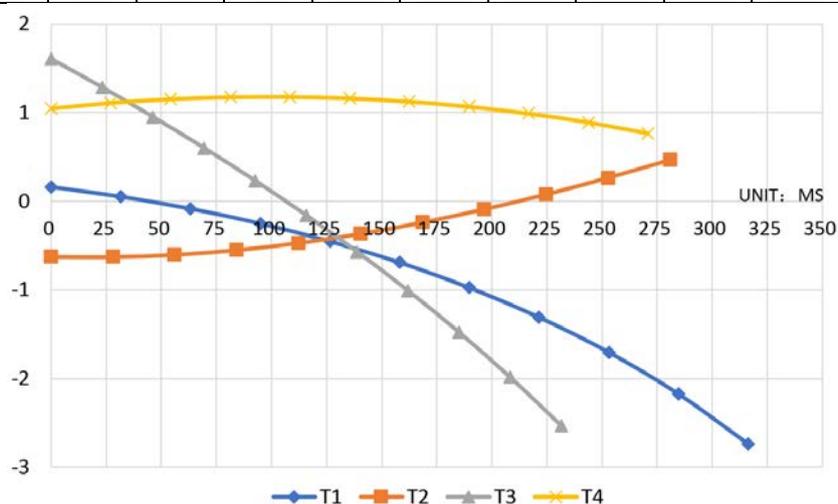


Fig. 6 Lixian tones curves

Figure 6 is the tone curves of Lixian dialect. The region of LZ values is -2.73 to 1.60, so the region of the five degrees is -3 to 3. The LZ value between -3 and -2, the corresponding five degree is 1. The LZ value between -2 and -1, the five degree is 2. The LZ value between -1 and 0, the five degree is 3. The LZ value between 0 and 1, the five degree is 4. The LZ value between 1 and 2, the five degree is 5.

Finally, we found that, in Lixian dialect, Yinping is a falling tone, its value is 41, it has the longest time. Yangping is a rising tone and its value is 34. Shang is a falling tone and the value is 51, its time is shortest. Qu is a level tone, its value is 44.

#### **4. Summary**

Through the quantitative analysis of the tone of Lixian dialect with the method of experimental phonetics, this paper summarizes the tone system of Lixian dialect, the pitch range of each tone and the evolution rule of tones from the middle ancient times to now. Finally, the following conclusions are drawn: First, there are four tones in Lixian dialect, they are Yinping (41), Yangping (34), Shang (51) and Qu (44). Second, there are great changes in the process of evolution of Lixian dialect. Finally, the time order of the four tones is  $T1>T2>T4>T3$ .

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