

An Experimental Study on Monosyllabic Tone in Taihe Dialect

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In this paper, the experimental phonetics method is used to study the monosyllabic tone of Taihe dialect. 288 recorded language materials were analysed by Praat speech analysis software, and the fundamental frequency data were extracted and normalized to obtain the tonic type and value of the tones of Taihe dialect, which were 213 for the level tone, 44 for the rising tone, 23 for the falling-rising tone, and 52 for the falling tone. Compared with the traditional investigation results of single-character tone in Taihe, the tone type and tone value of the level tone have not changed greatly, while the tone types of the rising tone, the falling-rising tone, and the falling tone have not changed basically, and the tone values have all decreased. Then, the duration of the vowel part was extracted and the tonic length of the Taihe dialect was analysed, and it was found that the duration of the level tone was the longest, followed by the falling-rising tone and rising tone, and finally the tonic length of the falling tone was the shortest.

Keywords: Taihe dialect, monosyllabic tones, experimental phonetics

Introduction

Taihe County is located in the North-western part of Anhui Province and belongs to Fuyang City. Taihe dialect belongs to the Central Plains Mandarin area, and there are mainly two types of dialects in Anhui Province, namely, Shangfu and Xinbeng. He Wei (2005) believed that Taihe County belongs to Shangfu area, and the cities and counties in Anhui Province that also belong to this area are Fuyang City, Bozhou City, Suixi County, Suzhou City, Lingbi County, Mengcheng County, Guoyang County, Lixin County, Jieshou City, Linquan County, and Funan County (He, 2005). According to the records of *Chorography of Anhui Province, Dialect Annals* (Compilatory Commission of Anhui Chorography, 1997), there are four tones in the Central Plains Mandarin area of Northern Anhui, which are level tone, rising tone, falling-rising tone, and falling tone. According to the record,

the ancient full turbid falling-rising tone characters are merged into the falling tone. Most of the ancient clear tone vowels and secondary turbid tone vowel words are pronounced as level tone, and most of the ancient full turbid tone vowel words are pronounced as rising tone. The tone values of the vocal tones of each local language are mostly 212 (or 213), 55, 24, 53 four tones. (p. 32)

Wang Tingting (2014) summarized the phonological characteristics of the phonetic system of Taihe dialect through field investigation and analysis of the corpus, and pointed out that there are 23 consonants in Taihe

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dialect including zero consonants, as shown in Table 1:

Table 1

Initial Consonant Table of Taihe Dialect

b [p]	p [p ^h]	m [m]	f [f]
d [t]	t [t ^h]	n [n]	l [l]
g [k]	k [k ^h]	h [x]	[ɣ]
j [tɕ]	q [tɕ ^h]	x [ɕ]	
zh [tʂ]	ch [tʂ ^h]	sh [ʂ]	r [ɹ]
z [ts]	c [ts ^h]	s [s]	

Based on the previous studies of Taihe dialect, this paper uses experimental phonology to study the monosyllabic tones of Taihe dialect, so as to further understand the characteristics of Taihe's vocal tones.

Chinese is a typical tonal language, and tone is the most important feature of Chinese pronunciation. Therefore, the study of Chinese tone has always been an important topic in phonetics. Since the 1980s, with the vigorous development of science and technology, acoustic experimental tools have been developed and innovated, the objects of tone experiments have been expanded, and the research contents have been deepened. The use of acoustic experiments to study dialects in China began with Liu Fu, whose *Record of Experiments on the Four Tones* (1951) was the first experimental phonology monograph in China, in which he used experimental phonology to examine the standard tones of 12 local dialects in China at that time. Modern dialect research has continued to refine theories in the field and build a comprehensive framework for the quantitative study of dialects. Linguists pay more attention to the academic issues related to the tone curve, and the research focus is also on determining the tone-bearing segment and normalizing the fundamental frequency data. At the same time, based on the national conditions, they gradually expand their research horizons to various dialect areas and carry out research on the monosyllabic tones of local dialects. Among them, scholars represented by Shi Feng also put forward the idea of constructing an acoustic pattern and the theory of related phonetic experiments. The number of studies on the dialects of Taihe County is small, and there is a lack of experimental studies. This paper is based on experimental phonology in order to show the characteristics of Taihe dialect more clearly, and also to provide some ideas and experiences for subsequent experiments.

Experiment Description

Pronunciation Collaborators

Four pronunciation collaborators participated in this study, all male, who were born in Taihe and used Taihe dialect as their daily communication language, and had never mastered another dialect. See Table 2 for more details:

Table 2

Pronunciation Collaborators

Name	Age	Native place	Education level
Sun Meng	28	Lixing Town, Taihe County	Undergraduate
Sun Wei	41	Lixing Town, Taihe County	Junior high school
Kong lingbo	30	Lixing Town, Taihe County	Junior college
Xie Xinghuai	58	Lixing Town, Taihe County	Senior school

Example Word List

There are four tone categories in Taihe dialect. When making a list of verified example words, the example words are listed according to the four recognized tone categories of level tone, rising tone, falling-rising tone, and falling tone. Zhu Xiaonong (2010) believed that when studying a language tone, the initial consonant of the first example character should be unaspirated b [p] and d [t], and the vowels should be single vowels a, I, and u, and then combined with various tones. According to the above criteria, the tone survey example character selected in this paper is 12 monosyllabic characters commonly used in Taihe dialect, with three example characters in each tone category. The specific sample characters are as follows:

1. Level tone: 扒 (ba), 逼 (bi), 嘟 (du)
2. Rising tone: 拔 (ba), 鼻 (bi), 毒 (du)
3. Falling-rising tone: 打 (da), 比 (bi), 补 (bu)
4. Falling tone: 霸 (ba), 闭 (bi), 布 (bu)

Experimental Equipment

The recording location for this experiment was a closed and quiet bedroom. The recording device was a Huawei laptop and AirPods Bluetooth headphones with fixed micro recorder. The recording software was Praat, with a sampling rate of 44,100 Hz and mono recording.

Experimental Procedures

Recording

The experimental example words are 12 single words, and each example word is read six times with an interval of one second between each word, and only the middle four times are taken to ensure the stability of the recording samples. Therefore, there are 48 available recording samples for each tone, and a total of 192 recording samples for the four tones. The recording files are stored in wav format. Among them, there are six unqualified sound files in the sample of the first pronunciation partner, and being repeated by mean value of the same token. Before the formal recording, the example words are presented to the pronunciation collaborators in the form of PowerPoint, so that the speakers can familiarize themselves with the corpus first, and each speaker can pronounce in a natural and stable state.

Annotation

Determining the segment which could be the whole carried of tone is the premise of voice segmentation and annotation, and it is one of the important parts of tone experiment. At present, most scholars agree that the main vowels and their transition segments are the tone bearing segments (Lin, 1965; You & Yang, 2001; Shi & Wang, 2006; Zhu, 2001; Ming, 2017). In this experiment, this view is also used as the division standard of tone-bearing segments.

According to Lin (1965),

the pitch curve begins with a rising curve, and the appearance of the “elbow segment” has nothing to do with the nature of the word or the tone of the voice, but may be due to the emphasis of the pronunciation and the inertia of the vocal cord movement. The appearance of the “falling end segment” may be related to the length and strength of the airflow produced by the articulation, but not to the tone or the nature of the rhyme end. People do not feel the presence of the elbow and the falling tail when they listen and discriminate, so for the accuracy of phonetic measurement, the elbow and the falling tail can be omitted. (p. 13)

According to this standard, 192 single-word audio files are annotated in Praat software, and the annotation is divided into two tiers. The first tier annotates characters, and the second tier selects vowel segments as the whole carried of tone, and the elbows and tails are removed when annotating vowels, as shown in Figure 1.

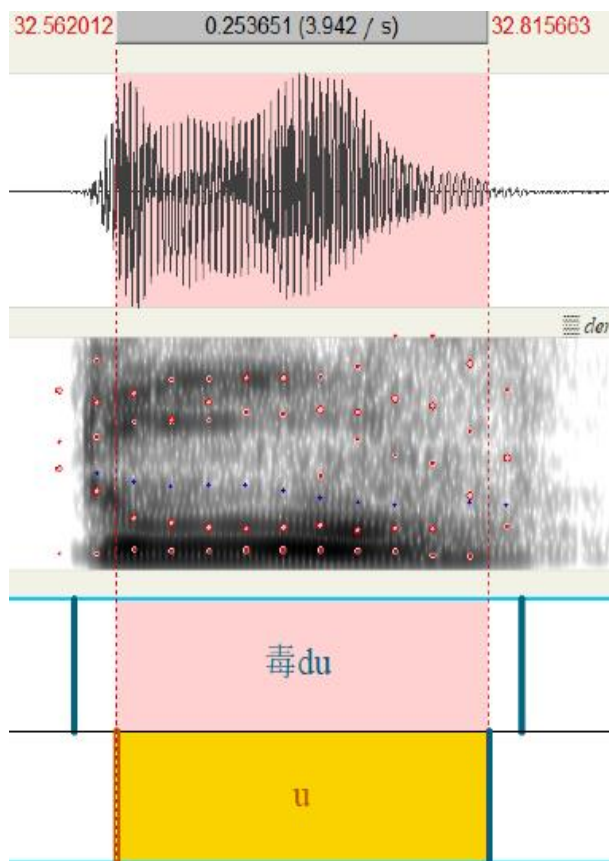


Figure 1. The annotation of the character “毒”.

Extraction and Processing of Fundamental Frequency Data

In order to be accurate and objective, the experiment selects 10 fundamental frequency points in the whole carried of tone as experimental data, and imports them into the excel table to obtain the average fundamental frequency of the four tone categories, as shown in Table 3.

Table 3

The Average Fundamental Frequency of Monosyllabic Tone in Taihe

time point	1	2	3	4	5	6	7	8	9	10
level tone	134.49	130.12	125.31	123.98	127.21	132.46	137.41	141.87	142.61	151.16
rising tone	164.54	164.76	167.39	168.55	166.47	162.62	156.05	149.51	155.01	159.89
falling-rising tone	132.90	136.04	138.59	144.81	150.55	154.10	155.08	150.72	144.73	149.86
falling tone	179.62	179.96	178.50	173.40	161.47	144.46	139.11	137.68	135.99	135.83

According to the data in the above Table 3, the F0 curve of Taihe dialect is drawn by excel, as shown in Figure 2.

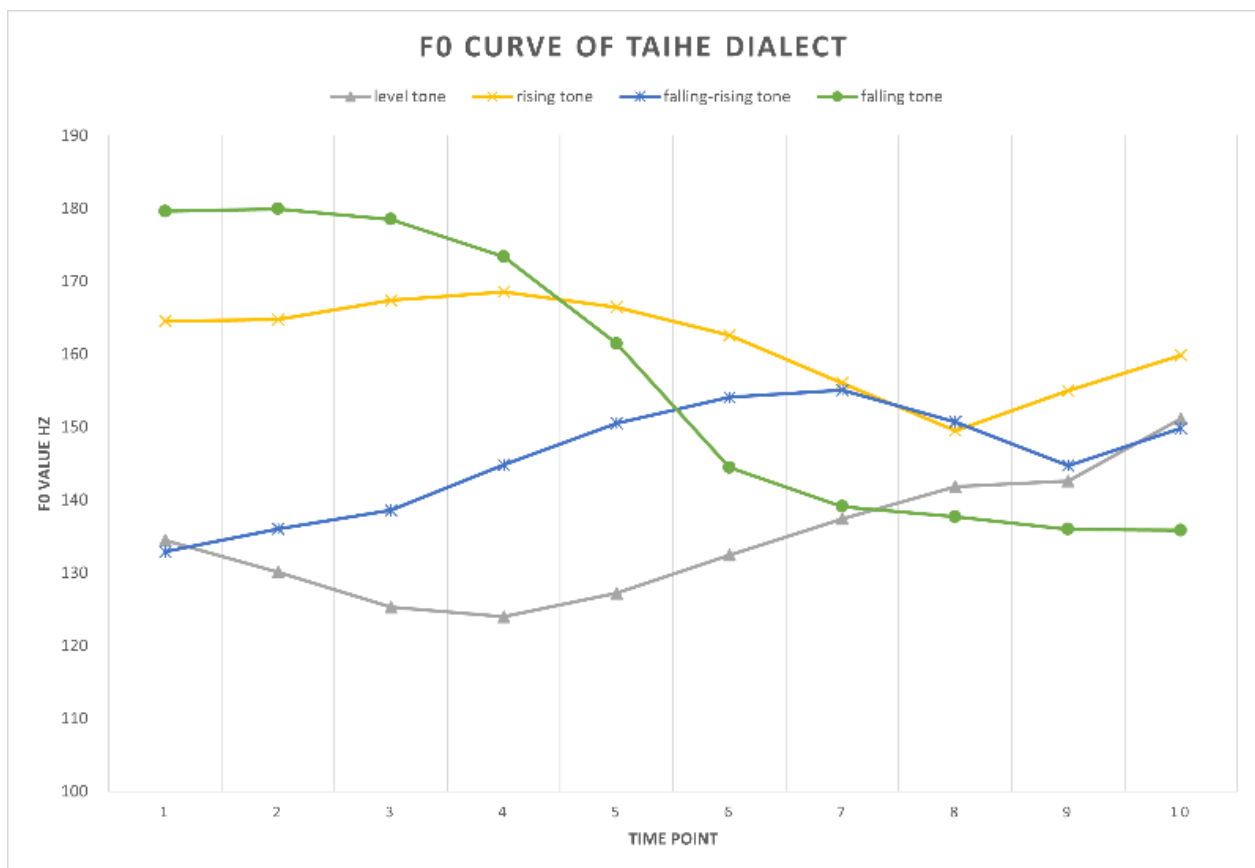


Figure 2. F0 curve of Taihe dialect.

Normalization of F0 Data

To normalize the fundamental frequency values, the *T*-value method proposed by Shi Feng (1986) is used here to calculate the *T*-value (with two decimal places) corresponding to the fundamental frequency at each point, and the *T*-value formula is $T = 5 * (\lg x - \lg b) / (\lg a - \lg b)$, where “a” is the upper frequency of the pitch domain, “b” is the lower frequency of the pitch domain, and x is the frequency of the measurement point, as shown in Table 4.

Table 4

T-Value of Monosyllabic Tone in Taihe Dialect

time point	1	2	3	4	5	6	7	8	9	10
T-value of tones										
T-value of level tone	1.09	0.65	0.14	0.00	0.34	0.89	1.38	1.81	1.88	2.66
T-value of rising tone	3.80	3.82	4.03	4.12	3.95	3.64	3.09	2.51	3.00	3.41
T-value of falling-rising tone	0.93	1.25	1.49	2.08	2.61	2.92	3.00	2.62	2.08	2.54
T-value of falling tone	4.97	5.00	4.89	4.50	3.55	2.05	1.55	1.41	1.24	1.22

According to the *T*-value, excel can be used to make the *T*-value curve of Taihe dialect, as shown in Figure 3.

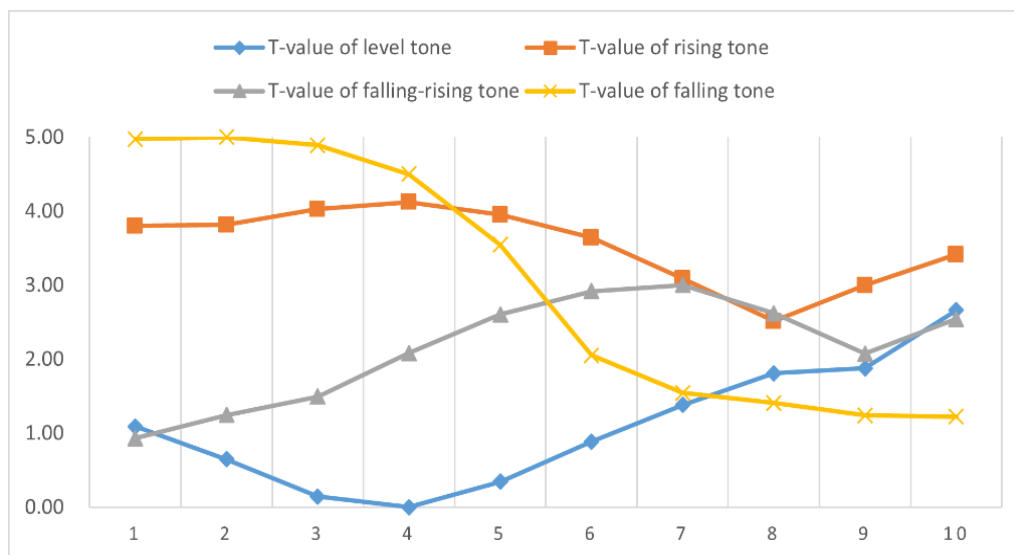


Figure 3. T-value curve of monosyllabic tone in Taihe dialect.

The obtained *T*-value is the five-degree reference scale of *X* point. According to the *T*-value, the tone pattern is regulated by five degrees. Here, the “boundary” strategy mentioned by Liu Lili (2011) is adopted: The *T*-value is between 0 and 1.1, the fifth value is recorded as 1, the *t*-value is between 0.9 and 2.1, the fifth value is recorded as 2, the *t*-value is between 1.9 and 3.1, and the fifth value is recorded.

Level tone is a zigzag tone that starts at the two-degree interval, the concave point is at the lowest point of the one-degree interval, and the end point is at the three-degree interval, so the tone value of level tone in Taihe dialect can be recorded as 213.

Rising tone is a high flat tone, with its starting point in the four-degree interval and its ending point still in the four-degree interval. The overall *T*-value curve is relatively flat, so the tone value of rising tone in Taihe dialect can be recorded as 44.

The falling-rising tone is a low rising tone, with the starting point in the two-degree interval and the highest point in the three-degree interval, and the following curve is still in the three-degree interval and relatively gentle, so the rising tone value in Taihe dialect can be recorded as 23.

Falling tone is a high-pitched tone, starting at the top of the five-degree interval and ending at the two-degree interval, so the de-tonal value in Taihe dialect can be recorded as 52.

Extraction and Analysis of Duration

The duration of the monosyllabic tone is another important parameter to examine the tone. Shi Shaowei (2007), after analyzing the tone lengths of 40 locations in the *Phonetic Database of Modern Chinese Dialects*, concluded that

the single-character tone lengths basically follow this pattern: in a tone pattern with all four types of flat ascending and descending tones, the flexuose tone is the longest, followed by the acclinic and assurgent tones, and the katabatic tone is the shortest. (p. 86)

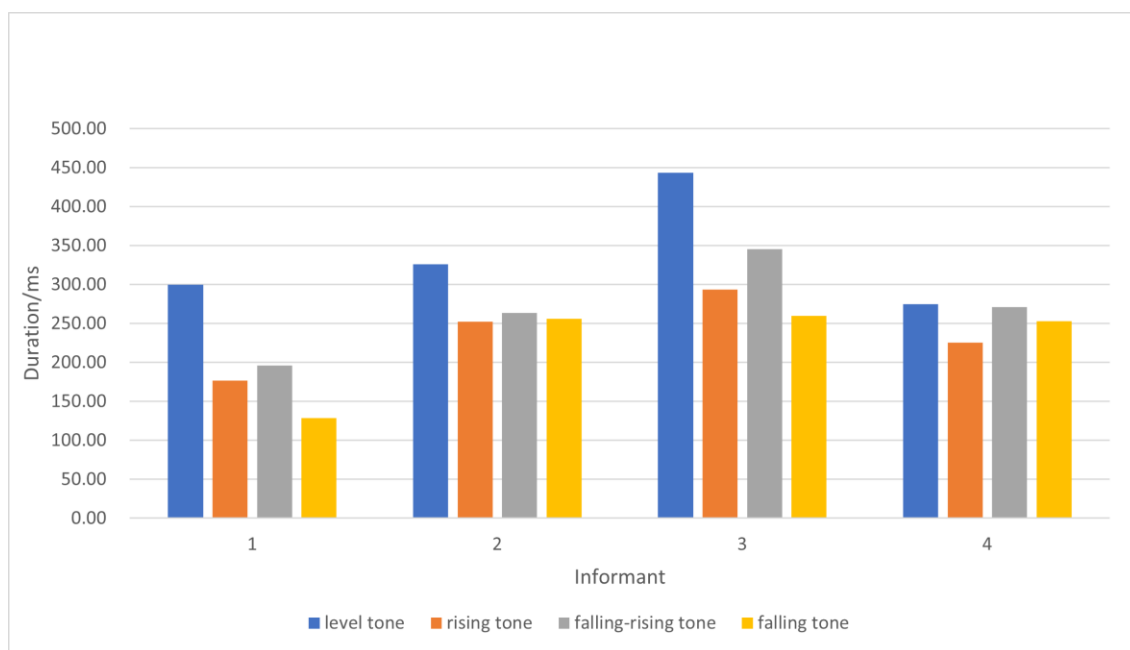
However, he also pointed out that not all locations conform to this pattern and the *Phonetic Database of Modern Chinese Dialects* contains only 40 representative locations, not all dialect areas, so it can only be used as a reference. In this paper, we first extracted the duration of the whole carried of tone from all the recording

samples of the four pronunciation partners, and obtained the mean value of absolute duration of the tone, as shown in Table 5, and Figure 4 is the absolute duration graph derived from the data in Table 5.

Table 5

The Mean Value of Absolute Duration of Tones

tone \ informant	level tone	rising tone	falling-rising tone	falling tone
1	299.75	176.58	195.92	128.50
2	326.25	252.08	263.58	255.83
3	443.75	293.50	345.58	259.58
4	274.67	225.17	271.33	252.75

*Figure 4.* The mean value of absolute duration of tones.

From Table 5 and Figure 4, it can be seen that all four speakers have a common feature: The duration of the level tone is the longest, followed by the falling-rising tone, and the duration of the rising and falling tones are shorter. The difference is that for the first three pronouncers, the duration of rising tone is longer than the duration of falling tone, while for the fourth pronouncer, the duration of falling tone is longer than the duration of rising tone.

The pronunciation speed of different speakers often varies greatly due to the influence of personal habits, physical state, emotional changes, and other factors in the process of pronunciation, and the pronunciation speed of the same speaker often varies. Therefore, we had to normalize the data to derive the relative duration of the tones. There are different methods of calculating relative duration. In this paper, we adopt the method of calculating relative duration from the paper “The Pattern of Phonetic Length of Single and Double Character Groups in Suzhou Dialect” by Liao Rongrong (1983): We take the absolute duration of one tone as the reference value, and take it as 100%, and the percentage of the absolute duration value of other tones compared with it is their relative duration value. In this paper, the level tone with the largest mean value of absolute duration is taken as the reference value, and the percentage value derived from comparing the mean value of absolute duration of

the other three tones with it is taken as the relative duration value. According to the tone category, the relative duration values of each tone category of the four speakers are calculated as shown in Table 6. Figure 5 is a graph of relative duration drawn according to the data in Table 6.

Table 6

Relative Duration of Monosyllabic Tone in Taihe Dialect

tone informant	level tone	rising tone	falling-rising tone	falling tone
1	100	58.91	65.36	42.87
2	100	77.27	80.79	78.42
3	100	66.14	77.88	58.5
4	100	81.98	98.78	92.02

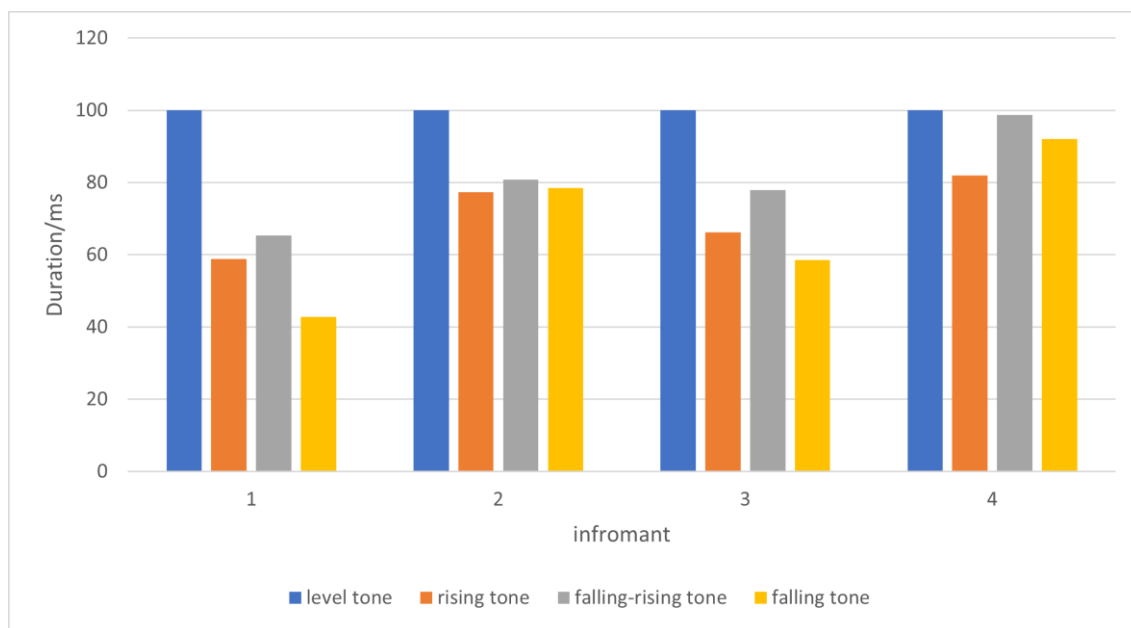


Figure 5. Relative duration of monosyllabic tone in Taihe dialect.

From Table 6 and Figure 5, it can be seen that all four pronouncers have the longest duration of level tone, followed by the falling-rising tone, but the difference between the duration of rising tone and falling tone is not great; only the fourth pronouncer has a longer duration of falling tone than rising tone, which may be related to personal pronunciation habits.

We can conclude that the duration of the tones in Taihe dialect is basically level tone > falling-rising tone > rising tone > falling tone, which is different from Shi Shaowei's (2007) conclusion in that the longest duration is not a flexuose tone but a acclinic tone, but the same is true for that the shortest duration is a katabatic tone.

Comparison and Analysis of Experimental Data

The experimental analysis shows that Taihe dialect has four tones, namely, level tone (213), rising tone (44), falling-rising tone (23), and falling tone (52). Comparing this result with previous studies, it is found that the tone patterns of these four tones have not changed significantly. The level tone is a zigzag tone that falls first and then rises, the rising tone is a short high flat tone, the falling-rising tone is a low rising tone, and the falling tone is a high falling tone. However, there are also differences, that is, the tone values of rising tone (44), rising tone (23),

and falling tone (52) are lower than those of rising tone (55), rising tone (24), and falling tone (53) recorded in *Chorography of Anhui Province, Dialect Annals* (Compilatory Commission of Anhui Chorography, 1997).

Conclusion

In this paper, the monosyllabic tones of Taihe dialect were studied experimentally in terms of both tone type and tone value. The experimental results show that the tone types of level tone (212), rising tone (44), falling-rising tone (23), and falling tone (52) are consistent with previous findings, but there are differences in the tone values of rising tone, falling-rising tone, and falling tone. In addition, the duration of each tone is analyzed. According to the data analysis, the sequence of the duration of each tone is “level tone > falling-rising tone > rising tone > falling tone”. The specific reasons for these differences need to be further investigated in the future. In the follow-up study, the experiment will try to investigate more pronunciation collaborators to further improve this aspect of the study, in order to more accurately depict the tonal pattern of Taihe dialect.

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