

A Study on the Relationship between Tone and Lyrics in Gannan Tea-Picking Opera: Integrating Linguistic Acoustics and Melodic Analysis

Mingxia Zhang * and Shunwei Liu

Department of Music, Ganzhou Teachers College, Ganzhou, Jiangxi, China

* Corresponding Author: Mingxia Zhang

Abstract. Studying the relationship between opera singing and dialects is essential for exploring the deeper meanings of music and culture. Based on existing data, this article focuses on the relationship between tone and melody in the relationship between tone and melody. By introducing artificial intelligence technology, this paper utilizes quantitative annotation of dialect tone fundamental frequency and melody pitch curves, replacing traditional manual aural discrimination to ensure data consistency and scale. Furthermore, the word-tone combination types of the Hakka dialect are analyzed, and the mapping matching degree between the tone curve and the melody curve is quantitatively calculated. Finally, through a combination of qualitative and quantitative analysis, we aim to accurately and efficiently explore the regularities of the relationship between tone and melody in the Hakka dialect of Xinfeng County, Gannan, and opera singing.

Keywords: Gannan Tea Picking Opera; Singing Style; Dialect; Relationship between Tone and Lyrics.

1. Introduction

Gannan Tea Picking Opera is an integral part of Hakka culture. To delve deeper into its relationship with Hakka culture, we must begin with the Hakka dialect and explore the principles of their integration. The use of dialect and pronunciation to determine the regional affiliation of music has been around since ancient times. The "Book of Song: Music" states: "In the early Jiangzuo period, there was also the Fuwu dance." It was once said that the Fuwu dance was a Wu dance. Investigating its origins, it is not a Wu ci. [1] "Modern man Zhang Geng also said in "On the Art of Opera": "Chinese language is a monophonic character, with more characters and phrases having the same sound, and even more characters and phrases with similar sounds. If you don't pronounce the characters clearly, and you don't distinguish the four tones of yin and yang, you will not be able to understand it. Therefore, when creating and polishing the tune, we pay full attention to the four-tone trend of the lyrics, and create the melody under these conditions. [2] "It can be seen that the relationship between local language and local traditional vocal art is very close.

"Relationship between tunes and lyrics" refers to "the relationship between the tune and the lyrics in the same piece of music. To put it in detail: within the scope of unified content, the relationship between the self-regulating rules of singing and the self-regulating rules of lyrics. [3]"

Mr. Yu Huiyong divided into "three major relationships between tunes and words" in his book "Research on the Relationship between Tune and Ci [4]" - the tone relationship between tunes and words, the rhythm relationship between tunes and words, and the structural relationship between tunes and words. This author's research focuses on the relationship between the melody and the lyrics of the tea-picking opera in Xinfeng County, Ganzhou. Due to space limitations, I will firstly examine the relationship between the melody and the lyrics; secondly, I will limit my research to Xinfeng County, Ganzhou City. Due to the complex dialectal landscape and the existence of language islands in the southern region, tracing the relationship between tea-picking opera and dialects across the entire region is complex and difficult to generalize.

Traditional research on the relationship between melody and lyrics relies heavily on researchers' oral transmission and sensory experience, lacking objective and quantitative analytical methods. This makes it difficult to replicate, verify, and scale research conclusions, hindering the further

development of this field to a certain extent. In recent years, the rapid development of artificial intelligence technology has provided revolutionary tools to address this dilemma. The introduction of technologies such as music information retrieval, speech signal processing, and machine learning has made it possible to perform automated and refined analysis of massive amounts of audio data. Thus, this paper aims to integrate language acoustics and melodic analysis, and introduce artificial intelligence technology as a core driver to conduct an in-depth, interdisciplinary, data-driven analysis of the relationship between the melody and the lyrics of the tea-picking opera in Xinfeng County, Ganzhou.

1.1 A Review of Current Research Status at Home and Abroad

Regarding the current research status of the relationship between tea-picking opera lyrics and lyrics in Xinfeng County, southern Jiangxi, the author searched the current research status abroad in Web of Science and Scopus, but found no research on the relationship between tea-picking opera lyrics and lyrics in Xinfeng County. Regarding the domestic research status, the author searched the full-text database of China Journal Network with the theme of "Southern Gansu Tea Picking Opera". It can be seen that the Panlong dialect of Gan County was selected as the representative of the Hakka dialect in southern Jiangxi to discuss the relationship between its melody and dialect. There is no literature specifically focusing on the relationship between the tea picking opera in Xinfeng County.

Most previous studies have taken one or two representative samples and conducted qualitative analysis on them, but none have conducted quantitative analysis on the relationship between accents and words in this region. As such, without a certain amount of support, its representativeness is questionable. The author adopts a method of combining qualitative analysis and quantitative analysis in this article. Qualitative analysis is embodied in this article in two aspects: identification attributes and element analysis. Selecting representative samples and determining the category to which the examples belong belongs to identification attributes. Analyzing the different tones of the Hakka dialect in Xinfeng County is element analysis. Quantitative analysis is the explanation of quantity, which in this article is mainly reflected in the aspects of state quantification and relationship quantification.

1.2 Research Objectives and Main Work

In view of the above problems, the research goal of this article is to construct a research framework that integrates language acoustics and melody analysis to achieve accurate, efficient and large-scale analysis of the relationship between tea-picking opera lyrics in Xinfeng County, southern Jiangxi.

This study responds to the national strategy of digital protection and inheritance of intangible cultural heritage. It aims to scientifically decode and archive the relationship between the dialect and melody of the tea-picking opera in Xinfeng County, southern Jiangxi, so as to build a solid "data gene library" for its living inheritance.

2. Materials and Methods

In this article, there are some important concepts that need to be explained. The "qiang" in "qiangci" refers to music and tunes, and "ci" refers to the literary part of the folk music studied. I divide "ci" into two units: characters and phrases composed of characters with different tones. Therefore, this article will explore the relationship between melody and character tones from two perspectives: the relationship between melody and individual characters (i.e., "single-character tunes") and the relationship between melody and phrases (i.e., "double-character tunes").

The source of my statistical data is the book "Gannan Tea Picking Opera Music Score [5]" which I reprinted from the Xinfeng County Folk Art Troupe. The book divides tea picking opera into 10 sections: Ludiao, Hunandiao, Caichadiao, Caidiao, Huagudiao, Xiaodiao, Zadiao, Yuancidiao, Chuanzi, and percussion scores. I selected eight vocal genres, excluding Chuanzi and percussion

scores, and selected five pieces from each category, for a total of 40 pieces, to analyze them one by one.

The main research steps of this paper are as follows:

First, Dataset Construction: Systematically collect and organize audio data of representative Gannan Hakka folk songs and digitize the lyrics;

Secondly, Phonetic Experiment: Using the tone experiment method of experimental phonetics to study the pitch values of words, based on primary data, we derive accurate pitch values for the Xinfeng County Hakka dialect. These are then imported into Praat to obtain the fundamental frequency curves of the dialect word tones and the corresponding melody pitch curves.

Third, Quantitative Feature Extraction and Matching Degree Calculation: The tone combinations of Hakka dialect characters were classified, and the mapping matching degree between the character tone curve and the musical tone curve was quantitatively calculated.

3. Results & Discussion

3.1 Speech Experiment

The pronunciation character list selected by the author is from the "Dialect Survey Character List" of the Institute of Linguistics, Chinese Academy of Social Sciences. Based on this tone identification character list, 10 characters were selected from each tone category according to the tone categories of the Xinfeng County Hakka dialect as samples. Of the 10 samples, those with a broken or missing fundamental frequency curve, as well as those with excessive sound intensity caused by the speaker's loud voice or proximity to the recording equipment, were discarded and replaced with new samples from the speaker's tone identification character list.

Four more speakers were selected, one from each of the four townships in the east, west, south, and north of Xinfeng County. Ten samples were selected from each of the six tone categories of the Xinfeng County Hakka dialect, resulting in 60 samples for each speaker. Ultimately, a total of 240 samples were collected from the four speakers for the experiment.

1) Monophonic Tone Frequency Data

The author imported the selected 240 sample audios into praat in wav format in order to obtain the syntax map of each character. Here, I chose a Yinping character and a rising tone character for explanation. The reason is that the starting and end points of the tone segments [6] of rising and falling tones have different judgment methods and need to be explained separately. The Yinping character has a rising tone and the rising tone character has a falling tone. The two characters have opposite trends. For example, the language diagram of the Yinping character "kai" and the upper tone character "gu" (the curve in the picture indicates the tone trend):

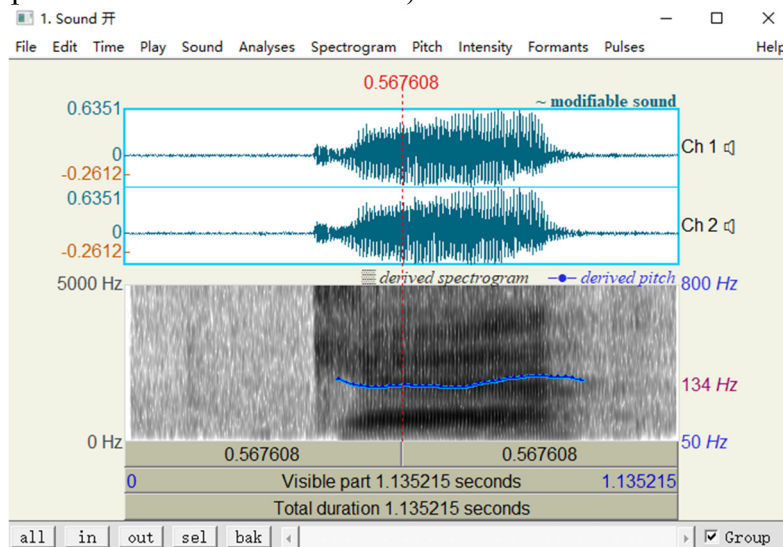


Figure 1. Diagram of the Chinese character "kai" in Yinping

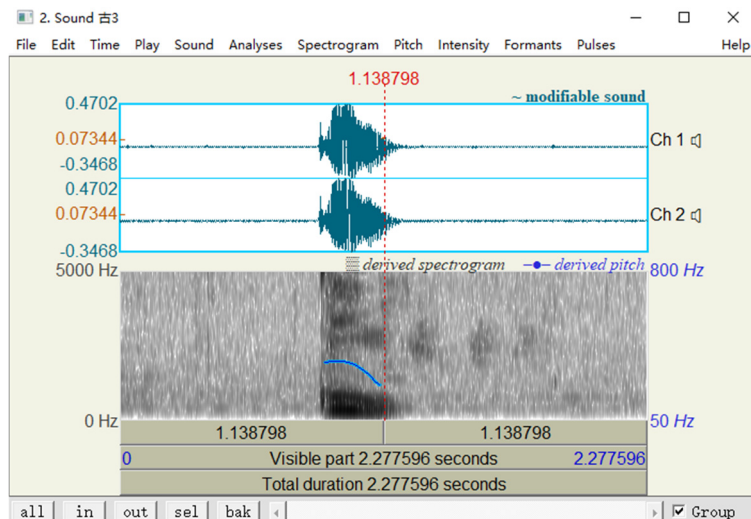


Figure 2. Diagram of the "ancient" language with upper tones

According to Mr. Zhu Xiaonong's practice on phonetic experiments in "Phonetics" , the tone duration of each character was divided into ten equal parts, and the fundamental frequency data at 11 equal points automatically measured by praat was obtained. Then import these 11 fundamental frequency data into Excel to get the average fundamental frequency of this word. For example, the 11 equal points diagram of the Yinping character "kai":

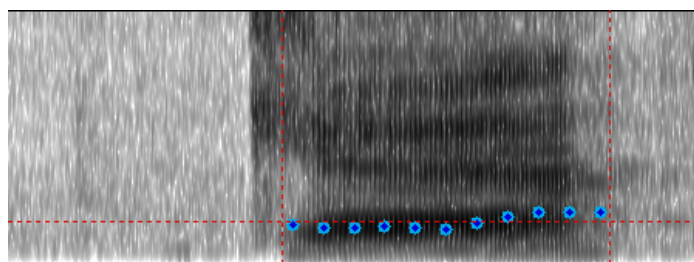


Figure 3. Yinping character "kai" fundamental frequency 11 equal points diagram

The fundamental frequency data imported into Excel is:

Table 1. Fundamental frequency value table of eleven equal points of the character "KAI" in Yinping

equal points	Duration (unit: S)	Fundamental frequency (unit: HZ)
0%	0.491608	131.956886
10%	0.529608	130.571710
20%	0.567608	134.098315
30%	0.605608	133.220361
40%	0.643608	130.995348
50%	0.681608	129.826228
60%	0.719608	136.225683
70%	0.757608	145.806899
80%	0.795608	154.949527
90%	0.833608	158.213834
100%	0.871608	157.272647

After importing the 240 words used for analysis into Excel one by one, the fundamental frequency of each tone type spoken by each speaker was obtained and the average value was obtained. After obtaining the fundamental frequency, use the T value method to obtain the fifth value. The formula is:

$$T=5*(lgx-lgb)/(lga-lgb) [7]$$

The T values of these four speakers are averaged to represent the single tone T value of the Hakka dialect in Xinfeng County. See the table below (retain to two decimal places):

Table 2. Mean T-value table of monophonic tones of Hakka dialect in Xinfeng County

tone \ sampling point	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Yinping (n=10)	1.59	1.51	1.48	1.48	1.55	1.66	1.83	2.03	2.23	2.42	2.52
Hinata (n=10)	1.60	1.51	1.43	1.38	1.36	1.35	1.37	1.39	1.42	1.42	1.42
Upper voice (n=10)	3.08	3.14	3.15	3.09	2.96	2.76	2.51	2.18	1.82	1.39	1.03
Remove the voice (n=10)	2.89	2.81	2.72	2.62	2.49	2.31	2.11	1.86	1.57	1.27	0.98
Penetration (n=10)	3.26	3.79	3.78	3.73	3.69	3.63	3.57	3.48	3.40	3.30	3.18
Yang enters (n=10)	3.68	3.70	3.73	3.75	3.77	3.78	3.79	3.79	3.78	3.75	3.70

Finally, the tonal values of each tone type in Xinfeng County Hakka dialect are as follows:

Table 3. Tonal value table of single words in Hakka dialect in Xinfeng County

tone	Yinping	Hinata	rising voice	Qusheng	vaginal penetration	Yang enters
Tone Values	23	22	41	31	4	45

As shown in the table above, the Xinfeng County Hakka dialect is divided into six tones, including the entering tone, which is short and has a yin-yang distinction.

3.2 The Relationship between Single-Word Tones and Dialect Style

The relationship between the tones of dialect words discussed here begins with the consistency between the dialect tones and the melody progression. Regarding the relationship between melody and lyrics, my country has long held the saying that "melody follows lyrics." However, this doesn't mean that reversed words are prohibited. Mr. Sun Congyin, in "The Relationship between Opera Singing and Language," stated: "We previously emphasized the importance of lyrics in the progression of the melody, demonstrating that opera singing inherits one of the characteristics of traditional vocal music—avoiding reversed words. [8]" However, this doesn't mean reversed words are prohibited in opera singing. This situation is often observed, with reversed words resulting from the use of typical tones or the retention of cadences. "In this typical tonal situation, while objective analysis may indicate reversed words, to an insider, this doesn't affect the understanding of the lyrics' meaning. According to existing literature and my analysis, there are actually three types of relationships between melody and lyrics in traditional Chinese music: conformity, neutrality, and nonconformity. The author's criteria for determining these three categories are as follows: those whose singing style and the melody are consistent are considered conforming; those whose continuous single-note progression is caused by the reduction of the melody are considered intermediate, not inconsistent, but not completely consistent; and those whose singing style and the melody are opposite are considered non-conforming.

According to the above method, the relationship between the singing style and the melody of the 40 collected tea-picking opera tunes was analyzed one by one. The results are listed below:

The 40 tea-picking opera tunes contain a total of 1,227 lyrics. Of these, 849 characters use the straight tone pattern, accounting for 69% of the total; 186 characters use the rising tone pattern, accounting for 15%; 27 characters use the descending tone pattern, accounting for 2%; 140 characters use the descending tone pattern, accounting for 12%; and 25 characters use the rising and descending tone pattern, accounting for 2%.

Table 4. Statistics of the relationship between Gannan Tea Picking Opera's melody and single-word tones

Tune melody Tune type		Flat and straight melody	Upward melody		Downward melody	
			Rising melody	Descending melody	Descending melody	Rising and falling melody
Yinping melody	Number of words	239	37	6	33	8
	Percentage	74	12	2	10	2
Yangping melody	Number of words	158	33	8	22	3
	Ratio%	71	15	4	9	1
Shangsheng	Number of words	187	34	5	21	5
	Ratio%	74	14	2	8	2
Qusheng	Number of words	184	56	8	49	7
	Ratio%	61	18	3	16	2
Yinru	Number of words	74	22	0	15	0
	Ratio%	67	20	0	13	0
Yangru	Number of words	7	4	0	0	2
	Ratio%	54	31	0	0	15

Overall, all tones are dominated by the straight tone pattern, but the proportion varies greatly, ranging from 54% to 74%. Except for the yang-ru combination, the proportion of descending and ascending tone patterns in the remaining tones is roughly equal, ranging from 10% to 20%. First, let's look at the usage of the yinping characters. The tone value of the yinping is semi-low rising. In addition to the straight tone, the rising tone is used more frequently, followed by the falling tone, while the falling and rising tone and the rising and falling tone are rarely used; the tone value of the yangping character is semi-low flat, and the usage of each tone is consistent with that of the yangping character; the tone value of the shangsheng character is semi-high falling. In addition to the straight tone, the rising tone is used more than the falling tone, and the rising and falling tone and the falling and rising tone are rarely used; the tone value of the qusheng character is low falling, and the rising tone is used more than the lower-general tone; the tone value of the yinru character is semi-high, and the straight tone is used most, followed by the shangsheng tone, and then the falling tone, while the other two types are not used; the tone value of the yangru character is semi-high rising, and the straight tone is followed by the shangsheng tone, and then the rising tone, and the falling and falling tone are not used.

As can be seen, in the use of single-character tones, straight tones, resulting from the large number of characters and the small number of tones, account for the largest proportion. However, the use of other types of tones with distinct directions and tones exhibits a certain degree of inconsistency.

3.3 The Relationship between Double-Character Tones and Tones

Mr. Yang Yinliu stated in "A Preliminary Study of Linguistic Musicology": "When a character is assigned a single tone, the character itself has no tonal progression; it only has a relative pitch relationship with the preceding and following characters. [9]" When a word has multiple sounds, pay attention to the relative height relationship between the last sound of the previous word and the first sound of the following word. The lining characters of "dap" and "quick" do not necessarily need to conform to the regularity of character tones. The last word of the previous sentence can be separated from the first word of the following sentence. "In view of this, it is necessary to arrange and analyze the different combinations of tones in the Hakka dialect of Xinfeng County one by one. Two characters are a group, and each group is a combination of the preceding character and the following

character. Then, the relationship between the tone and the tone pattern must be analyzed. Take the two-character tone combination with the first character Yinping as an example.

The analysis process is:

First, among the 40 Gannan tea-picking opera tunes sampled and analyzed, a total of 227 groups of tunes starting from Yinping were identified. The continuous tone changes of the two-character tones involved in the lyrics are as shown in the following table:




Table 5. The pronunciation table of tone combinations starting with Yinping

prefix \ The last word	Yinping	Hinata	rising voice	Qusheng	vaginal penetration	Yang enters
Yinping	23-23 31-23 22-4	23-22 22-22	23-41 22-33	23-31 22-33	23-4 22-4	23-45 22-45
Continuous pitch change group	19	18	10	25	38	1

Second, we categorized the tones and melodies of yinping-yinping, yinping-yangping, yinping-shangsheng, yinping-qusheng, yinping-rusheng, and yangping-rusheng into different tones. Taking yinping-yinping as an example:

There are 75 such combinations, 19 of which have continuous pitch changes. Of these 75 combinations, 25 met the criteria; 31 were in the middle; and 19 did not meet the criteria. See the table below for details:

Table 6. Linked Readings of Yinping and Yinping Tones and Examples

Linked Reading	Unchanging Tone		Continuous Tone Change	
Pitch Progression	23-23		31-23	22-4
Example Words	 花 金		 哥 哥	 苏 州
Compliant or Not	Compliant		Compliant	Compliant

Without changing the tone, the pitch progression for this combination is from half-low rising to half-low rising. Both characters "Hua Jin" (flower) and "Jin" (gold) follow the ascending melody. "Hua" (flower) progresses from mi to sol, and "Jin" (gold) progresses from re to mi, which is a consistent situation. The continuous tone changes of this type of combination are divided into two cases. The first case is to change the first word, changing the first word from semi-low rising tone to low falling tone. The two words "Brother" are accompanied by re and jump downward to la, which conforms to the tone value trend of low falling tone, and then ascend from la to do, which belongs to the case of compliance; the second case is that the tones of both words are changed. The first word is changed from semi-low rising tone to semi-low flat tone, and the latter word is changed to semi-high tone, and the tone value progresses from semi-low flat tone to semi-high tone. The two words "Suzhou" are accompanied by mi and ascend to sol. The melody direction is completely consistent with its tone value, so it is classified as compliance.

After comparing the remaining combinations using the above method, we obtained the overall tonal relationships of the tea-picking opera lyrics in Xinfeng County, Gannan. See the table below (this table refers to combinations of yinping tones with various character tones as yinping combinations, and so on):

Table 7. Overview of Tonal Relationships in Tea-picking Opera Lyrics in Xinfeng County, Gannan

Character Tone Combinations	Total Number	Number that Matches	Proportion	Number that is in the Middle	Proportion	Number that Does Not Match	Proportion
Yinping Combinations	227	89	39%	78	34%	60	27%
Yangping Combinations	144	83	58%	39	27%	22	15%
Shangsheng Combinations	187	31	17%	120	64%	36	19%
Qusheng Combinations	231	46	20%	112	48%	73	32%
Yinru Combinations	104	27	26%	51	49%	26	25%
Yangru Combinations	4	1	25%	1	25%	2	50%
Total	897	277	31%	401	45%	219	24%

4. Conclusion

The previous sections of this chapter separately analyzed and explained the relationship between the qiangge (tune) and single- and double-character tunes in Gannan Tea Picking Opera. Regarding the overall situation, the author summarizes it in five points:

First, in the relationship between qiangge and single-character tunes, the use of straight qiangge (tune) is predominant, with each type accounting for between 54% and 74%. Of the other four qiangge types, ascending qiangge and descending qiangge are relatively common, while descending qiangge and ascending qiangge are rarely used.

Secondly, the overall statistical results of the tonal relationships of two-character tunes and tones in Gannan Tea Picking Opera are as follows:

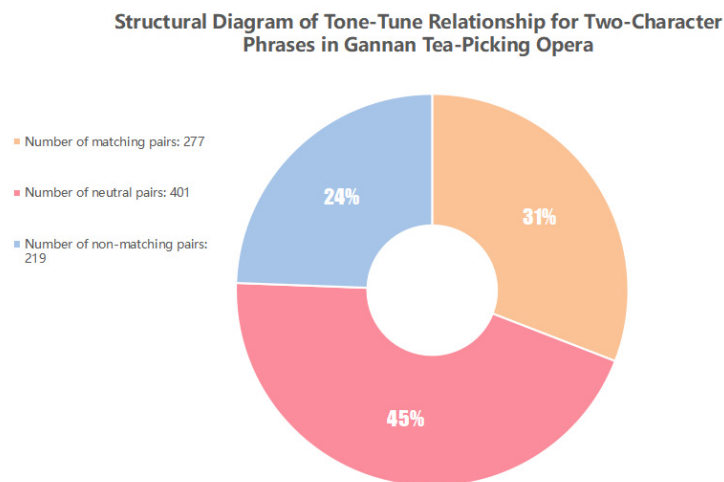


Figure 4. Tonal Relationship Structure of Two-Character Tones and Tones in Gannan Tea Picking Opera

As can be seen from the above figure, the author analyzed a total of 897 tonal combinations of various types in Xinfeng County Tea Picking Opera. Of these, the most common tones and tones were those with neutral relationships, comprising 401 groups (45%). The second most common tones were those with 277 groups (31%), and the last most common tones were those with non-neutral relationships, comprising 219 groups (24%).

Third, the most common tones were yinping and yangping combinations, with yinping combinations accounting for 39% of the total. Yangping combinations also had a relatively high number of positive relationships, accounting for 58%.

Fourth, the number of neutral tones in shangsheng, qusheng, and yinru combinations was significantly higher than in the other three tone combinations, ranging from 48% to 64%.

Fifth, the number of non-conformities in the Yang-Ru combination accounted for 50%, despite the sample size consisting of only four groups.

The quantitative analysis results show that the relationship between the tune and the words in Xinfeng County's tea-picking opera is far from a simple binary opposition of "conformity" or "non-conformity," but rather exhibits a dynamic balance full of tension. The high 45% "centering" phenomenon reveals its core creative logic: while the melody generally echoes the direction of the tune, it also retains ample freedom for the aesthetic expression of the music. In other words, "correct pronunciation" is the foundation, but "rounded tune" is a higher artistic pursuit. This "limited harmony" model embodies the wisdom of folk artists in seeking the optimal balance between the constraints of linguistic rules and the freedom of musical creation. It also provides an empirical case for understanding the complexity and diversity of the "tunes and words" relationship in Chinese folk opera. However, the relationship between intonation and intonation is influenced by more than just the dialect's pitch. It may also involve the inherent laws of local music, and even the historical and geographical environments in which both music and dialect depend. These issues cannot be resolved solely through the existing knowledge of a single discipline, and therefore require further in-depth research.

Acknowledgments

The above paper is from the "Chinese Music History and Appreciation of Masterpieces" course alliance of Jiangxi Province.

References

- [1] Shen, Y. (1974) *Book of Song*. Zhonghua Book Company, Beijing.
- [2] Zhang, G. (1980) *On the Art of Chinese Opera*. China Drama Publishing House, Beijing.
- [3] Yu HY. (2008) *A Study of the Relationship Between Melody and Lyrics*. Central Conservatory of Music Press, Beijing.
- [4] Yu HY. (2008) *A Study of the Relationship Between Melody and Lyrics*. Central Conservatory of Music Press, Beijing.
- [5] Jiangxi Provincial Music Working Group. (1956) *Music of the Gan Nan Tea-Picking Opera*. Jiangxi People's Publishing House, Nanchang.
- [6] Zhu XN. (2010) *Phonetics*. Commercial Press, Beijing.
- [7] Shi F. (1986) Tone Analysis of Double-Character Phrases in Tianjin Dialect. *Language Research*, 1:77-90.
- [8] Sun CY. (1983) The Relationship Between Opera Singing Melodies and Language, in *Language and Music*. People's Music Publishing House, Beijing.
- [9] Yang YI. (1983) Preliminary Exploration of Linguistic Musicology, in *Language and Music*. People's Music Publishing House, Beijing.