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A Comparative Study of Intangible Cultural Heritage Nuo Songs Based on Folk Song Linguistic Quantitative Analysis

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Abstract: The inheritance of intangible cultural heritage is a holistic cultural phenomenon. This study introduces quantitative linguistic methods to study the textual characteristics of Nuo songs in Southwestern Nuo operas. Initially, the frequency distribution of words in Nuo song texts is examined, and the "natural" nature of Nuo songs is verified using Zipf's law. By calculating the numerical value of the h-point on the word frequency curve in Nuo songs, prose, and new poetry texts, as well as the value of the "a-index," one-way ANOVA revealed the connection in lexical richness among the three literary genres. Statistical analysis and clustering results of Nuo songs compared with prose and new poetry indicate certain similarities and differences. The proportion of 2-gram and 3-gram rhyme schemes is used to identify the similarities and differences in rhyming phenomena between Nuo songs and "Hua'er" folk songs and Yuan operas. The study demonstrates that quantitative linguistic research methods are a beneficial approach to discovering the linguistic characteristics of Nuo songs, compensating for the lack of objectivity in qualitative studies of Nuo songs. It also serves as a valuable supplement to the quantitative linguistic analysis of folk songs in intangible cultural heritage, which is conducive to the inheritance and dissemination of Nuo operas.

Keywords: Nuo Songs, Prose, New Poetry, "Hua'er," Yuan Operas, Quantitative Linguistics

1. Introduction

The term "Nuo" refers to an ancient ritual of the Huaxia people in China. In ancient times, to avert misfortune and pray for safety, people donned symbolic masks and costumes to dance, which gradually evolved into a culture, succinctly termed "Nuo." Generally speaking, we consider the origins of Chinese opera to be rooted in a form of local drama from the pre-Qin period, characterized by song and dance—known as Nuo opera. As one of the national intangible cultural heritages, Nuo opera, while not traditionally classified as drama, absorbed the characteristics of dramatic performance and gradually transformed into what we now recognize as Nuo opera, particularly with the emergence of Yuan operas and the flourishing of Yuan zaju (variety plays). However, it has always been closely intertwined with people's lives and even their existence, with every form of Nuo opera becoming a folk phenomenon since its inception. It encapsulates and accumulates the culture and folk arts from ancient times to modern history. In summary, Nuo opera is a type of drama that conveys the laboring people's desire to expel diseases and calamities to ensure health and peace for the populace, while also fulfilling their realistic aspirations for a good life, such as having children, warm clothing, and sufficient food.

Nuo culture is primarily distributed along the Yellow River, the Yangtze River, and in the southwestern regions of China. The southwestern part of China is the area where Nuo opera and Nuo culture are most intact, encompassing Sichuan Province, Chongqing Municipality, Guizhou Province, Yunnan Province, and the Tibet Autonomous Region [1]. The Nuo operas in the southwestern provinces exhibit various types, levels, and forms, making them an important region with significant research and academic value for the study of Chinese Nuo opera and Nuo culture. The practice of Nuo has always been carried out as an artistic medium. Throughout history, in every era, place, and occasion, the performance of Nuo has been artistically expressed. Initially, it relied on dance and music, later incorporating storytelling, drama, and also utilizing costumes, calligraphy,

painting, acrobatics, martial arts, and so on. Why? Because it is believed that art can please the gods and entertain people [2]. The singing that takes place during Nuo activities is commonly referred to as "Nuo songs." The content of these songs is quite extensive, often depicting the process of Nuo, the wishes of the host family, and mythological stories. Nuo songs should not be measured by the standards of traditional operas, nor by the yardsticks of Western musicals or dramas, because the historical trajectory of Nuo opera is much longer and its functions and impacts on people are far more extensive than those of traditional operas or Western dramas. Apart from being influenced by traditional operas after their rise to prominence, Nuo opera has essentially followed its own established patterns.

The preservation and propagation of such a significant dramatic form is a long and arduous task. The transmission and dissemination of Nuo opera are inseparable from language as a medium, and the linguistic patterns and textual characteristics of Nuo songs merit in-depth study. Current research on Nuo culture covers a wide range of aspects. Liu discusses the local historical and cultural connotations embodied in the Nuo drama "Meng Jiangnu" and how it enriches the legend with more localized significance [3]. Liao addresses the traditional and transformative perspectives on the musical forms and types of Nuo dance, specifically in Nanfeng Nuo dance [4]. Zhou discusses the early Chinese shamanic customs and the widespread use of masks in music, dance, and drama, as well as the concurrent practice of heavy facial painting [5]. Zhu speaks about the two interchangeable musical systems in Guizhou Fuquan Yang opera, one for ritual performances and the other for flower plays, noting that there is no strict boundary between the two [6]. These studies have respectively researched and discussed Nuo opera, enhancing people's understanding of Nuo culture and contributing wisdom and strength to its dissemination and inheritance. However, current research remains at a qualitative level, lacking support from scientific linguistic data. There has been no examination of the intrinsic linguistic patterns within Nuo song texts from a linguistic perspective, and it is necessary for us to conduct further exploration.

In recent years, data-intensive scientific research has been thriving, and data-driven methods have brought new opportunities to the study of language and style due to their ability to reflect the intrinsic characteristics of language—gradience and probability—enhancing the interpretive power of linguistic patterns [7]. Quantitative Linguistics, a hallmark of which is the publication of the book "Psycho-Biology of Language: An Introduction to Dynamic Philology" by American linguist G.K. Zipf, is grounded in authentic textual corpora and employs statistical quantitative methods, providing a disciplinary basis and foundation for contemporary quantitative linguistics [8]. The methods of Quantitative Linguistics, guided by a systemic perspective, are based on real language materials and use mathematical methods to abstractly and dynamically analyze and describe language phenomena, structures, structural attributes, and their interrelationships, revealing the patterns of language phenomena [9]. Computational Stylistics (CS), a field that employs computational and statistical methods to study the form, social embedding, and aesthetic potential of literary texts, operates on larger datasets with more transparent methods, offering new scales of observation and interpretation for literary studies, testing existing theories, and forming new ones [10]. Research has shown that the distribution of linguistic structures in texts of different genres varies [11], as Hou et al. pointed out after measuring the length of sentences and words in texts and examining the word classes and initial word classes, these indicators can also be used to distinguish written and spoken language styles in Chinese [12]. To make full use of existing cultural heritage protection systems and policies to effectively inherit and develop excellent traditional cultures. It can be seen that starting from the characteristics of language structure and using statistical methods to explore the stylistic features of Nuo songs should also be feasible.

Several linguists abroad have attempted to conduct quantitative research on poetry from the perspective of quantitative linguistics, achieving preliminary results. Romanian quantitative linguist Popescu and Professor Altmann from the University of Bochum in Germany, among other researchers, conducted a series of quantitative studies on 54 poems by

Slovak poet Eva Bachletov. The results indicated that "the higher the Gini coefficient, the lower the lexical richness of the text" [8]. Subsequently, domestic scholars Zhang et al. examined the quantitative characteristics of the folk songs "Hua'er" from the northwest region of China and found that the vocabulary usage in "Hua'er" conforms to Zipf's law [8]. Long et al. investigated the linguistic features of the ancient songs of the Miao people in the eastern dialect area of the Miao language and compared them with the texts of regulated verse, new poetry, and "Hua'er," confirming that the Miao ancient song texts written in the Miao language adhere to the internal mechanism laws of human language [13] . Pan pointed out from the perspective of the main parts of speech in prose and new poetry that the proportion of nouns and pronouns in prose and new poetry texts is relatively close, which is the only common point among the many quantitative indicators examined, and identified the main differences between new poetry and prose [14] . Pan explored the acoustic feature of rhyme in four types of poetry by examining the rhyming issues in Chinese poetic works [15] .

In order to examine the quantitative linguistic characteristics of Nuo song texts from an objective and empirical perspective, this paper aims to investigate whether Nuo songs conform to Zipf's law. What are the similarities and differences between the two distinct literary styles of new poetry and prose, and is there any connection between the textual features of Nuo songs and these genres? Both "Hua'er" and Nuo songs are orally transmitted and created by the working people. Yuan opera, a popular artistic form during the Yuan Dynasty, includes variety plays and lyrical pieces, and some Nuo songs integrate artistic forms such as variety plays and rap. Are there any connections in acoustic features between Nuo songs, "Hua'er," and Yuan opera? To address these questions, we will employ a combination of qualitative and quantitative methods to explore the linguistic characteristics of Nuo song texts from the southwestern region and compare them with the texts of new poetry, prose, Yuan opera, and "Hua'er." We intend to adopt objective, empirical, and verifiable quantitative linguistic methods to provide a new perspective for the study of Nuo culture.

2. Materials and Methods

2.1 Materials

The corpus selected for this study is derived from the book "Research on Nuo Ritual Music and Songs," published by Shanghai University Press in 2016. This book is the first comprehensive and systematic collection and organization of Nuo ritual music and song resources from 26 provinces, municipalities, and autonomous regions across the country. Through methods such as screening, comparison, analysis, and synthesis, it distills the unique and distinctive characteristics of the rap art preserved in the "Nuo songs" of various regions, which possess significant literary value, and provides a basic organization and discussion of them [2]. We randomly selected 10 Nuo songs from the ninth chapter of "Research on Nuo Ritual Music and Songs," which focuses on the southwestern region. Additionally, 10 essays were randomly selected from the "Chinese Prose Network," 10 Yuan operas were randomly chosen from the "Ancient Chinese Poetry and Prose Network," 10 modern poems from the 1920s and 1950s were randomly picked from the "Chinese Poetry Database," and 10 "Hua'er" songs were randomly selected from "A Comprehensive Study of Chinese Hua'er" [16]. Figure 1 provides detailed information on these four parts of the materials.

Nuo Song		prose			New Poetry			Yuan Opera			Hua'er
no.	title	no.	author	title	no.	author	title	no.	author	title	no.
1	Soldiers and Horses March	1	Bi Shumin	Extending Middle Age	1	Yang Huan	The Dying Star	1	Su Jingchen	Banshe Diao: The Whistle Tune - Emperor Gaozu's Return to His Hometown	1
2	Singing the Twelve Months' Flowers	2	Feng Zikai	Three Lentil Seedlings	2	Yu Guangzhong	The Great River Flows East	2	Zhang Kejiu	Changong Qu: On the Ninth Day	2
3	Lecturing on the Mother	3	Feng Jicai	Reading Books is Also Reading People	3	Wen Yiduo	The Solitary Goose	3	Wang Pan	Zhao Tianzi: Ode to the Trumpet	3
4	Paying Respect to the Local Chieftain	4	Ji Xianlin	Childhood Matters	4	Lin Hengtai	Mistreatment	4	Lu Zhi	Intoxication in the East Wind: The Qixi Festival	4
5	Crying Marriage Song	5	Lao She	To Survive the Exam is Divine	5	Lu Xun	Autumn Night	5	Yu Ji	Nanxiang Yijiamei: Inviting Young Prefect Xiong	5
6	Pan Song	6	Li Juan	The Sorrow of a Horse	6	Zhou Mengdie	The Beggar	6	Xu Zaisi	Qingjiang Yin: Longing	6
7	Selecting the Spouse's Field	7	Wang Guozhen	Musings on Rain	7	Feng Naichao	Waibaidu Bridge	7	Zhang Yanghao	Shui Xian Zi: Ode to the South of the Yangtze	7
8	Choosing Men and Women	8	Wang Meng	Midsummer	8	Xu Zhimo	Wait for You	8	Zhang Dai	Preface to the Memories of Tao'an	8
9	Zhao Qiao's Artistic Painting of the Divine Beam	9	Xi Murong	The Capacity of the Soul	9	Guo Xiaochuan	The Country Road	9	Wang Shifu	The Romance of the West Chamber: Farewell at the Long Pavilion	9
10	Healing Song	10	Yang Jiang	Wind	10	Zhu Ziqing	A Gift to a Friend	10	Cao Xueqin	A Lifetime's Mistake	10

Figure 1: Corpus Samples Used in the Study

2.2 Methods

This paper begins by statistically analyzing the word frequency distribution of Nuo song texts to examine whether they conform to Zipf's law. Subsequently, a clustering experiment is conducted to explore the relationships between

Nuo songs and other literary forms such as prose, new poetry, "Hua'er," and Yuan opera. The specific research steps are as follows: (1) The "CorpusWordParser," developed by Professor Xiao Hang and available on the official website of the Beijing Foreign Studies University Corpus Linguistics, is utilized for word segmentation and part-of-speech tagging of Nuo songs, prose, new poetry, Yuan opera, and "Hua'er" texts, followed by manual verification. (2) Statistical analysis of the frequency of nouns and pronouns in the texts of Nuo songs, prose, and new poetry is performed. Altmann-Fitter is applied to fit the word frequency distribution data of the Nuo song corpus to Zipf's law; Quita is used to calculate the h-point values on the word frequency curves of Nuo song, prose, and new poetry texts, and the "a-index" is computed using a specific formula. One-way ANOVA is employed to test the significance of the "a-index" across various texts. Additionally, nouns and pronouns serve as clustering indices for a systematic clustering experiment between Nuo songs and prose, as well as new poetry. The specific operation is as follows: Proportional methods are used to standardize the values of each clustering indicator. The aim of this paper is to identify closely related samples through clustering indices, focusing on the samples rather than the variables, hence employing the inter-group linkage method of hierarchical cluster analysis for Q-type clustering. Finally, considering the characteristics of Chinese rhymes, a 2-gram and 3-gram method is applied to analyze the rhyming phenomena in the texts of Nuo songs, "Hua'er," and Yuan opera. In conclusion, this study provides a quantitative description and theoretical interpretation of the quantitative characteristics of Nuo song texts, drawing on linguistic research findings and relevant theories.

3. Results and Discussions

3.1 General Characteristics of Nuo Songs

The study indicates that the frequency distribution of linguistic units within a text can reflect the characteristics of the text and even the language itself [17]. The fundamental law of quantitative linguistics—Zipf's law—is proposed through observing the relationship between the frequency, probability, and order of lexical units in language [18]. By examining the characteristics of the single-word proportion and the "a-index" in various text corpora, it was found that among all text corpora, prose has the lowest lexical richness, showing a clear stylistic difference from new poetry. However, the proportion of nouns and pronouns in prose and new poetry texts is relatively close, which can be said to be a concrete manifestation of the "prose-like" nature of contemporary poetic texts [15]. Nuo songs are mostly narrative in form and consist of colloquial expressions that do not strictly adhere to a five-, six-, or seven-character line structure, nor do they pursue perfect rhyme or syntactic neatness. This paper aims to explore the relationship between Nuo songs and prose and new poetry by examining the "a-index" values in their respective text corpora and using the frequency of nouns and pronouns as clustering indices for a clustering experiment. Table 1 lists the frequency and probability of words appearing in the southwestern Nuo song corpus in descending order (the top 15 words, with probability equal to the word frequency divided by the total number of words). Figure 2 is the Zipf curve of word frequency in Nuo song texts, arranged in descending order. Table 2 is a list of index values for Nuo songs, prose, and New Poetry corpora. Table 3 is a list of Pearson correlation coefficient test results between average vocabulary size and "a-index" values. Table 4 is a one-way ANOVA list of "a-index" values for various text corpora. Table 5 is the word frequency of nouns and pronouns in Nuo songs, prose, and New Poetry. Figure 3 is the result of a clustering analysis using the frequency of nouns and pronouns in the texts.

Table 1: Frequency and Frequency Distribution of the Top 15 Words in 10 Nuo Song Samples

Rank	Word	Frequency	Probability
1	I	62	0.0236
2	de	54	0.0206
3	le	43	0.0164
4	yo	42	0.0160
5	la	42	0.0160
6	you	39	0.0149
7	want	36	0.0137
8	come	36	0.0137
9	a	36	0.0137
10	Ping	33	0.0126

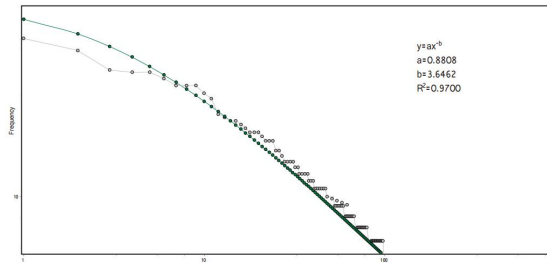| 11 | ah | 31 | 0.0118 |
12	is	26	0.0099
13	draw	25	0.0095
14	open	24	0.0092
15	what	24	0.0092

Figure 2: Zipf's Curve for Nuo Songs (Logarithmic Coordinates)

Firstly, the coefficient of determination R^2 can be used to measure the degree to which a set of data conforms to a particular model or law. From Table 1, it can be observed that the cumulative frequency of the 15 most frequent words in Nuo songs reaches 0.2108, which is approximately 22%, aligning with the principle of least effort in Zipf's law. The most frequent word, "I" (wo), has a frequency of

0.0236, which is less than 0.1. Liu , in his statistical analysis of word frequency in the Lancaster Corpus of Mandarin Chinese, found that the most frequent word "of" (de) has a frequency of 0.0615, also less than 0.1[8]. Figure 2, showing the fit of Nuo songs to Zipf's law, indicates a coefficient of determination R^2 of 0.9700, suggesting that the word frequency distribution in Nuo song texts closely adheres to the distribution predicted by Zipf's law. The results of this paper are largely consistent with these findings, thereby indicating that the word frequency distribution pattern in Nuo songs reflects their uniqueness and that the internal linguistic mechanisms of Nuo song texts exhibit "self-organization." Since the singers are laborers who pass down the songs orally, the texts of Nuo songs are simple, comprehensible, and closely related to people's lives, thus gaining popularity and dissemination. Additionally, the universality of Zipf's law in describing word frequency distribution patterns across different types of Chinese texts is once again confirmed.

Table 2: List of "a-Index" Values in Nuo Songs(N S), Prose(P), and New Poetry(N P) Corpora

	Case Num.	Mean	SD	SE	95% Confidence Interval of the Mean		Min Value	Max Value
					Lower Bound	Upper Bound		
N S	10	4.977	5.1016	1.6132	1.3275	8.6265	1.31	18.56
P	10	6.538	2.2456	0.7101	4.9316	8.1444	2.83	9.33
N P	10	6.632	1.265	0.4	5.7271	7.5369	5	9.5
Total	30	6.049	3.2764	0.5981	4.8256	7.2724	1.31	18.56

Table 3: List of Pearson Correlation Coefficient Test Results between Text Average Vocabulary Size and "a-Index" Values

		A-Index	Text Vocabulary Size
A-Index	Pearson Correlation	1	0.115
	Sig. (2-tailed)		0.543
	Sample Size	30	30
Text Vocabulary Size	Pearson Correlation	0.115	1
	Sig. (2-tailed)	0.543	
	Sample Size	30	30

Table 4: One-Way ANOVA Table of "A-Index" Values Across Various Text Corpora

	Sum of Squares	Degrees of Freedom	Mean Square	F-Value	Significance
Between Groups	17.282	2	8.641	0.793	0.463
Within Groups	294.028	27	10.89		
Total	311.31	29			

Secondly, each text's h-value can be calculated using Quita, which in turn allows for the determination of the "a-index" for each text corpus. A higher "a-index" indicates greater lexical richness in the text, while a lower value suggests less lexical diversity. From the "a-

index" values listed in Table 2 for Nuo songs, prose, and New Poetry corpora, it is evident that Nuo song texts have lower lexical richness, which supports the notion that Nuo songs are colloquial literary forms orally transmitted by the working people. The lexical

richness of prose texts is closer to that of New Poetry from the 1920s and 1950s. This suggests that the three genres—Nuo songs, prose, and new poetry—generally share similar, albeit low, lexical richness. Since the selected texts are not equal in length or vocabulary size, the results from Table 3 show that the Pearson correlation coefficient between text vocabulary size and the "a-index" is only 0.115, with a significance level of 0.543, indicating that $p > 0.05$, suggesting a weak or no correlation between the two. This validates the use of the "a-index" to measure lexical richness among texts without the confounding influence of vocabulary size, thus yielding more reasonable results. Table 4 demonstrates the use of one-way ANOVA to test for differences in the "a-index" values of text word frequencies across various text corpora. The results indicate an F-value of 0.793 with a significance level of 0.463, and $p > 0.05$. This suggests that there is no significant difference in the "a-index" values among the different text corpora, indicating that the lexical richness of the selected Nuo songs, prose, and new poetry from the 1920s and 1950s is comparably low, with a certain degree of similarity among the chosen texts.

Table 5: Word Frequency of Nouns and Pronouns in Nuo Songs, Prose, and New Poetry

Title or Serial Number	Nouns	Pronouns	Standardized Noun Data	Standardized Pronoun Data
Nuo Song 1	48	0	19	0
Nuo Song 2	69	11	17	3
Nuo Song 3	61	3	18	1
Nuo Song 4	85	16	24	7
Nuo Song 5	77	99	14	18
Nuo Song 6	54	17	13	2
Nuo Song 7	35	23	23	7
Nuo Song 8	43	24	18	10
Nuo Song 9	95	25	18	5
Nuo Song 10	57	8	19	4
Prose 1	161	45	14	3
Prose 2	28	18	13	8
Prose 3	80	77	10	11
Prose 4	198	102	13	7
Prose 5	80	56	12	9
Prose 6	133	69	14	6
Prose 7	71	14	14	3
Prose 8	132	27	12	3
Prose 9	72	49	9	10
Prose 10	114	31	11	4
New Poetry 1	7	4	16	10
New Poetry 2	62	15	20	7
New Poetry 3	82	46	14	8
New Poetry 4	6	4	13	3
New Poetry 5	128	52	14	6
New Poetry 6	36	13	17	3
New Poetry 7	79	21	18	3
New Poetry 8	54	85	8	14
New Poetry 9	59	28	18	6
New Poetry 10	39	32	8	18

From the clustering results in Figure 3, it can be observed that the texts of Nuo Song 2 "Singing the Twelve Months' Flowers," Nuo Song 9 "Zhao Qiao's Artistic Painting of the Divine Beam," and Nuo Song 10 "Healing Song" cluster together with New Poetry 6 "The Beggar," New Poetry 7 "Waibaidu Bridge," and New Poetry 9 "The Country Road." The text of Nuo Song 6 "Pan Song" clusters with New Poetry 4 "Mistreatment," Prose 1 "Extending Middle Age," Prose 7 "Musings on Rain," Prose 8 "Midsummer,"

and Prose 10 "Wind." The text of Nuo Song 8 "Selecting Men and Women" clusters with New Poetry 1 "The Dying Star." The texts of Nuo Song 4 "Paying Respect to the Local Chieftain" and Nuo Song 7 "Selecting the Spouse's Field" cluster with New Poetry 2 "The Great River Flows East." The text of Nuo Song 5 "Crying Marriage Song" clusters with New Poetry 10 "A Gift to a Friend." As we know, New Poetry is a poetic genre distinct from classical forms, using vernacular language as its fundamental linguistic tool, and has emerged based on the beneficial assimilation of Chinese classical poetry, folk songs, and foreign poetry by many poets. The dramatization of New Poetry has been an advocated creative method since the rise of new literature. Moreover, "prose" has four meanings, one of which is the "essay" or "lyric prose" that stands alongside poetry, fiction, and drama. Therefore, we can see that there is a certain similarity between the Nuo song texts and prose and New Poetry in the corpus.
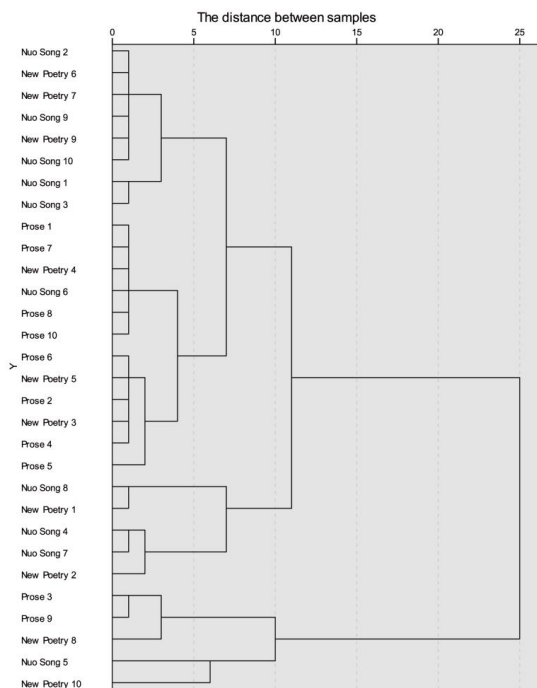

Figure 3: Results of Hierarchical Cluster Analysis Based on the Frequency of Nouns and Pronouns in Texts

Ultimately, it can be observed that in addition to instances where Nuo song texts cluster with prose and modern poetry, the texts of Prose "Three Lentil Seedlings," Prose 4 "Childhood Matters," and Prose 6 "The Sorrow of a Horse" cluster together with New Poetry 3 "The Solitary Goose" and New Poetry 5

"Autumn Night." Furthermore, the texts of Prose 3 "Reading Books is Also Reading People" and Prose 9 "The Capacity of the Soul" cluster with New Poetry 8 "I Wait for You."

3.2 Rhythmic Comparison of Nuo Songs

Pan, referring to the eighteen rhymes, employs 2-gram and 3-gram methods to analyze the rhyming phenomena in various poetic texts. By examining the co-occurrence of the final syllable's rhyme in each verse, the rhyming characteristics of each poetic text can be identified [15]. Building on this approach, this paper aims to investigate the rhyming features in Nuo songs, "Hua'er," and Yuan operas by referring to the eighteen rhymes and using 2-gram and 3-gram methods. In the three major text corpora of Nuo songs, "Hua'er," and Yuan operas, there are 31 types of letter combinations in the final syllables of all verses that form rhymes. Table 6 lists the proportion of rhyming feet in all 2-gram and 3-gram rhyme combinations within each text corpus, that is, the proportion of combinations that can form rhymes among all co-occurring final syllable rhyme combinations; Figure 4 presents a histogram of the rhyming proportions for 2-gram and 3-gram combinations.

Table 6: List of Rhyme Proportions in 2-gram and 3-gram Syllable Rhyme Combinations at the End of Text Lines in Various Text Corpora (%)

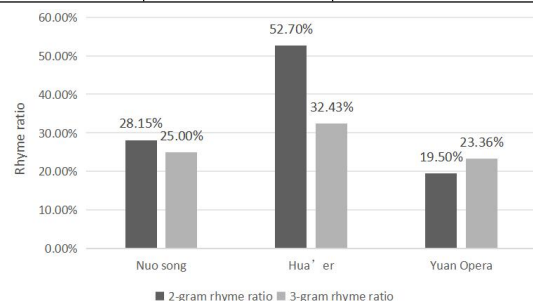| Text Corpus	2-gram Rhyme Ratio (%)	3-gram Rhyme Ratio(%)
Nuo Song	28.15	25.00
Hua'er	52.70	32.43
Yuan Opera	19.50	23.36

Figure 4: Histogram of Rhyme Proportions for 2-gram and 3-gram Combinations

It is evident from Table 6 and Figure 4 that there are differences in the acoustic feature of "rhyme" usage among the text corpora. For

instance, as shown in Table 6 and Figure 4, the proportion of 2-gram rhyming feet greater than 20% is observed in Nuo songs and "Hua'er," with "Hua'er" having a significantly higher proportion than Nuo songs, while the proportion for Yuan operas is less than 20%. Based on this, we infer that the reason for the higher than 20% 2-gram rhyming feet proportion in Nuo songs and "Hua'er" may be attributed to the fact that both are main melody songs created by the working people. Main melody songs are defined from a thematic perspective, primarily referring to excellent songs that extol the country's beautiful landscapes, celebrate local customs and folk traditions, praise the people's good life, and commend the people's excellent qualities and national spirit [19]. Employing the same rhyme allows listeners to immerse themselves in the harmonious melody of this regular variation, making it catchy and enjoyable to sing, fully savoring the exhilarating melodic feast. This serves to alleviate the hardships of labor and to express people's aspirations for a better life. Therefore, this could also explain why Nuo songs and "Hua'er" have a long history and have been beloved by people of all ethnic groups in the region since ancient times, continuing to be passed down to this day.

Table 6 and Figure 4 also reveal that in terms of 3-gram rhyming foot proportions, Nuo songs, Yuan operas, and "Hua'er" have similar ratios in alternate-line rhyming, indicating that the rhymes at the end of verses in these texts may involve mid-line rhyme changes or the interspersion of other rhymes. We infer that the reason for this is that although Nuo songs and "Hua'er," like Yuan operas, have set patterns, they are not rigid and differ from regulated verse and Song dynasty lyrics, exhibiting greater flexibility that reflects the novel artistic forms favored by the people, provided by different social lives. Rhyme changes, akin to the rhetorical device of "interlacing" in phonetics, disrupt the orderly and consistent expression, enriching the phonetic form with variation. Such changes are often triggered by shifts in emotion and content, drawing a fluctuating emotional curve through formal alterations, which more easily resonate with the audience. Moreover, different rhymes can convey distinct emotional hues, showcasing a variety of styles

and providing an experience of layering and a sense of freshness and wonder on the musical level. This also leads us to infer that Nuo songs may have tendencies towards folk and dramatic elements. It is also evident that "Hua'er" has the highest occurrence of 2-gram and 3-gram rhyming phenomena, leading us to deduce that "rhyme" in its creation primarily appears between adjacent lines or in alternate-line rhyming.

Additionally, Table 6 and Figure 4 collectively illustrate that while Nuo songs share similarities with "Hua'er" and Yuan operas, different texts exhibit varying degrees of preference for the acoustic feature of rhyming. Concurrently, beyond 2-gram and 3-gram rhyming patterns, Nuo songs undoubtedly possess unique rhyming methods. It is hoped that future research will uncover more about the acoustic characteristics of Nuo songs and conduct pairwise comparisons within the text corpora to further explore their similarities and differences.

4. Conclusion

Within the framework of quantitative linguistic theory, this paper introduces quantitative linguistic methods and employs a combination of qualitative and quantitative approaches to systematically explore the textual characteristics of the Nuo songs in Chapter 9 of "Research on Nuo Ritual Music and Songs," which pertains to the Southwest region. This exploration addresses the questions posed at the beginning of this paper. By examining the word frequency distribution, it was confirmed that the textual word frequency distribution of Nuo songs closely adheres to Zipf's law. Furthermore, from the perspective of the probabilistic distribution of textual word classes, the a-index and clustering experiments revealed that while Nuo songs differ from prose and new poetry, they also share similarities, with a slightly higher resemblance to new poetry. Additionally, a tendency towards folk and dramatic characteristics in Nuo songs was observed. The proportions of 2-gram and 3-gram rhyming feet also highlighted the similarities and differences between Nuo songs, "Hua'er," and Yuan operas in terms of rhyming phenomena. The data obtained in this study further validate some of the previous research findings, contributing to the

achievement of objective, empirical, and verifiable conclusions.

Given the ancient roots and the extensive length of Nuo drama scripts, the workload for initial data collection and processing is considerable. Therefore, this study focuses on the Nuo songs from the Southwest region as presented in "Research on Nuo Ritual Music and Songs" as the textual corpus. However, this selection sufficiently illustrates the quantitative linguistic characteristics of Nuo songs and provides new research perspectives and methodologies for future studies on Nuo drama. It also imbues the subject with contemporary significance and innovative vitality, encouraging its continued and fostering cultural exchange and integration among various ethnic groups. We anticipate that future research on Nuo drama will incorporate an array of quantitative methods to further investigate the intrinsic linguistic mechanisms of this cultural form.

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