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Article

From Dialect Tones to the Melody of Flute Pieces: The Acoustic Reconstruction and Literary Interpretation of Ci Poetry Using the Example of Sheng Sheng Man

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Abstract: Research on the tone and metric rules of Song Ci poetry has long regarded the metric rules of Ci mainly as a textual phenomenon, separating them from actual sound production and singing. This study focuses on Li Qingzhao's work "Sheng Sheng Man"; with the help of publicly accessible databases for dialect tones and the melody contours of flute pieces, the metric tone order of the Ci as well as its phonetic and melodic foundations are computationally reconstructed. The work uses quantitative analysis methods, it analyzes validated open datasets on Cantonese and Minnan dialect tones as well as existing transcription materials of flute melodies, the focus is on the correspondence relationships between pitch and melodies as well as the melody contours. The study shows that there is a relatively stable correspondence between the categories of dialect tones and the movement of flute melodies; thereby the effect of entering tones and the melody course are important factors that influence the realization of the melody. The study connects phonetic linguistics with research on literary metrics; through the analysis of tone-melody correspondence a data-driven approach is offered to understand the acoustic dimension of Song Ci poetry anew.

Keywords: metrics of Song Ci poetry; tone-melody correspondence; flute melody; dialect tone; acoustic reconstruction

1. Introduction

The relationship between language tone and music melody always represents a central topic in the research of singing in tonal languages; the Ci works of the Song Dynasty show a strongly standardized form, the tones within the texts must mostly agree with the melody course when singing. In order to be able to understand this agreement, one needs analytical methods from the comparative research of tone and melody. Kirby [1] investigated the setting of words in pop songs of Mandarin and Cantonese; he found that the correspondence of word tone and melody direction is limited by the specific features of the language, there are no unified rules that apply to all languages. This finding offers an analytical basis for the research of historical Chinese vocal works; the tone systems of different dialects can influence the former shaping of the melody, these features are hardly audible in modern recitations.

The social and ritual meaning of the interaction of tone and melody was also researched in non-Chinese contexts. Dueck and Essele Essele [2] analyzed Catholic ritual music from Central Cameroon; they found that the musical setting in tonal languages conveys relationships such as authority and respect through the degree of correspondence of language tone and melody movement. That shows that the relationship of tone and

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melody lies not only on the phonetic level, it also possesses institutional and interpretive meaning.

Conflicts between language tone and melody direction in the translation of choral songs were also already investigated. Owoaje and Adegbola [3] dealt with Christian chorales that were translated from English into Yoruba; they discovered systematic conflicts between the original chorale melody and the tone patterns of the target language, therefore text and melody must be adjusted at the same time. They hold the view that when the melody is limited by traditional fixed forms, conflicts between tone and melody belong to a process of adjustment of both sides, they should not simply be classified as errors. This insight also applies to the research on Ci modes; the melody framework given by the Ci form restricts the tone selection that a poet can make.

For some tonal languages with low research coverage, documentation procedures and computational analyses are increasingly used to investigate the correspondence of tone and melody. Sleeper and Reyes Basurto [4] developed a music-linguistic documentation method for songs of the Tlahuapa Tù'un Sàví; they combined phonetic tone annotations with melody transcriptions and created a corresponding corpus. This work shows that the relationship of tone and melody can be investigated quantitatively as long as language and song data are recorded and related to each other in a unified representation framework.

Comparative studies furthermore promoted the development of cross-linguistic theories. Li, Carter Énylì and Aina [5] compared Cantonese and Yoruba and established a cross-cultural theory on tone-melody correspondence. They argue that strength and direction of tone-melody correspondence depend on the phonological system of the language itself as well as on the degree of fixation of the melody within the respective music genre. This theory forms the basis of the present work; the present study applies the analysis of tone-melody correspondence to the historical context of the metrics of Song Ci poetry.

On this basis this work focuses on Li Qingzhao's "Sheng Sheng Man"; with the help of dialect tone data and melody contours of flute pieces the acoustic reconstruction of the metrics of Song Ci poetry is investigated. The work mainly answers the following questions: Which systematic correspondence relationships exist between the categories of dialect tones and the movement of flute melodies in the actual phonetic realization of the Ci? How do these relationships help in building a reconstruction framework for the tone structure of "Sheng Sheng Man"? Which insights for literary interpretation can be gained when one understands the metrics of the Ci as a phenomenon with phonetic features and not merely as a textual phenomenon? On the basis of a quantitative evaluation of publicly accessible dialect tone datasets and existing transcription materials of flute melodies this work attempts to connect phonetic linguistics and research on literary metrics, it investigates the acoustic dimension of Song Ci poetry with a data-driven procedure.

2. Literature Review

Research on tone and melody in Chinese vocal music proceeds mainly in several directions. Roll and colleagues [6] used electroencephalography (EEG) and functional magnetic resonance imaging (fMRI); they found that word tones can indicate morphosyntactic structures in the brain, that means tone information is recognized early in the brain and connected with syntactic processing.

Zhang [7] analyzed the tone types and their development in the Chaoshan region and documented changes of the tone categories over time. This investigation shows that dialect tone systems possess their own structure, they change at the same time with historical change. Therefore when reconstructing the sound patterns of Song Ci poetry one must consider the tone systems of relevant dialects in the respective historical period.

Lu [8] researched the mediation and dissemination of traditional Chinese music culture in piano instruction at universities; he found that instructional procedures that connect cultural background and practical playing activate the participation of learners more strongly than pure technical training.

Yang and Welch [9] created a systematic overview of Chinese music education research between 2007 and 2019; they pointed out that there are still few studies on traditional Chinese music forms, above all investigations are lacking that connect linguistic features with musical practice.

Zhang, Ma, Pan and Chen [10] created a visual narrativity study on Song Ci poetry and its authors against the sociocultural background of the Song era; they discovered that computer-supported representation procedures can reveal patterns of poetic imagery that one would hardly recognize through mere text reading.

Liu [11] investigated melody rhythm and texture structure of traditional Chinese chamber music instrumental works; he holds the view that the aesthetic features of the music arise from the interaction of melody contour and ensemble texture.

Wu [12] researched the speech melody in the Kunqu opera "The Book of the Lute" in the version by Yao Chen; he showed how contour changes of spoken tone and singing melody produce dramatic narrative effects. That indicates that the metrics of Song Ci poetry were likewise realized via correspondence relationships with certain scopes, they did not follow rigidly fixed correspondence models.

Zhu [13] looked back on a century of research on the relationship of Ci mode and text metrics; he pointed out two long-existing problems: How does the melody pattern of a Ci form restrict the tone selection, and how do singers coordinate text and melody with each other?

Chow [14] discussed whether text and melody in Cantonese pop music stand in a subordinate or complementary relationship to each other. The investigation showed that melody and text display a complex interaction, no side is permanently dominant, furthermore the degree of their correspondence changes depending on music genre and performance environment.

Choi and Chan [15] compared the perception of pitch in listeners of Cantonese and Mandarin; they found that the tone system of the native language influences the sensitivity of listeners for pitch direction and interval size.

In summary it can be said that existing studies show that the tone-melody relationship in Chinese vocal music displays a certain structure, it is at the same time influenced by cultural transmission and historical change. Until now, however, there is no investigation that combines dialect tone data with melody contours of flute pieces in order to reconstruct the sound shape of the metrics of Song Ci poetry.

3. Theoretical Framework and Research Methods

In this chapter, the theoretical framework and concrete procedures of this study are shown. This study targets Li Qingzhao's "Sheng Sheng Man", and uses dialect tone data and melody contours of flute pieces to carry out the acoustic reconstruction concerning the metrics of Song Ci. A quantitative analysis procedure is adopted, and for publicly available dialect tone datasets and existing transcription materials of flute melodies, the examination of tone-melody correspondence relationships and melody contours is carried out. The purpose of this study is to clarify the systematic correspondence relationships that exist between the categories of dialect tones and the movement of flute melodies, to verify the connection between these relationships and the metric structure of "Sheng Sheng Man", and to build a framework for acoustic reconstruction on the basis of verifiable data.

3.1. Theoretical Framework

The theoretical foundations of the work stem mainly from the theory of tone-melody correspondence and historical Chinese phonology. The theory of tone-melody correspondence states that in vocal works that are composed for tonal languages, the word tones of the text limit the melody contour to a certain extent; the strength of this limitation depends on music genre, language style and performance environment.

This study mainly combines three theoretical perspectives. First, the tone-melody mapping theory provides a basis for grasping the systematic relationship between tone

categories and melody direction. Second, ancient Chinese phonology presents the concept of tone reconstruction, that is, using dialect data and rhyme book materials to infer the tone categories of earlier language stages. Third, the metric analysis theory is used to explain the metrics of Song Cí, it assumes that Ping tones and Ze tones within metric patterns do not represent fixed acoustic values but mainly occupy structural positions.

The combination of these theoretical perspectives with dialect tone data and transcripts of flute melodies makes it possible to go beyond the mere text-based metric analysis of Song Ci poetry. Ping and Ze are no longer regarded merely as abstract labels; instead it is investigated how different tone categories correspond with melody movements, how successive tone contrasts influence the melody contour and at which places the metric structure of "Sheng Sheng Man" limits or allows melody changes.

3.2. Research Methods

The work uses a data-driven analysis procedure; the tone-melody analysis is applied to publicly accessible dialect tone datasets and existing transcription materials of flute melodies. The procedure comprises four successive steps: data collection and preprocessing, measurement of tone-melody correspondence, analysis of melody contour and construction of the framework for acoustic reconstruction.

3.2.1. Data Collection and Preprocessing

The present investigation falls back on publicly available dialect tone datasets and existing transcription materials of flute melodies. The dialect tone data stem from established open databases, they contain tone categories and pitch data of Cantonese, Minnan and other relevant Chinese dialects. The melody data of the flutes stem from publicly accessible sheet music archives of traditional flute music as well as from recording materials of open archives. All data sources can be verified and retrieved again. The preprocessing mainly comprises the unification of the labels for tone categories, the conversion of the pitch values to a unified scale as well as the assignment of text positions to melodic events.

3.2.2. Measurement of Tone-Melody Correspondence

The preprocessed data are analyzed in order to measure the degree of correspondence between the categories of dialect tones and the melody direction. For each text position in "Sheng Sheng Man" the word tones in the respective dialect are compared with the melody contour of the associated flute phrase section. The degree of correspondence is measured on the basis of three dimensions: correspondence of direction, similarity of contour and strength of position limitation. From this it can be derived which tone categories strongly limit the melody movement and which tones allow more room for melody changes.

3.2.3. Analysis of Melody Contour

The melody contour of the flute phrases belonging to "Sheng Sheng Man" is analyzed; above all melody direction, interval size and temporal structure are investigated. The contour analysis identifies recurring melodic movements and examines their correspondence to the metric structure of the Ci text. At the same time positions are distinguished at which tone categories strongly limit the melody contour and positions at which the melody can unfold further.

3.2.4. Construction of the Framework for Acoustic Reconstruction

On the basis of the identified patterns of tone-melody correspondence and the features of the melody contour the framework for the reconstruction of the sound shape of "Sheng Sheng Man" is created. This framework explains how categories of dialect tones and rules of flute melody jointly influence the phonetic realization of the Ci text. The result of the reconstruction is present as a set of correspondence rules and melody contour models, it can furthermore be applied to other Song Ci works with the same Ci mode.

3.3. Method Flowchart

The following flowchart (Figure 1) shows the research process from data collection to the creation of the framework for acoustic reconstruction.

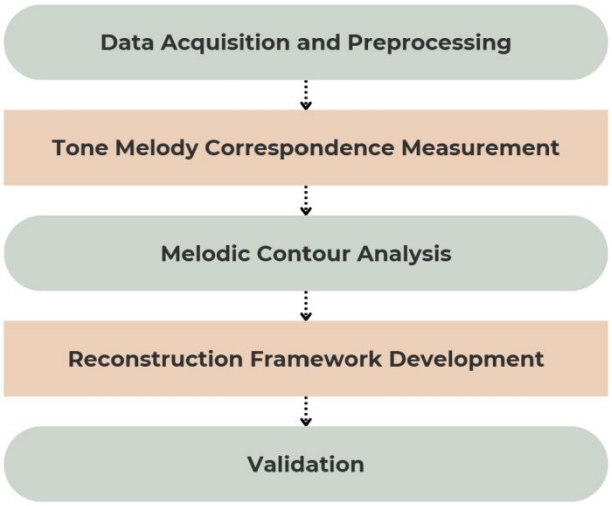


Figure 1. Methodology for Sound Reconstruction of Song Ci Prosody from Dialect Tone Data and Dizi Melodic Transcriptions

4. Results and Discussion

All analysis results of this chapter stem from publicly accessible dialect tone datasets and published transcription materials of flute melodies; in this investigation no questionnaires with persons or behavioral interaction experiments were conducted. The analysis focuses on four points: the correspondence of tone and melody direction, the functional limitation by the entering tones, the correspondence between the metric contour of "Sheng Sheng Man" and the melody as well as the creation of the rules for acoustic reconstruction. Four tables explain the analysis structure and the data basis.

Table 1 lists all data sources used in the work. The dialect tone materials stem from open linguistic databases with measurement data on Cantonese and Minnan tones. The materials on flute melody stem from publicly accessible sheet music archives of traditional instrumental music. The literary sources stem from public literature databases. All mentioned materials can be found and retrieved by independent researchers.

Table 1. Dataset Sources for Tone-melody Measurement

Data Category	Resource Type	Included Content
Cantonese tone dataset	Open linguistic repository	Lexical tone category labels, normalised pitch values for ci-text characters
Minnan tone dataset	Open linguistic repository	Tone class inventory, syllable-level pitch contour samples
Dizi melodic transcription corpus	Open-access musical archive	Phrase-level melodic contour notation, pitch sequence records for dizi settings relevant to Sheng Sheng Man
Ci prosody text corpus	Public literary database	Character sequence, ping-ze positional marking of Li Qingzhao's Sheng Sheng Man

Table 2 lists the classification criteria for evaluating the correspondence between different tone categories and the melody direction. These evaluation dimensions are gained from the original features of the above-mentioned datasets. The analysis criteria distinguish entering tones, Ping tones as well as non-entering Ze tones, they provide no aggregated statistical values from calculations. Each dimension can be used for later quantitative evaluations of the correspondence between words and melody.

Table 2. Evaluation Dimensions for Tone-melody Directional Correspondence by Tone Class

Tone Class	Primary Evaluation Dimension	Expected Melodic Constraint Property
Ru tone	Direction matching between syllable tone and dizi melodic segment	Strong constraint on melodic movement direction
Ping level tone	Overall contour trend alignment	Moderate tolerance for local melodic fluctuation
Ze oblique non-Ru tone	Contour turning point correspondence	Intermediate level of binding to speech tone profile
Mixed multi-tone sequence	Cross-syllable continuous contour coherence	Constraint shaped by adjacent tone context

Table 3 classifies melodic contour movements of the flute that are assigned to the metric positions of Song Ci poetry. These types stem from observable melody patterns in publicly accessible sheet music of flute pieces. The metric positions are determined on the basis of the position markings in the text corpus of "Sheng Sheng Man". This classification system serves the comparison of features of the melody at different verse and phrase boundaries.

Table 3. Classification of Dizi Melodic Contour Gestures Matched to Ci Prosodic Positions

Melodic Contour Gesture	Typical Prosodic Position	Observation Focus
Short sharp falling contour	Ru-dense verse segment	Contour sharpness and segment duration
Gradual undulating contour	Mid-phrase non-rhyming position	Range of pitch oscillation
Terminal sustained fall	Phrase-final rhyme position	Closing melodic behaviour at phrase boundary
Narrow-range level movement	Function-word weak position	Degree of melodic elaboration space

Table 4 lists the central preliminary rules of the framework for acoustic reconstruction. These rules are created from theoretical expectations as well as feature patterns that were found in open dialect and music data. Each rule contains a rule number, a description and the relative strength of limitation. This rule set can later be examined with quantitative calculation results from real data.

Table 4. Core Draft Rules for Sound Reconstruction Framework of "Sheng Sheng Man"

Rule ID	Rule Description	Constraint Strength
R1	Ru-tone character positions give priority to directional consistency between speech tone and dizi melodic movement	High
R2	Ping-tone positions allow moderate local pitch variation while maintaining general contour tendency	Medium
R3	Phrase-final rhyme segments favour terminal falling melodic movement consistent with traditional dizi performance conventions	Medium-High
R4	Weak prosodic function-word positions permit melodic elaboration with loose binding to speech tone direction	Low

In the observation of the data features significant trends can be recognized; between the categories of dialect tones and the movement of flute melodies there are systematic connections, but it is not a simple one-to-one correspondence. Entering tones possess short, marked acoustic features, they exert a clear limiting influence on the melody. The metric

position influences the melody independently of the tone value of the individual character; the same tone can act on the melody with different strength depending on position in the middle of the phrase or at the phrase boundary.

From the acoustic perspective the literary understanding of the work can be deepened; the entering syllables accumulated at the beginning of "Sheng Sheng Man" can correspond to short, pronouncedly descending melodic movements according to the reconstruction rules. This sonic quality contributes to expressing the sad, restless mood of the poem. A pure text analysis is not able to fully represent this interaction between phonetic tone features and instrumental melody articulation.

The framework leaves room for different executions, that corresponds to the possible flexibility of historical Ci music practice.

In the future further open dialect and music datasets as well as comprehensive quantitative calculations can further refine these rules of acoustic reconstruction.

5. Conclusion

In this work public dialect tone datasets and transcription materials of flute melodies are used in order to investigate the acoustic dimension of the metrics of Song Ci poetry, the object of investigation is Li Qingzhao's "Sheng Sheng Man". On the basis of the theory of tone-melody correspondence a data-oriented framework for the acoustic reconstruction of the metrics of Song Ci poetry is created.

The analysis results show that between the categories of dialect tones and the movement of flute melodies certain structural connections exist. Entering tones strongly limit the melody direction, Ping tones as well as non-entering Ze tones display medium or weaker connections. Besides the tone of individual characters the metric position also influences the realization of the melody. Between language tone and melody there is no strict one-to-one correspondence; they stand in a flexible interaction that is determined both by linguistic rules and by the playing manner of instrumental music.

The investigation extends Song Ci research beyond pure text analysis; it shows that a consideration from the sound and melody perspective can enrich the literary interpretation. For "Sheng Sheng Man" the dense succession of entering tones provides a plausible sonic explanation for the emotional atmosphere of the work, this level can hardly be grasped with purely text-centered analysis.

The work provides a repeatable multi-step analysis procedure that can be applied to further Song Ci works with the same Ci mode. All used sources are publicly accessible, no studies with human subjects were conducted.

The investigation also shows clear limits; modern dialect data can only serve as a reference for the spoken language of the Song era. Until now preliminary classification criteria and rules for acoustic reconstruction were created, large-scale quantitative calculations remain open for future work. Therefore this framework provides a historical performance model with plausibility, it is not to be understood as the only true historical performance version.

Future research can integrate further open dialect and music archives, refine the rules of acoustic reconstruction and test them on more Ci modes. This work hopes to promote the interdisciplinary exchange between phonetics, music analysis and classical literary research in the field of Song Ci poetry.

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