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Analysing the relationship between tone and melody in Chaozhou songs

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ABSTRACT

This paper uses corpus analysis to explore relationships between tone and melody in folk and contemporary songs in Chaozhou, a Chinese dialect with eight lexical tones and a wealth of tone sandhi. Results suggest that: (1) there is a high degree of correspondence between tone and melody in Chaozhou song; (2) tone sandhi influences tone-melody correspondence; (3) tones realised in context can be categorised into high-, mid-, and low-pitch groups according to the tone-pitch extreme rather than final pitch; (4) when single tones are performed melismatically across groups of notes, relationships between initial notes of successive groups shapes tone-melody matching.

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Introduction

Composers and singers have to pay more attention to the relationship between words and melody when they write or sing in tone than in non-tone languages. In tone languages, pitch is used to determine the meaning of words (Yip, 2002, p. 1). In other words, changing the pitch of a syllable's tone leads to a change in the meaning of the word. Because of this particular feature of tone languages, the song melody is likely to be shaped not only by musical concerns but also by the relationships between the melody and the lexical tones of the lyrics. Thus questions of whether, and to what extent, differences in linguistic pitch in tone languages affect the construction of song melody have attracted a lot of attention and have contributed to a vast literature providing valuable insights into the relationship between tone and melody in Chaozhou songs.

Previous studies have used various approaches and measurements to analyse the relationship between tone and melody in tone languages. This diversity urged us first to decide whether we should take into account the match between individual tones and corresponding musical patterns (Bright, 1957, 1963; Mark & Li, 1966) or the match of pitch direction between a sequence of tones and a sequence of notes (Kirby & Ladd, 2016; List, 1961; Mendenhall, 1975; Richards, 1972; Wong & Diehl, 2002; Yung, 1983). It appears that more studies have more effectively interpreted the tone-melody correspondence

by employing the second approach, as noted by Ladd and Kirby (2020).

Since the change of pitch direction in tones and notes is involved, the identification of pitch of tones, particularly of contour tones, and consideration of the corresponding notes are central to the present study. Hence the next issues are (1) should we identify the pitch of tones by concentrating on the tone endings (Chan, 1987; Wong & Diehl, 2002) or should we consider other aspects such as the extreme pitch-value of a tone? (2) when there is more than one note performed on a tone, should we consider the note-transition based on the sequential note-initial, or the sequential note-ending (Wong & Diehl, 2002), or the note-ending-note-initial relationship (Mendenhall, 1975)? Different decisions may lead to various outcomes of tone-melody correspondence. To figure out a relatively appropriate way to investigate the tone language and the music tradition in the discussion, we decided to compare the relevance of different decisions concerning the tone-melody correspondence in Chaozhou songs by developing them in the light of competing hypotheses.

It is assumed that the change in pitch direction and the size of musical intervals may reflect the relative pitch between the tones of two syllables in a song's lyrics. The discussion of relative pitch has been seen in a few studies of the relationship between tone and melody. Tanese-Ito's focus on Thai court songs (1988) found that a primary

pitch where a mid-tone is sung is used as a reference to contrast different pitch levels of tones. Yung (1983) found singers in Cantonese opera manifest nine lexical tones at three pitch-levels and imitate the pitch-levels in a melodic line. Studies of singing styles *táəm* and *Hrlī* in Kammu found that the lexical tones, High and Low, are differentiated by certain sizes of musical intervals (Karlsson, 2018; Karlsson et al., 2014). Wong and Diehl (2002) suggest an ordinal (rather than a scalar) mapping between melodic movement and the levels of tones in Cantonese contemporary songs. It will be interesting to see how the relation between tones is taken into account when Chaozhou songs are sung or composed.

While tonal contours of successions of syllables in tone languages are shaped by the lexical tones that are part of each syllable when considered in isolation (citation tones), they are also shaped by changes in those tones that arise when syllables are ordered in sequences, as would occur in the context of speech. Such changes are referred to as tone sandhi, and Chaozhou is rich in tone sandhi; it is a language with eight citation tones when spoken in isolation and a complex tone sandhi when spoken in context. Given the prevalence of tone sandhi in Chaozhou speech, it is of interest to explore whether the citation tones or the tones realised with sandhi are more important in determining tone-melody correspondence. While it would seem implicit that the values of sandhi tones should be taken into account in the analysis (Lu, 2017), Sollis (2010) has reported relative consistency in the tone-melody correlation between spoken lines of text and the sung text in *Pikono* (a genre of fictitious stories from Duna in the Southern Highlands of Papua New Guinea), by comparing the words when sung with the same words spoken in isolation. In the present study, we developed a hypothesis that tones undergo sandhi in Chaozhou songs and tested it by comparing the rate of tone-melody correspondence between texts where the tones have their citation values and texts where tones in a non-phrase-final position are computed from sandhi values (see the section ‘Citation tones vs sandhi tones’).

Finally, we made cross-genre comparisons between Chaozhou folk songs and contemporary songs. It was suggested in some early works that the modernised form of songs may follow the restriction of tone-melody matching to a lesser extent. Chao (1956) mentioned that most contemporary songs are less likely to follow the rules of lexical tones than traditional/classic songs in Mandarin Chinese. List (1961) found the degree of tone-melody matching varies in different genres of Thai vocal music, with the highest degree of coordination at 100% in a lullaby and 59% in an acculturated popular song. However, Schellenberg’s study on *Shona* (2009), a Bantu language spoken in Zimbabwe, did not show

different degrees of tone-melody matching in three songs of different types (a biblical hymn, a traditional song and a national anthem). Apart from the contradictory results from these earlier works, studies of contemporary/popular songs in tone languages have shown a high degree of tone-melody correspondence at 91.8% in Cantonese (Wong & Diehl, 2002) and 77% in Vietnamese (Kirby & Ladd, 2016). It is thus of interest in the present study to see how far the tone-melody correspondence in contemporary songs differs from that in folk songs.

This article, therefore, is concerned with the relationship between tone and melody in different genres of Chaozhou songs. It should be noted that most of the publications related to this topic so far have been descriptive (Liu, 2012; Yu, 2012, 2013; Zhong, 2018). Much of the material has not addressed the issues in question. Furthermore, no relevant literature in English exists, so far as the authors are aware. This corpus analysis of Chaozhou songs may shed further light on the issues which have been raised.

Chaozhou tones and songs

Chaozhou citation tones and tone sandhi

The Chaozhou language is spoken mainly in the Chaozhou cultural region¹ by the Chaozhou people (also known as Teochew or Chiuchow, 潮州) in Eastern Guangdong province in China, and by the Chaozhou ethnic group in many countries in Southeast Asia, such as Thailand, Malaysia, Singapore, Cambodia, Vietnam, etc., and in other parts of the world. Although the Chaozhou language is a branch of the South Min dialect in South China, it has a substantial global population of speakers of approximately 30 million.²

Chaozhou has eight citation tones and a wealth of tone sandhi. The term ‘citation tone’ commonly refers to the tone spoken in isolation (see Bao, 1999, p. 79; Lin, 2019), while ‘tone sandhi’ refers to the tone alteration in connected speech (Chen, 2000, p. 19). The best-studied case of tone sandhi may be the ‘third-tone Sandhi’ in Mandarin Chinese, in which the changed tonal value from ‘213’ to ‘35’ is triggered by the following third tone ‘213’ (Chang & Kuo, 2016; Chen & Kager, 2011;

¹ The Chaozhou cultural region consists mainly of three cities, Chaozhou, Shantou (汕头市) and Jieyang (揭阳市), and may include Shanwei City (汕尾市) in a broader sense (Li, 2012). It has also become known as ‘Chao-Shan’ (潮汕) recently.

² Information is from a Chinese website: <http://www.chaofeng.org/article/detail.asp?id=1796>. Another website (<https://baike.baidu.com/item/%E6%BD%AE%E6%B1%95%E5%9C%B0%E5%8C%BA>) points out that the current population of Chaozhou is over 40 million globally; however it does not clarify whether it excludes overseas ethnic Chaozhou who do not speak the language.

Table 1. Eight Chaozhou citation tones for the syllable 'si' in the CZ and ST varieties.

Tone	Value (CZ)	Value (ST)	Character	Example
1	33	33	Mid-level	si – 诗 poet
2	53	53	High-falling	si – 死 death
3	213	213	Low-dipping	si – 四 four
4	<u>21</u>	2	Low-checked	si – 薛 a surname 'si'?
5	55	55	High-level	si – 时 time
6	35	35	High-rising	si – 是 yes
7	11	11	Low-level	si – 逝 disappeared
8	<u>54</u>	5	High-checked	si – 蚀 erosion

Notes: The numerical notation of the tones is based on aural and acoustic analysis in previous investigations by Zhan (1993), Lin (1995), and Lin (2019). It should be noted that the dipping tone is notated as '213' in Lin's and Zhan's reports but as '22' in Lin's study. We have adopted '213' for the tone in line with Chao's five-level system. The underlined '21' and '54' are called Chinese entering tones or checked tones and are shorter in duration than the other tones.

Chen et al., 2015; Speer & Xu, 2008).³ In the Chaozhou language, the tone sandhi patterns are final-prominent or right-prominent (Lin, 2019). This means, in general, tones in the non-final position of a phrase undergo sandhi, but the syllable (or the word)⁴ in the final position of the phrase keeps the value of its citation tone.

The eight citation tones vary slightly from one area to another in the Chaozhou cultural region. The varieties involved in the present study are from Chaozhou City (hereafter the CZ variety) and Shantou City (hereafter the ST variety). The two are similar in their citation tones but show differences in some forms of sandhi tones. The values of the citation tones are indicated in Table 1 with Chao's numerical notation (Chao, 1930), together with the eight meanings of the syllable 'si' when it is pronounced at different pitches. Each character of the tone, e.g. mid-level or high-falling, presents the interaction between tonal register and tonal contour.

As shown in Table 2, in the CZ variety all citation tones undergo sandhi when they are spoken in the non-final position of a bi-syllable, which generates four more contour tones (excluding checked tones), '23', '42', '24' and '12'. By contrast, seven out of eight citation tones in the ST variety are realised as sandhi tones when they are in this context. Overall, the sandhi tones in the ST tend to be slightly more level and higher. This dialectal difference

between two varieties was considered when the corpus of Chaozhou songs was analysed.

Chaozhou songs and the corpus

Songs in the Chaozhou cultural region are rich and varied in musical genres and functions (see Figure 1). These genres can be described as either folk songs or as contemporary songs depending on whether or not they can be traced to traditional cultural practices. Folk songs serve different groups of people depending on whether they are in the plains, the mountains or in the areas close to the sea. The functions of the songs, therefore, vary widely. For example, *Yu'ge* (fishing songs, 渔歌) are heard only among the people who live in the seaside of Shantou and Shanwei City; *Shan'ge* (mountain songs, 山歌) belong to the *She* ethnic group who live in the mountain area of Chaozhou City. Folk songs are sung in the Chaozhou language except for the *Shan'ge*, which are mostly sung in the *She* language⁵ spoken by the *She* People. *Er'ge* (Nursery rhymes, 儿歌), *Xiaodiao* (short tunes, 小调) and *Ge'ce* (song-book, 歌册) are prevalent in most of the areas of the Chaozhou cultural region.

Contemporary Chaozhou songs have been developed in recent decades. The peak of their development was in the period from the late 1980s to the mid-1990s when South China's popular music industry was at its most successful throughout the country, but then they gradually declined in popularity as the industry declined. During the peak period, composers and lyricists co-produced a great body of Chaozhou contemporary songs to meet the demands of the music market and to promote local culture in a relatively popular way. From the local musicians' perspective, it was a golden time of contemporary music in the Chaozhou cultural region.⁶ Some of the contemporary songs became classics and are remembered and sung by the locals who are in their 30s and 40s.

One of the differences between folk songs and contemporary songs in Chaozhou is the application of different musical scale systems. The pentatonic scale with five notes 'do, re, mi, so, la', is employed in the production of Chaozhou folk songs. 'Fa' and 'si' are not necessarily excluded, but they are mostly placed in an insignificant position as passing notes or as an appoggiatura. The composition of contemporary songs breaks with traditional principles by using a heptatonic scale to embrace more fashionable elements. Although contemporary songs target larger audiences via the music industry,

³ We adopt Chao's tone system by numbering the lexical tones from 1 to 5. In this system, '5' is the highest tone and '1' the lowest. The combinations of two or three figures, e.g. '55', '35', '53', '213', indicate the contours of tones, e.g. level, rising, or falling, or dipping.

⁴ In Chinese languages, a word is generally equivalent to a syllable, in general; Chinese is a monosyllabic language. As Duanmu (1994) explained, 'nearly every syllable is a morpheme' and 'except for a few weak syllables, every regular syllable has a tone'. This feature is shared by most Chinese languages including Chaozhou because they have the same written form. In the present study, 'syllable' and 'syllable tone' are equivalent to 'word' and 'word tone'.

⁵ It has been suggested that the *She* language is a combination of the Hakka, Cantonese and Min dialects, with ancient Tai as a source of substrate words (Lin et al., 2006). Relevant references may also be found in Lin and Hong (2005), Huang and Li (1963), and You et al. (2005).

⁶ The information was provided by local musicians during fieldwork in May 2019 in Shantou City.

Table 2. The sandhi realisation in the CZ and ST varieties.

Tones	Value and character (CZ)	Value and character (ST)	Example (CZ)
1	33→23, Mid-rising	33→33, Mid-level	家私 (furniture) ke ³³ → ²³ si ³³
2	53→24/35, Mid-rising/High-rising	53→35, High-falling	水流 (water flow) tsui ⁵³ → ³⁵ liu ⁵⁵
3	213→42/53, Mid-falling/High-falling	213→55, high-level	报告 (report) bo ²¹³ → ⁴² kau ²¹³ 报 复 (revenge) bo ²¹³ → ⁵³ hok ⁵⁴
4	21→54, high-checked	2→5, high-checked	国魂 (soul of a country) kok ²¹ → ⁵⁴ hun ⁵⁵
5	55→213, Low-dipping	55→11, Low-level	茶壶 (teapot) te ⁵⁵ → ²¹³ hu ⁵⁵
6	35→21, Low-falling	35→21, Low-falling	部门 (department) pou ³⁵ → ²¹ mun ⁵⁵
7	11→12, Low-rising	11→12, Low-rising	树顶 (on the top of a tree) ts' iu ¹¹ → ¹² ten ⁵³
8	54→21, Low-checked	5→2, Low-checked	学费 (tuition fee) hak ⁵⁴ → ²¹ hui ²¹³

The table is based on the findings from Zhan (1993), Lin (1995), and Lin (2019). The change from the value of citation tone to the value of sandhi tone is marked by an arrow '→'. Tone '53' (in the third row) and '213' (in the fourth row) in CZ variety are context-sensitive. Whether the sandhi tone is mid-rising/mid-falling or high-rising/high-falling is determined by the register of following tone (Bao, 1999, p. 80). The norm is that the sandhi is mid-rising/mid-falling if the following tone is mid- or low-registered; the sandhi tone is high-rising/high-falling if the following tone is high-registered.



Figure 1. Genres and sub-genres of Chaozhou songs cited from Zhang (2014). A modification has been made to the structure of the diagram in the original, but the details remain the same. The sub-genres of *Er'ge*, *Xiaodiao* and *Ge'ce* are included in the corpus.

most local musicians do not label them 'popular songs'. They prefer to use the term 'new folk songs' or 'dialect songs'.

Field observation and literature study on the tone-melody relationship in Chaozhou

Chaozhou folk singers, in particular the older generation, rely on their implicit knowledge to deal with the relationship between tone and melody. They explained that, because the linguistic tones themselves contain

itches and pitch contours, improvising a song can be based on the artistic use of word tones of the text. This kind of improvisation is usually seen in *Xiaodiao* (short tunes, 小调). The tunes are created on the basis on what singers have observed, thought and experienced throughout their lives, or on the works of a famous poet, children's literature, etc. Certainly, the selection of musical pitches depends on the folk singer's musical experience and skills.

Setting words to a pre-existing tune or employing short skeletal melodies to frame a narrative song can

also be seen in some musical practice. At traditional Chaozhou weddings, a female singer is invited to organise and conduct the whole ritual by singing a set of songs (青娘母歌, *Qingniangmu'ge*). She sometimes improvises the text by rapidly selecting appropriate words with the 'correct' tone but occasionally has to adjust the melodic pitches to use words which are significant but do not have the 'correct' tones. *Ge'ce* (Song-books, 歌册, a type of narrative song), on the other hand, require a bit more creativity. Relying on a few semi-fixed melodic skeletons, singers can sing for hours on end a story written by writers of texts about historical events, or about a famous figure or role model, etc., always referring to the written text as they improvise the melodies.⁷

Whether the singer relies on a pre-existing tune or not, the way the musical pitches are organised is usually linked to the singer's experience of the spoken Chaozhou language. In interviews with Chaozhou folk singers, however, it seems that it is not necessary for them to be consciously aware of the principles that govern the fit between text and tune, because the process of creativity is reported as being at least partly pre-conscious. Hence, it is of interest to see to what extent the tone-melody correspondence may be observed in their singing.

When it comes to writing a contemporary song in the Chaozhou language, most of the songwriters tend not to write text ahead of the tune because the tones of the words would restrict the sung melody. Instead, developing a 'beautiful and fashionable' melody is the priority (Wang, 2012). This practice is believed to enable a flexible space where musicality and contemporary elements come together in songs. However, the priority given to the tune sets, in fact, a high bar for the lyric-writer and thus inspires writers to develop more-or-less explicit heuristics for matching text and tune; Liu, a famous lyricist in the Chaozhou cultural region, suggests that musical intervals and rhythms can be references to establish the overall contour of a melody and that the interval size is the key to selecting words with 'correct' pitches (Liu, 2012). However, without looking closely into contemporary songs, how exactly composers do what they do, and to what extent the tone-melody correspondence is reflected in their work, remains unknown.

It is interesting that Liu also mentioned that the distance between two melodic pitches acts as a metric for measuring the relationship between two tones. To explain this method, he draws a picture of the note-tone correspondence: 'C-C' can be matched with two tones at the same pitch level; words with tones from low to mid

are fitted into the interval 'C-D'; words with tones from low to high are fitted into 'C-E'. This ordinal scaling is not necessary to indicate the absolute matching between tone and note but it clarifies the relationship between two tones at different levels. Similarly, Yu (2013) introduced the possibility of grouping Chaozhou lexical tones at three levels, high, mid and low, in the writing of tone-melody relationship folk songs. Yu's grouping of tones inspired Zhong's analysis of four sample Chaozhou folk songs (Zhong, 2018). By categorising the melodic notes and linguistic tones into three groups of high, mid and low, Zhong looked at the potential correspondence between the tone sequence of 'high-mid-low' and the three associated notes, although the tone-melody correspondence was not quantified. We shall address questions raised in these approaches through the corpus analysis of Chaozhou songs.

Corpus analysis: methods

Data corpus

The corpus of Chaozhou songs contains ten folk songs and ten contemporary songs (see Appendix). Six of the folk songs were recorded from local singers during fieldwork in 2013, 2015 and 2019 and were then transcribed by the first author. The other four songs come from an anthology entitled *The folk Songs of Chao-Shan* (Chen et al., 2012) in which songs were collected from Chaozhou singers and composers at different times for research and cultural preservation. These ten are widely identified as folk songs because the texts either originated from anonymous writers/singers in the past (e.g. the *Er'ge* and *Xiaodiao*) or were written in the form of traditional Chinese poetry by local writers (e.g. the *Ge'ce*). Most of the tunes were developed by singers with different styles so there may be various versions in which each folk song in the present corpus stands for one of the styles. The selected contemporary songs are mainly those regarded as classics among the songs composed in the late 1980s to the mid-1990s. They were recommended by local musicians, amateurs and listeners during fieldwork in May 2019. The scores come from *The Folk Songs of Chao-Shan*, but the video and audio versions are available on YouTube and other Chinese video-sharing websites.

The 20 Chaozhou songs generated a data corpus of 2247 bigrams (ordered two-syllable pairs), with 1432 from the folk songs and 815 from the contemporary songs. The data corpus was coded for the purpose of comparing different factors relevant to tone-melody correspondence, and for calculating the rate of matches and mismatches between tone and melody in two genres of

⁷ The relevant information is cited from Zhang (2017).

Table 3. Two categorisations of tones based on emphasis on different aspects of tones.

Approach	ID	Groups of tones	Citation tones	Tones in the context with sandhi	Relation between two tones (example)
Emphasis on ending pitch of tones	1	High-pitch	55, <u>54</u> , 35	55, <u>54</u> , 35, 24	E.g. the relation between '55' and '53' is The transition from High- to Mid-pitch group (H-M).
	2	Mid-pitch	53, 33, 213	53, 33, 23, 213	
	3	Low-pitch	11, <u>21</u>	42, 11, 21/21, 12	
Emphasis on tone-pitch extreme	1	High-pitch	55, <u>54</u> , 35, 53	55, <u>54</u> , 35, 53	E.g. the relation between '55' and '53' is the transition from High- to High-pitch group (H-H).
	2	Mid-pitch	33	33, 23, 24, 42	
	3	Low-pitch	11, 213, <u>21</u>	11, 213, 12, 21/21	

Chaozhou songs. All the data were recorded in Excel and analysed in RStudio.

Citation tones or sandhi tones

To test the effect of tone sandhi, we coded the values of tones in a twofold manner to see if the tones realised in context are more relevant to the correspondence between tone and melody in Chaozhou songs. First, by treating tones in song lyrics as the tones spoken in isolation, their values as citation tones are numerically notated; and second, by identifying the tones spoken in the context with sandhi, their values as sandhi tones are computed. The two treatments resulted in two sets of data. One is the set of data coded from the values of citation tones. The other is the set of data coded from both the values of sandhi tones realised in the non-phrase-final position and values of citation tones realised in the phrase-final position (see the previous section for 'Chaozhou citation tones and tone sandhi').

Categorisation of tones

Based on their tonal composition, there are 208 possible bigram types, 64 consisting of two citation forms and 144 that include at least one sandhi form. To reduce complexity, we grouped together tones with the same pitch level.

In their analysis of Cantonese songs Wong and Diehl divided the six tones into three groups of high-, mid- and low-pitch by emphasising the ending point of tones (2002). For instance, a tonal ending with a '5' (e.g. tone '55', or '25') belongs to a high-pitch group; a tonal ending with a '3' (e.g. tone '33' or '23') goes into a mid-pitch group, and a tonal ending with a '1' or '2' goes into a low-pitch group. This approach is consistent with the results of Chan's study of modern Cantonese songs (Chan, 1987) and with Kirby and Ladd's ranking of tones in the analysis of Vietnamese popular songs (Kirby &

Ladd, 2016). Although Chaozhou researchers and musicians hold a similar view of dividing tones into three groups, it is initially unclear whether the emphasis on the ending point of tones will serve as a group identifier in Chaozhou songs. Both the pre-analysis from a small sample out of the current corpus and Zhong's analysis of four Chaozhou folk songs predict that it might rather be the extent of deviation of tone from the neutral level (hereafter, tone-pitch extreme) that plays a critical role in the categorisation of tones. For example, '5' and '1' which are furthest from the neutral value '3' stand for a high pitch-level and a low pitch-level; '3' represents the middle pitch-level in the case of '33', '24', '42' and '23'; tone '213' is treated as a low tone because of its wider span in the lowest pitch-register.

We thus developed two different approaches to the competing hypotheses in which tones are assigned into three groups of high-, mid- and low-pitch (see Table 3 for the hypotheses and the group ID of 1, 2 and 3).

We also considered more possibilities in reflecting the categorisation of tones. By assigning tones into five groups of Very-high-, High-, Mid-, Low- and Very-low-pitch (identified by the numbers 1, 2, 3, 4 and 5), we compared the tone-melody correspondence from the five-group categorisation with that from the three-group categorisation.

Transition of notes

In the analysis, two notes correspond to two successive tones. We made clear which notes were considered when the successive tones were attached to two single notes. It is also apparent that if there is ornamentation, only the principal note is analytically functional. However, when there is more than a single note performed on a tone, the question of which note should form part of the analysis comes into play. We first identified melismas performed on syllable tones (except the last) in lines of lyrics as meaningful phrases, but we treat melismas on final syllable tones as expressive decorations (in line with the

Line one

The number for syllables	01	02	03	04	05	06	07	08	09	10	11	12	13	14
Lyric in Chinese	月	娘	月	光	光	秀	才	郎	骑	白	马	过	洞	堂
Lyric in IPA	gue?nīe	gue?kɿŋ		kɿŋ,		siu	tshai	nɿŋ,	khia	bē?	be,	kue	taŋ	tɿŋ.
Values of citation tones	54	55	54	33	33	213	55	55	55	54	53	213	11	55
Values of sandhi tones (in bold)	21	55	21	23	33	42	213	55	213	21	53	42	12	55
Lyric in English (The moon is bright. A scholar is riding on a white horse, passing through the Dongtang.)													

Figure 2. Examples from the folk song ‘Moon lady’. Different modes of note-transition were labelled as ‘I-I’ (note C–F), ‘E-I’ (note D–F) and ‘E-E’ (note D–D). The notes F and G (in the grey frame) at the end of line four were excluded because they serve as decoration to the melody. Transition from syllable_05 to _06, from syllable_08 to _09, and from syllable_11 to _12 and their corresponding notes were excluded from the data corpus, too.

views of singers whom we interviewed). Then, we considered three modes of note-transition in the analysis: (1) the transition between two initial notes of successive melismas (labelled as I-I for this sequential note-initial relationship); (2) the transition between two ending notes of successive melismas (labelled as E-E for this sequential note-ending relationship); (3) the transition from the ending note of a melisma to the initial note of the subsequent melisma (labelled as E-I for this note-ending-note-initial relationship). The change of pitch direction in two notes was notated. The interval sizes on two notes were also measured in semitones and were then coded numerically for the purpose of analysis. It should be noted that we considered only the first note of a melisma performed on the last word of a line; note/tone-transitions across a boundary between two lines in the lyrics were excluded from the data (see the example in Figure 2 for more details).

Calculating the correspondence between tones and notes

In the present study, the relationship between tones and notes can take the form of similar motion, oblique motion or contrary motion (Kirby & Ladd, 2016; Ladd & Kirby, 2020). These three terms are used to represent the constraints on sequences of two syllable tones and two musical notes. Specifically, in similar motion, two lines (tones and notes) go in the same direction; in oblique motion, one line goes up or down while the other stays at the same pitch; in contrary motion, two lines go in opposite directions. Apart from this, we also divided the oblique motion into oblique-I and oblique-II to distinguish the direction of pitch in the two lines (see Figure 3 for more details). Oblique-I refers to the case where the line of tones goes up or down while the line of notes stays at the

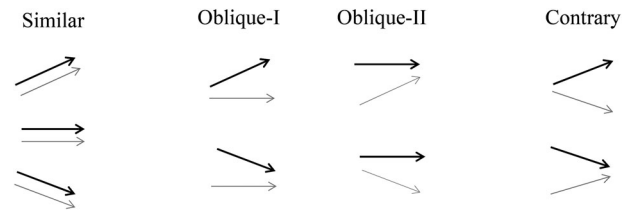


Figure 3. Relationships between tones and notes. The black arrows stand for the lines of tones, and the grey arrows are for the lines of notes.

same level; oblique-II refers to the case where the line of tones remains at the same level while the line of notes goes up or down.

The relationship between two tones can be expressed by $\Delta T = t1 - t2$, where $t1$ and $t2$ are the group IDs of the two consecutive tones. For example, the transition ΔT from a high-level group to a low-level group in the three-group categorisation is ‘ $-2 = 1-3$ ’, in which the minus sign ‘ $-$ ’ indicates that the direction of pitch change is downward while the number 2 means the measurement of the distance is two-tone-groups wide. Likewise, the transition ΔT from a Very-high- to a Very-low-level group in the five-group categorisation is ‘ $-4 = 1-5$ ’. Meanwhile, the pitch directions of two successive notes are identified by $\Delta P = \text{sign}(p2-p1)$, where $p1$ and $p2$ are the pitch levels of the musical notes. Hence, ΔP can have three values: 1 for an upward trend, 0 for an unchanged direction, and -1 for a downward trend. We can then compare the pitch directions of a two-tone sequence and the corresponding two-note sequence. If they have the same sign, they are considered a match. Otherwise, a mismatch is counted. Processing the 2247 pairs of tones (and the notes attached) gave the total number of mismatches. The degree of tone-melody correspondence is then measured by the number of matches; these matches are called

Table 4. The outcomes of Pearson's r correlation coefficient test between categorisations of tones and modes of note-transition, based on the data of tones in the context with sandhi.

Genre of songs	Categorisation of tones	I-I	E-E	E-I
Folk ($n = 1432$)	Emphasis on the tone-pitch extreme	0.87	0.77	0.84
	Emphasis on the ending pitch of tones	0.62	0.58	0.60
Contemporary ($n = 815$)	Emphasis on the tone-pitch extreme	0.79	0.65	0.73
	Emphasis on the ending pitch of tones	0.56	0.51	0.53

Table 5. The outcomes of Pearson's r correlation coefficient test between categorisations of tones and modes of note-transition, based on the data of citation tones.

Genre of songs	Categorisation of tones	I-I	E-E	E-I
Folk ($n = 1432$)	Emphasis on the tone-pitch extreme	0.22	0.22	0.22
	Emphasis on the ending pitch of tones	0.17	0.18	0.16
Contemporary ($n = 815$)	Emphasis on the tone-pitch extreme	0.18	0.20	0.18
	Emphasis on the ending pitch of tones	0.15	0.15	0.14

similar motions. The mismatches, on the other hand, are divided into oblique-I motions, oblique-II motions and contrary motions.

Results and discussion

We conducted a Pearson correlation coefficient analysis to assess the relationships between two categorisations of tones and three modes of note-transition (the confidence levels were computed using an $\alpha = 0.05$). We also compared the effects of three modes of note-transition on the degree of tone-melody correspondence in Chaozhou songs, by assigning tones to different groups. The analyses were based on the data coded first for tones as though realised in contexts where sandhi occurred (Tables 4 and 6), and second for tones in (isolated) citation form (Tables 5 and 7).

Citation tones vs. sandhi tones

Table 4 shows that the values of the Pearson correlation coefficient lie between .51 and .87, whereas they are all below .25 in Table 5. This striking difference between the two tables indicates that a significantly higher degree of correlation between the categorisation of tones and the mode of note transition in Chaozhou songs resulted from sandhi values rather than citation values. Furthermore, the proportions of similar motions in different contexts in Table 6 calculated using sandhi are strikingly higher than those in Table 7, overall. These outcomes show that

there is a clear effect of tone sandhi on the tone-melody correspondence in Chaozhou songs.

The correlations between categorisations of tones and modes of note transition

While Table 4 shows that the categorisations of tones and the modes of note transition are strongly correlated (according to Cohen's standard of evaluating the strength of correlation: Cohen, 1988, 1992), the degree of correlation varies. The categorisation emphasising the tone-pitch extreme and the mode I-I based on the sequential note-initial relationship had the highest correlated value ($r = .87$ for the folk songs and $r = .79$ for the contemporary songs). Outcomes in Table 6 show that the rate of tone-melody matches reached a maximum of 89% in the folk songs and 78% in contemporary songs in this context. However, the rate of similar motions fell from 89% to 60% in folk songs and from 78% to 56% in contemporary songs when the ending pitch of tones was emphasised. The relatively low degree of tone-melody correspondence suggests that this approach found in the analysis of Cantonese songs is, in fact, not applicable for the corpus analysis of Chaozhou songs.

From Table 6, the effect of the mode E-I based on the note-ending-note-initial relationship is slightly less than that of mode I-I, but by only 3%. Meanwhile, the fact that the least effect was found for mode E-E based on the sequential note-ending relationship suggests that it is not appropriate for the language and music culture under discussion. The result in the seventh column in Table 6 suggests that the combination of emphasising ending pitch of tones and employing mode E-E produced the lowest degree of tone-melody correspondence (58%). However, this combination in the analysis of Cantonese songs resulted in a high rate of tone-melody matching at 91.8% (Wong & Diehl, 2002).

Would a five-group categorisation be better than a three-group categorisation? To answer this question, we assigned tones into five groups in multiple ways, including considering the tone-pitch extreme, ending pitch of tones, the average of tonal values,⁸ as well as other ways of assigning seemingly ambiguous tones into different groups. However, the highest rates of similar motions generated among these assignments (84% for folk songs and 76% for contemporary songs), are still no better than those of three-group categorisation based on emphasising the tone-pitch extreme (89% and 78%).

⁸ In this categorisation of tone, tones are assigned to five groups identified by their average of tonal values, e.g. the average value of '53' or '35' is 4, of '213' is 2, and of '21' or '12' is '1.5'. The ranks of tone at five pitch levels are 4.5-5, 3.5-4, 3, 2-2.5, 1-1.5.

Table 6. The outcomes of relationships between tones and melody in Chaozhou songs based on the data of tones in the context with sandhi.

	I-I	Emphasis on the tone-pitch extreme			Emphasis on ending pitch of tones		
		E-E	E-I	I-I	E-E	E-I	
Folk	Similar	1271(89%)	1134 (79%)	1227 (86%)	860 (60%)	833 (58%)	848 (59%)
	Oblique-I	85 (6%)	188 (13%)	122 (9%)	290 (20%)	329 (23%)	309 (22%)
	Oblique-II	62 (4%)	75 (5%)	61 (4%)	216 (15%)	165 (12%)	197 (14%)
	Contrary	14 (1%)	35 (2%)	22 (2%)	66 (5%)	105 (7%)	78 (5%)
Contemporary	Similar	637 (78%)	552 (68%)	623 (76%)	460 (56%)	439 (54%)	447 (55%)
	Oblique-I	121 (15%)	158 (19%)	124 (15%)	236 (29%)	249 (31%)	243 (30%)
	Oblique-II	29 (4%)	49 (6%)	27 (3%)	66 (8%)	62 (8%)	68 (8%)
	Contrary	28 (3%)	56 (7%)	41 (5%)	53 (7%)	65 (8%)	57 (7%)

Table 7. The outcomes of relationships between tones and melody in Chaozhou songs based on the data of citation tones.

	I-I	Emphasis on the tone-pitch extreme			Emphasis on ending pitch of tones		
		E-E	E-I	I-I	E-E	E-I	
Folk	Similar	621 (43%)	587 (41%)	606 (42%)	706 (49%)	628 (44%)	675 (47%)
	Oblique-I	381 (27%)	431 (30%)	403 (28%)	293 (20%)	373 (26%)	323 (23%)
	Oblique-II	245 (17%)	205 (14%)	229 (16%)	193 (13%)	183 (13%)	185 (13%)
	Contrary	185 (13%)	209 (15%)	194 (14%)	240 (17%)	248 (17%)	249 (17%)
Contemporary	Similar	381 (47%)	356 (44%)	382 (47%)	336 (41%)	303 (37%)	334 (41%)
	Oblique-I	227 (28%)	248 (30%)	229 (28%)	255 (31%)	278 (34%)	257 (32%)
	Oblique-II	143 (18%)	156 (19%)	133 (16%)	173 (21%)	192 (24%)	164 (20%)
	Contrary	65 (8%)	69 (8%)	62 (8%)	73 (9%)	79 (10%)	70 (9%)

The degree of tone-melody correspondence

The third column of Table 6 shows that the degree of tone-melody correspondence in the contemporary songs was lower than in folk songs. The proportion of similar motion in contemporary songs made up 78% of the total, compared to 89% in folk songs and the percentage of contrary motions in the contemporary songs was three times higher than in folk songs (3% vs 1%) and the rate of oblique motions (19%) nearly doubled the folk songs percentage (10%).

We compared oblique-I and oblique-II motions and showed that while the rates of oblique-II motions in both folk and contemporary songs stay at the same level (4%), the percentages of oblique-I motions (15%) in contemporary songs are much higher than in folk songs (6%). It thus implies that oblique-I motion, when referred to the line of tones, may rise or fall while the pitches of the notes at the same level, and may be more acceptable to contemporary composers than by folk singers.

Focusing on the details of contrary motions, we found that 13 out of 14 instances of contrary motions were from the folk song 'A lantern song of twelve months' (Table 8), which is striking. The remaining instance came near the end of the folk song 'A hundred pictures on lanterns', where a pause (a quaver rest) indicates the end of the singing. This pause may weaken the violation of lexical tone in the singing. However, the remarkable number of contrary motions in 'A lantern song of twelve months' requires closer inspection. It is surprising that these violations do not affect the popularity of this folk song in the Chaozhou cultural region.

Table 8. Sources of contrary motions in the Chaozhou folk songs and contemporary songs.

Genre	Total	Contrary motions	
		Neighbouring	Non-neighbouring
<i>Folk songs</i>			
A lantern song of twelve months	13	12	1
A hundred pictures on lanterns	1	1	0
<i>Contemporary songs</i>			
Falling leaves	1	1	0
A morning song in the water town	2	2	0
Flying, the colourful clouds	1	1	0
Bitter love	3	2	1
Deep river	4	3	1
The moon that night	3	3	0
Love is in the earth	10	8	2
Ying'Ge Dance	4	4	0

Examination shows that most of the contrary motions (12/14) in 'A lantern song' occur between two neighbouring tone groups, e.g. Mid-Low or High-Mid, which means the distance between two tones at different levels is minimised. Additionally, familiarity of this folk song, which belongs to one of the best-known opera repertoires in the Chaozhou cultural region, may have contributed to its popularity.

In contrast, as shown in Table 8, contrary motions can be found in almost all the contemporary songs. Twenty four out of 28 instances of contrary motions were observed between two neighbouring tone groups, which means only four cases occurred between the high-pitch group and the low-pitch group. This result indicates that contrary motions are more tolerable but the violation

of tones in non-neighbouring tone groups occur only rarely.⁹

Overall, the high percentages of similar motions (89% and 78%, respectively) in the folk songs and contemporary songs confirm the close relationship between tone and melody in Chaozhou songs. Although it is not surprising that the tone-melody relationship is more robust in the Chaozhou folk songs, overall, the sacrifice of tonal clarity is still somehow restricted in contemporary songs. This result might show why Chaozhou contemporary songs are regarded as ‘new folk songs’ or ‘dialect songs’ by musicians in the Chaozhou cultural region, although the genre is open to the absorption of the more cosmopolitan, fashionable elements of popular song.

Conclusions

In the corpus analysis of Chaozhou songs, we have examined the effect of tone sandhi on the correspondence between tone and melody by comparing those tones in their citation form. Findings would suggest that tones should be coded from their sandhi values when they are sung in song lyrics, otherwise tone-melody correspondences are significantly reduced.

We have also tested the correlation between sequences of tones and interval sizes, with signs indicating the directions of pitch change. By comparing different approaches in the corpus analysis, we have shown that the tone-pitch extreme, rather than the ending pitch, plays an essential role in the identification of the pitch level of tones. When we consider note transition, we see that the sequential note-initial relationship is more effective than the note-initial-note-ending relationship, and that is in turn more effective than the sequential note-ending relationship. This result may be caused by the effect of the tone-pitch extreme. We have also ruled out any real need to apply a five-group categorisation of tones in the current sample of Chaozhou songs by comparing multiple ways of assigning tones to different groups of Very-high-pitch, High-pitch, Mid-pitch, Low-pitch and Very-low-pitch.

A high degree of correspondence between tone and melody is found in Chaozhou songs, with 89% in folk songs and 78% in contemporary songs. Meanwhile, the higher rate of similar motions in the folk songs suggests that folk singers are more likely to follow the rule

of tone-melody matching than are contemporary composers. We also divided the oblique motions into oblique-I and oblique-II. We found that contemporary composers are more tolerant of the oblique-I motions, while the oblique-II motions were treated similarly by folk singers and contemporary composers.

Having checked the numbers and instances of contrary motions in Chaozhou songs, we found, overall, that both folk singers and contemporary composers avoid the violation of a constraint against contrary settings in tone production. Where contrary motions are concerned, the violations occur mostly between neighbouring tone groups, e.g. from a Low-pitch group to a Mid-pitch group, or from a Mid-pitch group to a High-pitch group. However, on the whole contrary motions are more acceptable to contemporary composers than to folk singers. While this may reflect different compositional and performance usages in the two genres, it may be a consequence of the use of different scale systems in each genre.

The results of the Pearson’s correlation coefficient tests also confirm that the association between sequences of tones and their corresponding melodic intervals is highly correlated. We infer that the interval size employed to reflect the pitch distance between two tones in neighbouring groups or non-neighbouring groups (e.g. from a Low-pitch group to a High-pitch group), might reflect a categorical boundary in production or perception; the further the interval size is from the categorical boundary, the more influential the non-neighbouring tone groups would become. Future work would involve testing this hypothesis by looking at how native speakers perceive the difference between neighbouring and non-neighbouring tone groups in Chaozhou songs.

Finally, the current focus on the match of pitch direction between a sequence of tones and of notes provides us with a general picture of how tone-melody correspondence works. However, we have somewhat neglected the details of performance practices in Chaozhou songs, particularly in reference to contour tones. We hope to address this issue in future work.

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⁹ Bob Ladd (personal communication) has helpfully suggested that this finding can be expressed as ‘contrary settings get worse as the interval widens’, noting that this parallels a finding by McPherson and Ryan (2018) in respect of Malian (Dogon) songs except that they found this occurred with respect to the *melody* rather than the *tones*. He suggests that this may be because in Chaozhou there are so many different tones, allowing for a sense of lesser or greater distance between them, whereas in Dogon tones exist as either high or low only.

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Appendix. Chaozhou folk songs and contemporary songs in the corpus.

Folk songs				
	Genre	Title	Singer	Notater
1	<i>Er'ge</i> (Nursery rhyme)	Og a Og	YiWen Yu	Xi Zhang
2	<i>Er'ge</i> (Nursery rhyme)	Counting fingerprints	HanTong Feng	MaYuan Chen
3	<i>Er'ge</i> (Nursery rhyme)	Rain falls	Unknown	MeiSong Chen
4	<i>Xiaodiao</i> (Short tune)	A goose in the sky	YiWen Yu	Xi Zhang
5	<i>Xiaodiao</i> (Short tune)	Moon lady	YiWen Yu	Xi Zhang
6	<i>Xiaodiao</i> (Short tune)	Song of moonlight	Juan Hu	Xi Zhang
7	<i>Xiaodiao</i> (Short tune)	Going to the field with my water buffalo	YiWen Yu	Xi Zhang
8	<i>Ge'ce</i> (Songbook)	New sounds from one hundred birds	ShaoHong Lin	Xi Zhang
9	<i>Xiaodiao</i> (Short tune)	A lantern song of twelve months	Peng Chen	HuanGen Chen
10	<i>Ge'ce</i> (Songbook)	A hundred pictures on lanterns	MeiLing Huang	HuanGen Chen
Contemporary songs				
	Genre	Title and year of publishing	Composer	Lyrcist
11	Contemporary	Falling leaves (1994)	ShengXin Jiang	JinFeng Li
12	Contemporary	A pot of tea, a pot of moon (1994)	XiaoQi Chen	XiaoQi Chen
13	Contemporary	A morning song in water town (1992)	ShengXin Jiang	ZeQiong Wang
14	Contemporary	Flying, the colourful clouds (1989)	Zai Lan	ShengXin Jiang
15	Contemporary	Bitter love (1989)	ShuHua Song	XiaoQi Chen
16	Contemporary	Deep river (1989)	PeiYu Wang	Liu Yu
17	Contemporary	The moon that night (1994)	JianHui Liu	JinFeng Li
18	Contemporary	Love is in the earth (1998)	Zai Lan	XiaoQi Chen
19	Contemporary	You are a flower in March (1995)	YouAi Yang	JinFeng Li
20	Contemporary	<i>Ying'Ge</i> Dance (1990)	Zai Lan	XiaoQi Chen