What About Tone?

聲調呢？

The correlation between linguistic tone and musical pitch in two diachronic genres of Mandarin music

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1. Introduction

Music is often known as the "universal language," and it seems an unarguable proposition that nearly all, if not all, of the world's cultures contain some form of music. The majority of the world's people speak a tonal language (Moira Yip 2002), and the world's most widely spoken language, Mandarin Chinese, is a tonal language. Thus, it should come as no surprise that linguistic tone and musical pitch interact when singers sing songs in tonal languages. Mandarin Chinese, and the Sinitic languages in general, is no exception.

The question at hand is not only whether tonal languages, and in this case Mandarin Chinese, show a correlation between linguistic tone and musical pitch, but whether older, more traditional and more culturally endogenous songs demonstrate a higher correlation between tone and tune than newer songs from the twentieth century that exhibit a higher degree of Western influence. While the existing literature does examine the question of correlation between linguistic tone and musical pitch in Mandarin, there is a relative paucity of literature comparing genres of music. In this paper, I examine four songs, two traditional folk songs and two songs stemming from the *shídàiqǔ* style of songs sung in Shanghai from the 1920s to the 1940s and hypothesize that the two older folk songs will demonstrate a higher degree of correlation between the two than the newer Shanghai-style songs.

I use three different frameworks: Lian Hee Wee's (2007) existing framework, which proves to be so loose that it is not useful; a middle-ground framework that straightforwardly looks at individual syllables and transitions but fails to yields clear conclusions; and finally, a model that takes both overall F_0 (fundamental frequency) and melismatic syllables (individual syllables mapped to multiple pitches) into account. This third model combines both (1) the transitions between F_0 of spoken speech and musical pitch and (2) melismatic syllables; from it, I conclude

that in fact older folk songs do demonstrate more correlation between linguistic tone and musical pitch than newer Shanghai songs, validating my hypothesis.

2. Linguistic and musical background

Before launching into the main body of the paper, I present some basic information about Mandarin and Cantonese tones, and some musical concepts fundamental to the discussion.

2.1 Mandarin tones

As is commonly known, Mandarin has four tones. In this paper, I am using the standard value of Mandrain and the notation of Yuen Ren Chao, in which 5 represents the highest pitch and 1 represents the lowest pitch. (This is the opposite convention of tonal work in most Amerindian linguistics, in which 1 represents the highest pitch [Yip 2002].) Under this system, we have the following values for Mandarin tones (with the classic examples):

Tone 1 55
媽 *mā* 'mother'

Tone 2 15
麻 *má* 'hemp'

Tone 3 214/21
馬 *mǎ* 'horse'

Tone 4 51
罵 *mà* 'scold'

The Mandarin third tone undergoes a number of changes of which it is important to be aware. Although the textbook third tone is a falling-rising tone, in situations in which the third tone is not utterance-final it becomes what is known as a "half-third tone," in which the falling part of the tone is sharply curtailed or even absent, in which case the tonal value of the tone becomes 21 instead of 214, lacking the final rise. In some areas, such as Taiwan, all third tones in effect become "half-third tones," so even utterance-final Mandarin tones are pronounced in this manner. Mandarin's most prominent tonal sandhi occurs when two third tones follow each other:

the first third tone becomes a second tone, so what would be a 21-214 tonal value (remember that non-utterance-final third tones become half third-tones) becomes instead 15-214. For example, the quintessential Mandarin greeting 你好 *nǐhǎo* 'hello' consists of two sequential third tones. Because of this, it is actually pronounced as *níhǎo*. Another example would be of the words 買 *mǎi* 'buy' and 埋 *mái* 'bury.' When these words precede a third-tone syllable, say 狗 *gǒu* 'dog,' the expressions are synonymous: 買狗 *mǎi gǒu* 'to buy a dog' and 埋狗 *mái gǒu* 'to bury a dog' are both pronounced *mái gǒu* and are synonymous!

Mandarin also contains a "neutral tone," which is usually found on a "small subset of syllables, mainly affixes but also non-initial syllables of some bisyllabic words" (Yip 2002). Some of the syllables on which the neutral tone falls are completely toneless, i.e. syllables such as 的 *de*, the possessive particle. In other situations, for instance in bisyllabic, reduplicated words, the neutral tone falls on syllables which normally have lexical tone; an example would be in 妹妹 *mèimei* 'younger sister', in which the first syllable is reduplicated but the second syllable is toneless/neutral (Yip 2002). Because the exact phonetic realization of the neutral syllable is controversial – broadly speaking, some scholars claim that it results from a "spreading" of the previous tone onto the syllable carrying the neutral tone, while other scholars claim that the underlying tone of the neutral tone is a low tone – I have refrained from including it in the first two approaches I present because these two choices would require that one decide whether the neutral tone is H or L, a controversial manner. However, I *have* included neutral-toned syllables in the third approach (F_0 and melismatic syllables) of this paper, because in that approach I simply measure the actual F_0 of syllables as spoken. This does not require a theoretical

commitment to either school of thought regarding the neutral tone and merely measures the F_0 of any syllable as spoken.

2.2 Cantonese tones

Although Cantonese is not the focus of this paper, it is discussed in some of the literature and thus a brief examination of its tonal system is also necessary. Cantonese has nine tones. Six are for open syllables (the pronunciation of the characters in Mandarin are also given for comparison). Tone numbering (Tone 1, Tone 2, etc.) is the conventional ordering. The numbers describing the tone's contour, i.e. 55 for tone 1, 22 for tone 4, etc., follow Chao's system, so 5 is the highest pitch and 1 is the lowest pitch.

Tone 1 (upper level)		55	Tone 4 (lower level)		22 or 21
詩 *si55*	M: *shī*	'poem'	時 *si22*	M: *shí*	'time'
Tone 2 (upper rising)		35	Tone 5 (lower rising)		24
史 *si35*	M: *shǐ*	'history, story'	市 *si24*	M: *shì*	'city, market'
Tone 3 (upper departing)		44	Tone 6 (lower departing)		33
試 *si44*	M: *shì*	'to try'	是 *si33*	M: *shì*	copula

The remaining three tones, which together form the traditional nine tones of Cantonese, are versions of tones 1, 3 and 6, except that these last three tones are for closed syllables:

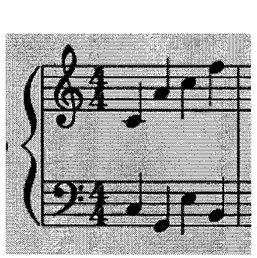
Tone 7		5	Tone 9		3
識 *sik5*	M: *shì*	'recognize'	食 *sik3*	M: *shí*	'eat, food'
Tone 8		4			
錫 *sik4*	M: *dì*	'tin'			

2.3 Musical background

There are two main ways by which one can compare linguistic tone and musical pitch: melismatic syllables and transitions. Any spoken syllable may be mapped to one or more musical

pitches. A syllable that is mapped to multiple pitches is termed "melismatic." However, many – even most – syllables are not mapped this way to multiple notes (otherwise, music would become rather challenging to listen to, as it would probably undulate back and forth considerably!) An inspection of all four pieces studied in this paper reveals that in all of them, non-melismatic syllables form a majority of the syllables. Therefore, the important thing to examine is the transitions between notes, because if one focused solely on melismatic syllables, then many syllables would simply be un-analyzable.

As for transitions, when two syllables are each mapped to one note (so neither syllable is melismatic), then the transition consists of the two pitches. If a syllable is mapped to multiple pitches, as in the case of melismatic notes, then the notes that form the transition are the last note of the preceding syllable and the first note of the following syllable.



I also use conventional octave notation to notate musical notes when they are discussed in text, not in staff. In the figure to the left, the notes in the treble clef would be notated as C4, A4, C5 and F5. The notes in the bass clef are C3, G2, E3 and B2. (In other words, the letter marks the pitch and the number the octave.) Finally, a "semitone" is the smallest interval used in Western classical and art music. On a piano keyboard, it is the difference between any two notes (C to C#, C# to D, D to D#, D# to E, etc.)

3. Previous literature

Significant work has been done cross-linguistically to examine the correlation between tone and tune. The literature presented here focuses mostly on Sinitic and African languages with a

brief interlude into the Pakistani language of Kalam Kohistani, since these are the main language groups, besides Chinese, in which this topic has been studied

3.1 African languages and Kalam Kohistani

Paul Richards (1972) addressed the relationship between tone and melody in a Hausa song composed for the independence of Nigeria in 1960. He concluded that when possible, Hausa singers attempt to maintain a correlation between tone and pitch. Hausa contains three tones: a low tone, a high tone and a falling tone, the last of which Richards ignored because it is infrequent in music. Therefore, with a low tone and a high tone in consideration, there are three types of syllable-to-syllable transitions that can take place – rising, level or falling. Pitch-to-pitch transitions can also take three forms: rising, level or falling. Richard defined three types of movement: parallel, contrary and oblique, determined by the correlation between syllable-to-syllable transitions and pitch-to-pitch transitions. Parallel movement occurs when tone and pitch move in the same direction; contrary movement occurs when tone and tunes move in opposite directions (rising/falling or falling/rising); and oblique movement occurs when one of either transition is rising or falling and the other is level. Of the 35 lines and 380 syllables of the song, Richards found that parallel transitions formed 53.4 percent of the total number of transitions; oblique transitions formed 36.6 percent of the total; and contrary transitions formed 10 percent of the total. He concluded that this is not simply a distribution according to chance, since this would result in parallel transitions forming 27.4 percent, oblique 52.6 percent and contrary movements 20 percent of the total.

More recently, Murray Schellenberg (2007) also applied the same framework to three different types of songs for Shona, also finding that statistically speaking, there was a higher-

than-probable number of parallel correlations than would otherwise be expected. Schellenberg analyzed three Shona songs: a Biblical hymn, a traditional song and the national anthem of Zimbabwe. He also concluded that there is a greater proportion of parallel transitions than one would expect simply by chance, which suggests that Shona songwriters attempt to maintain some sort of correlation between spoken tone and the sung melody. However, Schellenberg also found that the areas in the songs that exhibit parallelism are unpredictable. In other words, it was not the case that the beginning of the songs or heads of syllable demonstrate more or less correlation between linguistic tone and musical pitch.

Not all scholars have found that there is a correlation between tone and pitch. In fact, Joan Baart (2004) and V. Kofi Agawu (1994) concluded that for Kalam Kohistani and Ewe, respectively, there is little correlation between tone and tune in both languages.

Kalam Kohistani, spoken in mountain valleys in northern Pakistan, contains five contrastive tones, although the tones differ from those of Mandarin, in that the tones fall over the entire word and not over individual syllables. There is a high level tone, a high-to-low falling tone, a delayed high-to-law falling tone, a low-level tone and a low-to-high falling tone. Baart examined 14 samples of a traditional form of Kalam Kohistani poetry, comparing the direction of pitch change in the song's melody with the direction of pitch change in the syllables in normal spoken speech. She found that the direction of tone pitch matches the direction of tone less than 50 percent of the time. However, she also discovered that if she ignored level sequences and only examined rising and falling tone and tune, that the degree of correlation was much stronger: 74 percent of rising tone sequences corresponded to rising sung pitches and 87 percent of falling sequences corresponded to falling verses.

Agawu (1994) asserted that there in Ewe, there was little correlation between tone and pitch. After analyzing eight songs, she concluded that statistically speaking the correlation between tone and pitch is insignificant and there is no locus of predictability as to where tone and pitch would coincide. Her choice of songs included funeral dirges, work songs, a song sung when animals happen upon little children and a series of "interludes" sung to recount cultural stories and tales, illustrating a wide range of genres. While Agawu concluded that statistically speaking there can be no correspondence between tone and tune, she did offer the additional concluding thought that the rhythm of spoken speech may be an important factor in Ewe music.

3.2 Work in Sinitic languages

Scholars have also investigated the interaction of linguistic tone and musical pitch in the Sinitic languages, largely in Mandarin and Cantonese Chinese. I first present Chao's (1954) hierarchy, which ranks genres of Chinese music on their correlation between pitch and tone, placing traditional singsong and chanting as showing the most correlation and contemporary atonal composition as showing the least correlation. I then examine various genres of both Cantonese and Mandarin music. First, I review Bell Yung's (1989) and Jonathan Stock's (1999) examinations of Cantonese and Mandarin opera, respectively, which arrive at very different conclusions regarding the role of tone. I then move on to newer genres of music: Patrick Wong and Randy Diehl (2002) and Wing See Vincie Ho (2006) both argue that Cantonese popular music demonstrates a high degree of correlation between linguistic tone and musical pitch. Finally, Lǐ Bàochén (1964) briefly offers an examination of popular Mandarin music of the 1960s, making a general claim that Mandarin music requires a correlation between tone and pitch, without offering many specific details.

We can see, therefore, that there is a paucity of literature comparing genres of Mandarin music from different chronological periods and any possible difference in the way that they treat tone and pitch. While Chao gives a general hierarchy for Chinese music and Li offers some thoughts on then-contemporary Mandarin popular music, neither really compares two genres across time periods in more than a general sense: this is the main reason I have chosen to address this line of research in this paper.

3.2.1 Chao's hierarchy

Chao's (1954) examination of tone and intonation in Chinese music results in a genre hierarchy, namely "singsong, chanting, recitative, tonal composition and atonal composition" in Chinese (p. 52). Singsong is a type of style that falls between ordinary speech and music, which "is based largely on the phonemic tones of the words, spoken in a stereotyped manner." Chanting is described as being largely, but not unambiguously, dictated by tone. Recitative, next on the scale, is the "traditional form of Chinese drama," and while the music does usually follow the tones of the words, the tone values in an artificial dialect, known as "Chung-chou" (although the Chinese characters are not given, this is probably 中州 *zhōngzhōu* 'central province/state'), are the ones on which the music is based. Chao's also separates between "tonal compositions" and "non-tonal compositions." He claims that older compositions demonstrate more of a correlation between the two, while the majority of contemporary music does not take tone into account at all. Chao offers, however, very little empirical or quantitative information to back up his assertions about this hierarchy; therefore, although this hierarchy corresponds with my intuition about the relationship between tone and pitch in older versus newer genres of music, it is of limited use.

3.2.2 Chinese opera

Two authors who studied Chinese opera, an art which differs significantly from language to language, arrived at differing conclusions about the interaction between tone and tune. Yung (1989) came to the conclusion that Cantonese opera attempts to maintain correspondence between tone and tune as best it could, while Stock (1999) concluded that the melodic structure of Beijing opera's arias dictates the tones of the song.

Cantonese opera contains a limited number of aria melodic structures, and Yung examined the structural relationship between linguistic tones and these arias. She examined three different features of Cantonese's tones: inflection, duration and pitch level. For tonal inflection, she found that approximately three-quarters of the syllables were associated with a single pitch, while the remainder was melismatic. Pitch contours of the tone matched those of the syllable to which they are sung. For example, the majority of syllables with level linguistic contours were sung to a single pitch, while syllables that were sung to rising or falling linguistic contours were taken care of by being sung either to single pitches with ornamental glides or to two- or three-pitch figures that appropriately reflect the linguistic tone. In other words, a syllable such as 詩 *si55* 'poem' would be sung to a level pitch, while a syllable such as 史 *si35* 'history, story' would be sung either to a rising sequence of notes or a single pitch preceded by a lower ornamental glide, thus mimicking the rising contour. There were also a number of exceptions to this general rule of pitch matching, the most important of which was that line-ending pitches could be modified (and deviate from what is expected) in order to fulfill rather stringent musical requirements for these areas. For duration and rhythm, closed syllables – tones 7 through 9, which are shorter in duration and more clipped – tended to be sung on either staccato notes or notes that are "immediately followed by a break in the voice."

From the perspective of pitch, Yung surprisingly found that the text's linguistic tones were matched to *specific* musical pitches. In other words, specific tones were often sung on specific pitches. This not a common conclusion across the literature, given that in a tonal system of limited tones, this would result in the same musical pitches being sung continuously throughout music. In particular, Yung found that in her sample, tone 1 (55) was sung on a G, all instances of tone 3 (44) were sung on C, and the vast majority of tone 4 (22) syllables were sung on note G. While there were certainly a number of anomalies that did not correspond to the patterns that she outlined, Yung attributed this to ironclad rules about the structure of the aria.

In fact, Stock (1999) argued that ironclad rule about aria structure dictated rules for Beijing opera as a whole: the formalized nature of Beijing opera's arias mandated that tone not be taken into account to any considerable degree, instead being suppressed in favor of meeting the rules of musical structure. Stock cited Yung's work, noting that perhaps part of the reason why tonal correlation to specific musical pitches may be so strong in Cantonese opera is because Cantonese opera singers often do not sing from written lyrics and music but are instead required to learn lyrics in a very short period of time; a very conventional correlation between musical pitch and linguistic tone would allow a singer to very quickly learn the music, or to sort of approximate the melody if the actual music is forgotten. Stock did not comment on whether this was the case for Mandarin opera singers.

Stock analyzed a cadence in an opera by 周信芳 Zhōu Xìnfāng, a cadence that is expected to end on F#, but instead ends on a G#. After dismissing that this is simply due to a performance or transcription error or due to some sort of "dramatic raising" of the pitch, he suggested that the higher-pitched note could be due to interference from linguistic tone, or that the last syllable of the line was not as important as the other syllables and thus saw a higher degree of linguistic

variability. However, the syllable to which this G# falls was actually a third-tone syllables, which would seemingly require a lower pitch, not a higher pitch. Other scholars of Beijing opera have found that final syllables tend to be the most regular. Stock therefore concluded that in lieu of tone, larger aria structure should be considered responsible for this unexpected note. The actual details of the aria structure are not important – the important point is that the tone is not correlated with tune in this situation.

3.2.3 Cantonese and Mandarin popular music

Moving on from opera, we begin with the work of Wong and Diehl (2002) and Ho (2006), both of whom examined Cantonese pop music. Both the works of Wong and Diehl and of Ho concluded that this type of music, colloquially down as "Cantopop," demonstrated a measurable correlation between linguistic tone and musical pitch.

Wong and Diehl found that the direction of movement of F_0 (fundamental frequency) of musical pitch tended to match the direction of movement of F_0 of tone in spoken speech. To serve as a sample, Wong and Diehl chose four contemporary Hong Kong Cantonese songs from the early 1990s. They then divided the six Cantonese tones into three pitch categories (H, M and L), based on the tonal target: thus, tones 1 and 2 (contours of 55 and 35) were H tones; tone 3 (44) was an M tone; and tones 4 through 6 (22, 24, 33) were L tones. They concluded, "in general, an ordinal mapping between musical note and tone group occurs such that the direction of pitch change into two consecutive musical notes is the same as in the two consecutive tone groups attached to them" (Wong and Diehl 1999, p. 204). They gave as an example an excerpt of the song *zo33 yuen22 ye24 suen33* 'In the Field' by Kwan Ching-kit, in which the first two syllables are mapped to G4 and D4, respectively. G4 is higher than D4; similarly, *zo33* has a higher tone

than *yuen22*. This would be considered a situation in which the linguistic tone and the musical pitch are considered to map correctly. Given this framework, Wong and Diehl found that the total percentage of all the transitions in their musical sample that mapped correctly was 91.81 percent: 38.79 percent of all transitions were rising transitions that mapped correctly; 42.70 percent were falling transitions; and 10.32 percent were same-pitch transitions. In other words, 38.79 percent of all transitions contained a transition from a lower-tone syllable to a higher-tone syllable (say from *yuen22* to *zo33*) that was mapped appropriately to rising musical pitch (say from D4 to A4).

In order to confirm this framework empirically, Wong and Diehl also composed three sets of melodies that differed only by the last note. The sentence was 下一個字是試 *Ha33 yat5 go44 zi33 hai33 si44* 'The next word is 'to try.'' The last syllable could be replaced with 詩 *si55* 'poem' or 是 *si33*, the copula, resulting in the sentences "The next word is 'poem'" and "The next word is [the copula]." This was mapped to two melodic sequences, of which I will present the first. (The principle is the same in both sequences.) The first five syllables were mapped to E4-A4-F4-F4-E4-, with the last musical pitch as -A4 (5 semitones above E4), -C5 (8 semitones above E4) or -E4 (the same.) Speakers were provided with the first five words ("The next word is…") and were asked to fill in the last syllable based on what they heard in the music. Wong and Diehl hypothesized that because A4 was 5 semitones and C5 was 8 semitones above E4, speakers would interpret syllables mapped to A4 and C5 as M or H tones; while speakers would interpret syllables mapped to E4 as low tones.

Indeed, they found that when the last note was A4 (5 semitones above the preceding note), 12 speakers interpreted the last syllable as *si55* and 11 speakers interpreted this as *si44*. When the last note was C5 (8 semitones above the preceding note), all 24 speakers interpreted this syllable

as *si55*. When the last note was E4 (the same pitch as the preceding note), all 24 speakers interpreted this syllable as *si33*. In other words, speakers were consistent across the board in interpreting the tone of the last syllable based on the musical pitch of the last syllable, which would *not* be the case if speakers did not perceive that musical pitch reflected linguistic tone. In that situation, one would expect that speakers would randomly choose a word, dividing roughly into thirds for each syllable.

Ho (2006) conducted three separate perception tests. First, he chose 50 Cantonese pop songs from the 1990s, giving these songs to 20 native speakers of Cantonese and asking them to identify any "tone-melody mismatches" based on their intuition as native speakers. Cantonese speakers identified only two songs as containing a case of lyrical mismatch. Ho's second perception test consisted of replacing two syllables in a song – a name of a city – with a set of alternative two-syllable names, none of which contained the same tone. The original city was Seoul, 漢城 *hon33 sing22*; the only two acceptable replacements out of a list of ten cities were Lyon 里昂 *lei24 ngong22* and Berlin 柏林 *paak33 lam22*. The only acceptable replacements were ones that contained two lower-level tones. (As a comparison, other choices, which were deemed unacceptable, included New York 紐約 *nau35 joek33* and Hong Kong 香港 *heong55 gong35*). Finally, Ho asked five native Cantonese speakers to set the American folk song *Red River Valley* to lyrics. The lyrics revealed a surprising degree of similarity among the musically untrained native speakers. Although the speakers composed the lyrics in isolation, they only came up with different tones for five of the 38 syllables; in other words, while the exact lyrics were different, the tones themselves remained similar. From these results, Ho concluded not only do Cantonese speakers pay significant attention to tone and tune, but also that there were fairly strict rules about mapping.

Lǐ Bàochén [李抱忱] (1964) offered general principles on the interaction between linguistic tone and musical pitch in Mandarin, although his work lacked specific examples. His work asserted that "as long as one pays attention to the four tones of Mandarin, then there will be far fewer mistakes than if one completely ignores the tones [只要作曲的時候注意四聲，錯誤就比根本不注意四聲要少得多了 *zhǐyào zuòqǔ de shíhòu zhùyì sìshēng, cuòwù jiù bǐ gēnběn bú zhùyì sìshēng yào shǎo de duō le*]." Li's first example was from an old Chinese folk song (beginning with 少小離家老大回 *Shǎoxiǎo líjiā lǎodà huí*, 'Leaving Home when Young, Returning in Old Age'), a song that he claimed to demonstrate good correspondence between linguistic tone and musical pitch. However, Li did not go into much detail about why *Shǎoxiǎo* is acceptable – he offered only general statements about the relationship between the two, eschewing any sort of test or principle. In *Shǎoxiǎo*, there are a number of correlations on melismatic syllables – for example, 兒 *ér*, 童 *tóng* and 識 *shì* are melismatically mapped to sequences of rising notes (for the first two) and falling notes (for the last syllable.) He does not address transitions. Li does offer a more specific claim when he discusses his last example, 淚羅江上 *Lèi luó jiāng shàng* 'Tears fall on the river,' in which he claims to have placed primary emphasis on certain words, namely 水 *shuǐ*, 流 *liú* and 愁 *chóu*. *Chóu* is the only melismatic syllable of the three; it is mapped to F4-B4, thus matching the rising contour of the second tone. *Shuǐ* is mapped to E4, following B4 and preceding E4; *liú* is mapped to B4, following G4 and preceding B4. Ostensibly, one could perhaps argue that *shuǐ* is mapped correctly because as a third tone (and somewhat of a low tone), it is mapped to a lower note than the preceding note (E4 being lower than B4). Similarly, the *liú* could possibly be mapped correctly because it is mapped

to a higher note (B4 being higher than G4). Fundamentally, however, Li leaves us to speculate on the details of the correlation between tone and pitch.

4. Wee's framework: an existing model?

I have so far refrained from presenting Wee's (2007) model for the correspondence between tone and pitch because it is one of the approaches used to analyze songs, so it merits a more detailed presentation.

Wee divides Mandarin tone into two groups, the first and second tones as H tones and the third and fourth tones as L tones. He bases this division on work that has shown that when the various tones are prolonged, the first and the second tones end on higher pitches, roughly between 250 Hz to 275 Hz; while the third and fourth tones end on lower pitches, roughly between 125 Hz to 150 Hz. Wee then defines a "head" of a measure as a syllable that is "associated to the note that has the primary accent in the musical melody." Essentially, this means that the head of a measure is the first note of any measure.

The main crux of Wee's theory is that there are two different ways in which the musical head can map correctly to the syllable head. Wee argues that tone maps correctly pitch in either of the following situations:

(1) "if the notes in the melodic tier associated to that syllable reflects its phonological tone contour"; or

(2) "if tonal contrasts are preserved at the edges in the melody (if syllable X is associated to notes ABC, then A and C are the edges.)" (p. 9)

The first condition essentially is tailed for melismatic syllables: if a syllable maps to tone 2, for example, and the two notes that map to the syllable are rising, then the syllable satisfies the criteria; similarly for tone 4. Tone 3 is more complex, as it can be associated to either a "low, leveled melody or a contoured melody that is falling then rising" (p. 9). Wee's second condition accounts for those situations that do not include melismatic notes. Recall that in Wee's classification, tones 1 and 2 are defined as H tones and tones 3 and 4 as L tones. There are thus four possible transitions in this type of thinking: HH, HL, LH and LL. If "adjacent syllables are tonally non-contrastive" (p. 12), that is, we are looking at either a HH or a LL transition, then this requirement is "vacuously satisfied" because there is no contrast between two consecutive H syllables or two L syllables. The only two types of transitions left, then, are HL and LH. For an HL transition, an acceptable transition between the two notes would involve either two notes that are equal in pitch or a higher-pitched note preceding the lower-pitched note.

For example, take the two syllables 國防 *guó fáng* 'national defense.' The first syllable is a second tone and thus an H tone; the second syllable is a third tone and thus an L tone. To satisfy Wee's criterion, the first syllable would have to be mapped to a note that is either equal in pitch to the second note – say, F4 to F4 – or to a note that is higher in pitch than the second note – say, F4 to C4. The reverse conditions are true for LH transitions.

These rules only apply to head syllables; Wee explicitly states that these rules do not apply to non-head syllables. Yet he does not explain why only heads are covered by his theory. Furthermore, it seems somewhat strange that the criteria for picking head syllables is entirely musical, without any linguistic factors whatsoever. If I choose to write a piece in an unusual meter such as 12/8, in which there are 12 eighth notes in one measure, then this would mean that there would only be (on average) one head syllable every 12 syllables, assuming there are no

melismatic syllables. On the other hand, if I set the same text to 3/8 time, then there will be approximately four times as many head syllables. Is this not problematic?

5. Elements of Chinese music

Before presenting the main analysis of the songs in this paper, I will give here a very brief overview of two elements of Chinese music: the pentatonic scale and Western influences, in order to get a sense of context for the particular songs that I have chosen.

One of the most famous characteristics of Chinese music is the pentatonic scale, a scale that is composed of five pitches, as opposed to the heptatonic seven-note scale, which forms the basis of modern Western art music. The pentatonic scale may be played on the black keys of a modern piano: C#, D#, F#, G# and A# (John Levis 1936). The number of semitones between the notes of the pentatonic scale is therefore 2, 3, 2, 2 and 3: in other words, between C# and D# are 2 semitones, between D# and F#3 semitones, F# and G# 2 semitones, etc. This stands in contrast to the Western heptatonic scale, in which the number of semitones between the notes is 2, 2, 1, 2, 2, 2 and 1. While the influence of the pentatonic scale on the interaction between linguistic tone and musical pitch is not covered extensively in the literature, it seems to me that its influence is small, for two reasons. First, as we have seen, the majority of the literature on the subject (although not all the literature, i.e. Yung's findings about Cantonese opera) focuses on the direction of change of musical pitch and not the actual values of the pitches themselves. It is important that a particular transition is rising, but not that it is mapped to F# as opposed to G#, or the third tone in a scale, for example. Second, three of the songs in my sample -- both folk songs and the Shanghai song 五月的風 *Wǔyuè de fēng* – use the pentatonic scale, while the remaining Shanghai song 夢中人 *Mèngzhōngrén* uses the heptatonic scale. As we will see in the final

approach that uses spoken F_0 and melismatic syllables, *Wǔyuè de fēng* and *Mèngzhōngrén* are very similar in their correlation of tone and pitch, which leads me to believe that the use of the pentatonic scale is not significant.

Western interaction with Chinese music began in the early sixteenth century (Frederick Lau 2008). European composers in general became more aware of Chinese music beginning in the eighteenth century, and in fact the folk song 茉莉花 *Mòlìhuā*, one of the songs analyzed in this essay, was included as a prominent musical theme in Giacomo Puccini's 1926 opera *Turandot*, in which it is associated with "Turandot's splendor" (William Ashbrook and Harold Powers 1991). While there was early influence of Western arts on Chinese music as early as the Yuan (1271-1368) and Ming (1368-1644) dynasties, "the impact of their [Westerners'] music in China was confined to the imperial court" (Lau 2008, p. 91). It was not until the late nineteenth and early twentieth centuries that Western tonal music began to spread extensively through China. It gained particular strength in the 1910s and 1920s, and by the 1930s Shanghai was nicknamed the "New York of the Orient" (Lau 2008, p. 92). The two songs that I have chosen are from the genre called 時代曲 *shídàiqǔ* 'songs of the era,' resulting from "the craze for Western-style jazz and dance halls, fusing the local traditional music with jazz, adding saxophone, violin and xylophone to Chinese instruments such as the high-pitched *gaohu* fiddle and the *yangqin* dulcimer" (Stephen Jones 2000, p. 33). To the listener, this type of music sounds both distinctively Western and Chinese: Western in the use of Western musical instruments and musical conventions, but Chinese in the singing (obviously) and often in the use of the pentatonic scale.

6. Hypothesis

I hypothesize that the two folk songs will demonstrate a greater degree of correlation between linguistic tone and musical pitch than the two Shanghai *shídàiqǔ*-style songs from the early twentieth century: the reason being that traditional folk musicians, less influenced by Western musical norms, would have made more an effort to maintain a correlation between linguistic tone and musical pitch, while popular composers and lyricists of the Shanghai *shídàiqǔ* school would have been heavily influenced by Western musical structures, which do not take phonemic tone into account. The remainder of this paper consists of various analytical approaches to examining tone and pitch in the two songs. This hypothesis matches what we would expect given Chao's (1956) hierarchy, which posits that the most traditional genres of chanting, recitative and singsong shows the most correlation between tone and tune, with atonal modern compositions completely lacking in this correlation.

The two folk songs I chose are:

茉莉花, *Mòlìhuā* "Jasmine Flower" (hereafter MLH)

海蓮花 *Hǎiliánhuā* "Mangrove Flower" (hereafter HLH)

MLH was composed during the reign of the 乾隆 Qiánlóng emperor during the Qing Dynasty. There are two slight variations, one from Jiāngsū province and one from Zhèjiāng province. The music for this version of MLH is from Soong (1980), a collection of folk songs from the 1980s; this arrangement is identical to Xu and Zhao's (2005) arrangement, although the latter arrangement is in Chinese numerical notation while Soong's is in conventional Western musical

notation. The second folk song, HLH, is from Shānxī province, and about a girl named "Mangrove Flower."

The two Shanghai *shídàiqǔ* songs are

夢中人 *Mèngzhōng rén* "Man in my Dreams" (hereafter MZR)

五月的風 *Wǔyuè de fēng* "Wind of May" (hereafter WYDF)

MZR, in particular, has become a very famous song, composed by 陳歌辛 Chén Gēxīn and was the theme song of the film 薔薇處處開 *Qiángwéi chùchù kāi*, which premiered in February 1942 (Sun Rui 2004). WYDF is a so-called 'slow song' (慢歌 *màn'gē*), which was released independently.

For each song, I was careful to avoid the effects of repetition, which would artificially influence a result either way – if a particular section happened to have a large number of transitions that had either a large degree of correlation with tone or very little correlation with tone, this would skew the results either way. Therefore, any sequence in which *both* the lyrics and the notes were exact replications of an earlier section of the song was excluded.

7. Approaches

7.1 Approach 1: Wee's framework

The results of analyzing the four songs under Wee's framework follow. I have bolded the percentage of violations of Wee's criteria in each song for comparison.

MLH (folk song): Of the 17 measures (excluding repetition) in this piece, there are two violations of Wee's criteria (**10 percent**). Of the 15 measures that conform to Wee's criteria, 11 measures vacuously satisfy the criteria: 4 measures contain only one syllable, while the other 7 measures contain a head and subsequent syllables that are not tonally contrastive.

HLH (folk song): Of the 24 measures in this piece, there are three violations of Wee's criteria (**12.5 percent**). Of the 21 measures that conform to his criteria, 15 measures vacuously satisfy the criteria: 7 measures contain only one syllable, while the other 8 measures contain non-tonally-contrastive syllables.

MZR (Shanghai song): Because of the way in which the music is written, the majority of measures contain only one syllable, which has the effect that nearly every measure of this piece satisfies Wee's criteria vacuously. By this measure, out of the 48 measures (excluding repetition) in this piece, there are six violations of Wee's criteria (**12.5 percent**). Of the 42 measures that conform to his criteria, a full 40 (!) measures vacuously satisfy the criteria: 29 measures contain only one syllable, while 11 measures contain non-tonally-contrastive syllables.

WYDF (Shanghai song): Of the 21 measures in this piece, there are four violations of Wee's criteria (**14.3 percent**). Of the 19 measures that conform to his criteria, 14 measures vacuously satisfy the criteria: 6 measures contain only one syllable, while the other 8 measures contain non-tonally-contrastive syllables.

There are a number of problems with this approach; most importantly, we find that the majority of syllables vacuously satisfy the requirements. Wee reports a high success rate of 97.2 percent after examining Chinese folk songs This is not surprising, insofar that the only way to fail to meet Wee's criteria is to have an HL transition mapped to two notes in which the first pitch is lower than the second pitch (or the completely reverse situation for an LH transition.) If a measure contains only one note (which happens to describe the majority of syllables in MLH) then in fact the vast majority of syllables meet the requirement simply because there is no other syllable or musical pitch in that measure!

This data would seem to reveal that the Shanghai songs and the folk songs demonstrate a similar correlation between linguistic tone and musical pitch. Violations of Wee's criteria were 10% and 12.5% for the folk songs and 12.5% and 14.3% for the Shanghai *shídàiqǔ* songs, hardly a conclusive difference. While this could perhaps be a conclusion – there is in fact no different

between genres! – it seems in haste to simply conclude that Wee's theory demonstrates that there is little difference between the two genres of song. In particular, I am skeptical to simply stop here, because it flies in the face of Chao's hierarchy and my intuition that older songs with less Western influence should demonstrate more correlation between tone and pitch.

7.2 Approach 2: Straightforward tone/pitch matchup

If Wee's theory is problematic, then we obviously need an alternative paradigm to examine these songs – essentially, what we should do is to devise a paradigm that "tightens up the rules" and fixes the problems of Wee's theory, in hopes of being able to identify some sort of pattern in the folk songs and the Shanghai songs.

As the exclusion of all non-head syllables has been deemed to be a problem, we can fix this by stating that we will take all syllables into account, and not simply head syllables, however that may be determined. As for tones, we can keep the system of H tones and L tones that Wee uses, since this is not one of the more problematic issues with his theory. The H tones are tones 1 and 2 (contours of 55 and 15, which both end in 5) and the L tones are tones 3 and 4 (contours of 214 and 51, which both end in 1 if one counts the "half-third" tone as the normal phonetic realization of the third tone.) Any transitions that involve the neutral tone have not been included in the following results, since the assignation of the neutral tone to either H or L tone depends on which school of thought one follows about the tone (see section 2.1 for more discussion.)

Given this type of breakdown, we have the following results from the four songs:

Folk songs:

	Rising	Flat	Falling
HH	8	2	7
HL	6		9
LH	10	1	7
LL	9	1	7

	Rising	Flat	Falling
HH	47.06%	11.77%	41.18%
HL	40%		60%
LH	55.56%	5.56%	38.89%
LL	52.94%	5.88%	41.18%

Shanghai songs:

	Rising	Flat	Falling
HH	11	2	9
HL	6	4	8
LH	11	5	7
LL	9	0	9

	Rising	Flat	Falling
HH	50%	9.09%	40.91%
HL	33.33%	22.22%	44.44%
LH	47.83%	21.74%	30.43%
LL	50%		50%

The highlighted and bordered sections represent what we would expect given the tonal transitions. In a transition from a Low tone to a High tone, for instance, we would expect that the correspondingly mapped musical pitches would go from low to high, in order to preserve the tonal contrast. It is not immediately apparent what type of musical transition a tonal transition from High to High or a transition from Low to Low should look like, which is why they are not highlighted and bordered. Given these results, the most striking conclusion is that in the folk songs, the majority of transitions from High to Low are mapped correctly to falling transitions (60 percent), while in the Shanghai songs, only 33.33 percent, a third, of the High-to-Low transitions are mapped correctly. However, when we look at the other three categories of tones, we find that none of them map quite as neatly as HL transitions in folk songs. Barely a majority of LH transitions are mapped correctly to rising musical transitions (55.56%), and in Shanghai-style songs it is only a plurality (33.33%). For HH transitions and LL transitions, it is difficult to argue which way the transitions should go at all. Is the proper transition a rise, since the second High tone will be higher than the first High tone? Or could it be the other way around, if the stress is on the first syllable? Similar questions arise for Low-to-Low transitions. In large part, this uncertainty is why this theory also proves inadequate to explain the correspondence between tune and tone.

7.2.1 A brief interlude into melismatic notes

Up until this point, we have focused on transitions between notes and not on the condition of melismatic notes. The majority of syllables are not mapped melismatically, with most syllables being mapped in a one-to-one relationship to music. Thus, it is logical to focus primarily on transitions between notes because while (by definition) there is a transition between every and any two notes, many syllables are mapped one-to-one to musical notes, so an analysis that relies primarily on melismatic syllables would only be able to take a small subset of many songs into account. Nevertheless however, it seems an oversight to completely ignore melismatic notes in the analysis of these four songs.

Folk songs:

	Rising	Falling	Other
1	8	1	10
2	4	1	3
3	6	6	3
4	4	9	0

	Rising	Falling	Other
1	42.11%	5.26%	52.63%
2	50.00%	12.50%	37.50%
3	40.00%	40.00%	20.00%
4	30.77%	69.23%	0.00%

Shanghai songs:

	Rising	Falling	Other
1	7	1	0
2	5	6	0
3	7	5	0
4	10	4	0

	Rising	Falling	Other
1	87.50%	12.50%	0.00%
2	45.45%	54.55%	0.00%
3	58.33%	41.67%	0.00%
4	71.43%	28.57%	0.00%

In the tables above, the leftmost column represents the tone number. “Rising” and “Falling” are self-evident musical transitions; “Other” represents any transition that cannot be defined as one of the two, generally transitions that undulate up and down multiple times. The highlighted and bordered values represent what we would expect for tones 2, 3 and 4: tones 4 and 3 to falling transitions (since their contours are 51 and 21(4) respectively) and tone 2 to rising transitions.

It does seems that a melismatic comparison of these two structures gives somewhat of an edge to the folk songs over the Shanghai songs in degree of correlation between tone and tune (matching the hypothesis), at least for tones 2 and 4. For tone 2, 50 percent (a plurality) of

second-tone melismatic syllables in the folk songs mapped correctly to rising melodic sequences, while only 45.45 percent (a minority) map correctly in the Shanghai songs. Similarly, 69.23 percent (a majority) of fourth-tone melismatic syllables in the folk songs mapped correctly to falling melodic sequences, while only 28.57 percent (a minority) map correctly in the Shanghai songs. However, tone 3 does not exhibit any clear tendencies, evenly split between rising and falling transitions (40% and 40%) in folk songs, and having a majority of rising transitions in Shanghai songs (58.33%). Melismatic syllables give us some hint at how to properly crack the answer to the question, but it is not until they are combined with an overall look at F_0 that we can really answer the question.

7.3 Approach 3: Combining F_0 and melismatic notes

Essentially, the examination of syllables in this strict linear manner is not the key to understanding the correlation between tones and pitch. Focusing too narrowly on the syllable-to-syllable transition in the music, based solely on citation tonal values, obscures the bigger picture. Music does not consist solely of note-to-note transitions and has a bigger form. This is why I propose a theory of correlation between linguistic tone and musical pitch that does not focus narrowly on dictionary tonal values, but rather on the F_0 of actual spoken speech and the overall contours. The data collection and more details for the theory are presented below.

I recorded a native speaker of Mandarin Chinese reading the lyrics of the four songs, without any indication of any musical melody given. The speaker was a male, 22-year-old native speaker of Mandarin Chinese from Hsinchu, Taiwan. I provided him with a copy of the lyrics in traditional Chinese characters and instructed him to read the lyrics in a normal voice. Praat software was then used to generate a spectrogram of his speech. I divided the speech into

discreet syllables and used Praat to find the mean fundamental frequency (F_0) of each syllable; this is the same approach that Schellenberg (2007) used to find the F_0 of individual syllables in continuous Shona speech. The transitions between the F_0 of each syllable were noted as either Rising, Falling or Flat (if the F_0 of two spoken syllables were within 1.5 Hz, the standard that Schellenberg (2007) adopted for his study, then the transition was coded as being Flat.) Although the recording itself as a whole was fairly non-problematic, there were a number of minor issues. In a small number of situations, Praat was unable to determine the F_0 of a particular syllable, even though I was able to hear the syllable and distinguish what speech it was. Furthermore, in one situation, the speaker was supposed to read 海蓮花 *hǎiliánhuā* 'mangrove flower' but instead spoke 海花兒 *hǎihuāér* 'aquatic plant,' which is probably a case of lexical interference. These three syllables were not included in the analysis.

The first methodological and theoretical issue that presented itself was whether to consider simply the *direction* of F_0 change in this situation, or whether to consider the *difference* in F_0 as well: Only direction was considered. Wong and Diehl's (2007) study found that only the direction of change of F_0 mattered. No previous literature in Mandarin has argued that the quantitative difference in F_0 of musical pitch or linguistic tone can be correlated. Also, in a very simple sense, no speaker has the same F_0 for any individual tone even within the same utterance, and no two speakers produce any individual tone at the same F_0 with any consistency (Yip 2002).

I considered transitions to be "matching" if the direction of change in F_0 of the musical notes and the spoken syllables were the same. (An example of this theory in use is provided later on.) From these preliminary results, we arrive at:

HLH: 25 of 44 transitions match	56.18%
MLH: 22 of 39 transitions match	56.40%
WYDF: 15 of 39 transitions match	38.40%

MZR: 31 of 67 transitions match 46.27%

We can see that based on these initial results, the folk songs (HLH and MLH) demonstrate more of a correlation between tone and pitch than the Shanghai songs. Yet there is only a 10 percent difference between MZR and HLH under this system – is the difference really that small? As discussed in the immediately preceding section, though transitions are not the only way that we can measure the correlation between the two: what if we take melismatic pitches into account?

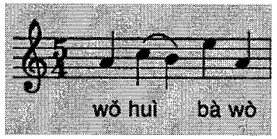
I therefore further propose that if the musical transition does not match spoken speech's F_0 transition, a secondary way in which the syllable may "map" correctly to the notes is by melismatic notes. This is applicable to tones 2, 3 and 4. Tone 1 is excluded because, as a completely level high tone – recall that the tonal numbering for this tone is 55, and indeed the majority of the tone 1s of the Praat spectrograms are remarkably level – if it were mapped melismatically to one or more notes, by definition this mapping of the note would not match the level character of tone 1. A melismatic tone 2 (15) is mapped correctly if it is mapped to a series of rising notes; a melismatic tone 3 (21, unless utterance-finally, then 214) is mapped correctly if it is mapped to a series of falling notes; and a melismatic tone 4 (51) is mapped correctly if it is mapped to a series of falling notes.

To put it all together, this is the framework that I am proposing for determining if linguistic tone and musical pitch correlate:

1. If the direction of F_0 of the song and the direction of F_0 of the musical pitch match between two syllables, then this is coded as a matching transition.
2. However, for those melismatically-mapped syllables in tones 2, 3 and 4 that do not precede a matching transition (as outlined in condition 1), they can also be

considered as mapping correctly if they are mapped to corresponding sequences of pitch: rising sequences for tone 2, falling sequences for tones 3 and 4.

To give an example, let us assume that we have a five-note sequence as follows:



If this sequence were mapped to the following sequence of tones with the following F_0:

wǒ [mapped to A4]	F_0: 110 Hz	Transition: A to C [Rising]	√
huì [mapped to C5-B4]	F_0: 150 Hz	Transition: B to E [Rising]	
bà [mapped to E5]	F_0: 130 Hz	Transition: E to A [Falling]	√
wò [mapped to A4]	F_0: 110 Hz		

In the transition from *wǒ* to *huì*, the F_0 rises from 110 Hz to 150 Hz, and the musical transition correspondingly from A4 to C5. This maps correctly. Similarly, from *bà* to *wò*, F_0 falls from 130 Hz to 110 Hz, and the music also falls accordingly. However, from *huì* to *bà*, F_0 falls from 150 Hz to 130 Hz but the music rises from B4 to E5: so this does not match, and does not satisfy condition (1) above. However, because *huì* is mapped to the falling C5-B4 sequence (matching its nature as a fourth-tone syllable), it satisfies condition (2) above, for melismatic notes.

Given this type of structure, we have the following results for the four songs:

<u>Folk songs</u>
MLH: 22 of 39 transitions match 56.40%
8 of 9 tone 2/3/4 syllables that are mapped melismatically are mapped correctly.
[22 transitions + 8 melismatic] / [39 transitions + 9 melismatic syllables] = **62.50%**

HLH: 25 of 44 transitions match 56.18%
0 of 1 tone 2/3/4 syllable that is mapped melismatically are mapped correctly.
[25 transitions + 0 melismatic] / [44 transitions + 1 melismatic syllable] = **55.56%**

Shanghai shídàiqǔ
MZR: 31 of 67 transitions match 46.27%
3 of 12 tone 2/3/4 syllables that are mapped melismatically are mapped correctly.
[31 transitions + 3 melismatic] / [67 transitions + 12 melismatic syllables] = **43.03%**

WYDF: 15 of 39 transitions match 38.46%
2 of 5 tone 2/3/4 tone syllables that are mapped melismatically are mapped correctly.
[15 transitions + 2 melismatic] / [39 transitions + 5 melismatic syllables] = **38.64%**

For two of the songs (the folk song HLH and Shanghai WYDF), there is very little difference made (within a percentage point), but for the folk song MLH, the addition of melismatic syllables accentuates the total percentage of correct mappings between linguistic tone and musical pitch, while for the Shanghai song MZR, the addition of melismatic syllables decreases the total percentage of correct mappings.

Although this is not a perfect correlation – which would be implausible – we can see here that the two folk songs clearly show a higher degree of correlation between linguistic tone and musical pitch than the Shanghai songs, confirming my hypothesis that older folk songs demonstrate more correlation between linguistic tone and musical pitch than newer songs. More than half of the transitions of the folk songs map correctly, according to this theory that utilizes both actual spoken F_0 and melismatic syllables.

As for why there is not a perfect correlation, there could be many possible reasons. From a musical perspective, it could be possible that the melodies of the folk songs have become corrupted over time, and that original melodies that may have had more correlation between linguistic tone and musical pitch have changed considerably with the passage of time. Folk songs are not composed in the Western classical sense, with strict musical fidelity – whereas there is only one correct rendering of Beethoven's Fifth Symphony, there are many variations on folk songs worldwide. Much like English spelling was not standardized in the time of Shakespeare,

with variation being perfectly acceptable, there is almost not simply "one" acceptable edition of a folk song. Furthermore, the sources that I used offered Western-style transcriptions of the music. Because Western music notation was not introduced widely to China until the late 1800s (Lau (Lau 2008), it seems likely that there may have been some sort of infidelity in the transcription of the folk songs to conventional Western musical notation.

8. Conclusion

In this paper, I hoped to address the question of whether there is a difference in the correlation of Mandarin tone and linguistic pitch in two genres of Mandarin music that originate from different chronological periods. A review of the literature on the subject of tone and pitch across various languages revealed that there is to some degree a correlation between the two in many languages, although the particular details varied significantly. The literature on the relationship between tone and pitch in Cantonese revealed that in both Cantonese opera and popular music, musicians aimed to maintain a degree of correlation between tone and pitch. Chao offered a general hierarchy of various genres' correlation between tone and pitch, with Li Baochen adding general thoughts on Mandarin.

I thus decided to compare genres in music with an analytical eye, finding the extant literature in this area to be somewhat lacking. To this end, I used three different analytical approaches to examine the relationship between linguistic tone and musical pitch in four different songs, which represent two different genres of music: older folk songs and newer, Shanghai *shídàiqǔ* songs from the early twentieth century. I found Lian Hee Wee's (2007) approach to be overly permissive, with criteria allowing any number of syllables to match the requirements, resulting in no significant difference between the two genres of music. The second

model, which kept the H/L tonal distinctions but scrapped the exclusive focus on heads and looked straightforwardly at the relationship between tones and transitions, did not prove to shed much light on the situation either. Finally, a method that utilized both the F_0 contours of actual speech and melismatically-mapped syllables of Mandarin's contour tones was able to demonstrate a difference between the two genres: in the two folk songs, a majority of the transitions/melismatic syllables were found to map correctly to their linguistic tones (averaging about 60 percent), while in the Shanghai *shídàiqǔ* style songs, less than half of the transitions, with an average of about 40 percent of the syllables mapping correctly to their respective transition or syllable. My initial impressions and prediction that older songs should demonstrate a higher degree of correlation between tone and pitch two turned out to be indeed correct.

Further research could be done in at least two areas. An examination of a wider number of genres of Chinese music would certainly shed more light on this problem: nursery songs, national anthems, revolutionary anthems, 1980s popular music and contemporary (2000s) popular music are among the many possible genres that researchers could examine, to see if the general trend of older genres less influenced by Western music showing a high degree of correlation between tone and pitch holds. In addition, the majority of the work in the field has been done for standard Cantonese and standard Mandarin, with a general paucity of work considering other Sinitic languages. There are also many dialects of Mandarin (and I do not use "dialect" in the traditional sense, but in the sense of mutually intelligible varieties of the language that native speakers would identify as 普通話 *pǔtōnghuà* 'Mandarin') in which the phonetic values of the tones differ significantly from their values in standard Mandarin. It would be very valuable to see a comparison of tone-pitch correlation of the same songs across different varieties of Mandarin and different Sinitic languages.

9. Appendices

A list of the appendices follows. Particular notes for each appendix are contained here.

9.1 Sheet music of each song, as well as the songs analyzed through Wee's approach

In MLH and MZR, certain sections of the music are boxed, with the third line being crossed out. These are sections that repeat, which are not included in any of the analyses (see last paragraph of section 6 for more information.)

Line 1 underneath the music is the text in traditional Chinese characters.
Line 2 is the text in Mandarin pīnyīn Romanization.

Line 3 is the key for each measure to mark whether it fulfills Wee's criterias:

X marks a violation of Wee's requirements; * marks a fulfillment of Wee's requirements; **T** means the measure vacuously satisfies the criteria because the syllables are not tonally-contrastive; and **I** means the measure vacuously satisfies the criteria because the measure has only one syllable.

9.2 Interlinear glosses

Due to the nature of the software used to produce the appendices, I have not included the gloss for the songs in Appendix 9.1 and have separated the gloss into this separate appendix.

Line 1 is the text in traditional Chinese characters.
Line 2 is the text in Mandarin pinyin Romanization.
Line 3 is the morpheme-by-morpheme gloss.
Line 4 is a natural English translation.

9.3 Approach 2 analysis

Syllables	**Tones**	**H/L**	**Direction of musical transition**
hǎo yì	34	LL	Rising
yì duǒ	43	LL	Rising
duǒ mò	34	LL	Rising
mò lì	44	LL	Rising
lì huā	41	LH	Falling

The partial table above is reproduced from MLH.

Column 1 (the leftmost) contains the two syllables of the transition in pinyin.
Column 2 notes the tones of the two syllables.
Column 3 is simply a conversion of the tones in column 2 to H or L.

Column 4 gives the direction of the transition of the musical notes, according to the music given in Appendix 1.

Please note that '5' refers to the neutral tone.

9.4 Approach 3 analysis

Syllable	F_0 of syllable	Transition of syllable F0 to next note	Transition of musical pitch to next note	Match	Qualified melismatic syllables	Match
hǎo	140.42	Rising	Rising	X		
yì	178.77	Falling	Rising			
duǒ	127.57	Rising	Rising	X		
mò	161.62	Falling	Rising		M	y
lì	136.49	Falling	Falling	X		
huā	126.84					

The partial table above is reproduced from MLH.

Column 1 gives the syllable written in pīnyīn.

Column 2 gives the F_0 of the syllable as measured by the Praat spectrogram of the native speaker.

Column 3 (Transition of syllable F_0 to next note) gives the direction of the transition of the syllable's F_0 to that of the next note. For example, in the first line, the F_0 of *hǎo* is 140.42 Hz, while the F_0 of *yì* is 178.77. Because the F_0 of *yì* at 178.77 Hz was higher than the F_0 of *hǎo* of 140.42 Hz, this transition is coded as Rising.

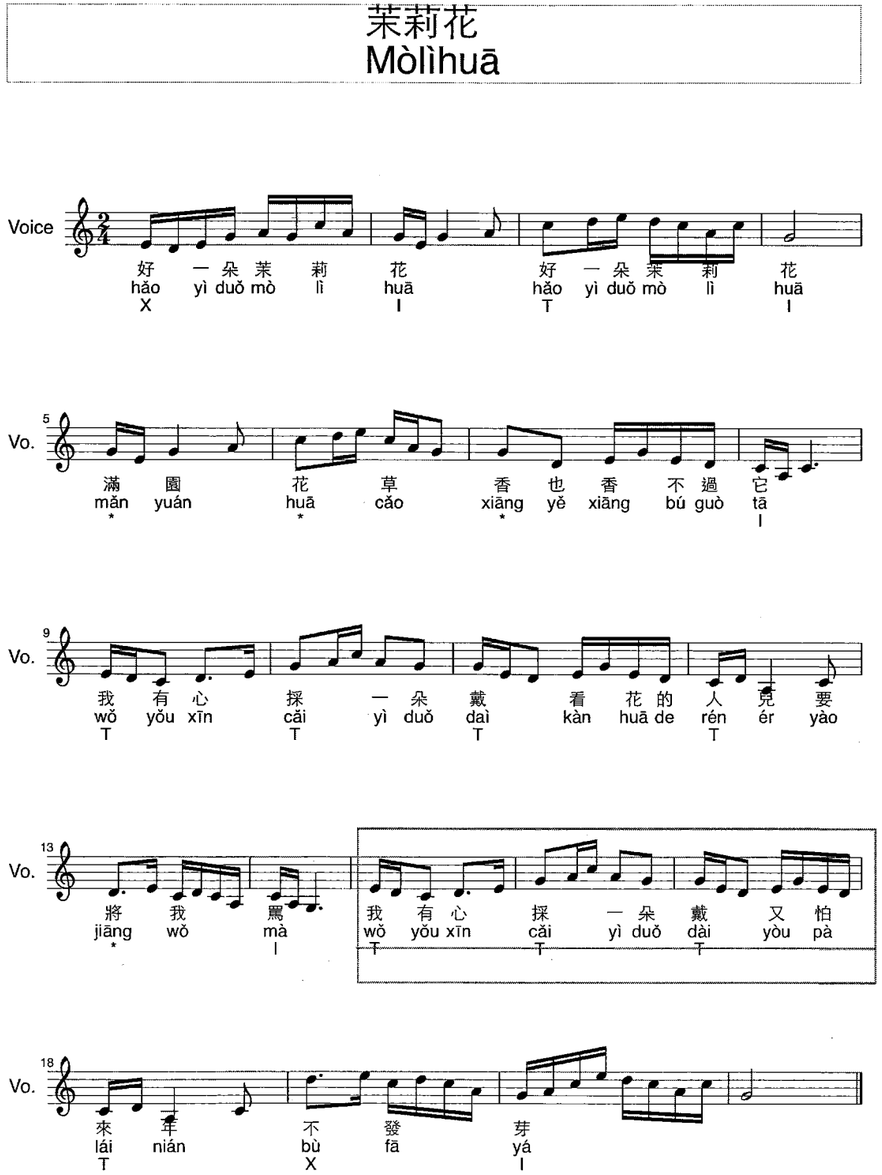
Column 4 (Transition of musical pitch to next note) gives the direction of the transition of the musical pitches, according to the music given in Appendix 9.1.

Column 5 (Match) simply marks an X where the transitions of the syllable F_0 and musical pitch match.

Column 6 (Qualified melismatic syllables) marks those syllables in tones 2, 3 and 4 that do not precede a correctly mapped transition, but are mapped melismatically to multiple pitches.

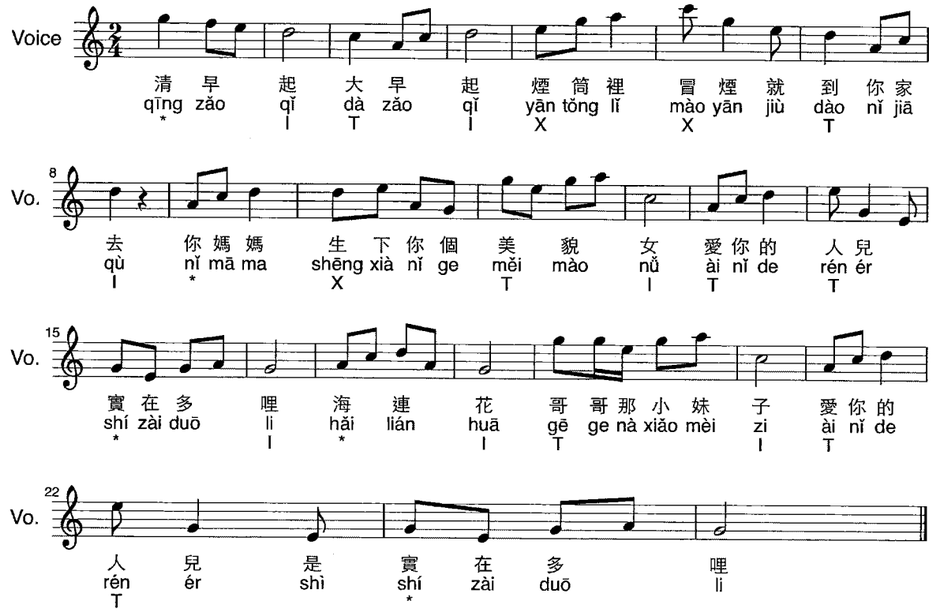
Column 7 (Match) marks a y in which the syllables match. According to this chart, *mò* is correctly mapped to a sequence of falling pitches, according to the music given in Appendix 9.1.

9.1 Sheet music and Wee's analysis



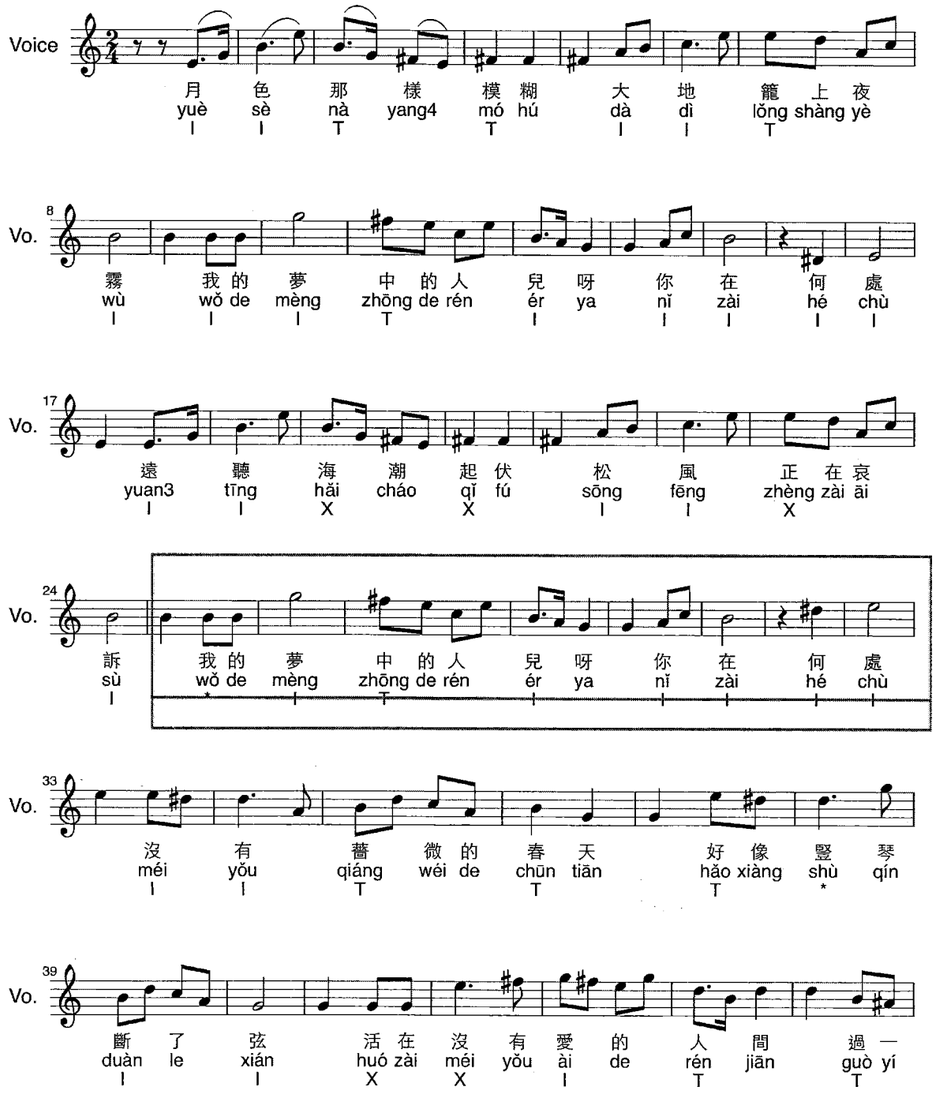
(9.1)

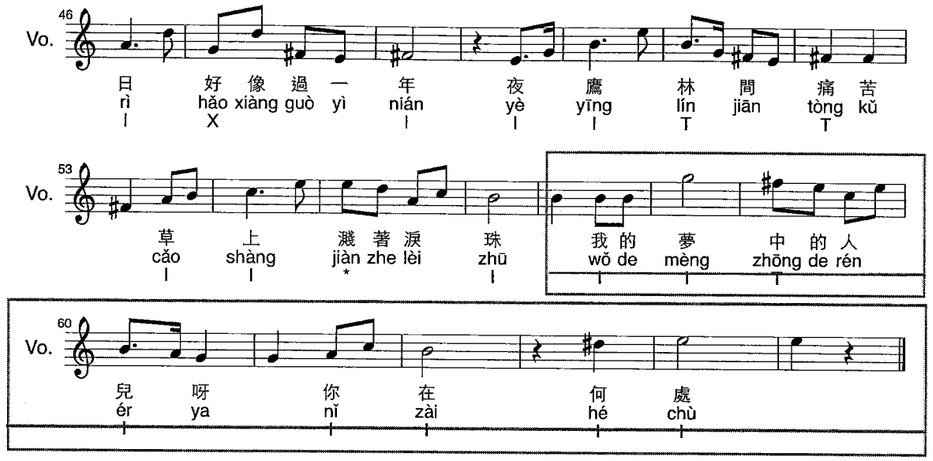
海蓮花
Hǎiliánhuā



(9.1)

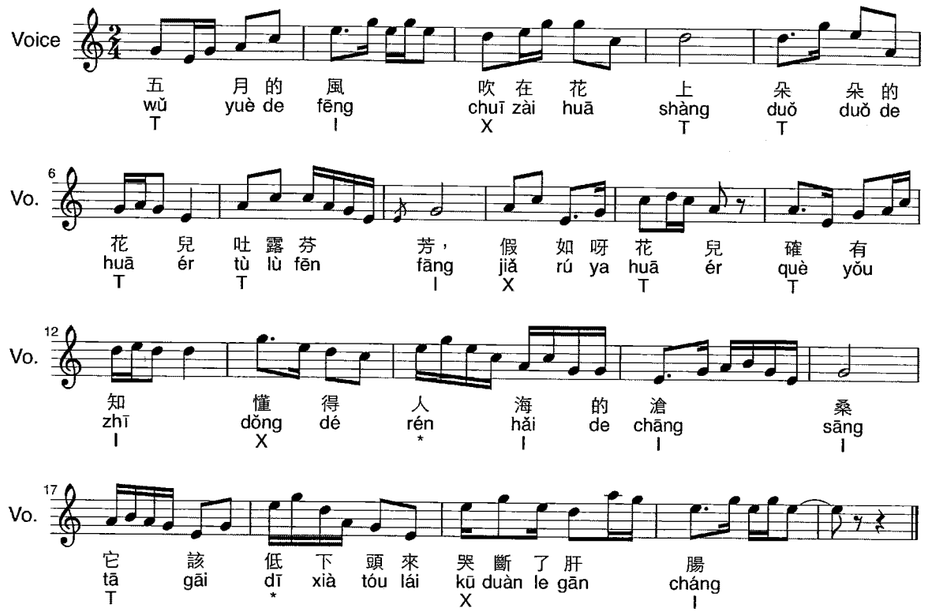
夢中人
Mèngzhōngrén




46
Vo.
日 好 像 過 一 年 夜 鷹 林 間 痛 苦
rì hǎo xiàng guò yì nián yè yīng lín jiān tòng kǔ
I X I I I T T
53
Vo.
草 上 濺 著 淚 珠 我 的 夢 中 的 人
cǎo shàng jiàn zhe lèi zhū wǒ de mèng zhōng de rén
I I * I I I I
60
Vo.
兒 呀 你 在 何 處
ér ya nǐ zài hé chù

(9.1)

五月的風
Wǔyuè de fēng



9.2 Interlinear glosses

Notes on glosses. CLF = classifier; ER = rhotacization particle; PS = possessive (similar to English *'s*); PT = utterance-final particle

MLH

好 一 朵 茉莉 花， [repeat]， 滿 園 花 草 香 也
Hǎo yì duǒ mòlì huā, [repeat], mǎn yuán huācǎo xiāng yě xiāng
good one CLF jasmine flower, [repeat], entire yard flower grass fragrant also
What a pretty jasmine flower, [repeat], all the foliage in the garden is fragrant, but is not more

香 不 過 它。 我 有 心 採 一 朵 戴，
bú guò tā. Wǒ yǒu xīn cǎi yì duǒ dài,
fragrant not over it I have heart pick one CLF bouquet,
fragrant than the flower. I really want to pick a bouquet,

看 花 的 人 兒 要 將 我 罵。 我 有 心 採 一 朵
kàn huā de rén ér yào jiāng wǒ mà. Wǒ yǒu xīn cǎi yì duǒ
look flower PS person ER must will me angry. I have heart pick one CLF
those looking at the flower will be angry at me. I really want to pick a

戴， 又 怕 來年 不 發芽。
dài, yòu pà láinián bù fāyá.
bouquet, furthermore fear next-year not germinate.
bouquet, but I also fear the flower will not grow next year.

HLH

清早 起， 大早 起， 煙筒 裡 冒煙 就 到 你 家 去，
Qīngzǎo qǐ, dàzǎo qǐ, yāntǒng lǐ màoyān jiù dào nǐ jià qù,
morning rise, early rise, pipe in smoke at-once toward you house go,
Awake in the morning, early, when you smoke your pipe let us go to your house,

你 媽媽， 生下 你 個 美貌 女， 愛 你 的 人 兒
nǐ māma, shēngxià nǐ ge měimào nǚ, ài nǐ de rén ér
you mother, born you CLF pretty girl, love you PS person ER
Your mother has just given birth to a pretty girl, the people who love you

實在 多 哩。 海蓮花， 哥哥 那 小 妹子， [repeat]
shízài duō li. Hǎiliánhuā, gēge nà xiǎo mèizi, [repeat]
certainly many PT. mangrove-flower, brother that small sister, [repeat]
are certainly may. Mangrove Flower, brother and that small sister, [repeat]

MZR

月 色 那樣 模糊， 大地 籠 上 夜霧， 我 的 夢 中
Yuè sè nàyàng móhú, dàdì lǒng shàng yèwù, wǒ de mēng zhong
Moon color that cloudy, ground cage top dark, I PS dream middle
The color of the moon is that dark, on the ground the cage is dark. The person in

的 人 兒 呀， 你 在 何處？ 遠 聽 海潮 起伏，
de rén ér ya, nǐ zài héchù? Yuǎn tīng hǎicháo qǐfú,
PS person ER PT, you at where? Far listen waves rise
my dreams: where are you? From afar, I hear the waves rising,

松風 正 在 哀訴。 [repeat] 沒有 薔薇 的 春天，
sōngfēng zhèng zài āisū. [repeat] Méiyǒu qiángwēi de chūntiān,
pine-wind currently at whine. [repeat] there-is-no rose PS spring,
the wind is whistling through the pines. [repeat] There is no rose-like springtime,

好像 竪琴 斷 了 弦， 活 在 沒有 愛 的 人間，
hǎoxiàng shùqín duàn le xián, huó zài méiyǒu ài de rénjiān,
just-like harp break ASP string, live in there-is-no love PS world,
it is as if a harp has broken a string. To live in a world without love,

過 一 日 好像 過 一 年。 夜鷹 林間 痛苦，
guò yí rì hǎoxiàng guò yì nián. Yèyīng línjiān tòngkǔ,
pass one day just-like pass one year. Nighthawk woodland painful,
to pass a day is just like passing a year. The nighthawk and the woodland are painful,

草 上 濺 著 淚 珠。 [repeat]
cǎo shàng jiàn zhe lèi zhū. [repeat]
grass top splash ASP pearl tears. [repeat]
on the top of the grass are splashed pearly tears. [repeat]]

WYDF

五月 的 風， 吹 在 花 上， 朵朵 的 花 兒 吐露 芬芳。
wǔyuè de fēng, chuī zài huā shàng, duǒduǒ de huā ér tǔlù fēnfāng.
May PS wind, blow at flower top, petal PS flower ER reveal fragrance.
The windws of May blow over the flowers, their petals revealing their fragrance.

假如 呀， 花 兒 確 有 知 懂得 人海
Jiǎrú ya, huāér què yǒu zhī dǒng dé rénhǎi
Pretend PT, flower ER certainly have knowledge understand many-people
Let's pretend, the flowers certainly understand people's

的	滄桑，	它	該	低下	頭	來	哭	斷	了	肝腸。
de	chāngsāng,	tā	gāi	dīxià	tóu	lái	kū	duàn	le	gāncháng.
PS	vicissitudes	it	should	lower	heads	come	cry	cut-short	ASP	liver-sausage

vicissitudes. They should lower their heads and cut their livers.

9.3 Approach 2 analysis

MLH

Syllables	Tones	H/L	Direction of musical transition
hǎo yì	34	LL	Rising
yì duǒ	43	LL	Rising
duǒ mò	34	LL	Rising
mò lì	44	LL	Rising
lì huā	41	LH	Falling
hǎo yì	34	LL	Rising
yì duǒ	43	LL	Rising
duǒ mò	34	LL	Falling
mò lì	44	LL	Falling
lì huā	41	LH	Falling
mǎn yuán	32	LH	Rising
yuán huā	21	HH	Rising
huā cǎo	13	HL	Falling
cǎo xiāng	31	LH	Flat
xiāng yě	13	HL	Falling
yě xiāng	31	LH	Rising
xiāng bú	12	HH	Falling
bú guò	24	HL	Falling
guò tā	41	LH	Falling
wǒ yǒu	33	LL	Falling
yǒu xīn	31	LH	Rising
xīn cǎi	13	HL	Rising
duǒ dài	34	LL	Flat
kàn huā	41	LH	Falling
huā de	15		Falling
de rén	52		Falling
rén ér	22	HH	Falling
ér yào	24	HL	Rising
yào jiāng	41	LH	Rising
jiāng wǒ	13	HL	Falling
wǒ mà	34	LL	Rising
wǒ yǒu	*Repetition. Not included in data.*		
yǒu xīn			
xīn cǎi			
cǎi yì			
yì duǒ			
duǒ dài			
yòu pà	44	LL	Falling
pà lái	42	LH	Falling
lái nián	22	HH	Falling
nián bù	24	HL	Rising
bù fā	41	LH	Falling
fā yá	12	HH	Falling

(9.3) **HLH**

Syllables	Tones	H/L	Direction of musical transition
qīng zǎo	13	HL	Falling
zǎo qǐ	33	LL	Falling
dà zǎo	43	LL	Falling
zǎo qǐ	33	LL	Rising
yān tǒng	13	HL	Rising
tǒng lǐ	33	LL	Rising
mào yān	41	LH	Falling
yān jiù	14	HL	Falling
jiù dào	44	LL	Falling
dào nǐ	43	LL	Falling
nǐ jiā	31	LH	Rising
jiā qù	14	HL	Rising
nǐ mā	31	LH	Rising
mā mā	11	HH	Rising
shēng xià	14	HL	Rising
xià nǐ	43	LL	Falling
nǐ ge	35		
ge mèi	53		
mèi mào	34	LL	Rising
mào nǚ	43	LL	Falling

Syllables	Tones	H/L	Direction of musical transition
de rén	52		
rén ér	22	HH	Falling
ér shí	22	HH	Rising
shí zài	24	HL	Falling
zài duō	41	LH	Rising
duō li	45		
hǎi lián	32	LH	Rising
lián huā	21	HH	Falling
gē gē	11	HH	Flat
gē nà	14	HL	Falling
nà xiǎo	43	LL	Rising
xiǎo mèi	34	LL	Rising
mèi zi	45		
ài nǐ	43	LL	Rising
nǐ de	35		
de rén	52		
rén ér	22	HH	Falling
ér shì	24	HL	Falling
shì shí	42	LH	Rising
shí zài	24	HL	Falling
zài duō	41	LH	Rising
duō li	15		

(9.3) **MZR**

Syllables	Tones	H/L	Direction of musical transition
yuè sè	44	LL	Rising
sè nà	44	LL	Falling
nà yàng	44	LL	Falling
yàng mó	42	LH	Rising
mó hú	22	HH	Flat
dà dì	44	LL	Rising
dì lǒng	43	LH	Flat
lǒng shàng	34	HL	Falling
shàng yè	44	LL	Falling
yè wù	44	LL	Falling
wǒ de	35		
de mèng	54		
mèng			
zhōng	41	LH	Rising
zhōng de	15		
de rén	52		
rén ér	22	HH	Falling
ér ya	25		
nǐ zài	34	LL	Rising
zài hé	42	LH	Falling
hé chù	24	HL	Falling
yuǎn tīng	31	LH	Flat
tīng hǎi	13	HL	Rising
hǎi cháo	32	LH	Falling
cháo qǐ	23	HL	Falling
qǐ fú	32	LH	Rising
sōng fēng	11	HH	Rising
fēng zhèng	14	HL	Flat
zhèng zài	44	LL	Rising
zài āi	41	LH	Rising
āi sù	14	HL	Rising

wǒ de	*Repetition. Not included in data.*
de mèng	
mèng	
zhōng	
zhōng de	
de rén	
rén ér	
ér ya	
nǐ zài	
zài hé	

Syllables	Tones	H/L	Direction of musical transition
méi yǒu	23	HL	Falling
yǒu qiáng	32	LH	Rising
qiáng wéi	22	HH	Rising
wéi de	25		
de chūn	51		
chūn tiān	11	HH	Falling
hǎo xiàng	34	LL	Falling
xiàng shù	44	LL	Falling
shù qín	22	HH	Rising
qín duàn	24	HL	Falling
duàn le	45		
le xián	52		
huó zài	24	HL	Flat
zài méi	42	LH	Rising
méi yǒu	23	HL	Rising
yǒu ài	34	LL	Rising
ài de	45		
de rén	52		
rén jiān	21	HH	Rising
guò yí	42	LH	Falling
yí rì	24	HL	Falling
rì hǎo	43	LL	Falling
hǎo xiàng	34	LL	Rising
xiàng guò	44	LL	Falling
guò yī	41	LH	Falling
yī nián	12	HH	Rising
yè yīng	41	LH	Rising
yīng lín	12	HH	Falling
lín jiān	21	HH	Falling
jiān tòng	14	HL	Rising
tòng kǔ	43	LL	Flat
cǎo shàng	34	LL	Rising
shàng jiàn	44	LL	Flat
jiàn zhe	45		
zhe lèi	54		
lèi zhū	41	LH	Falling

wǒ de	*Repetition. Not included in data.*
de mèng	
mèng	
zhōng	
zhōng de	
de rén	

Syllables	Tones	H/L	Direction of musical transition
nǐ zài			
zài hé			
hé chù			

(9.3) **WYDF**

Syllables	Tones	H/L	Direction of musical transition
wǔ yuè	34	LL	Rising
yuè de	45		
de fēng	51		
fēng chuī	11	HH	Falling
chuī zài	14	HL	Flat
zài huā	41	LH	Rising
huā	14	HL	Flat
shàng			
duǒ duǒ	33	LL	Falling
duǒ de	35		
de huā	51		
huā ér	12	HH	Rising
ér tǔ	23	HL	Rising
tǔ lù	34	LL	Flat
lù fēn	41	LH	Rising
fēn fāng	11	HH	Rising
jiǎ rú	32	LH	Rising
rú ya	25		
ya huā	51		
huā ér	12	HH	Flat
ér què	24	HL	Falling
què yǒu	43	LL	Rising
yǒu zhī	31	LH	Rising
dǒng dé	32	LH	Falling
dé rén	22	HH	Rising
rén hǎi	23	HL	Falling
hǎi de	35		
de chāng	51		
chāng	11	HH	Rising
sāng			
tā gāi	11	HH	Falling
gāi dī	11	HH	Rising
dī xià	14	HL	Falling
xià tóu	42	LH	Falling
tóu lái	22	HH	Falling
lái kū	21	HH	Rising
kū duàn	14	HL	Rising
duàn le	45		
le gān	51		
gān	12	HH	Falling
cháng			

9.4 Approach 3 analysis

MLH

Syllable	F_0 of syllable	Transition of syllable F0 to next note	Transition of musical pitch to next note	Match	Qualified melismatic syllables	Match
hǎo	140.42	Rising	Rising	X		
yì	178.77	Falling	Rising			
duǒ	127.57	Rising	Rising	X		
mò	161.62	Falling	Rising		M	y
lì	136.49	Falling	Falling	X		
huā	126.84					
hǎo	125.26	Rising	Rising	X		
yì	164.99	Falling	Rising			
duǒ	122.78	Rising	Falling			
mò	133.84	Falling	Falling	X		
lì	123.08	Falling	Falling	X		
huā	118.42					
mán	154.41	Falling	Rising		M	y
yuǎn	138.32	Rising	Rising	X		
huā	165.18	Falling	Falling	X		
cǎo	107.62	Rising	Flat		M	y
xiāng	150.98	Falling	Falling	X		
yě	136.62	Flat	Rising			
xiāng	136.97	Falling	Falling	X		
bú	120.86	Flat	Falling			
guò	119.34	Falling	Falling	X		
tā	110.22					
wǒ	153.5	Falling	Falling	X		
yǒu	134.4	Rising	Rising	X		
xīn	176.3	?	Rising			
cǎi	unknown	?	Falling		M	
yì	140.1	Falling	Falling	X		
duǒ	106.7	Rising	Flat			
dài	140.8				M	y
kàn	148.3	Rising	Falling		M	
huā	161.3	Falling	Falling	X		
de	132.1	Falling	Falling	X		
rén	117.7	Flat	Falling		M	y
ér	117.5	Rising	Rising	X		
yào	143.2	Falling	Rising			
jiāng	140.4	Rising	Falling			
wǒ	212.2	Falling	Rising		M	y
mà	197.7				M	y
wǒ	*Repetition. Not included in data.*					
yǒu						
xīn						

Syllable	F_0 of syllable	Transition of syllable F0 to next note	Transition of musical pitch to next note	Match	Qualified melismatic syllables	Match
cǎi						
yì						
duǒ						
dài						
yòu	167.4	Falling	Falling	X		
pà	156.8	Falling	Falling	X		
lái	130.7	Falling	Falling	X		
nián	120.4	Rising	Rising	X		
bù	136.3	Falling	Falling	X		
fā	117.0	Falling	Falling	X		
yá	90.0					

(9.4) **HLH**

Syllable	F_0 of syllable	Transition of syllable F0 to next note	Transition of musical pitch to next note	Match	Qualified melismatic syllables	Match
qīng	210.3	Falling	Falling	X		
zǎo	171.1	Falling	Falling	X		
qǐ	164.0					
dà	161.3	Falling	Falling	X		
zǎo	122.8	Rising	Rising	X		
qǐ	133.7					
yān	182.6	Falling	Rising			
tǒng	151.4	Falling	Rising			
lǐ	125.5	Rising				
mào	159.0	=	Falling			
yān	157.2	Rising	Falling			
jiù	164.0	Falling	Falling	X		
dào	149.3	Falling	Falling	X		
nǐ	116.7	Rising	Rising	X		
jiā	134.0	Rising (?)	Rising	X		
qù	316.9					
nǐ	131.6	Rising	Rising	X		
mā	174.1	Rising	Rising	X		
ma	181.5	Rising				
shēng	189.7	Falling	Rising			
xià	180.3	Falling	Falling	X		
nǐ	122.1	Rising	Falling			
ge	131.1	Falling	Rising			
měi	116.9	Rising	Rising	X		
mào	134.7	Rising	Falling		M	
nǚ	212.6					
ài	160.6	Falling	Rising			
nǐ	127.6	Falling	Rising			
de	124.8	Rising	Rising	X		
rén	132.6	Falling	Falling	X		
ér	130.3	Rising	Rising	X		
shí	132.3	=	Falling			
zài	148.6	Rising	Rising	X		
duō	143.7	Falling	Falling	X		
li	102.1					
hǎi						
huā						
ér						
gē	165.6	Rising	=			
ge	172.5	Rising	Falling			
nà	175.9	Falling	Rising			
xiǎo	128.2	=	Rising			

Syllable	F_0 of syllable	Transition of syllable F0 to next note	Transition of musical pitch to next note	melismatic Match	Qualified syllables	Match
nǐ	135.4	Falling	Rising	X		
de	124.9	=	Falling			
rén	125.7	=	Falling			
ér	129.3	Rising	Rising	X		
shí	289.7	Falling	Falling	X		
zài	148.4	Rising	Rising	X		
duō	150.1	Falling	Falling	X		
li	132.5					

(9.4) **MZR**

Syllable	F_0 of syllable	Transition of syllable F0 to next note	Transition of musical pitch to next note	Match	Qualified melismatic syllables	Match
yuè	197.1	Falling	Rising		M	
sè	173.9	Falling	Falling	X		
nà	164.8	Falling	Falling	X		
yàng	136.4	Falling	Rising		M	y
mó	117.8	Flat	Flat	X		
hú	112.5					
dà	175.1	Falling	Rising		M	
dì	147.7	Falling	Flat		M	
lǒng	112.1	Rising	Falling			
shàng	148.5	Falling	Falling	X		
yè	143.7	Falling	Falling	X		
wù	130.7					
wǒ	120.0	Rising	Flat			
de	137.0	Rising	Flat			
mèng	167.8	Falling	Rising			
zhōng	163.8	Falling	Falling	X		
de	144.5	Falling	Falling	X		
rén	128.7	Falling/Flat	Falling	X		
ér	126.9	Falling	Falling	X		
ya	110.2					
nǐ	117.7	Rising	Rising	X		
zài	149.4	Falling	Falling	X		
hé	118.6	Rising	Falling			
chù	139.0					
yuǎn	126.9	Rising	Flat		M	
tīng	185.2	Falling	Rising			
hǎi	136.5	Falling/-	Falling	X		
cháo	133.4	Falling	Falling	X		
qǐ	107.9	Rising	Rising	X		
fú	110.8					
sōng	176.7	Rising	Rising	X		
fēng	179.5	Falling	Flat			
zhèng	163.5	Falling	Rising			
zài	147.0	Falling	Rising			
āi	130.4	Flat	Rising			
sù	130.0					
wǒ	*Repetition. Not included in data.*					
de						
mèng						
zhōng						
de						
rén						
ér						

Syllable	F_0 of syllable	Transition of syllable F0 to next note	Transition of musical pitch to next note	Match	Qualified melismatic syllables	Match
ya						
nǐ						
zài						
hé						
chù						
méi	160.8	Rising	Falling		M	y
yǒu	172.3	Falling	Rising		M	y
qiáng	150.5	Rising	Rising	X		
wēi	164.1	Falling	Falling	X		
de	143.9	Rising	Rising	X		
chūn	151.0	Flat	Falling			
tiān	152.3					
hǎo	130.2	Rising	Falling			
xiàng	154.1	Rising	Falling			
shù	190.7	Rising	Rising			
qín	146.7	Falling	Falling	X		
duàn	160.4	Rising	Falling		M	
le	133.3	Falling	Falling	X		
xián	98.6					
huó	147.0	Rising	Flat			
zài	177.0	Flat	Rising			
méi	177.2	Falling	Rising			
yǒu	162.2	Flat	Rising			
ài	161.2	Falling	Falling	X		
de	125.8	Flat	Falling			
rén	125.5	Rising	Rising	X		
jiān	140.8					
guò	182.5	Falling	Falling	X		
yí	163.2	Falling	Falling	X		
rì	143.6	Falling	Falling	X		
hǎo	118.4	Rising	Rising	X		
xiàng	155.4	Flat	Falling			
guò	153	Falling	Falling	X		
yì	132.5	Falling	Rising			
nián	110.8					
yè	211.3	Falling	Rising		M	
yīng	191.1	Falling	Falling	X		
lín	149.8	Rising	Falling		M	
jiān	188.2	Falling	Rising			
tòng	147.9	Falling	Flat			
kǔ	123.6					
cǎo	120.2	Rising	Rising	X		
xiàng	157.3	Falling	Flat		M	
jiàn	151.9	Falling	Falling	X		
zhe	118.9	Falling	Falling	X		

Syllable	F_0 of syllable	Transition of syllable F0 to next note	Transition of musical pitch to next note	Match	Qualified melismatic syllables	Match
lèi	132.4	Rising	Falling		M	
zhū	125.4	Falling				
wǒ	*Repetition. Not included in data.*					
de						
mèng						
zhōng						
de						
rén						
ér						
ya						
nǐ						
zài						
hé						
chù						

(9.4) **WYDF**

Syllable	F0 of syllable	Transition of syllable F0 to next note	Transition of musical pitch to next note	Match	Qualified melismatic syllables	Match
wǔ	154.6	Rising	Rising	X		
yuè	187.3	Falling	Rising			
de	144.6	Rising	Rising	X		
fēng	166.0	Flat	Falling			
chuī	166.5	Falling	Flat			
zài	156.8	Flat	Rising		M	
huā	155.8	Falling	Flat			
shàng	128.2					
duǒ	178.2	Falling	Falling	X		
duǒ	159.1	Falling	Falling	X		
de	138.1	Rising	Falling			
huā	165.7	Falling	Rising			
ér	135.7	Falling	Rising			
tǔ	113.0	Rising	Flat			
lù	132.7	Flat	Rising			
fēn	132.9	Falling	Rising			
fāng	127.7					
jiǎ	113.0	Rising	Rising	X		
rú	130.5	Rising	Rising	X		
ya	401.1	Falling	Falling	X		
huā	181.6	Falling	Flat			
ér	150.7	Rising	Falling			
què	169.1	Falling	Rising		M	y
yǒu	118.5	Rising	Rising	X		
zhī	190.8	Falling				
dǒng	121.7	Flat	Falling		M	y
dé	120.8	Falling	Rising		M	
rén	116.4	Rising	Falling			
hǎi	121.9	Falling	Falling	X		
de	109.2	Rising	Falling			
chāng	147.1	Falling	Rising			
sāng	134.4					
tā	165.5	Rising	Falling			
gāi	169.5	Rising	Rising	X		
dī	187.4	Falling	Falling	X		
xià	163.6	Falling	Falling	X		
tóu	125.3	Falling	Falling	X		
lái	116.9	Rising	Rising	X		
kū	211.0	Falling	Rising			
duàn	143.7	Falling	Falling	X		
le	111.3	Rising	Falling			
gān	127.9	Flat	Falling			
cháng	128.3				M	

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