Postprint of an Acoustic Study of Tones in the Dongguan Guancheng Dialect

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Date: 2020-11-10T00:00:00+00:00

Abstract

This study conducts an acoustic analysis of monosyllabic and disyllabic tones in Guancheng dialect, measuring tonal values and contours of monosyllabic tones as well as tone sandhi patterns in disyllabic combinations. The experiment extracts fundamental frequency (F0) and applies semitone normalization. The results are compared with the 1993 publication *A Brief Account of Dongguan Dialect* and the 2010 work *A Phonetic Study of Dongguan Cantonese* to reveal the process of change. The study finds that the entering tone in Guancheng dialect is gradually merging into the yang rising tone, while the yin level tone shows a tendency to split into two categories: a high level tone 55 and a falling-rising tone 323, which are currently in a state of mixed usage. Based on normalization processing, Guancheng dialect is classified into seven citation tones. For disyllabic tones, tone sandhi in Guancheng dialect yields only two outcomes: high-level sandhi and high-rising sandhi. Comparison with previous literature reveals that the number of high-level sandhi cases has been increasing in recent years, while high-rising sandhi has decreased, which may be related to the split of the yin level tone. Tone sandhi is relatively free, influenced by many potential factors beyond phonetic conditions, and is currently in a rapid process of phonological change that is unbalanced and shows significant individual variation. Additionally, whether this type of "non-continuous tone sandhi" in Cantonese can be termed "tone sandhi" remains controversial in academia.

Full Text

An Acoustic Study of Tones in Dongguan Guancheng Dialect

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Abstract

This study presents an acoustic analysis of monosyllabic and disyllabic tones in Guancheng dialect, measuring the tonal values and contours of single syllables as well as tone sandhi patterns in disyllabic combinations. The experiment extracts fundamental frequency (F0) and normalizes the data using the semitone method. The results are compared with *A Brief Account of Dongguan Dialect* (1993) and *A Study of Dongguan Cantonese Phonology* (2010) to reveal processes of change. The study finds that the changed entering tone in Guancheng dialect is gradually merging with the yang rising tone, while the yin level tone shows a tendency to split into two categories: a high level tone (55) and a falling-rising tone (323), currently in a state of free variation. Based on normalized data, Guancheng dialect can be divided into seven single-character tones. For disyllabic tones, tone sandhi in Guancheng dialect yields only two outcomes: high level sandhi and high rising sandhi. Comparison with previous literature reveals that the number of high level sandhi forms has continuously increased in recent years, while high rising sandhi has decreased, possibly related to the splitting of the yin level tone. Tone sandhi is relatively free, influenced by many potential factors beyond phonetic conditions, and is currently undergoing rapid phonological change characterized by imbalance and significant individual variation. Additionally, whether this "non-phonetic tone sandhi" in Cantonese can be called "tone sandhi" remains controversial in academia.

Keywords: Guancheng dialect; Cantonese; tone; tone sandhi

1.1 Significance of Tone Research

Ancient Chinese scholars long ago recognized the existence of tones in Chinese, as evidenced by the establishment of the traditional "four tones" and the distinction between initials and finals, which reflects an early awareness of tonal phonemes. Tone is not unique to Chinese or Sino-Tibetan languages, yet among the thousands of languages worldwide, those that use pitch differences to distinguish meaning constitute only a small fraction, and the functional load of tone varies significantly. As Zhao Yuanren (1980) noted, in Northern European countries such as Lithuania and Sweden, "tone carries a very light burden in phonemic distinction," whereas "in most Eastern languages, tone carries a heavy burden." Consequently, the issue of tone in Sino-Tibetan languages has always attracted linguists' attention, and tonal research helps reveal the origin of tone, the genealogical relationships among related languages, and the essential differences between Sino-Tibetan and other language families.

For Chinese specifically, tonal research also aids in understanding the developmental trajectories of both the standard language and dialects. At the synchronic level, Chinese dialects exhibit tremendous variation in tone, demonstrating the richness of phonological systems. At the diachronic level, Chinese dialects often preserve remnants of ancient Chinese phonological components, reflecting historical evolution; the merging and splitting patterns of tonal cat-

egories across different regions provide clues about the spread of the standard language and its fusion with dialects across both temporal and spatial dimensions.

In the 1920s, Zhao Yuanren and Liu Fu used kymographs to measure tones and discovered that pitch height is determined by vocal fold vibration frequency. Subsequently, the five-point scale method provided a basis for tone measurement in dialect surveys. With technological advances, particularly the application of computers, automatic F0 extraction and linear predictive coding of speech have made more precise acoustic measurement of tones possible, enabling linguists to establish experimental methods for tonal measurement beyond traditional field surveys relying on auditory perception.

Acoustic study of tones complements traditional field survey methods based on listening and transcription, overcoming the subjectivity of human perception. Tone perception, as a psychological quantity, may be influenced by the researcher' s native language background and context, diverging from pitch as a physical quantity. Acoustic research extracts F0 through instruments or software to determine tonal values and classify tonal contours, and can summarize patterns of tone sandhi through statistical analysis, making the results quantifiable and replicable, thus meeting scientific research standards.

1.3 Selection of the Dialect Point

This tonal study selects Dongguan Guancheng dialect from the Yue dialect group as its research subject, based on the following considerations:

First, from a diachronic perspective, Yue dialects possess numerous tonal types that retain many traces of Middle Chinese phonology, including entering tone categories and stop codas. Detailed description of Yue dialect tones provides a pathway for exploring Middle Chinese phonology.

Second, from a synchronic perspective, Yue dialects exhibit considerable internal variation, with different dialect points showing substantial differences in the number and phonetic values of tones, as well as diverse tone sandhi patterns. Some regions have even experienced stop coda loss and the merging of entering tones into other tonal categories, reflecting the influence of the standard language on Yue dialect evolution. Measuring tones in flux helps reveal this evolutionary process.

Third, previous research on Yue dialect tones has concentrated primarily on the two most representative dialect points of Guangzhou and Hong Kong (e.g., Li Xinkui 1995; Lin Jianping 1999), while surveys of other regions have rarely been conducted, and acoustic analyses are even scarcer. This study selects Dongguan Guancheng to address this gap in geographical coverage. Since Li Lilin (2010) found significant tonal differences across districts within Dongguan city, this research is limited to Guancheng district to enhance consistency of results. According to Chen Xiaojin' s (1993) survey, Guancheng dialect has

already exhibited stop coda loss in entering tones, yet these tones remain a distinct category without merging into others. This study will track the current phonological status of this tonal category to reveal ongoing sound changes.

2.1 Basic Information

Dongguan City is located in the northeastern Pearl River Delta of Guangdong Province, between 113°31 E to 114°15 E and 22°39 N to 23°09 N, covering an area of approximately 2,460.5 square kilometers. The city administers districts including Guancheng, Shilong, and Humen. Guancheng district, situated in north-central Dongguan, serves as the city' s political, economic, and cultural center, and lies along the water transportation route between Guangzhou and Hong Kong, making its language potentially susceptible to influence from both cities. Guancheng district has a population of approximately 250,000. Apart from migrants, the vast majority speak Yue dialect, with only one village—Luoshang Shangling, with about 330 residents—speaking Hakka (Chen Xiaojin 1993). This mirrors Dongguan' s overall situation, where Yue dialect predominates with minority Hakka usage.

[Figure 1: see original paper] Map of Dongguan City (image from the internet)

Guancheng dialect belongs to the Guanbao (Dongguan, Bao' an, Hong Kong New Territories) subgroup of Yue dialect and differs somewhat from Guangzhou dialect. The following briefly introduces Guancheng' s initial, final, and tonal system. Previous research on Guancheng dialect is scarce; the following description draws from *A Brief Account of Dongguan Dialect* (Chen Xiaojin 1993), *Dongguan Dialect Dictionary* (Li Rong, Zhan Bohui, and Chen Xiaojin 1997), and *A Study of Dongguan Cantonese Phonology* (Li Lilin 2010).

2.2 Initial Consonants

Chen Xiaojin' s (1993) survey shows that Guancheng dialect has 19 initial consonants (including the zero initial). These are as follows:

/K / Ø zero initial a (~ge)
Source: Chen Xiaojin, *A Brief Account of Dongguan Dialect* (1993)

Li Lilin (2010) presents a different consonant system, arguing that a set of fricative and affricate initials should be described as laminal / /, /t /, and /t / rather than apical sounds. Additionally, zero-initial words beginning with /u/ all carry heavy labiodental friction but do not contrast with the zero initial, so /v/ is not listed as a separate initial. He also merges /k / and /K / into /k/ and /k / respectively, streamlining the system to only 16 initials. The disagreement between the two scholars concerns only the degree of phonological analysis, not transcriptional differences.

2.3 Finals

Guancheng dialect has 40 finals in total, listed as follows:

Source: Chen Xiaojin, *A Brief Account of Dongguan Dialect* (1993)

Notably, although Guancheng dialect possesses all stop codas (/-p/, /-t/, /-k/, /- /), /- / occurs only in the final /a /, and /-p/ occurs only in / p/. Furthermore, "the /-t/ coda shows a tendency to evolve toward the /-k/ coda," with the two gradually merging in a manner that varies by speaker. These phenomena demonstrate that entering tone finals in Guancheng dialect are undergoing change, corroborating the subsequent discussion of the disappearance and merging of entering tones.

2.4 Tone System

According to late 20th-century dialect surveys, Guancheng dialect contains eight tonal categories:

Source: Chen Xiaojin, *A Brief Account of Dongguan Dialect* (1993)

Unlike Guangzhou dialect, Guancheng dialect does not distinguish yin and yang in the departing tone and features a special category called "changed entering" (变入). This term, coined by earlier researchers, refers to "entering tone characters that have lost their stop codas," having "changed from checked to smooth syllables, from closed to open," yet remaining a distinct category without merging with others. The establishment of "changed entering" reflects the decline of entering tones in Cantonese. Chen Xiaojin (1993) discusses the development of this category: "Whether the evolution of [changed entering characters] will follow the pattern of ancient voiceless entering tones merging into level, rising, and departing tones remains to be observed." Another characteristic of Guancheng dialect is its contour tone—the yin level tone is recorded as 213. Contour tones are rare in Yue dialects and may indicate fusion with other dialects, warranting researchers' attention.

Li Lilin's (2010) description of Guancheng tones differs somewhat from the earlier survey:

Source: Li Lilin, *A Study of Dongguan Cantonese Phonology* (2010)

He agrees that the yin level is a contour tone but argues it should be rising-falling rather than falling-rising. He also proposes that after coda loss, the changed entering tone has merged into the yang rising tone, as in the character "发". His proposed phonetic values for yang rising, yin entering, and yang entering are all higher than Chen Xiaojin's (1993) system, though the contours remain the same. Overall, the two scholars' disagreements are minor, focusing on the contour shape of yin level and the merging of changed entering. The former may be influenced by differences in dynamic versus stable articulation phases, manifesting in spectrograms as "onset curvature" and "offset falling"; the latter represents a diachronic difference, as Cantonese entering tones are in flux, with

different regions undergoing change at different times and to different degrees. Guancheng dialect has experienced a dynamic process from coda loss to merging into other tonal categories, revealed through scholarly investigation.

3.1 Data Collection

Based on Chen Xiaojin' s (1993) tonal classification, this study acoustically analyzes eight tonal categories in Dongguan Guancheng dialect, using quantitative methods to more accurately describe the dialect' s tonal categories and values. The experiment uses Praat, a speech analysis software developed by Paul and David (2013), and scripts to extract F0 through autocorrelation algorithms. Smooth tones are sampled at 20 points, while checked tones at 15 points. Since changed entering tones are formed by the loss of stop codas from entering tones and are no longer abrupt in articulation, they are also sampled at 20 points.

Due to objective constraints, recordings were made by participants themselves under researcher guidance using smartphones, with a uniform sampling rate of 44.10 kHz, 16-bit resolution, and monophonic recording. The researcher compiled word lists for monosyllabic and disyllabic items, randomized the presentation order, and displayed them via PowerPoint, with one item per slide and a 3-second interval between slides.

When extracting and processing F0 data, onset and offset segments caused by physiological articulatory constraints should be removed, focusing analysis on the middle contour segment. Howie (1976) argued that tone range is limited to the vowel and subsequent voiced portions of a syllable, while Ping Yueling et al. (2001) considered voicing in sonorant initials as merely their articulatory feature without tonal significance, whereas final nasals [n] and [ŋ] are important tone-bearing segments. Since the recording materials include sonorant initials, F0 extraction avoided the initial consonant portions.

3.2 Data Processing

After F0 data collection, normalization is often necessary to handle the vast differences across speech samples and facilitate quantitative analysis. In addition to pitch, duration is a concomitant feature of tone that affects auditory perception. Acoustic analysis of tones requires duration normalization, typically using relative time coordinates to select F0 data at 5%, 10%, 20%···90%, 100% points, reducing inter-sample variation caused by random factors. In practice, scripts batch-process the data.

The semitone is considered the best unit for tonal research reflecting psychoacoustic characteristics. Multiple studies have demonstrated that this logarithmic space significantly correlates with pitch change (Nolan, 2003; Carlson, 2004; Li Aijun, 2005). In musical temperament, an octave is divided into 12 intervals, each being a semitone. The relationship between semitone and F0 is as follows (F0 unit: Hz):

$$St = 12 \times \log_2(F_0/F_{ref})$$

where St is the semitone value and F_0 is the fundamental frequency. When using the semitone method to describe tonal values, F_{ref} typically adopts the lower frequency limit. After discarding unqualified samples (with heavy noise, breathing sounds, etc.), F0 data are converted to semitone values, then to corresponding five-point scale values.

3.3 Speakers

The speakers consist of two males and two females, aged 19-21, all native Guancheng dialect speakers with Guancheng-native parents, and long-term residents of Dongguan. One female currently studies in Guangzhou, creating some possibility of influence from Guangzhou Cantonese contact. However, Guangzhou Cantonese is widely disseminated throughout Guangdong and does not necessarily require interpersonal contact to exert influence; in this sense, every participant may be subject to such influence. All participants are university students who also speak Mandarin.

Speech sample information reveals individual differences in tonal range. The two male speakers' F0 ranges are 94-162 Hz and 89-147 Hz respectively, while the two female speakers' ranges are 78-371 Hz and 101-304 Hz.

3.4.2 Disyllabic Tone Word List

To investigate tone sandhi in connected speech in Guancheng dialect, acoustic analysis is required for all possible combinations of different tonal categories as first and second syllables. For a dialect with eight tonal categories, there are theoretically 64 possible combinations. Previous dialect surveys have shown that some tonal combinations do not exhibit sandhi, such as yang level + yin rising, or departing + yin entering. However, within the same tonal combination, multiple patterns may occur: first syllable sandhi, second syllable sandhi, both changing, or neither changing. For example:

Previous research has revealed two important aspects:

1. Regardless of the original tone category, if sandhi occurs, there are only two outcomes: changing to a high level tone (55) or a high rising tone (45).

2. Most sandhi forms are habitual, unrelated to lexical or grammatical meaning; only some serve to distinguish meaning or word class.

To test these findings, this experiment' s word list covers all possible sandhi types under each combination. (Due to length, the list is appended). Two decades later, do words that previously underwent sandhi still do so? Are the tonal values of high level and high rising sandhi obtained through auditory

impression accurate? Beyond the cautious but unsatisfactory explanation of "habitual sandhi," are there alternative ways to explain Guancheng' s sandhi patterns? In terms of sandhi, Guancheng and Guangzhou dialects share a common Yue dialect characteristic: widespread high level and high rising sandhi with difficult-to-explain conditioning. Therefore, in explaining Guancheng' s sandhi phenomena, we appropriately reference existing research on sandhi in other Yue dialect areas.

4. Monosyllabic Tone Parameter Analysis

After normalizing the female speakers' F0 data by converting F0 to semitones and averaging across tonal categories, the upper frequency limit is 247 Hz and the lower limit 141 Hz, encompassing approximately 10 semitones, with each five-point scale interval containing two semitones. The results for each tonal category are as follows:

[Figure 1: see original paper] Normalized monosyllabic tone results (female)

After averaging the male speakers' F0 data across tonal categories, the upper frequency limit is 137 Hz and the lower limit 95 Hz, encompassing approximately 7 semitones, with each scale interval containing 1.4 semitones. The results are as follows:

[Figure 2: see original paper] Normalized monosyllabic tone results (male)

After averaging all speakers' F0 data across tonal categories, the upper frequency limit is 192 Hz and the lower limit 119 Hz, encompassing approximately 8.5 semitones, with each scale interval containing 1.7 semitones. The results are as follows:

[Figure 3: see original paper] Normalized processing results for each tonal category

From a gender perspective, tonal contours are generally similar between male and female speakers, though females show slightly higher tonal onsets. Synthesizing male, female, and overall results, a notable phenomenon is that the changed entering tone (with lost stop coda) shows a tendency to merge with the yang rising tone. For both male and female speakers, the F0 curves of yang rising and changed entering tones nearly coincide, and speakers themselves perceive the two tones as essentially identical, corroborating Li Lilin' s research.

The yang entering tone also shows partial stop coda loss. Among the four speakers, three (two males and one female) produced the character "搭" without the stop coda as [ta]. To avoid affecting the description of yang entering tone values, F0 data for "搭" were excluded from yang entering statistics. Partial coda loss in yang entering characters, merging of changed entering into yin level tone, gradual disappearance of the /-p/ coda, and confusion between /-t/ and /-k/ codas all constitute evidence that Guancheng' s entering tones are in a dynamic evolutionary process, indicating that the loss of entering tones is an

unbalanced development that often spreads gradually from some lexical items to others. Beyond Guancheng, other dialect areas in Dongguan show varying degrees of entering tone syllable smoothing, a common phenomenon in the Yue dialect region.

During auditory analysis and F0 extraction, the yin level tone clearly split into two categories: one high level and one lower, not associated with specific characters. After semitone conversion, statistical results are as follows:

[Figure 4: see original paper] Two variants of yin level tone values

The two readings of yin level tone currently appear relatively free, with females showing more stable patterns, though this requires testing with larger samples. The first category is a high level tone with a smooth contour, transcribable as 55 or 44. Regarding the second category, I argue this is the source of disagreement between Chen Xiaojin (1993) and Li Lilin (2010): Chen described it as a low falling-rising tone (213), while Li considered it basically low rising with a slight final fall, transcribable as 132 or 13. The essence of the disagreement concerns whether the initial and final falls represent onset/offset curvature or the tone-bearing segment. Examining spectrograms of all characters with this tone reveals that the F0 curve often shows, beyond initial falling, a concave falling-then-rising shape in the middle segment. When this appears relatively early, it is perceived as low rising; when late, as low falling. In this experiment, males' productions showed stronger low rising perception, while females showed stronger low falling perception. Overall, transcription as low falling-rising may be more appropriate. Moreover, this tone basically ranges within the 2-3 scale values, yet is perceptually distinct from both the low rising yang rising tone (23) and the low falling departing tone (32), and should be transcribed differently. Therefore, the tonal value is proposed as 323.

Why does yin level tone exhibit two relatively free variants? Two factors may be involved: influence from Guangzhou and Hong Kong Cantonese, and influence from its own high level sandhi.

First, free variation in yin level tone is not new to the Yue dialect region, having long existed widely in Hong Kong and Guangzhou Cantonese. The yin level tone in Guangzhou and Hong Kong has two readings: high level (55) and high falling (52/53), considered by scholars such as Gao Huanian (1980), Shi Feng (1994), and Zhan Bohui (2002) as two variants of yin level. According to Li Xinkui (1995), older Guangzhou Cantonese used high level and high falling to distinguish nouns from non-nouns, but among younger speakers in Guangzhou and Hong Kong, the two variants have merged, with high level becoming dominant and high falling rarely used. Shi Qisheng (2004) compared the use of yin level and high level sandhi in Ball' s Cantonese textbooks *Cantonese Made Easy* (CME, 1883) and *How to Speak Cantonese* (1912), finding that current yin level variants in Cantonese originated from high level sandhi. That is, the high falling tone is the base tone, but high level sandhi was used to distinguish meaning and gradually diffused through the lexicon, eventually replacing the high

falling tone. Yao Yumin (2010), examining materials predating CME (1883), reached the same conclusion.

Referencing the evolutionary history of yin level tone in Guangzhou and Hong Kong Cantonese, the emergence of yin level variants in Guancheng dialect may be influenced by its own high level sandhi. Chen Xiaojin' s (1993) survey found that high level sandhi in Guancheng occurred no less frequently than high rising sandhi, and appeared most often in yin level tone (transcribed as 213), as in the disyllabic word "中间" where the second yin level character changes to high level. However, the diffusion of high level sandhi from disyllabic words to monosyllabic base tones is unlikely to have occurred within a short period. In this process, language contact and integration played a facilitating role. As standard languages, Guangzhou and Hong Kong Cantonese exert radiating influence on other Yue dialect areas. Both predominantly use high level tone, and with Dongguan' s proximity to these cities, frequent communication, and the high mutual intelligibility between Guancheng and Guangzhou dialects, influence from these varieties is highly probable. This significant change in Guancheng' s yin level tone greatly impacts our subsequent analysis of disyllabic tone sandhi patterns.

5. Disyllabic Tone Parameter Analysis

As mentioned earlier, Guancheng' s sandhi patterns closely resemble Guangzhou' s, featuring both high level and high rising sandhi. That is, sandhi outcomes are fixed while sources are diverse. This sandhi does not result from tonal changes induced by sequential phonetic interaction (connected speech sandhi). Its looseness lies in that identical phonetic conditions may or may not trigger sandhi, may produce high level or high rising sandhi, or both. The origin and function of this sandhi type remain undetermined in academia.

Similar to monosyllabic tone measurement methods, 322 disyllabic items were randomly ordered and presented to participants via PowerPoint at 3-second intervals. Praat scripts extracted F0 data, sampling 20 points for each smooth-tone syllable and 15 for each checked-tone syllable. Data for first and second syllables under each phonetic condition were integrated and converted to five-point values using the semitone method. The lower frequency limit for semitone conversion and the five-point scale correspondences remain consistent with monosyllabic analysis.

Taking "yin level + yang entering" as an example, the data include: 中药, 听日, 精肉, 返学, 虾肉. According to the *Dongguan Dialect Dictionary*, in 中药 and 听日 the first syllable undergoes high level sandhi while the second remains unchanged; in 精肉, 返学, and 虾肉 neither syllable changes. Normalized results are as follows:

[Figure 5: see original paper] Yin level + yang entering

This represents an ideal case where the first-syllable yin level tone shows a clear split into two categories: one with tonal value 44/55 (high level), occurring in 听日 and 中药; the other with value 323 (low falling-rising). This differs from

the *Dongguan Dialect Dictionary*, possibly reflecting sound change or individual free choice. However, such aggregate averaging cannot reflect speakers' sandhi choices. For example, the first syllable of 虾肉 shows normalized value 44, but this does not mean the high level sandhi result is 44; rather, three speakers chose high level sandhi while one maintained the low falling-rising base tone. Frequency statistics for high level sandhi production are as follows:

Frequency of high level sandhi production by speakers

For dialects where sandhi outcomes are fixed but occurrence is not phonetically conditioned and is relatively free, frequency statistics are more informative than averaging for understanding sandhi patterns. The following analysis of the remaining 63 tonal combinations uses frequency statistics for high level and high rising sandhi, comparing them with patterns recorded in the *Dongguan Dialect Dictionary* (1997). Due to space constraints, only combinations with yin level as the first syllable are listed here; the complete table is provided in the appendix (see Appendix 2).

Frequency statistics for disyllabic sandhi (first syllable = yin level portion)

Notably, when processing disyllabic recordings, we found instances where changed entering characters retained stop codas, reflecting the imbalance of sound change and significant individual variation. Meanwhile, yin entering and yang entering characters also showed occasional coda loss.

Frequency statistics reveal that, except for yin rising tone (which as a high rising tone cannot undergo high rising sandhi), yin entering tone (with value 55, not requiring high level sandhi), and changed entering tone (with too few characters to form many combinations), all other phonetic conditions show some degree of high level or high rising sandhi. This also relates to individual preference—whether sandhi occurs and which type appears is not uniform. Diachronically, current sandhi patterns differ considerably from those recorded in the 1997 *Dongguan Dialect Dictionary*, manifesting as: (1) previously sandhi but now not, e.g., "工" in 工人, "青" in 青菜; (2) previously not sandhi but now sandhi, e.g., "虾" in 虾肉, "孖" in 孖仔; (3) sandhi in both periods but different types, e.g., "丈" in 姑丈 previously underwent high rising sandhi, but two speakers in this study produced high level sandhi.

Thus, the phonetic conditions for sandhi are indeed rich. Whether sandhi occurs and which type appears under identical conditions seems somewhat arbitrary, suggesting that even if sandhi rules exist, they are not simply associated with phonetic conditions. First, it must be noted that in both Guancheng and Guangzhou dialects, sandhi occurs at the character level—these characters can undergo sandhi not only in disyllabic or polysyllabic contexts but also when standing alone as words. For example, "糖" can undergo high rising sandhi in 麻糖 and 棉花糖, and also when standing alone in 吃糖, 一粒糖, or 糖好好吃. Thus, whether sandhi occurs relates to whether the character itself possesses the capacity for sandhi—some characters never undergo sandhi under any conditions, while sandhi under different conditions tends to concentrate in the same set of

characters. Examples from this word list appearing under different conditions include:

(1) 女 (base tone: yang rising)
High level sandhi (current): 仔 (yin rising) 女, 女人 (yang level), 侄 (yang entering) 女
High level sandhi (dictionary): 女人
No sandhi (dictionary): 仔女, 侄女
High rising sandhi (current): 养 (yang rising) 女, 嫁 (departing) 女, 叻 (yin entering) 女, 精 (yin level) 女, 契 (yang rising) 女
High rising sandhi (dictionary): 养女, 嫁女, 叻女, 精女, 契女, 傻女
Note: For 傻女, half the speakers used high level sandhi, half high rising.

(2) 面 (base tone: departing)
High rising sandhi (current): 被 (yang rising) 面, 面裤 (departing), 脚 (changed entering) 面
High rising sandhi (dictionary): 被面, 面裤, 脚面
No sandhi: 面口

(3) 刷 (base tone: changed entering)
High rising sandhi (current): 牙 (yang level) 刷
High rising sandhi (dictionary): 鞋 (yang level) 刷

These examples show sandhi may relate to lexical meaning: when 面 means "face" it does not change, but when meaning "surface" it undergoes high rising sandhi. Sandhi may also relate to diminutives: under identical phonetic conditions of yang level + changed entering, 牙刷 undergoes sandhi while 鞋刷 does not. However, the sandhi patterns of 女 reveal Guancheng sandhi' s complexity: while distinguishing "female" vs. "daughter" can explain sandhi differences in 女人 versus 养女 or 契女, it cannot explain 仔女 (where 女 parallels 仔 to mean "daughter") or 精女 (where 女 refers generally to clever women). These examples also demonstrate Guancheng dialect is undergoing vigorous sound change, with the imbalance of lexical diffusion manifesting both diachronically (between dictionary and current survey) and synchronically (among speakers).

Specific manifestations of sound change can also be seen in the shifting numbers of high level versus high rising sandhi forms. For better comparison with the *Dongguan Dialect Dictionary*, the following table includes only characters that underwent sandhi in at least half of the current study' s productions:

Changes in numbers of high level and high rising sandhi forms

The table shows that in the 1997 *Dongguan Dialect Dictionary*, high level and high rising sandhi occurred in similar numbers, but currently high level sandhi far exceeds high rising in both number and frequency. High level sandhi has continuously increased since 1997, while high rising sandhi has decreased, with some former high rising forms now trending toward high level, such as 花肠, 藤条, and 姨丈. This may result from sound change or relate to the speakers, who are all 19-21 years old. They have received rich linguistic input (Guancheng di-

alect, other Dongguan dialects, Guangzhou Cantonese, Mandarin, etc.), and native language acquisition occurs not through systematic learning like Mandarin pinyin but through interpersonal communication. It is impossible to receive complete native vocabulary input in early years, leading to overgeneralization of linguistic patterns. The widespread diffusion of high level sandhi in yin level tone may relate to overgeneralization by younger learners, explaining why the four participants showed such large variation in sandhi production—related to their individual understanding of sandhi rules: inferring whether high level or high rising sandhi should apply based on existing lexical experience. The non-phonetic nature of sandhi conditioning increases learning difficulty and accelerates sound change.

This pattern closely resembles changes Guangzhou Cantonese experienced over a century ago. Zhang Hongnian (2000) compared sandhi recorded in two editions of *Cantonese Made Easy* (1888 and 1907), finding high level sandhi increased from 31 to 114 instances, while high rising sandhi increased from 101 to 162. Though both types increased, high level sandhi grew much faster, laying the foundation for high level to become a free variant of yin level in Guangzhou Cantonese.

In the monosyllabic acoustic analysis above, we found Guancheng' s yin level tone also trending toward two free variants. If true, can we still call the high level reading of yin level in disyllabic contexts "high level sandhi" ? Indeed, whether this special sandhi form in Cantonese can be called "sandhi" has long been debated. Some conservative scholars argue only "connected speech sandhi" based on phonetic conditions qualifies as true sandhi; so-called "non-phonetic sandhi" does not. For example, Zong Fubang (1983) recognized only two sandhi types in Cantonese: (1) high falling tone in yin level changing to high level before another syllable, and (2) high falling and high level tones in yin level both changing to high level when combined. All other sandhi forms not explainable by phonetic conditions are "multiple readings of a single character." However, now that high falling and high level tones have merged, these "phonetic conditions" no longer exist—does this mean Cantonese no longer has sandhi? Another group of phoneticians has begun examining relationships between sandhi and grammatical/lexical meaning, attempting to explain sandhi causes and conditions beyond phonetics. This direction is reasonable because characters that undergo sandhi in disyllabic/polysyllabic contexts often show the same changes when standing alone as words. Li Lilin (2010) considers high sandhi (both high level and high rising) primarily nominal, including some diminutive and second-syllable sandhi. Researchers continue enumerating functions: sandhi distinguishing word class, proper nouns and place names, diminutives, etc. Li Xiaofan (2004) proposed that beyond phonetic sandhi, more attention should be paid to "phonosemantic sandhi": "Phonetic sandhi is a conditional sound change where character groups under identical phonetic conditions invariably undergo the same change with few exceptions. Phonosemantic sandhi differs, resembling diffusional sound change. Character groups with identical phonetic and grammatical-semantic conditions do not necessarily undergo the same change

simultaneously···Phonosemantic sandhi diffuses gradually from certain character groups to others." Thus, exploring Guancheng dialect from grammatical and semantic perspectives represents a future research direction, though such study faces great difficulty: Guancheng dialect is undergoing relatively rapid sound change, presenting a chaotic phonological landscape where consistent patterns are hard to establish, and any summarized rules may become obsolete within a few years.

Finally, F0 extraction and normalization of sandhi tokens yields phonetic values for high level and high rising sandhi:

[Figure 5: see original paper] Tonal values of high level and high rising sandhi

Based on these results, high level sandhi is best transcribed as 44, and high rising sandhi as 24. High level sandhi does not reach the highest point 55, likely due to different phonetic conditions. The function of high level sandhi is to distinguish itself from the base tone, and since most monosyllabic tones have values at or below 3, reaching value 4 is sufficient for distinction.

6. Limitations and Improvements

This study has several limitations: (1) Manual removal of onset and offset segments during F0 extraction may be inaccurate and lack uniform standards. (2) Evidence for changed entering merging into yang rising and yin level splitting relies solely on acoustic analysis and requires perceptual experiments for support. (3) Remote recording under non-uniform conditions and exclusion of some data due to noise may affect results. (4) The monosyllabic word list was not designed to ensure consistent initial and final conditions, which affect F0 curve length and shape. (5) The small number of participants, concentrated around age 20, may limit generalizability to other age groups.

Therefore, future experiments will incorporate perceptual tests, revise the word list, and include more participants across different age groups.

7.1 Monosyllabic Tones

Acoustic analysis reveals that Guancheng' s changed entering tone is gradually merging with yang rising tone, with almost no acoustic difference between them. However, proving complete merger requires evidence from perceptual experiments demonstrating whether native speakers also treat them as the same phoneme. Since changed entering tone still shows residual stop codas, it is temporarily retained as a separate category pending further sound change outcomes.

The yin level tone shows a tendency to split into two categories: a high level tone 55 and a falling-rising tone 323, currently in a state of free variation, possibly influenced by high level sandhi and sound changes in Guangzhou and Hong Kong Cantonese. Other tones' values and contours are derived through normalization analysis, resulting in seven tonal categories:

Monosyllabic tones in Dongguan Guancheng dialect

7.2 Disyllabic Tones

Guancheng dialect sandhi yields only two outcomes—high level and high rising—but the phonetic conditions triggering these are extremely rich. Sandhi may be influenced by lexical meaning, diminutives, word class, and individual regularization differences, and is undergoing rapid sound change with obvious imbalance and individual variation. Since it is impossible to exhaustively list all possible disyllabic tonal combinations, this summary reflects only the current experimental results; unlisted conditions do not necessarily preclude sandhi. Specific phonetic conditions are listed below, while lexical and diminutive sandhi rules require further investigation:

Disyllabic sandhi patterns in Dongguan Guancheng dialect

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Appendix: Disyllabic Tone Word List

[The original appendix contains extensive word lists and tables that are preserved in the original format but omitted here for brevity. The tables document all disyllabic tonal combinations and their sandhi patterns as described in the methodology section.]

Note: Figure translations are in progress. See original paper for figures.