Acoustic Analysis of Citation Tones and Tone Sandhi in New-Generation Ruijin Hakka (Post-Print)

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Abstract

Ruijin Hakka belongs to the Yuxin subgroup of the Hakka dialect. This paper takes the single-character tones and double-character tones of the new generation of Ruijin Hakka as its research object, and through acoustic analysis and phonological analysis methods, the following two conclusions can be drawn. (1) The single-character tones of the new generation of Ruijin Hakka have 7 tone categories. Yinping is a mid-level tone, marked as 33; Yangping is a mid-low tone, marked as 323; Shangsheng is a mid-falling tone, marked as 31; Yinqu is a mid-falling tone, marked as 31; Yangqu is a high-falling tone, marked as 41; Yinru is a high-falling tone, marked as 41; Yangru is a high-falling tone, marked as 4. (2) The double-character tones of the new generation of Ruijin Hakka are divided into two types: tone sandhi and non-tone sandhi. The types of tone sandhi are divided into initial-character sandhi, final-character sandhi, and initial-final character sandhi. In T+X combinations or X+T combinations, it is mainly initial-final character sandhi. The tone that does not change in double-character combinations is mainly Yangru; in T+X, Yangru as the final character does not undergo sandhi; in X+T, Yangru as the initial character does not undergo sandhi.

Full Text

Acoustic Analysis of Single-Character and Two-Character Tones in New-Style Ruijin Hakka

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Abstract: Ruijin Hakka belongs to the Yuxin subgroup of the Hakka dialect. This study investigates the single-character and two-character tones of new-style Ruijin Hakka through acoustic and phonological analysis, yielding two

principal conclusions. (1) New-style Ruijin Hakka has seven tone categories in single-character tones: Yin Ping is a mid-level tone, transcribed as 33; Yang Ping is a mid-low contour tone, transcribed as 323; Shang Sheng is a mid-falling tone, transcribed as 31; Yin Qu is a mid-falling tone, transcribed as 31; Yang Qu is a high-falling tone, transcribed as 41; Yin Ru is a high-falling tone, transcribed as 41; and Yang Ru is a high-falling tone, transcribed as 4. (2) Two-character tones in new-style Ruijin Hakka exhibit two patterns: tone sandhi and no change. Tone sandhi includes three types: initial-character change, final-character change, and both-character change. In T+X or X+T combinations, both-character change predominates. The tone that remains unchanged in two-character combinations is primarily Yang Ru, which does not change when occurring as the final character in T+X combinations or as the initial character in X+T combinations.

Keywords: new-style Ruijin Hakka; single-character tone; two-character tone; acoustic analysis; semitone method

The Chinese dialects of Jiangxi Province include Gan, Hakka, Mandarin, Wu, and Hui (Yan Sen 1986:1). Southern Jiangxi Hakka can be divided into eastern and western subgroups. The eastern subgroup includes eleven counties: Xingguo, Ningdu, Shicheng, Ruijin, Huichang, Xunwu, Anyuan, Dingnan, Longnan, Quannan, and Xinfeng. The western subgroup includes six counties: Dayu, Chongyi, Shangyou, Nankang, Ganxian, and Yudu (ibid.:23).

Major research on the Ruijin dialect includes *Ruijin Dialect* (Luo Zhaojin 1989) and *A Study of the Ruijin Dialect* (Liu Zemin 2007), while *A Draft Classification of Jiangxi Dialects* (Yan Sen 1986) and *An Overview of Jiangxi Hakka Dialects* (Liu Lunxin 2001) also analyze the initials, finals, and tones of Ruijin dialect. Regarding single-character tones, previous studies present two different conclusions about tone categories. One view holds that Ruijin dialect has seven tone categories: Yin Ping, Yang Ping, Shang Sheng, Yin Qu, Yang Qu, Yin Ru, and Yang Ru (Liu Lunxin 2001:73; Liu Zemin 2007:9). The other view posits six tone categories: Yin Ping, Yang Ping, Shang Sheng, Qu Sheng, Yin Ru, and Yang Ru (Yan Sen 1986:38; Luo Zhaojin 1989:28). Whether Qu Sheng should be divided into Yin Qu and Yang Qu is crucial for determining the tonal system of Ruijin dialect. Furthermore, existing research (Yan Sen 1986:38; Luo Zhaojin 1989:28; Liu Lunxin 2001:73; Liu Zemin 2007:9) shows agreement only on the tonal value of Yin Ru, with discrepancies in all other tones. Regarding tone sandhi in two-character combinations, one study (Luo Zhaojin 1989:29-33) suggests that among the six tones, only entering tones do not undergo sandhi, while Yin Ping, Yang Ping, Shang Sheng, and Qu Sheng all change in connected speech. Another study (Liu Zemin 2007:16-19) identifies three types of sandhi: Shang Sheng sandhi, Yang Ping sandhi, and reduplication sandhi. Both studies agree that except for entering tones, all other tones undergo sandhi in two-character combinations.

Based on fieldwork conducted in October 2017 and supplementary investigations in May 2018, this paper acoustically analyzes the tonal values and categories

of single-character tones and the sandhi patterns of two-character tones in new-style Ruijin Hakka to address two questions: (1) whether Yin Qu and Yang Qu should be distinguished as separate tone categories in new-style Ruijin Hakka, and (2) whether entering tones undergo sandhi in two-character combinations.

2. Overview of the Ruijin Dialect

2.1 Basic Information

According to the *Ruijin City Gazetteer* (2006:1), "Ruijin City is located in the southeastern border of Jiangxi Province, bordering Changting County of Fujian Province to the east, Yudu to the west, Huichang to the south, Ningdu to the north, and Shicheng to the northeast. National highways 323, 206, and 319 originate from or intersect in the urban area, and the Ganlong Railway runs east-west across the city. Geographic coordinates: 25°30'~26°20'N, 115°42'~116°22'E. The city measures approximately 65 km east-west and 90 km north-south, with a total area of about 2,448 km^2. The municipal government is located in Xianghu Town, 398 km from Nanchang (the provincial capital) and 143 km from Ganzhou. In 2000, Ruijin administered 7 towns (Xianghu, Rentian, Shazhouba, Jiubao, Wuyang, Xiefang, Ruilin) and 12 townships (Yeping, Ridong, Helong, Zetan, Yunshishan, Baying, Gangmian, Wantian, Xiaba, Dingpo, Dabaidi, Huangbai), comprising 268 village committees, 13 neighborhood committees, and 3,692 villager groups. The year-end permanent population was 132,275 households totaling 586,368 people, including 83,898 non-agricultural residents, with a population density of 241 persons per km^2. The Han population numbered 584,794, while minority groups including She, Mongolian, Hui, Tibetan, Miao, Zhuang, Dong, Bai, Korean, Uyghur, Tu, Dai, Yi, Buyi, Manchu, Tujia, Jingpo, Yao, and Gaoshan totaled 1,574 persons."

Ruijin Hakka belongs to the Yuxin subgroup of Hakka (Xie Liuwen, Huang Xuezhen 2007:240-241). Liu Zemin (2007:3) notes that "internal consistency is strong, and it can be roughly divided into two subareas. Centered on Xianghu Town in the urban area, including Shazhouba, Yeping, Helong, southern Ridong, southern Rentian, Huangbai, eastern Jiubao, eastern Yunshishan, eastern Wuyang, Zetan, and eastern Baying, the pronunciation and vocabulary are relatively uniform. These areas are located in central and eastern Ruijin and can be called the central area, while the remaining areas constitute the peripheral area. Within the peripheral area, the general situation is as follows: northern Ridong and northern Rentian are close to the Shicheng dialect; Dabaidi, Gangmian, Ruilin, and Dingpo are close to the Ningdu dialect; Xiaba and Wantian are close to the Yudu dialect; western Yunshishan, western Wuyang, Xiefang, and southern Baying are close to the Huichang dialect; and some areas in western Baying are close to the Changting dialect of Fujian." These locations can be compared with the map of Ruijin City, as shown below:

[Figure 1: see original paper]: Administrative map (left) and topographic map (right) of Ruijin City

2.2 Initials

Luo Zhaojin (1989:9; 14-16) identifies 21 initials in Ruijin Hakka: /p/ (扁), /p / (白), /m/ (棉), /f/ (凡), /v/ (温), /t/ (刀), /t / (汤), /n/ (拿), /l/ (犁), /ts/ (昨), /ts / (池), /s/ (书), /t / (丞), /t / (青), / / (牛), / / (消), /k/ (家), /k / (坤), /ŋ/ (鹅), /h/ (猴), /Ø/ (衣).

Liu Lunxin (2001:72) identifies 20 initials in Ruijin Hakka (using Xianghu Town and Yeping Township as examples): /p/ (巴), /p / (盆), /m/ (马), /f/ (非), /v/ (稳), /t/ (刀), /t / (吞), /n/ (脑), /l/ (李), /ts/ (再), /ts / (菜), /s/ (沙), /t / (弓), /t / (晴), / / (心), /k/ (歌), /k / (开), /ŋ/ (岸), /h/ (厚), /Ø/ (欧).

Liu Zemin (2007:8) identifies 21 initials in Ruijin Hakka (using Zetan Township and Renli Village as examples): /p/ (布), /p / (怕), /m/ (门), /f/ (夫), /v/ (胡), /t/ (打), /t / (图), /n/ (难), /l/ (兰), /ts/ (争), /ts / (杂), /s/ (山), /t / (战), /t / (前), / / (年), / / (绳), /k/ (减), /k / (看), /ŋ/ (眼), /h/ (贺), /Ø/ (医).

2.3 Finals

Luo Zhaojin (1989:16-28) identifies 51 finals in Ruijin Hakka: / / (资), /i/ (披), /e/ (耐), /a/ (打), / / (老), /o/ (科), /u/ (土), / / (漏), /ie/ (底), /ia/ (借), /i / (小), /io/ (茄), /iu/ (流), /in/ (金), /ien/ (田), /ion/ (全), /iun/ (军), /it/ (笔), /iet/ (节), /iot/ (月), /iut/ (卒), /ue/ (菜), /uo/ (涡), /ui/ (水), /un/ (伦), /uon/ (卵), /ut/ (骨), /uot/ (说), /iaŋ/ (晴), /ioŋ/ (乡), /iuŋ/ (龙), /iak/ (壁), /iok/ (弱), /iuk/ (六), /uŋ/ (空), /uk/ (毒), /ei/ (杯), /ai/ (外), /oi/ (灰), /iu/ (牛), /en/ (盆), /an/ (散), /aŋ/ (城), /oŋ/ (忙), /et/ (特), /at/ (辣), /ak/ (百), /ok/ (角), /m̩/ (唔, Yang Qu), /n̩/ (口, Yin Ru), and /ŋ / (五).

Liu Lunxin (2001:73) identifies 42 finals in Ruijin Hakka (using Xianghu Town and Yeping Township as examples): / / (知), /i/ (卑), /u/ (布), /e/ (杯), /ie/ (被), /ue/ (堆), / / (谋), /iu/ (丢), /o/ (波), /io/ (茄), / / (摆), /i / (阶), /u / (灰), /au/ (包), /iau/ (标), /en/ (等), /in/ (兵), /un/ (本), /uən/ (般), /an/ (班), /i n/ (变), / ŋ/ (帮), /iaŋ/ (良), /aŋ/ (横), /iaŋ/ (岭), /iuen/ (均), /iu n/ (软), / / (北), /i / (别), /ui / (出), / / (谷), /i / (笔), /i / (肉), /u / (钵), /iu / (月), /iui / (律), / / (剥), /i / (脚), /ai / (八), /a / (白), /ia / (壁), and /ŋ / (吴).

Liu Zemin (2007:8-9) identifies 46 finals in Ruijin Hakka (using Zetan Township and Renli Village as examples): / / (迟), /a/ (家), /i/ (比), /e/ (辈), / / (买), /ue/ (对), /o/ (过), /u/ (布), / / (毛), / / (斗), /an/ (板), /ia/ (借), /i / (表), /en/ (根), /u / (来), /oŋ/ (方), / ŋ/ (东), /aŋ/ (整), /i / (蟹), /i n/ (天), /e / (得), /uin/ (吞), /io/ (茄), / / (木), /a / (法), /iu/ (留), /i ŋ/ (浓), /u n/ (短), / / (落), / / (石), /iu / (倦), /i / (足), /u / (脱), /iu / (绝), /iuin/ (军), /iu n/ (全), /i / (织), /iaŋ/ (平), /i / (密), /i / (药), /ie/ (弟), /in/ (心), /ioŋ/ (凉), /i / (节), /ui / (出), and /ŋ / (m/n) (五吴唔).

2.4 Tones

2.4.1 Single-Character Tones Yan Sen (1986:38) identifies six tones in Ruijin dialect: Yin Ping (55, 通), Yang Ping (35, 农), Shang Sheng (21, 董), Qu Sheng

(53, 用), Yin Ru (2, 六), and Yang Ru (5, 绿).

Luo Zhaojin (1989:28-29) identifies six tones in Ruijin dialect: Yin Ping (55, 天), Yang Ping (24, 黄), Shang Sheng (11, 起), Qu Sheng (42, 忘), Yin Ru (2, 沃), and Yang Ru (5, 鹿). Yin Ping and Yang Ru are high-level tones, Yang Ping is a mid-rising tone, Shang Sheng and Yin Ru are low tones, and Qu Sheng is a mid-falling tone.

Liu Lunxin (2001:73) identifies seven tones in Ruijin Hakka (using Xianghu Town and Yeping Township as examples): Yin Ping (44, 东), Yang Ping (24, 田), Shang Sheng (21, 古), Yin Qu (42, 向), Yang Qu (43, 饭), Yin Ru (2, 七), and Yang Ru (5, 合).

Liu Zemin (2007:9) identifies seven tones in Ruijin Hakka (using Zetan Township and Renli Village as examples): Yin Ping (44, 高), Yang Ping (35, 平), Shang Sheng (212, 口), Yin Qu (42, 盖), Yang Qu (51, 大), Yin Ru (2, 一), and Yang Ru (4, 药). Yin Ping is a high-level tone, Yang Ping is a mid-rising tone, Shang Sheng is a low-level or low-rising tone, both Yin Qu and Yang Qu are falling tones, Yin Ru is a low tone, and Yang Ru is a high tone. Entering tones are checked tones with glottal stops (ibid.:3-4).

Based on previous research, Yin Ping is transcribed as 55 or 44, Yang Ping as 35 or 24, Shang Sheng as 21, 11, or 212, and Yang Ru as 5 or 4. Only Yin Ru is consistently transcribed as 2. Whether Yin Qu and Yang Qu should be merged into a single Qu Sheng is key to determining the number of tones in Ruijin dialect. If merged, the tone value is transcribed as 53 or 42; if separated, Yang Qu is transcribed as 43 or 51 and Yin Qu as 42.

2.4.2 Tone Sandhi in Two-Character Combinations Luo Zhaojin (1989:29-33) argues that among the six tones in Ruijin speech, only entering tones do not undergo sandhi, while Yin Ping, Yang Ping, Shang Sheng, and Qu Sheng all change in connected speech. However, the sandhi is not entirely regular; only most characters of the same tone category show consistent changes, while a minority maintain their base tone. Yin Ping changes to 24 before another character; Yang Ping changes to 22 after Yin Ping, Shang Sheng, Qu Sheng, or entering tones, and to 55 after Yang Ping; Shang Sheng changes to 45 before another character; Qu Sheng changes to 55 before and 21 after another character. The study also discusses neutral tone sandhi (ibid.:32-33).

Liu Zemin (2007:16-19) identifies three types of tone sandhi in Ruijin two-character combinations: Shang Sheng sandhi, Yang Ping sandhi, and reduplication sandhi. (1) Shang Sheng sandhi is the most common. In two-character combinations, when Shang Sheng occurs as the first character, it generally changes to Yin Ping. However, except when the second character is also Shang Sheng (where all words undergo sandhi), there are exceptions when other tones serve as the second character. Most of these exceptions are literary readings with strong written-language characteristics. (2) Yang Ping sandhi. When two Yang Ping characters combine, the second changes to Yin Ping. However, some

two-character combinations do not undergo sandhi, mostly verb-object constructions. A small number of Yang Ping characters also undergo sandhi after non-Yang Ping characters, likewise changing to Yin Ping. (3) Reduplication sandhi. Reduplicated words in Ruijin also undergo sandhi. Reduplicated address terms seem to undergo a type of analogical sandhi, where nearly all preceding syllables in unchecked-tone words become Yin Qu and following syllables become Yang Ping. One exception is the word nen^{5} nen^{5} (妈妈, "mother"), which does not change. However, in the new-style pronunciation of younger speakers, some reduplicated address terms are pronounced with two Yin Ping tones. Reduplicated forms of personal names are commonly used as nicknames in Ruijin, and Yang Ping characters in these nicknames frequently undergo sandhi following the pattern described above for reduplicated address terms. All reduplicated entering-tone words remain unchanged.

3. Experimental Setup

Recording took place in a hotel room in Ruijin City. The indoor environment was relatively quiet, meeting basic requirements for tone collection. Equipment included a laptop (ThinkPad e570c), condenser microphone (SONY ECM-44B), external sound card (SBX Sound Blaster), with a sampling rate of 22050 Hz, 16-bit resolution, and mono channel. Audio segmentation was completed in Adobe Audition 3.0. Fundamental frequency (F0) extraction was performed in Praat using scripts written by the Peking University Phonetics Laboratory. Twenty points were extracted for unchecked tones and fifteen points for checked tones. Data analysis and processing were completed in Excel.

Four speakers participated: two males and two females, all from a middle school in Ruijin City, native Ruijin speakers currently residing in Xianghu Town. Male speaker 1 (m1) was 17 years old; male speaker 2 (m2) was 17 years old; female speaker 1 (f1) was 17 years old; and female speaker 2 (f2) was 16 years old. The average age was 16.75 years. All four speakers were fluent in both Mandarin and Ruijin dialect, and spoke no other dialects.

Speakers read single characters and two-character words in Ruijin dialect at normal speech rat
Ruijin Dialect Single-Character Word List

Each tone combination included five two-character words (except for some combinations with f
Ruijin Dialect Two-Character Word List

The single-character and two-character word lists were adapted from *An Overview of Jiangxi Hakka Dialects* (Liu Lunxin 2001) and *A Study of the Ruijin Dialect* (Liu Zemin 2007), and were revised and reviewed by Liu Qingqing, a teacher at Ruijin No. 3 Middle School. The author takes responsibility for any errors in the word lists.

4. Acoustic Analysis of Single-Character Tones

The analysis procedure for single-character tones was as follows:

First, audio segmentation and naming. Using Adobe Audition 3.0, the audio was segmented into individual characters and renamed.

Second, F0 and duration extraction. F0 and duration were extracted for each single character in Praat, with twenty points extracted for unchecked tones (Yin Ping, Yang Ping, Shang Sheng, Yin Qu, and Yang Qu) and fifteen points for checked tones (Yin Ru and Yang Ru). Praat scripts were written by the Peking University Phonetics Laboratory.

Third, F0 conversion to semitones. The extracted F0 data were saved in Excel and converted to semitones using the semitone method. Since F0 varies across individual speakers and between genders, direct comparison is not possible, necessitating normalization. This study employs the semitone method, developed by Liu Fu. "The relationship between F0 changes and human auditory perception is generally logarithmic; logarithmic processing makes these values closer to human perception. … Current international research on tone and intonation still uses this method to convert F0 to semitones. The semitone method introduces the concept of twelve-tone equal temperament from Western music, where standard A = 440 Hz and a pitch one octave higher has double the frequency" (Kong Jiangping 2015:64). The specific calculation formula (ibid.) is: semitone $= 12 \times \log_2(f_1/f_2)$, where f_1 is the measured F0 value at each point and f_2 is the minimum value within each speaker's pitch range (Li Xuan; Wang Feng 2016:181).

Fourth, semitone plotting. Semitone data were plotted as line graphs in Excel, with the x-axis representing extraction points and the y-axis representing semitones. The y-axis was adjusted based on the maximum and minimum semitone values for each tone. Tone values were marked with reference to the (quarter-divided) y-axis.

Fifth, single-character tone analysis. First, differences in tonal patterns and values between male and female speakers were analyzed. Finally, based on both male and female speakers, the tonal patterns and values for new-style Ruijin Hakka were determined.

Analysis revealed that male speakers' single-character tone range (see left panel of Figure 2) falls between 1.8 and 7, approximately 5 semitones, with roughly 1.3 semitones between each degree. Female speakers' single-character tone range (see right panel of Figure 2) falls between 8 and 16, approximately 8 semitones, with roughly 2 semitones between each degree. Female speakers' tone range is higher than male speakers'. The semitone plots for male and female speakers are shown below:

[Figure 2: see original paper]: Semitone plots for male speakers (left) and female speakers (right)

Figure 2 shows that male speakers have smaller minimum and maximum semitone values and a narrower range than female speakers. The following analysis examines differences between male speakers (hereinafter M) and female speak-

ers (hereinafter F) across individual tones. For Yin Ping, both M and F show slightly declining curves rather than straight lines, indicating that level tones are not completely flat (Liu Wen; Yang Zhenghui; Kong Jiangping 2017:17). Yin Ping is transcribed as 43 for M and 33 for F. For Yang Ping, both male and female speakers show falling-rising contours, transcribed as 324 for M and 323 for F. For Shang Sheng, M shows a mid-falling-rising contour while F shows a mid-falling contour, transcribed as 312 for M and 31 for F. For Yin Qu, M shows a high-falling contour while F shows a mid-falling contour, transcribed as 41 for M and 31 for F. For Yang Qu, both M and F show high-falling contours, transcribed as 41 for both. For Yin Ru, both M and F show high-falling contours, transcribed as 41 for both. For Yang Ru, M shows a high-falling contour while F shows a high-level contour, transcribed as 54 for M and 5 for F.

Following the analysis of male and female speakers' single-character tone semitone curves, the combined semitone curve for new-style Ruijin Hakka (based on both genders) is presented below:

Figure 3 shows that the single-character tone range for new-style Ruijin Hakka falls between 5 and 12, approximately 7 semitones, with roughly 1.7 semitones between each degree. Yin Ping is a mid-level tone, transcribed as 33. Yang Ping is a falling-rising contour, transcribed as 323. Shang Sheng is a mid-falling tone, transcribed as 31. Yin Qu is a mid-falling tone, transcribed as 31. Yang Qu is a high-falling tone, transcribed as 41. Yin Ru is a mid-falling tone, transcribed as 41. Yang Ru is a high-level tone, transcribed as 4.

5. Acoustic Analysis of Two-Character Tones

The first four steps of two-character tone analysis (segmentation into two-character units and renaming, F0 extraction, semitone conversion, and plotting) follow the same procedure as single-character tone analysis, with the additional requirement that data for initial and final characters be separated by one column in Excel. The final step is two-character tone analysis, examining patterns and values for new-style Ruijin Hakka based on both male and female speakers from two perspectives: (1) with the same initial tone and seven different final tones, and (2) with the same final tone and seven different initial tones.

The semitone plot for two-character combinations with Yin Ping as the initial tone and Yin Ping as the final tone is shown below:

[Figure 4: see original paper]: Semitone plots for two-character tones with Yin Ping as initial (left) and Yin Ping as final (right)

The left panel of Figure 4 shows Yin Ping (33) as the initial tone with seven different final tones, spanning approximately 6 semitones with roughly 1.5 semitones between each degree. When the final tone is Yin Ping or Yin Qu, the initial Yin Ping changes from 33 to 34; when the final is Yang Ping, the initial changes from 33 to 434; when the final is Shang Sheng or Yang Qu, the initial

changes from 33 to 334; when the final is Yin Ru, the initial changes from 33 to 433. With Yin Ping as the initial, the final Yin Ping changes from 33 to 44; Yang Ping changes from 323 to 42; Yin Qu changes from 31 to 32; Yang Qu changes from 41 to 51; Yin Ru changes from 41 to 42. When the final is Yang Ru, the initial Yin Ping does not change. With Yin Ping as the initial, final Shang Sheng or Yang Ru do not change.

The right panel of Figure 4 shows Yin Ping (33) as the final tone with seven different initial tones, spanning approximately 5 semitones with roughly 1.3 semitones between each degree. When the initial is Yin Ping, the final Yin Ping changes from 33 to 43; when the initial is Shang Sheng, the final changes from 33 to 42; when the initial is Yin Ru, the final changes from 33 to 32; when the initial is Yang Ru, the final changes from 33 to 44. With Yin Ping as the final, initial Yang Ping changes from 323 to 212; Shang Sheng changes from 31 to 322; Yin Qu changes from 31 to 32; Yang Qu changes from 41 to 42; Yin Ru changes from 41 to 42; Yang Ru changes from 4 to 5. When the initial is Yang Ping, Yin Qu, or Yang Qu, the final Yin Ping does not change. With Yin Ping as the final, the initial Yin Ping does not change.

The semitone plot for two-character combinations with Yang Ping as the initial tone and Yang Ping as the final tone is shown below:

[Figure 5: see original paper]: Semitone plots for two-character tones with Yang Ping as initial (left) and Yang Ping as final (right)

The left panel of Figure 5 shows Yang Ping (323) as the initial tone with seven different final tones, spanning approximately 8 semitones with roughly 2.1 semitones between each degree. When the final is Yin Ping, Shang Sheng, Yang Qu, or Yang Ru, the initial Yang Ping changes from 323 to 23; when the final is Yang Ping, the initial changes from 323 to 24. With Yang Ping as the initial, the final Yin Ping changes from 33 to 44; Yang Ping changes from 323 to 212; Shang Sheng changes from 31 to 53; Yin Qu changes from 31 to 52; Yang Qu changes from 41 to 53; Yin Ru changes from 41 to 53. When the final is Yin Qu or Yin Ru, the initial Yang Ping does not change. With Yang Ping as the initial, the final Yang Ru does not change.

The right panel of Figure 5 shows Yang Ping (323) as the final tone with seven different initial tones, spanning approximately 9 semitones with roughly 2.2 semitones between each degree. When the initial is Yin Ping, the final Yang Ping changes from 323 to 43; when the initial is Yang Ping, the final changes from 323 to 212; when the initial is Shang Sheng or Yang Qu, the final changes from 323 to 33; when the initial is Yang Ru, the final changes from 323 to 32. With Yang Ping as the final, the initial Yin Ping changes from 33 to 44; Yang Ping changes from 323 to 223; Shang Sheng changes from 31 to 33; Yin Qu changes from 31 to 44; Yang Qu changes from 41 to 43; Yin Ru changes from 41 to 43; Yang Ru changes from 4 to 5. When the initial is Yin Qu or Yin Ru, the final Yang Ping does not change.

The semitone plot for two-character combinations with Shang Sheng as the

initial tone and Shang Sheng as the final tone is shown below:

[Figure 6: see original paper]: Semitone plots for two-character tones with Shang Sheng as initial (left) and Shang Sheng as final (right)

The left panel of Figure 6 shows Shang Sheng (31) as the initial tone with seven different final tones, spanning approximately 6 semitones with roughly 1.4 semitones between each degree. When the final is Yin Ping, Yin Qu, or Yin Ru, the initial Shang Sheng changes from 323 to 33; when the final is Shang Sheng, the initial changes from 323 to 35; when the final is Yang Qu or Yang Ru, the initial changes from 323 to 43. With Shang Sheng as the initial, the final Yin Ping changes from 33 to 43; Shang Sheng changes from 31 to 41; Yin Qu changes from 31 to 42; Yang Qu changes from 41 to 52; Yin Ru changes from 41 to 52. When the final is Yang Ping, the initial Shang Sheng does not change. With Shang Sheng as the initial, the final Yang Ping or Yang Ru does not change.

The right panel of Figure 6 shows Shang Sheng (31) as the final tone with seven different initial tones, spanning approximately 7 semitones with roughly 2 semitones between each degree. When the initial is Yin Ping, the final Shang Sheng changes from 323 to 31; when the initial is Yang Ping, the final changes from 323 to 42; when the initial is Yin Qu, the final changes from 323 to 32; when the initial is Yang Qu, the final changes from 323 to 32; when the initial is Yin Ru, the final changes from 323 to 31; when the initial is Yang Ru, the final changes from 323 to 42. With Shang Sheng as the final, the initial Yin Ping changes from 33 to 334; Yang Ping changes from 323 to 223; Shang Sheng changes from 31 to 33; Yin Qu changes from 31 to 33; Yang Qu changes from 41 to 42; Yin Ru changes from 41 to 43; Yang Ru changes from 4 to 5. When the initial is Shang Sheng, the final Shang Sheng does not change. With Shang Sheng as the final, the initial Shang Sheng does not change.

The semitone plot for two-character combinations with Yin Qu as the initial tone and Yin Qu as the final tone is shown below:

[Figure 7: see original paper]: Semitone plots for two-character tones with Yin Qu as initial (left) and Yin Qu as final (right)

The left panel of Figure 7 shows Yin Qu (31) as the initial tone with seven different final tones, spanning approximately 5 semitones with roughly 1.2 semitones between each degree. When the final is Yin Ping, Yin Qu, Yang Qu, or Yin Ru, the initial Yin Qu changes from 31 to 43; when the final is Yang Ping, the initial changes from 31 to 44; when the final is Shang Sheng, the initial changes from 31 to 434; when the final is Yang Ru, the initial changes from 31 to 52. With Yin Qu as the initial, the final Yin Ping changes from 33 to 43; Yang Ping changes from 323 to 213; Shang Sheng changes from 31 to 42; Yin Ru changes from 41 to 32. With Yin Qu as the initial, the final Yin Qu, Yang Qu, or Yang Ru does not change.

The right panel of Figure 7 shows Yin Qu (31) as the final tone with seven

different initial tones, spanning approximately 7 semitones with roughly 1.7 semitones between each degree. When the initial is Yang Ping, the final Yin Qu changes from 31 to 41; when the initial is Yang Ru, the final changes from 31 to 42. With Yin Qu as the final, the initial Yang Ping changes from 323 to 212; Shang Sheng changes from 31 to 32; Yin Qu changes from 31 to 32; Yang Qu changes from 41 to 32; Yin Ru changes from 41 to 32; Yang Ru changes from 4 to 5. When the initial is Yin Ping, Shang Sheng, Yin Qu, Yang Qu, or Yin Ru, the final Yin Qu does not change. With Yin Qu as the final, the initial Yin Ping does not change.

The semitone plot for two-character combinations with Yang Qu as the initial tone and Yang Qu as the final tone is shown below:

[Figure 8: see original paper]: Semitone plots for two-character tones with Yang Qu as initial (left) and Yang Qu as final (right)

The left panel of Figure 8 shows Yang Qu (41) as the initial tone with seven different final tones, spanning approximately 6 semitones with roughly 1.5 semitones between each degree. When the final is Yin Ping, Yang Ping, Shang Sheng, Yang Qu, or Yin Ru, the initial Yang Qu changes from 41 to 42; when the final is Yin Qu or Yang Ru, the initial changes from 41 to 43. With Yang Qu as the initial, the final Shang Sheng changes from 31 to 42; Yin Qu changes from 31 to 32; Yang Qu changes from 41 to 31; Yin Ru changes from 41 to 32. With Yang Qu as the initial, the final Yin Ping, Yang Ping, or Yang Ru does not change.

The right panel of Figure 8 shows Yang Qu (41) as the final tone with seven different initial tones, spanning approximately 7 semitones with roughly 1.8 semitones between each degree. When the initial is Yang Ping, Shang Sheng, or Yang Ru, the final Yang Qu changes from 41 to 42; when the initial is Yin Qu or Yang Qu, the final changes from 41 to 31; when the initial is Yin Ru, the final changes from 41 to 32. With Yang Qu as the final, the initial Yin Ping changes from 33 to 34; Yang Ping changes from 323 to 22; Shang Sheng changes from 31 to 32; Yin Qu changes from 31 to 33; Yang Qu changes from 41 to 32; Yin Ru changes from 41 to 32; Yang Ru changes from 4 to 5. When the initial is Yin Ping, the final Yang Qu does not change.

The semitone plot for two-character combinations with Yin Ru as the initial tone and Yin Ru as the final tone is shown below:

[Figure 9: see original paper]: Semitone plots for two-character tones with Yin Ru as initial (left) and Yin Ru as final (right)

The left panel of Figure 9 shows Yin Ru (41) as the initial tone with seven different final tones, spanning approximately 5 semitones with 1.5 semitones between each degree. When the final is Yin Ping, Shang Sheng, Yin Ru, or Yang Ru, the initial Yin Ru changes from 41 to 43; when the final is Yang Ping, Yin Qu, or Yang Qu, the initial changes from 41 to 42. With Yin Ru as the initial, the final Yin Ping changes from 33 to 43; Yang Ping changes from 323 to

313; Yang Qu changes from 41 to 42; Yin Ru changes from 41 to 42. With Yin Ru as the initial, the final Shang Sheng, Yin Qu, or Yang Ru does not change.

The right panel of Figure 9 shows Yin Ru (41) as the final tone with seven different initial tones, spanning approximately 6 semitones with 1.6 semitones between each degree. When the initial is Yin Ping, Yang Ping, Yin Ru, or Yang Ru, the final Yin Ru changes from 41 to 42; when the initial is Yin Qu, the final changes from 41 to 32; when the initial is Yang Qu, the final changes from 41 to 31. With Yin Ru as the final, the initial Yang Ping changes from 323 to 212; Shang Sheng changes from 31 to 323; Yin Qu changes from 31 to 32; Yang Qu changes from 41 to 42; Yin Ru changes from 41 to 43; Yang Ru changes from 4 to 54. When the initial is Shang Sheng, the final Yin Ru does not change. With Yin Ru as the final, the initial Yin Ping does not change.

The semitone plot for two-character combinations with Yang Ru as the initial tone and Yang Ru as the final tone is shown below:

[Figure 10: see original paper]: Semitone plots for two-character tones with Yang Ru as initial (left) and Yang Ru as final (right)

The left panel of Figure 10 shows Yang Ru (54) as the initial tone with seven different final tones, spanning approximately 7 semitones with 1.7 semitones between each degree. When the final is Shang Sheng, the initial Yang Ru changes from 4 to 5. With Yang Ru as the initial, the final Yang Ping changes from 323 to 311; Shang Sheng changes from 31 to 42; Yang Qu changes from 41 to 42; Yin Ru changes from 41 to 42. When the final is Yin Ping, Yang Ping, Yin Qu, Yang Qu, Yin Ru, or Yang Ru, the initial Yang Ru does not change. With Yang Ru as the initial, the final Yin Ping, Yin Qu, or Yang Ru does not change.

The right panel of Figure 10 shows Yang Ru (54) as the final tone with seven different initial tones, spanning approximately 6 semitones with 1.3 semitones between each degree. When the initial is Shang Sheng or Yin Qu, the final Yang Ru changes from 4 to 3; when the initial is Yang Ru, the final changes from 4 to 54. With Yang Ru as the final, the initial Yang Ping changes from 323 to 211; Shang Sheng changes from 31 to 32; Yin Qu changes from 31 to 41; Yang Qu changes from 41 to 32; Yin Ru changes from 41 to 42; Yang Ru changes from 4 to 54. When the initial is Yin Ping, Yang Ping, Yang Ru, or Yin Ru, the final Yang Ru does not change. With Yang Ru as the final, the initial Yin Ping does not change.

5.1 Single-Character Tones

Based on experimental analysis, new-style Ruijin Hakka has seven tone categories in single-character tones. The tone range spans from 5 to 12, approximately 7 semitones, with roughly 1.7 semitones between each degree. Yin Ping is a mid-level tone, transcribed as 33; Yang Ping is a mid-low contour tone, transcribed as 323; Shang Sheng is a mid-falling tone, transcribed as 31; Yin

Qu is a mid-falling tone, transcribed as 31; Yang Qu is a high-falling tone, transcribed as 41; Yin Ru is a high-falling tone, transcribed as 41; and Yang Ru is a high-falling tone, transcribed as 4.

Regarding tone categories, this study's finding of seven categories (Yin Ping, Yang Ping, Shang Sheng, Yin Qu, Yang Qu, Yin Ru, and Yang Ru) aligns with the results of *An Overview of Jiangxi Hakka Dialects* (Liu Lunxin 2001:73) and *A Study of the Ruijin Dialect* (Liu Zemin 2007:8-9).

Regarding tonal values, the transcription of new-style Ruijin Hakka in this study differs slightly

Comparison of tonal values in this study with previous research

The main differences appear in Yang Ping and Yin Ru. This study transcribes Yang Ping as a contour tone and Yin Ru as a high-falling tone, suggesting that Yin Ru in new-style Ruijin Hakka shows a tendency toward unchecked syllable characteristics.

From a phonological perspective, single-character tones can be described using H, M, and L (Tan Jingjing; Kong Jiangping 2006). Based on this study's results: Yin Ping is M, Yang Ping is MLM, Shang Sheng is ML, Yin Qu is ML, Yang Qu is HL, Yin Ru is HL, and Yang Ru is H.

Returning to the question raised in the introduction—whether Yin Qu and Yang Qu should be distinguished in new-style Ruijin Hakka—Liu Zemin (ibid.:10) argues that compared to Yang Qu, Yin Qu has a lower onset and higher offset with a slower falling contour, while Yang Qu has a higher onset and lower offset with shorter duration than Yin Qu. The distinction is not purely a contrast between high and low register but between gradual and steep falling contours. Thus, Yin Qu and Yang Qu differ in both F0 contour and duration. However, some studies (Yan Sen 1986:38; Luo Zhaojin 1989:28) treat Yin Qu and Yang Qu as a single Qu Sheng in Ruijin dialect. This study finds tonal value differences between Yin Qu and Yang Qu in new-style Ruijin Hakka, but perceptual experiments are needed to definitively determine whether they should be merged or remain separate. Therefore, the author and Chen Huanmao conducted preliminary tonal perception research in Ruijin in March 2018. The results (Li Bin, Chen Huanmao 2018:32-36) indicate that native Ruijin speakers cannot distinguish Yin Qu from Yang Qu when only F0 is manipulated while duration remains constant. Further perceptual experiments will be conducted to verify whether Yin Qu and Yang Qu are merging.

5.2 Two-Character Tone Sandhi

The acoustic analysis section examined two-character tone sandhi in new-style Ruijin Hakka fr

Tone sandhi patterns for T+X in new-style Ruijin Hakka

(Note: In Table 4, "+" after a tone indicates initial-character change; "+" before a tone indicates final-character change. Blank cells indicate no change in either character.)

From a phonological perspective, T+X sandhi patterns fall into two types: sandhi and no change. Sandhi includes three patterns: initial-character change, final-character change, and both-character change. Initial-character change occurs in 10 combinations: Yin Ping-Shang Sheng, Yin Ping-Yin Qu, Yin Ping-Yang Qu, Yang Ping-Yang Ru, Shang Sheng-Yang Ru, Shang Sheng-Yang Ru, Yin Qu-Yin Ru, Yin Qu-Yang Ru, Yang Qu-Yin Qu, Yang Qu-Yang Ru, and Yin Ru-Yang Qu. Final-character change occurs in 7 combinations: Yang Ping-Yang Ping, Yang Ping-Yin Qu, Yang Ping-Yin Ru, Yang Qu-Shang Sheng, Yang Qu-Yang Qu, Yang Ru-Shang Sheng, and Yang Ru-Yin Ru. Both-character change occurs in 16 combinations: Yin Ping-Yin Ping, Yin Ping-Yang Ping, Yin Ping-Yin Ru, Yang Ping-Yin Ping, Yang Ping-Shang Sheng, Yang Ping-Yang Qu, Shang Sheng-Yin Ping, Shang Sheng-Shang Sheng, Shang Sheng-Yin Qu, Shang Sheng-Yin Ru, Yin Qu-Yin Ping, Yin Qu-Yang Ping, Yin Qu-Shang Sheng, Yin Ru-Yin Ping, Yin Ru-Yang Ping, and Yin Ru-Yin Ru. Thus, in T+X combinations, new-style Ruijin Hakka primarily exhibits both-character change, followed by initial-character change, and finally final-character change.

In addition to sandhi, new-style Ruijin Hakka also shows cases of no change in two-character combinations. When Yin Ping is the initial, final Shang Sheng, Yin Qu, or Yang Qu do not change; when Yang Ping is the initial, final Yang Ru does not change; when Shang Sheng is the initial, final Yang Qu or Yang Ru does not change; when Yin Qu is the initial, final Yin Qu, Yang Qu, Yin Ru, or Yang Ru does not change; when Yang Qu is the initial, final Yin Ping, Yang Ping, Yin Qu, or Yang Ru does not change; when Yin Ru is the initial, final Shang Sheng, Yin Qu, Yang Qu, or Yang Ru does not change. When Yang Ping, Yin Qu, or Yin Ru is the final, the initial Yang Ping does not change; when Shang Sheng or Yang Qu is the final, the initial Yang Ru does not change; when Yang Ping, Shang Sheng, or Yin Ru is the final, the initial Yang Ru does not change. The combinations Yin Ping-Yang Ru, Shang Sheng-Yang Ping, Yang Qu-Yin Ping, Yang Qu-Yang Ping, Yang Qu-Yin Ru, Yang Ru-Yin Ping, Yang Ru-Yin Qu, Yang Ru-Yang Qu, and Yang Ru-Yang Ru show no change in either character.

The sandhi patterns for X+T combinations (where X represents seven possible final tones and

Tone sandhi patterns for X+T in new-style Ruijin Hakka

(Note: In Table 5, "+" before a tone indicates final-character change; "+" after a tone indicates initial-character change. Blank cells indicate no change in either character.)

From a phonological perspective, X+T sandhi patterns fall into two types: sandhi and no change. Sandhi includes three patterns: initial-character change, final-character change, and both-character change. Initial-character change occurs in 12 combinations: Yang Ping-Yin Ping, Yin Qu-Yang Ping, Yin Qu-Shang Sheng, Yin Ru-Yang Ping, Shang Sheng-Shang Sheng, Yin Ru-Shang Sheng, Yang Qu-Yin Qu, Yin Ping-Yang Qu, Yang Ping-Yang Qu, Shang Sheng-Yin Ru, Yang Ping-Yang Ru, Yang Ru-Yang Ru, and Yin Ru-Yang Ru. Final-character change occurs in 10 combinations: Yin Ping-Yin Ping, Shang Sheng-Yin Ping,

Yang Ru-Yin Ping, Yang Ru-Yang Ping, Yang Qu-Shang Sheng, Yang Ru-Shang Sheng, Yang Ru-Yin Qu, Yin Ru-Yang Qu, Yin Ping-Yin Ru, and Shang Sheng-Yang Ru. Both-character change occurs in 15 combinations: Shang Sheng-Yin Ping, Yin Ru-Yin Ping, Yin Ping-Yang Ping, Yang Ping-Yang Ping, Shang Sheng-Yang Ping, Yang Qu-Yang Ping, Yang Ping-Shang Sheng, Yang Ping-Yin Qu, Yin Qu-Yang Qu, Yang Qu-Yang Qu, Yang Ping-Yin Ru, Yin Qu-Yin Ru, Yang Qu-Yin Ru, Yin Ru-Yin Ru, and Yin Qu-Yang Ru. Thus, in X+T combinations, new-style Ruijin Hakka primarily exhibits both-character change, followed by initial-character change, and finally final-character change.

In addition to sandhi, new-style Ruijin Hakka also shows cases of no change. When Yin Ping is the final, the initial Yin Ping or Yang Ru does not change; when the final is Yang Ping, the initial Yang Ru does not change; when the final is Shang Sheng, the initial Yang Qu or Yang Ru does not change; when the final is Yin Qu, the initial Yang Ru does not change; when the final is Yang Qu, the initial Yin Ru does not change; when the final is Yin Ru, the initial Yang Qu does not change; when Yang Ru is the final, the initial Yang Ping, Shang Sheng, Yang Qu, or Yin Ru does not change. When Yin Ping is the initial, the final Shang Sheng or Yang Qu does not change; when the initial is Yang Ping, the final Yin Ping or Yang Ru does not change; when Shang Sheng is the initial, the final Shang Sheng or Yin Ru does not change; when Yin Qu is the initial, the final Yang Ping or Shang Sheng does not change; when Yang Qu is the initial, the final Yin Qu or Yang Ru does not change; when Yin Ru is the initial, the final Yang Ping, Shang Sheng, or Yang Ru does not change. The combinations Shang Sheng-Yin Ping, Yin Qu-Yin Ping, Yang Qu-Yin Ping, Yang Qu-Shang Sheng, Yin Ping-Yin Qu, Shang Sheng-Yin Qu, Yin Qu-Yin Qu, Yin Ru-Yin Qu, Shang Sheng-Yang Qu, Yang Ru-Yang Qu, Yin Qu-Yin Ru, Yang Qu-Yin Ru, Yin Ping-Yang Ru, and Yang Ru-Yang Ru show no change in either character.

Returning to the question raised in the introduction—whether entering tones undergo sandhi in two-character combinations in new-style Ruijin Hakka—previous studies (Luo Zhaojin 1989:29; Liu Zemin 2007:16-19) argue that except for entering tones, all other tones undergo sandhi in two-character combinations. This study's findings show that in T+X combinations: when Yang Ping is the initial, the final Yang Ru does not change; when Shang Sheng is the initial, the final Yang Ru does not change; when Yin Qu is the initial, the final Yin Ru or Yang Ru does not change; when Yang Qu is the initial, the final Yang Ru does not change; when Yin Ru is the initial, the final Yang Ru does not change. When Shang Sheng or Yang Qu is the final, the initial Yang Ru does not change; when Yin Ru is the final, the initial Yang Ru does not change. The combinations Yin Ping-Yang Ru, Yang Qu-Yin Ru, Yang Ru-Yin Ping, Yang Ru-Yin Qu, Yang Ru-Yang Qu, and Yang Ru-Yang Ru show no change in either character. In X+T combinations: when Yin Ping is the final, the initial Yang Ru does not change; when the final is Yang Ping, the initial Yang Ru does not change; when the final is Shang Sheng, the initial Yang Ru does not change; when the final is Yin Qu, the initial Yang Ru does not change; when the final is Yang Qu, the initial Yin Ru does not change; when Yang Ru

is the final, the initial Yin Ru does not change. When the initial is Yang Ping, the final Yang Ru does not change; when Shang Sheng is the initial, the final Yin Ru does not change; when Yang Qu is the initial, the final Yang Ru does not change; when Yin Ru is the initial, the final Yang Ru does not change. The combinations Yin Ru-Yin Qu, Yang Ru-Yang Qu, Yin Qu-Yin Ru, Yang Qu-Yin Ru, Yin Ping-Yang Ru, and Yang Ru-Yang Ru show no change in either character.

5.3 The Issue of Yin Ru De-checking

In single-character tones, Yin Ru is transcribed as 41, showing a tendency toward de-checking. In two-character T+X or X+T combinations, Yin Ru becomes an unchecked tone whether it appears as the initial or final character.

5.4 Limitations

With only two male and two female speakers, and only two examples each for the Yang Ping-Yang Ping and Yin Qu-Yang Ru combinations, the sample size is limited. Therefore, more speakers and additional single-character and two-character tones must be investigated to definitively establish the tone categories, values, and sandhi patterns of new-style Ruijin Hakka.

Conclusion

This study yields two principal conclusions. (1) New-style Ruijin Hakka has seven tone categories in single-character tones: Yin Ping is a mid-level tone, transcribed as 33; Yang Ping is a mid-low contour tone, transcribed as 323; Shang Sheng is a mid-falling tone, transcribed as 31; Yin Qu is a mid-falling tone, transcribed as 31; Yang Qu is a high-falling tone, transcribed as 41; Yin Ru is a high-falling tone, transcribed as 41; and Yang Ru is a high-falling tone, transcribed as 4. (2) Two-character tones in new-style Ruijin Hakka exhibit two patterns: tone sandhi and no change. Tone sandhi includes three types: initial-character change, final-character change, and both-character change. In T+X or X+T combinations, both-character change predominates. The tone that remains unchanged in two-character combinations is primarily Yang Ru, which does not change when occurring as the final character in T+X combinations or as the initial character in X+T combinations.

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