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Shi, M.

Citation

Shi, M. (2020, June 4). *Consonant and lexical tone interaction: Evidence from two Chinese dialects*. LOT dissertation series. LOT, Amsterdam. Retrieved from <https://hdl.handle.net/1887/92884>

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Title: Consonant and lexical tone interaction: Evidence from two Chinese dialects

Issue Date: 2020-06-04

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Appendix

Appendix I

I-1 Stimulus list of Lili Wu Chinese in Chapter 3

| MC tonal category | Unaspirated (U) | Aspirated (A) | Voiced (D) |
|-------------------|--------------------|----------------------|------------------------|
| <i>Ping</i> (I) | 低 tᶥ 'low' | 梯 tʰᶥ 'ladder' | 提 dᶥ 'to mention' |
| | 单 tɛ 'sole' | 瘫 tʰɛ 'paralysis' | 台 dɛ 'platform' |
| | 刀 ta 'knife' | 涛 tʰa 'billow' | 桃 da 'peach' |
| <i>Shang</i> (II) | 底 tᶥ 'bottom' | 体 tʰᶥ 'body' | 弟 dᶥ 'younger brother' |
| | 胆 tɛ 'gallbladder' | 毯 tʰɛ 'mat' | 淡 dɛ 'light' |
| | 岛 ta 'island' | 讨 tʰa 'to ask for' | 稻 da 'rice' |
| <i>Qu</i> (III) | 滴 tᶥ 'to drop' | 替 tʰᶥ 'to replace' | 地 dᶥ 'ground' |
| | 对 tɛ 'right' | 退 tʰɛ 'to retreat' | 代 dɛ 'dynasty' |
| | 到 ta 'to arrive' | 套 tʰa 'case' | 盗 da 'robber' |
| <i>Ru</i> (IV) | 滴 tᶥ? 'drop' | 贴 tʰᶥ? 'to paste' | 敌 dᶥ? 'enemy' |
| | 得 tɛ? 'to get' | 脱 tʰɛ? 'to take off' | 特 dɛ? 'specially' |
| | 搭 ta? 'and' | 塔 tʰa? 'pagoda' | 达 da? 'to extend' |

I-2 Final models to calculate the results presented in Table 3.4

| Generation-Category | Fixed structure | Random structure |
|---|--|---|
| Old-I&II; Middle-I; | (ot ₁ + ot ₂) * Consonant + Vowel + Repetition + Gender | (ot ₁ + ot ₂ Speaker) + (ot ₁ + ot ₂ Speaker: Consonant) + (ot ₁ + ot ₂ Item) |
| Young-I | (ot ₁ + ot ₂) * Consonant + Vowel + Repetition + Gender | (ot ₁ + ot ₂ Speaker) + (ot ₁ + ot ₂ Speaker: Consonant) |
| Middle-II; Young-III | (ot ₁ + ot ₂) * Consonant + Vowel + Repetition | (ot ₁ + ot ₂ Speaker) + (ot ₁ + ot ₂ Speaker: Consonant) + (ot ₁ Item) |
| Young-II; Old-III; Middle-IV; Young-IV | (ot ₁ + ot ₂) * Consonant + Vowel + Repetition | (ot ₁ + ot ₂ Speaker) + (ot ₁ + ot ₂ Speaker: Consonant) + (ot ₁ + ot ₂ Item) |
| Middle-III | (ot ₁ + ot ₂) * Consonant + Vowel | (ot ₁ + ot ₂ Speaker) + (ot ₁ Speaker: Consonant) + (1 Item) |
| Old-IV | (ot ₁ + ot ₂) * Consonant + Vowel | (ot ₁ + ot ₂ Speaker) + (ot ₁ + ot ₂ Speaker: Consonant) + (ot ₁ + ot ₂ Item) |

I-3a Final models to calculate the results presented in Table 3.5

| Generation | Fixed structure | Random structure |
|-------------------|----------------------------------|--|
| Old & Middle-aged | Category + Vowel + Repetition | (1 + Category Speaker) + (1 Item) |
| Young | Category + Vowel | (1 + Category Speaker) + (1 Item) |

I-3b Between-Category comparisons of the DOR/DOS ratio by Generation

A mixed model fitted to the DOR/DOS ratio with fixed factors Category, Generation, and their interaction was run. The random intercept for Speaker was also included. This was the maximal model which converged. Following the method used in Kirby (2018) and Kirby and Hyslop (2019), pairwise comparisons of the marginal means estimate were calculated using the *emmeans* function (Lenth, 2020). Fractional degrees of freedom computed using the Satterthwaite method, with *p*-values adjusted using the Tukey method for comparing a family of 4 estimates. n.s.: not significant.

| Contrast | Estimate | SE | df | <i>t</i> -ratio | <i>p</i> |
|-------------------------|----------|-----|------|-----------------|----------|
| Generation: Old | | | | | |
| I – II | .02 | .01 | 1379 | 2.24 | n.s. |
| I – III | .02 | .01 | 1379 | 1.69 | n.s. |
| I – IV | –0.12 | .01 | 1379 | –13.18 | < .001 |
| II – III | –0.01 | .01 | 1379 | –0.55 | n.s. |
| II – IV | –0.14 | .01 | 1379 | –15.44 | < .001 |
| III – IV | –0.14 | .01 | 1379 | –14.9 | < .001 |
| Generation: Middle-aged | | | | | |
| I – II | .01 | .01 | 1379 | .11 | n.s. |
| I – III | .01 | .01 | 1379 | 1.6 | n.s. |
| I – IV | –0.11 | .01 | 1379 | –12.15 | < .001 |
| II – III | .01 | .01 | 1379 | 1.5 | n.s. |
| II – IV | –0.11 | .01 | 1379 | –12.26 | < .001 |
| III – IV | –0.12 | .01 | 1379 | –13.75 | < .001 |
| Generation: Young | | | | | |
| I – II | .02 | .01 | 1379 | 1.68 | n.s. |
| I – III | .01 | .01 | 1379 | .62 | n.s. |
| I – IV | –0.06 | .01 | 1379 | –6.21 | < .001 |
| II – III | –0.01 | .01 | 1379 | –1.06 | n.s. |
| II – IV | –0.07 | .01 | 1379 | –7.89 | < .001 |
| III – IV | –0.06 | .01 | 1379 | –6.83 | < .001 |

I-4a Final models to calculate the results presented in Table 3.7

| Generation-Category- Position | Fixed structure | Random structure |
|--|--|---|
| Old-I-P1 | Consonant + Vowel | (1 Speaker) + (1 Item) |
| Old-I-P2; Middle-I-P1; Middle-IV-P1 | Consonant + Vowel | (1 Speaker) |
| Middle-I-P2; Young-I-P1; Young-III-P1 | Consonant + Gender | (1 Speaker) |
| Old-II-P1; Middle-II-P1 | Consonant | (1 Speaker) + (1 Item) |
| Young-II-P1 | Consonant + Gender | (1 Speaker) + (1 Item) |
| Middle-II-P2 | Consonant + Vowel + Gender | (1 Speaker) + (1 Item) |
| Old-III-P1&P2; Old-IV-P1 | Consonant + Vowel | (1 + Consonant Speaker) |
| Middle-III-P1 | Consonant + Vowel | (1 + Consonant Speaker) + (1 Item) |
| Middle-III-P2 | Consonant + Vowel + Gender | (1 + Consonant Speaker) |
| Old-IV-P2 | Consonant + Vowel + Repetition | (1 + Consonant Speaker) |
| Young-IV-P1 | Consonant + Vowel + Gender | (1 Speaker) |
| Others | Consonant did not significantly improve the model fit. | |

I-4b Between-Consonant comparisons of H1*–H2* by Generation, Category, and Position

A mixed model fitted to H1*–H2* with fixed factors Consonant, Generation, Category, and their full-fledged interactions was run. The random intercept for Speaker was also included. This was the maximal model which converged. Pairwise comparisons of the marginal means estimate were calculated with fractional degrees of freedom computed using the Satterthwaite method. The *p*-values were adjusted using the Tukey method for comparing a family of 3 estimates. n.s.: not significant.

| Contrast | Estimate | SE | df | <i>t</i> -ratio | <i>p</i> |
|--|----------|-----|-------|-----------------|----------|
| Generation: Old, Category: I, Position: 1 | | | | | |
| A – U | 2.63 | .49 | 12891 | 5.34 | < .001 |
| A – D | –0.74 | .49 | 12891 | –1.51 | n.s. |
| U – D | –3.37 | .49 | 12891 | –6.85 | < .001 |
| Generation: Middle-aged, Category: I, Position: 1 | | | | | |
| A – U | 1.37 | .49 | 12891 | 2.79 | < .001 |
| A – D | –0.74 | .49 | 12891 | –1.11 | n.s. |
| U – D | –3.37 | .49 | 12891 | –3.9 | < .001 |
| Generation: Young, Category: I, Position: 1 | | | | | |
| A – U | 2.17 | .49 | 12891 | 4.41 | < .001 |
| A – D | 1.85 | .49 | 12891 | 3.76 | < .001 |
| U – D | –0.32 | .49 | 12891 | –0.65 | n.s. |
| Generation: Old, Category: II, Position: 1 | | | | | |
| A – U | 2.04 | .49 | 12891 | 4.13 | < .001 |
| A – D | –0.04 | .49 | 12891 | –0.07 | n.s. |
| U – D | –2.08 | .49 | 12891 | –4.21 | < .001 |
| Generation: Middle-aged, Category: II, Position: 1 | | | | | |
| A – U | 2.85 | .49 | 12891 | 5.79 | < .001 |
| A – D | .39 | .49 | 12891 | .79 | n.s. |
| U – D | –2.46 | .49 | 12891 | –5.01 | < .001 |
| Generation: Young, Category: II, Position: 1 | | | | | |
| A – U | 1.89 | .49 | 12891 | 3.84 | < .001 |
| A – D | 2.41 | .49 | 12891 | 4.89 | < .001 |
| U – D | .52 | .49 | 12891 | 1.05 | n.s. |
| Generation: Old, Category: III, Position: 1 | | | | | |
| A – U | 2.12 | .49 | 12891 | 4.31 | < .001 |
| A – D | –0.72 | .49 | 12891 | –1.47 | n.s. |
| U – D | –2.84 | .49 | 12891 | –5.77 | < .001 |

Continued.

Generation: Middle-aged, Category: III, Position: 1

| | | | | | |
|-------|-------|-----|-------|------|--------|
| A – U | 2.16 | .49 | 12891 | 4.39 | < .001 |
| A – D | -0.05 | .49 | 12891 | -0.1 | n.s. |
| U – D | -2.21 | .49 | 12891 | -4.5 | < .001 |

Generation: Young, Category: III, Position: 1

| | | | | | |
|-------|------|-----|-------|-------|-------|
| A – U | 1.67 | .49 | 12891 | 3.39 | < .01 |
| A – D | 1.36 | .49 | 12891 | 2.77 | < .05 |
| U – D | -0.3 | .49 | 12891 | -0.62 | n.s. |

Generation: Old, Category: IV, Position: 1

| | | | | | |
|-------|-------|-----|-------|-------|--------|
| A – U | 4.75 | .49 | 12891 | 9.65 | < .001 |
| A – D | 3.12 | .49 | 12891 | 6.34 | < .001 |
| U – D | -1.63 | .49 | 12891 | -3.31 | n.s. |

Generation: Middle-aged, Category: IV, Position: 1

| | | | | | |
|-------|-------|-----|-------|-------|--------|
| A – U | 3.81 | .49 | 12891 | 7.73 | < .001 |
| A – D | 2.97 | .49 | 12891 | 6.03 | < .001 |
| U – D | -0.84 | .49 | 12891 | -1.72 | n.s. |

Generation: Young, Category: IV, Position: 1

| | | | | | |
|-------|-----|-----|-------|------|--------|
| A – U | 3.3 | .49 | 12891 | 6.7 | < .001 |
| A – D | 4.3 | .49 | 12891 | 8.74 | < .001 |
| U – D | 1 | .49 | 12891 | 2 | n.s. |

Generation: Old, Category: I, Position: 2

| | | | | | |
|-------|-------|-----|-------|-------|-------|
| A – U | 1.05 | .49 | 12891 | 2.14 | n.s. |
| A – D | -0.51 | .49 | 12891 | -1.04 | n.s. |
| U – D | -1.56 | .49 | 12891 | -3.18 | < .01 |

Generation: Middle-aged, Category: I, Position: 2

| | | | | | |
|-------|-------|-----|-------|-------|-------|
| A – U | .59 | .49 | 12891 | 1.2 | n.s. |
| A – D | -0.87 | .49 | 12891 | -1.77 | n.s. |
| U – D | -1.46 | .49 | 12891 | -2.97 | < .01 |

Generation: Young, Category: I, Position: 2

| | | | | | |
|-------|-------|-----|-------|-------|------|
| A – U | .84 | .49 | 12891 | 1.71 | n.s. |
| A – D | .51 | .49 | 12891 | 1.04 | n.s. |
| U – D | -0.33 | .49 | 12891 | -0.68 | n.s. |

Generation: Old, Category: II, Position: 2

| | | | | | |
|-------|-------|-----|-------|-------|------|
| A – U | .84 | .49 | 12891 | 1.7 | n.s. |
| A – D | -0.2 | .49 | 12891 | -0.41 | n.s. |
| U – D | -1.04 | .49 | 12891 | -2.1 | n.s. |

Generation: Middle-aged, Category: II, Position: 2

| | | | | | |
|-------|-------|-----|-------|-------|-------|
| A – U | 1.52 | .49 | 12891 | 3.08 | < .01 |
| A – D | .25 | .49 | 12891 | .51 | n.s. |
| U – D | -1.26 | .49 | 12891 | -2.57 | < .05 |

Generation: Young, Category: II, Position: 2

Continued.

| | | | | | |
|-------|-------|-----|-------|-------|------|
| A – U | .68 | .49 | 12891 | 1.37 | n.s. |
| A – D | .05 | .49 | 12891 | 1.02 | n.s. |
| U – D | –0.17 | .49 | 12891 | –0.35 | n.s. |

Generation: Old, Category: III, Position: 2

| | | | | | |
|-------|-------|-----|-------|-------|-------|
| A – U | 1.16 | .49 | 12891 | 2.35 | n.s. |
| A – D | –0.38 | .49 | 12891 | –0.77 | n.s. |
| U – D | –1.54 | .49 | 12891 | –3.12 | < .01 |

Generation: Middle-aged, Category: III, Position: 2

| | | | | | |
|-------|-------|-----|-------|-------|-------|
| A – U | 1.06 | .49 | 12891 | 2.15 | n.s. |
| A – D | –0.55 | .49 | 12891 | –1.12 | n.s. |
| U – D | –1.61 | .49 | 12891 | –3.27 | < .01 |

Generation: Young, Category: III, Position: 2

| | | | | | |
|-------|-------|-----|-------|-------|------|
| A – U | 1.01 | .49 | 12891 | 2.21 | n.s. |
| A – D | 1.02 | .49 | 12891 | 2.07 | n.s. |
| U – D | –0.07 | .49 | 12891 | –0.15 | n.s. |

Generation: Old, Category: IV, Position: 2

| | | | | | |
|-------|-------|-----|-------|-------|------|
| A – U | 1.12 | .49 | 12891 | 2.27 | n.s. |
| A – D | .94 | .49 | 12891 | 1.9 | n.s. |
| U – D | –0.18 | .49 | 12891 | –0.37 | n.s. |

Generation: Middle-aged, Category: IV, Position: 2

| | | | | | |
|-------|-------|-----|-------|-------|------|
| A – U | .89 | .49 | 12891 | 1.81 | n.s. |
| A – D | .62 | .49 | 12891 | 1.25 | n.s. |
| U – D | –0.27 | .49 | 12891 | –0.55 | n.s. |

Generation: Young, Category: IV, Position: 2

| | | | | | |
|-------|-------|-----|-------|-------|------|
| A – U | .89 | .49 | 12891 | 1.8 | n.s. |
| A – D | .83 | .49 | 12891 | 1.69 | n.s. |
| U – D | –0.05 | .49 | 12891 | –0.11 | n.s. |

Generation: Old, Category: I, Position: 3

| | | | | | |
|-------|-------|-----|-------|-------|------|
| A – U | .53 | .49 | 12891 | 1.08 | n.s. |
| A – D | –0.06 | .49 | 12891 | –0.12 | n.s. |
| U – D | –0.59 | .49 | 12891 | –1.2 | n.s. |

Generation: Middle-aged, Category: I, Position: 3

| | | | | | |
|-------|-------|-----|-------|-------|------|
| A – U | .22 | .49 | 12891 | .46 | n.s. |
| A – D | –0.39 | .49 | 12891 | –0.79 | n.s. |
| U – D | –0.61 | .49 | 12891 | –1.24 | n.s. |

Generation: Young, Category: I, Position: 3

| | | | | | |
|-------|-------|-----|-------|-------|------|
| A – U | .71 | .49 | 12891 | 1.45 | n.s. |
| A – D | .43 | .49 | 12891 | .86 | n.s. |
| U – D | –0.29 | .49 | 12891 | –0.59 | n.s. |

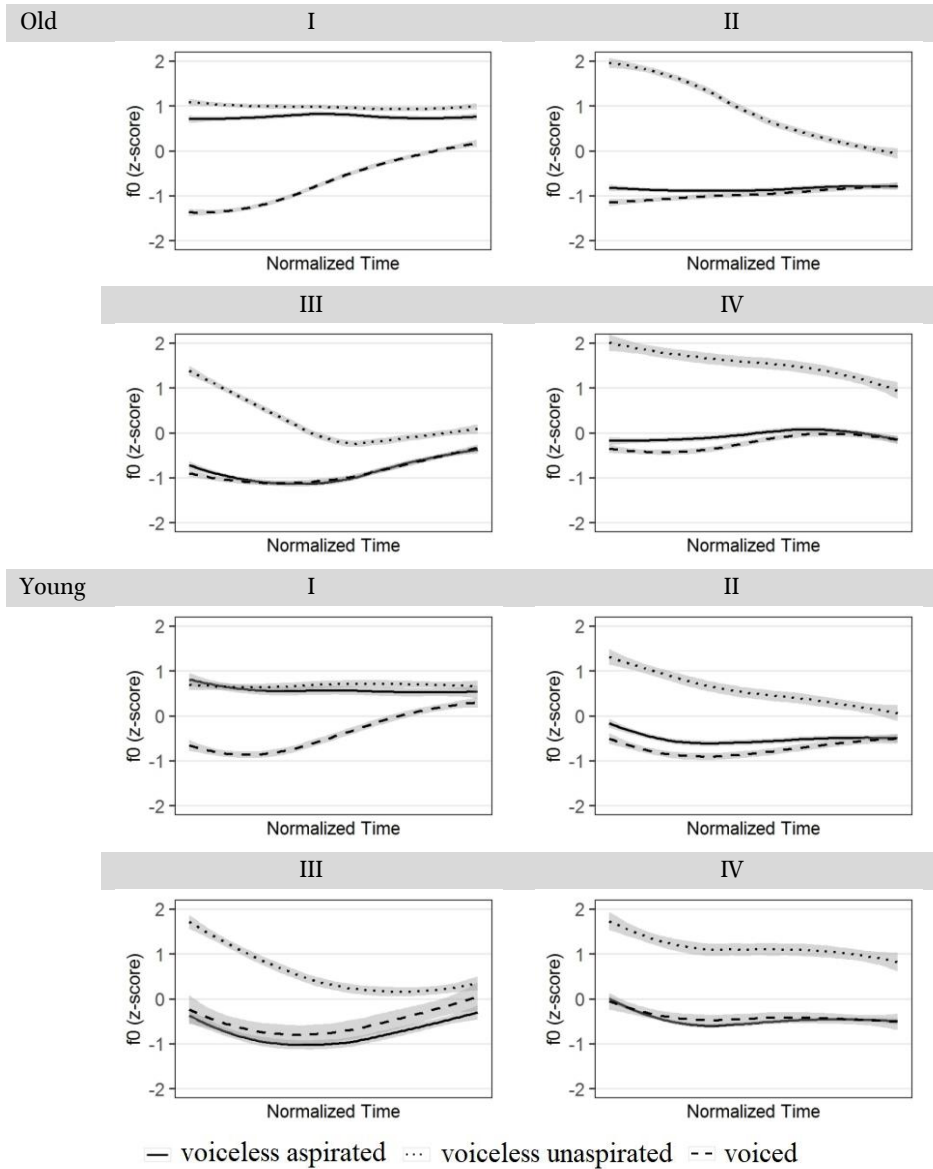
Generation: Old, Category: II, Position: 3

| | | | | | |
|-------|-----|-----|-------|------|------|
| A – U | .69 | .49 | 12891 | 1.39 | n.s. |
|-------|-----|-----|-------|------|------|

Continued.

| | | | | | |
|---|-------|-----|-------|-------|------|
| A – D | .01 | .49 | 12891 | .01 | n.s. |
| U – D | –0.68 | .49 | 12891 | –1.38 | n.s. |
| Generation: Middle-aged, Category: II, Position: 3 | | | | | |
| A – U | .88 | .49 | 12891 | 1.79 | n.s. |
| A – D | .08 | .49 | 12891 | .16 | n.s. |
| U – D | –0.8 | .49 | 12891 | –1.63 | n.s. |
| Generation: Young, Category: II, Position: 3 | | | | | |
| A – U | .76 | .49 | 12891 | 1.54 | n.s. |
| A – D | .51 | .49 | 12891 | 1.03 | n.s. |
| U – D | –0.25 | .49 | 12891 | –0.5 | n.s. |
| Generation: Old, Category: III, Position: 3 | | | | | |
| A – U | .53 | .49 | 12891 | 1.08 | n.s. |
| A – D | .36 | .49 | 12891 | .74 | n.s. |
| U – D | –0.17 | .49 | 12891 | –0.34 | n.s. |
| Generation: Middle-aged, Category: III, Position: 3 | | | | | |
| A – U | .25 | .49 | 12891 | .5 | n.s. |
| A – D | –0.89 | .49 | 12891 | –1.8 | n.s. |
| U – D | –1.13 | .49 | 12891 | –2.3 | n.s. |
| Generation: Young, Category: III, Position: 3 | | | | | |
| A – U | .58 | .49 | 12891 | 1.19 | n.s. |
| A – D | .63 | .49 | 12891 | 1.28 | n.s. |
| U – D | .04 | .49 | 12891 | .09 | n.s. |
| Generation: Old, Category: IV, Position: 3 | | | | | |
| A – U | –0.29 | .49 | 12891 | –0.59 | n.s. |
| A – D | .56 | .49 | 12891 | 1.13 | n.s. |
| U – D | .85 | .49 | 12891 | 1.72 | n.s. |
| Generation: Middle-aged, Category: IV, Position: 3 | | | | | |
| A – U | .21 | .49 | 12891 | .43 | n.s. |
| A – D | .23 | .49 | 12891 | .46 | n.s. |
| U – D | .01 | .49 | 12891 | .03 | n.s. |
| Generation: Young, Category: IV, Position: 3 | | | | | |
| A – U | .52 | .49 | 12891 | 1.05 | n.s. |
| A – D | .54 | .49 | 12891 | 1.1 | n.s. |
| U – D | .02 | .49 | 12891 | .05 | n.s. |

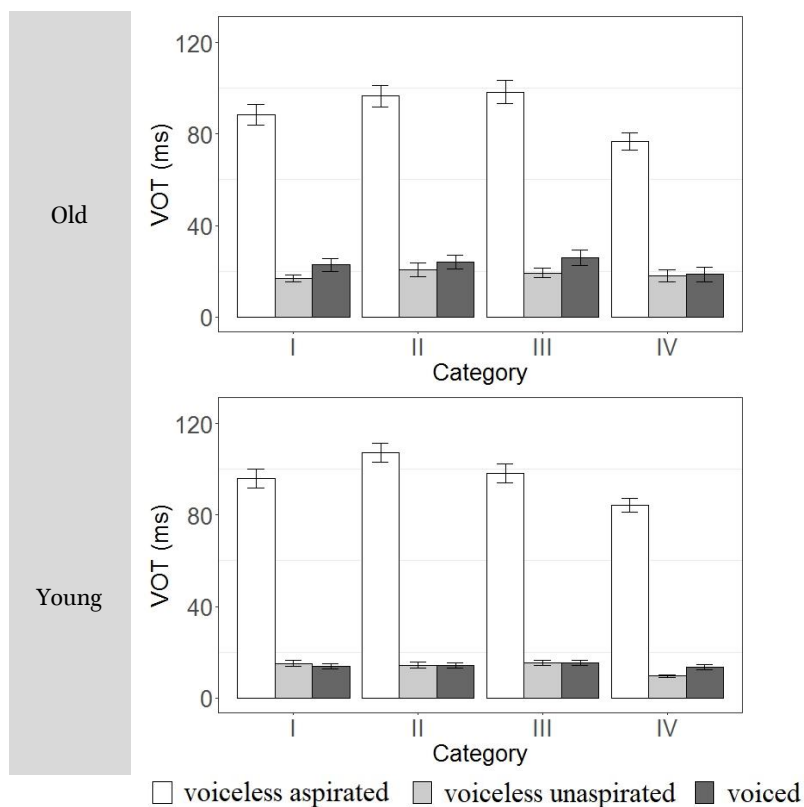
I-5 Acoustic data of Section 3.4

a. f_0 contour

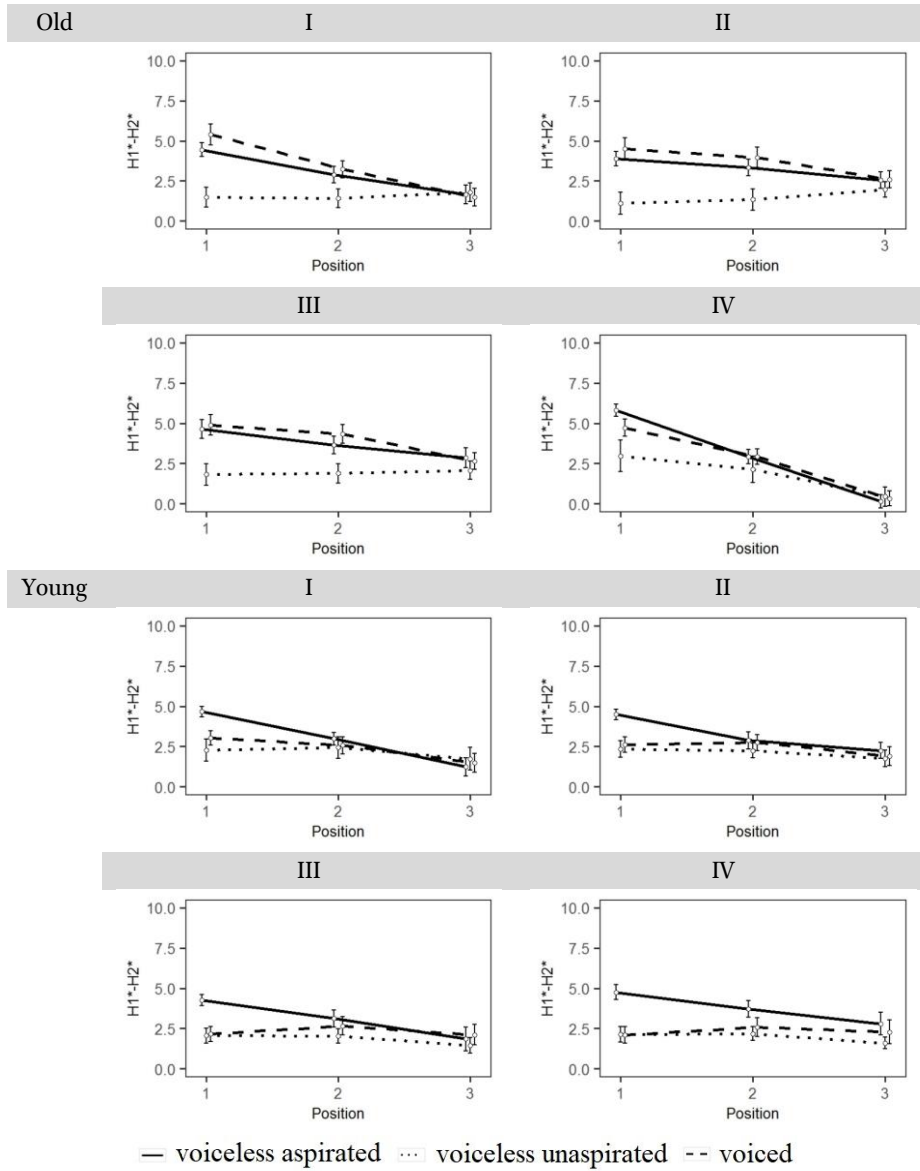
The general pattern of the f_0 contours is similar to the results reported in Section 3.3.6.1. That is, tonal split is absent in the MC *Ping* (I) tonal category. In the other

three tonal contexts (i.e., MC *Shang* II, *Qu* III, and *Ru* IV), the *f*₀ contours beginning with voiceless aspirated and voiced onsets merge. This pattern holds across generations.

b. VOT



In terms of VOT, the three-way laryngeal contrast in Lili Wu Chinese features a two-way distinction (i.e., short lag vs. long lag). The voiceless aspirated onsets have longer VOT values than the other two counterparts. The voiceless unaspirated and voiced onsets have similar short VOT values. None of the voiced onsets are realized with a lead VOT. This pattern holds across generations and is similar to the results reported in Section 2.3 as well as most Northern Wu dialects (Cao & Maddieson, 1992; Ren, 1992; Gao, 2015).

c. $H_1^*-H_2^*$ 

The general pattern of the $H_1^*-H_2^*$ values is similar to the results reported in Section 3.3.6.3. First, a consistently higher $H_1^*-H_2^*$ over one-third of vowels (Position 1) after aspirated onsets is observed. This pattern holds across generations. Second, all phonatory contrasts seem to vanish after the midpoint

(Position 2). This pattern again holds across generations. Third, across all MC tonal categories, the old-generation speakers show more comparable patterns of $H_1^*-H_2^*$ of vowels after voiced and aspirated onsets, whereas the young-generation speakers show a minimized $H_1^*-H_2^*$ difference, especially after voiced and unaspirated onsets.

I-6a Final models to calculate the results presented in Table 3.9

| Generation-Category- Position | Fixed structure | Random structure |
|----------------------------------|--|---|
| Old-I&III-P1 | Consonant + Vowel | (1 Speaker) |
| Young-I-P1 | Consonant + Vowel | (1 + Consonant Speaker) |
| Old-II-P1 | Consonant + Vowel + Gender | (1 Speaker) |
| Young-II-P1 | Consonant + Vowel | (1 + Consonant Speaker) + (1 Item) |
| Young-III-P1 | Consonant + Gender | (1 + Consonant Speaker) |
| Old&Young-IV-P1 | Consonant | (1 + Consonant Speaker) |
| Young-IV-P2 | Consonant + Vowel | (1 + Consonant Speaker) |
| Others | Consonant did not significantly improve the model fit. | |

I-6b Between-Consonant comparisons of CQ by Generation, Category, and Position

A mixed model fitted to CQ with fixed factors Consonant, Generation, Category, and their full-fledged interactions was run. The random intercept for Speaker was also included. This was the maximal model which converged. Pairwise comparisons of the marginal means estimate were calculated with fractional degrees of freedom computed using the Satterthwaite method. The *p*-values were adjusted using the Tukey method for comparing a family of 3 estimates. n.s.: not significant.

| Contrast | Estimate | SE | df | <i>t</i> -ratio | <i>p</i> |
|---|----------|-----|------|-----------------|----------|
| Generation: Old, Category: I, Position: 1 | | | | | |
| A – U | –0.05 | .01 | 4090 | –4.16 | < .001 |
| A – D | .01 | .01 | 4090 | 1.02 | n.s. |
| U – D | .06 | .01 | 4090 | 5.23 | < .001 |
| Generation: Young, Category: I, Position: 1 | | | | | |
| A – U | –0.04 | .01 | 4090 | –3.47 | < .01 |
| A – D | –0.04 | .01 | 4090 | –3.24 | < .01 |
| U – D | .01 | .01 | 4090 | .24 | n.s. |
| Generation: Old, Category: II, Position: 1 | | | | | |
| A – U | –0.07 | .01 | 4090 | –6.11 | < .001 |
| A – D | .01 | .01 | 4090 | .05 | n.s. |
| U – D | .07 | .01 | 4090 | 6.18 | < .001 |
| Generation: Young, Category: II, Position: 1 | | | | | |
| A – U | –0.06 | .01 | 4090 | –5.26 | < .001 |
| A – D | –0.04 | .01 | 4090 | –3.53 | < .01 |
| U – D | .02 | .01 | 4090 | 1.71 | n.s. |
| Generation: Old, Category: III, Position: 1 | | | | | |
| A – U | –0.05 | .01 | 4090 | –4.07 | < .001 |
| A – D | .01 | .01 | 4090 | .29 | n.s. |
| U – D | .05 | .01 | 4090 | 4.37 | < .001 |
| Generation: Young, Category: III, Position: 1 | | | | | |
| A – U | –0.06 | .01 | 4090 | –4.85 | < .001 |
| A – D | –0.05 | .01 | 4090 | –4.51 | < .001 |
| U – D | .01 | .01 | 4090 | .36 | n.s. |
| Generation: Old, Category: IV, Position: 1 | | | | | |
| A – U | –0.09 | .01 | 4090 | –7.39 | < .001 |
| A – D | .01 | .01 | 4090 | .59 | n.s. |
| U – D | .09 | .01 | 4090 | 7.98 | < .001 |

Continued.

Generation: Young, Category: IV, Position: 1

| | | | | | |
|-------|-------|-----|------|-------|--------|
| A – U | –0.08 | .01 | 4090 | –6.64 | < .001 |
| A – D | –0.07 | .01 | 4090 | –6.33 | < .001 |
| U – D | .01 | .01 | 4090 | .28 | n.s. |

Generation: Old, Category: I, Position: 2

| | | | | | |
|-------|-----|-----|------|------|------|
| A – U | .01 | .01 | 4090 | .83 | n.s. |
| A – D | .02 | .01 | 4090 | 1.76 | n.s. |
| U – D | .01 | .01 | 4090 | .94 | n.s. |

Generation: Young, Category: I, Position: 2

| | | | | | |
|-------|-------|-----|------|-------|------|
| A – U | –0.01 | .01 | 4090 | –0.08 | n.s. |
| A – D | –0.02 | .01 | 4090 | –1.33 | n.s. |
| U – D | –0.01 | .01 | 4090 | –1.25 | n.s. |

Generation: Old, Category: II, Position: 2

| | | | | | |
|-------|-------|-----|------|-------|------|
| A – U | .01 | .01 | 4090 | .49 | n.s. |
| A – D | .01 | .01 | 4090 | .38 | n.s. |
| U – D | –0.01 | .01 | 4090 | –0.12 | n.s. |

Generation: Young, Category: II, Position: 2

| | | | | | |
|-------|-------|-----|------|-------|------|
| A – U | –0.01 | .01 | 4090 | –1.16 | n.s. |
| A – D | –0.01 | .01 | 4090 | –0.34 | n.s. |
| U – D | .01 | .01 | 4090 | .83 | n.s. |

Generation: Old, Category: III, Position: 2

| | | | | | |
|-------|-------|-----|------|-------|------|
| A – U | –0.01 | .01 | 4090 | –0.89 | n.s. |
| A – D | .01 | .01 | 4090 | .27 | n.s. |
| U – D | .01 | .01 | 4090 | 1.16 | n.s. |

Generation: Young, Category: III, Position: 2

| | | | | | |
|-------|-------|-----|------|-------|------|
| A – U | –0.02 | .01 | 4090 | –1.37 | n.s. |
| A – D | –0.01 | .01 | 4090 | –0.76 | n.s. |
| U – D | .01 | .01 | 4090 | .61 | n.s. |

Generation: Old, Category: IV, Position: 2

| | | | | | |
|-------|-------|-----|------|-------|-------|
| A – U | –0.03 | .01 | 4090 | –2.37 | < .05 |
| A – D | .01 | .01 | 4090 | .85 | n.s. |
| U – D | .04 | .01 | 4090 | 3.21 | < .01 |

Generation: Young, Category: IV, Position: 2

| | | | | | |
|-------|-------|-----|------|-------|--------|
| A – U | –0.05 | .01 | 4090 | –4.37 | < .001 |
| A – D | –0.03 | .01 | 4090 | –2.75 | < .05 |
| U – D | .02 | .01 | 4090 | 1.6 | n.s. |

Generation: Old, Category: I, Position: 3

| | | | | | |
|-------|-----|-----|------|------|------|
| A – U | .01 | .01 | 4090 | .62 | n.s. |
| A – D | .01 | .01 | 4090 | 1.11 | n.s. |
| U – D | .01 | .01 | 4090 | .49 | n.s. |

Generation: Young, Category: I, Position: 3

Continued.

| | | | | | |
|-------|-------|-----|------|------|------|
| A – U | .01 | .01 | 4090 | .39 | n.s. |
| A – D | .01 | .01 | 4090 | .19 | n.s. |
| U – D | –0.01 | .01 | 4090 | –.21 | n.s. |

Generation: Old, Category: II, Position: 3

| | | | | | |
|-------|-------|-----|------|-------|------|
| A – U | .01 | .01 | 4090 | .46 | n.s. |
| A – D | .01 | .01 | 4090 | .3 | n.s. |
| U – D | –0.01 | .01 | 4090 | –0.16 | n.s. |

Generation: Young, Category: II, Position: 3

| | | | | | |
|-------|-------|-----|------|-------|------|
| A – U | –0.02 | .01 | 4090 | –1.45 | n.s. |
| A – D | –0.01 | .01 | 4090 | –0.34 | n.s. |
| U – D | .01 | .01 | 4090 | 1.12 | n.s. |

Generation: Old, Category: III, Position: 3

| | | | | | |
|-------|-----|-----|------|-----|------|
| A – U | .01 | .01 | 4090 | .23 | n.s. |
| A – D | .01 | .01 | 4090 | .43 | n.s. |
| U – D | .01 | .01 | 4090 | .18 | n.s. |

Generation: Young, Category: III, Position: 3

| | | | | | |
|-------|-------|-----|------|-------|------|
| A – U | –0.01 | .01 | 4090 | –0.3 | n.s. |
| A – D | –0.01 | .01 | 4090 | –0.79 | n.s. |
| U – D | –0.01 | .01 | 4090 | –0.48 | n.s. |

Generation: Old, Category: IV, Position: 3

| | | | | | |
|-------|-------|-----|------|-------|------|
| A – U | –0.01 | .01 | 4090 | –0.21 | n.s. |
| A – D | .01 | .01 | 4090 | .08 | n.s. |
| U – D | .01 | .01 | 4090 | .29 | n.s. |

Generation: Young, Category: IV, Position: 3

| | | | | | |
|-------|-------|-----|------|-------|------|
| A – U | –0.02 | .01 | 4090 | –1.71 | n.s. |
| A – D | –0.01 | .01 | 4090 | –1.07 | n.s. |
| U – D | .01 | .01 | 4090 | .64 | n.s. |

Appendix II

II-1 Stimulus list of Shuangfeng Xiang Chinese in Chapter 5

| Unaspirated (U) | Aspirated (A) | Voiced (D) |
|------------------|-----------------------------------|---------------------|
| 北 pe 'northern' | 撇 p ^h e 'to put aside' | 陪 be 'to accompany' |
| 滴 ti 'drop' | 踢 t ^h i 'to kick' | 题 di 'subject' |
| 得 te 'to gain' | 铁 t ^h e 'iron' | 头 de 'head' |
| 答 ta 'to answer' | 塔 t ^h a 'pagoda' | 桃 də 'peach' |
| 结 ke 'knot' | 客 k ^h e 'guest' | 狂 gɔn 'mad' |

II-2 Final models to calculate the results presented in Table 5.2

| Generation | Fixed structure | Random structure |
|------------|---|--|
| Old | $(ot_1 + ot_2) * \text{Consonant} + \text{Place}$ + Vowel + Repetition | $(1 \text{Speaker}) + (ot_1 + ot_2 \text{Speaker:}$ $\text{Consonant}) + (ot_1 + ot_2 \text{Item})$ |
| Young | $(ot_1 + ot_2) * \text{Consonant} + \text{Place}$ + Vowel | $(1 \text{Speaker}) + (ot_1 + ot_2 \text{Speaker:}$ $\text{Consonant}) + (ot_1 + ot_2 \text{Item})$ |

II-3a Final models to calculate the results presented in Table 5.7

| Generation-Position | Fixed structure | Random structure |
|---------------------|------------------------------------|---|
| Old-P1 | Consonant + Gender + Repetition | (1 + Consonant Speaker) |
| Old-P2 | Consonant + Vowel + Gender | (1 + Consonant Speaker) + (1 Item) |
| Young-P1 | Consonant + Vowel | (1 + Consonant Speaker) |
| Young-P2 | Consonant | (1 + Consonant Speaker) |

II-3b Between-Consonant comparisons of CQ by Generation and Position

A mixed model fitted to CQ with fixed factors Consonant, Generation, Position, and the full-fledged interactions was run. The random intercept for Speaker was also included. This was the maximal model which converged. Pairwise comparisons of the marginal means estimate were calculated with fractional degrees of freedom computed using the Satterthwaite method. The *p*-values were adjusted using the Tukey method for comparing a family of 3 estimates. n.s.: not significant.

| Contrast | Estimate | SE | df | <i>t</i> -ratio | <i>p</i> |
|--------------------------------|----------|-----|------|-----------------|----------|
| Generation: Old, Position: 1 | | | | | |
| A – U | –0.07 | .01 | 3293 | –8.96 | < .001 |
| A – D | –0.05 | .01 | 3293 | –6.81 | < .001 |
| U – D | .02 | .01 | 3293 | 2.16 | n.s. |
| Generation: Young, Position: 1 | | | | | |
| A – U | –0.06 | .01 | 3293 | –36.46 | < .001 |
| A – D | –0.01 | .01 | 3293 | –1.43 | n.s. |
| U – D | .05 | .01 | 3293 | 5.03 | < .001 |
| Generation: Old, Position: 2 | | | | | |
| A – U | –0.03 | .01 | 3293 | –3.32 | < .01 |
| A – D | –0.02 | .01 | 3293 | –2.57 | < .05 |
| U – D | .01 | .01 | 3293 | .75 | n.s. |
| Generation: Young, Position: 2 | | | | | |
| A – U | –0.02 | .01 | 3293 | –2.25 | n.s. |
| A – D | .01 | .01 | 3293 | .75 | n.s. |
| U – D | .03 | .01 | 3293 | 2.99 | < .01 |
| Generation: Old, Position: 3 | | | | | |
| A – U | .01 | .01 | 3293 | .09 | n.s. |
| A – D | –0.01 | .01 | 3293 | –0.27 | n.s. |
| U – D | –0.01 | .01 | 3293 | –0.35 | n.s. |
| Generation: Young, Position: 3 | | | | | |
| A – U | –0.01 | .01 | 3293 | –0.91 | n.s. |
| A – D | .01 | .01 | 3293 | .19 | n.s. |
| U – D | .01 | .01 | 3293 | 1.11 | n.s. |

