Acoustic Experimental Study on Monosyllabic and Disyllabic Tones in the Yishui Dialect (Post-print)

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Abstract

Yishui County in Linyi City, Shandong Province, boasts a long history as a millennium-old county. It enjoys a superior geographical location in the hinterland of the Yimeng Mountains and the upper reaches of the Yi and Shu Rivers. Two to three hundred thousand years ago, human ancestors thrived and proliferated in this region, creating an ancient and splendid agricultural civilization, and nurtured by its mountains and rivers, cultivated a distinctive local linguistic culture, forming the unique Yishui dialect. Based on recorded speech corpora, this study extracts fundamental frequency (F0) parameters and conducts normalization and semitone conversion to analyze the tonal patterns of monosyllabic and disyllabic lexical items in the Yishui dialect, providing a detailed description and summary of its four-tone tonal system. The results indicate that the dialect possesses four independent lexical tones: three falling tones and one level tone, with yinping, yangping, shangsheng, and qusheng having tonal values of 31, 54, 33, and 42, respectively. Falling tones constitute a prominent feature of this dialect, manifested in the merging patterns observed in tone sandhi. Disyllabic tonal combinations exhibit 16 patterns, which are reduced to 10 patterns following tone sandhi. Specifically, tone sandhi primarily occurs in the initial syllable: yinping shifts from a falling tone (31) to a rising tone (35) when preceding yinping, from a low falling tone (31) to a high falling tone (54) before shangsheng, and from a falling tone (31) to a level tone (33) before qusheng; shangsheng shifts from a level tone (33) to a falling tone (31) before yangping. This paper employs acoustic analysis methods to investigate and characterize the tonal system of the Yishui county dialect, aiming to contribute to the tonal research framework of Jiao-Liao Mandarin and Shandong dialects more broadly.

Full Text

Preamble

Course Paper for Experimental Phonetics

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An Acoustic Experimental Study of Monosyllabic and Disyllabic Tones in Yishui Dialect

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Abstract Yishui County in Linyi City, Shandong Province, is a historic county with a millennium-long heritage. Its advantageous geographical location lies in the heart of the Yimeng Mountains, at the upper reaches of the Yi River and Shu River. Two to three hundred thousand years ago, human ancestors thrived here, creating an ancient and splendid agricultural civilization, and under the nurturing influence of its mountains and rivers, cultivated a unique local linguistic culture, forming the distinctive Yishui dialect. Based on recorded speech materials, this study extracts fundamental frequency parameters and performs normalization and semitone conversion to analyze the tonal patterns of monosyllabic and disyllabic tones in Yishui dialect, providing a detailed description and summary of its four-tone system. Results indicate that the dialect has four independent monosyllabic tones: three falling tones and one level tone, with Yinping, Yangping, Shangsheng, and Qusheng having tonal values of 31, 54, 33, and 42 respectively. Falling tones represent a major characteristic of this dialect, manifested in the merging patterns observed in tone sandhi during connected speech. There are 16 possible tonal combination patterns in disyllabic words, which merge into 10 distinct patterns after tone sandhi. Tone changes primarily occur in the first syllable: Yinping changes from a falling tone 31 to a rising tone 35 before Yinping, from a low falling tone 31 to a high falling tone 54 before Shangsheng, and from a falling tone 31 to a level tone 33 before Qusheng; Shangsheng changes from a level tone 33 to a falling tone 31 before Yangping. This study employs acoustic analysis methods to investigate and describe the tonal system of the Yishui county dialect, aiming to supplement the tonal research framework for Jiao-Liao Mandarin and Shandong dialects as a whole.

[**Keywords**] Yishui dialect; monosyllabic tone; disyllabic tone; acoustic analysis

1. Introduction

Yishui County is located in the northeastern corner of Linyi City in southeastern Shandong Province, situated in the Yimeng Mountain region of central-southern Shandong. It borders Ju County to the east, meets Yiyuan and Mengyin counties to the west, adjoins Yinan County to the south, and connects with Anqiu and Linqu to the north, making it an ancient city with both advantageous geography and a long history. Yishui dialect belongs to the Qinglai sub-group of

Jiao-Liao Mandarin within Northern Mandarin (*Language Atlas of China*, 1987; Zhang Shuzheng, 2007). Phonological features differ between the eastern and western parts of the county (Zhao Min, 2007): the eastern region shares essentially the same pronunciation as Yishui county town and belongs to Jiao-Liao Mandarin, while the western region, closer to Mengyin, shares features with Central Plains Mandarin along with other Linyi area dialects.

Previous research on Yishui dialect has predominantly focused on grammatical aspects, with scholars investigating grammatical features, expressions, and usage of various word classes. For instance, Qin Weifen (2012) in "A Brief Analysis of the Usage of 'zi' in Yishui Dialect" and Xie Zhiwei (2013) in "Grammatical Features and Functions of the 'zi' Suffix in Yishui Dialect" both explored the grammatical characteristics and functions of affixes. Zhao Min, Wang Shengying, and Rong Wei (2014) conducted studies on degree adverbs in Yishui dialect, while Wu Yuli and Wang Kun (2009) in "A Comparative Study of Modal Particles 'lai' and 'qu' in Linyi Dialect (Yishui Speech)," Shi Lin (2011) in "The Preposition 'jiao' in Yishui Dialect," Han Yuxiang (2011) in "Degree Expressions of 'Sour, Sweet, Bitter, Spicy, and Salty' in Yishui Dialect," and Li Li (2015) in "A Study on Affixes in Linyi Dialect of Shandong" explored and summarized other word classes.

At the phonological level, *Yishui Dialect Gazetteer* compiled by Zhang Tingxing et al. (1999) systematically investigated and described the phonological system of Yishui dialect. Zhao Min from Sun Yat-sen University (2007) summarized and introduced the phonological characteristics of Yishui dialect, particularly the evolution of its initial, final, and tonal systems from medieval to modern times. Qian Zengyi et al. from Shandong University (2015) in *A Brief Gazetteer of Yishan Area Dialects in Shandong* also provided systematic 归纳 and introduction to the phonological systems of Yishan area dialects including Yishui.

Notably, with the rise of experimental phonetics in recent years, employing experimental phonetic methods to investigate tonal systems of Chinese dialects has become an increasingly popular research topic, yielding fruitful results for numerous dialect areas in Shandong. Sun Huiming (2007) from Ludong University in "An Experimental Study of Tones in Jiaodong Dialects" conducted acoustic experimental research on monosyllabic and disyllabic tones in many areas of Jiao-Liao Mandarin.

Building upon previous research, this study employs acoustic analysis methods to investigate and describe the tonal system of Yishui county dialect, aiming to supplement the tonal research framework for Jiao-Liao Mandarin and Shandong dialects as a whole.

2. Dialect Point Introduction

2.1 Basic Information on Yishui County Dialect

Yishui dialect belongs to the Qinglai sub-group of Jiao-Liao Mandarin within Northern Chinese. Within Shandong' s dialect classification, it falls under the Weifang subgroup of Eastern Shandong (Zhang Tingxing 1999). Located at the junction of Central Plains Mandarin and Jiao-Liao Mandarin, its eastern region shares essentially the same pronunciation as Yishui county town and belongs to Jiao-Liao Mandarin, while its western region, closer to Mengyin, shares features with Central Plains Mandarin along with other Linyi area dialects. Its geographical location is shown in the following map:

[FIGURE:N] Map of Shandong Province (Source: "Map of China: http://map.ps123.net/china/633.html"; Map of Linyi City Source: "Linyi Municipal People's Government Official Website: http://www.linyi.gov.cn/sq/lygk/dlwz.htm")

2.2 Phonological System

2.2.1 Initials Yishui dialect has 26 initials, including the zero initial. The initials and example characters are listed below (Zhang Yanxing et al. 1999):

ð 子葬凿　　t 醋仓曹　　四苏随　　延武雨热软荣

Notes:

The voiced fricative initials ð and z are sometimes pronounced as voiced affricates dð and dz, or voiceless affricates t and ts. This book uniformly records them as ð and z.

When z, tsh, and s are combined with palatal finals, they acquire a palatal coloring.

2.2.2 Finals Yishui dialect has 37 finals, including 10 monophthongs, 12 diphthongs, 8 nasalized finals, and 7 nasal-coda finals. The finals and example characters are listed below (Zhang Yanxing et al. 1999):

爬抓割　　i 家下压　　u 抓花瓦
ə 波车儿　　iə 姐结热　　uə 果河窝　　yə 月药虐弱
ɪ 资知吃　　支翅使　　i 习移日　　u 铺故五　　y 绿雨俗褥
盖害爱　　i 解鞋矮　　u 怪快外
包号袄　　i 条要绕
ən 门林秦　　iən 紧琴人　　uən 抡滚温　　yən 云军润
ŋ 党张昂　　i ŋ 讲羊让　　u ŋ 光黄汪
əŋ 登绷坑　　iŋ 星英仍

Note: The in ŋ and u ŋ is relatively rounded with nasal coloring.

2.2.3 Tones Yishui dialect has four tone categories in monosyllabic words, excluding neutral tone: one level tone and three falling tones. The tone categories,

values, and example characters are:

- Yinping: 213/21　高知多
- Yangping: 53　盖送饭
- Shangsheng: 44
- Qusheng: 21

According to *Yishui Dialect Gazetteer*, the tone sandhi patterns for disyllabic words are shown in Table 1 .

[Table content showing tone combinations with examples···]

Among the 16 tonal combinations, tone sandhi occurs in 5 cases, all when Yinping or Shangsheng appears as the first syllable. The merging patterns after sandhi occur in three cases of Shangsheng changes: 1. Shangsheng before Yangping changes from 44 to 213, merging with Yinping before Yangping. 2. Shangsheng before Shangsheng changes from 44 to 53, merging with Yangping before Shangsheng. 3. Shangsheng before Qusheng changes from 44 to 24, merging with Yinping (which changes from 213 to 24 before Qusheng) before Shangsheng.

3. Research Methods

3.1 Recording

This experiment selected four speakers (two male, two female), all native Yishui county residents who grew up in Yishui, Shandong Province, with Yishui dialect as their mother tongue. All acquired their native dialect before learning Mandarin and are currently enrolled at Peking University for one to three years.

Female speaker f1 (Hao Dena) was born November 24, 1997; female speaker f2 (Zhou Mengyao) was born October 5, 1997; male speaker m1 was born November 27, 1999; and male speaker m2 was born January 30, 2001.

Word lists were created according to different types and arrangements of monosyllabic and disyllabic tones (complete information in Table 2). Five example words were selected for each tone pattern. Disyllabic words were chosen with plosive initials for easier audio segmentation. Speakers were instructed to read the word list at consistent intensity, with each example read twice, clearly, accurately, and naturally, with adequate pauses between items. All recordings were conducted in quiet indoor environments using an Aigo R6611 professional mini recorder in WAV format at 44.1KHz sampling rate. Adobe Audition CC 2015 was used to segment and store WAV audio files by example word, yielding 160 monosyllabic and 640 disyllabic tone samples.

3.2 Parameter Extraction and Normalization

This study used Praat software to extract fundamental frequency (F0) values. WAV audio samples were imported into Praat, and pitch curves were examined using View & Edit to extract pitch values within selected syllable boundaries. F0 values were extracted at equal intervals from each sample to represent the pitch contour trajectory. Since Yishui dialect lacks entering tones and contains only smooth tones, 20 measurement points were extracted per syllable. Each speaker' s samples were then averaged by the four tone categories, and semitone values within each speaker' s pitch range were calculated using the following formula:

$$F(x) = 12 \cdot \log_2(x/\min)$$

where x represents the mean frequency at measurement points, min represents the minimum mean value among all measurement points, and F(x) represents the semitone value corresponding to the mean frequency.

4. Monosyllabic Tone Parameter Analysis

Based on F0 extraction and semitone conversion of the four speakers' samples, the averaged monosyllabic tone semitone values for male and female speakers were obtained, as shown in the figure below:

[FIGURE:N]

The figure reveals that Yangping is the highest tone, Yinping the lowest, with Yang, Qu, and Yin representing high, mid, and low falling tones respectively, while Shangsheng is a mid-level tone with slight final rise. With Yangping' s highest starting point designated as 5 and Yinping' s lowest as 1, Qusheng' s starting point, similar to Yangping' s endpoint but slightly lower than Yangping' s start, is designated as 4. Shangsheng' s start and end both reach 4, designated as 3; its slight final rise is insufficient to affect native speakers' tonal perception and is therefore treated as a level tone. Yinping' s starting point, close to Shangsheng and higher than Qusheng' s endpoint, is designated as 3. The summarized monosyllabic tone categories and values are presented below:

[Table of tone values]

Notably, after Yinping falls from 3 to 1, there appears to be an extension and dwell near 1, raising questions about whether this constitutes an inherent tonal feature. Separate semitone processing by gender revealed several gender differences in monosyllabic tone realization:

1. Female speakers' Yinping shows a pitch recovery after the 31 fall, though not prominent, approximating Qusheng' s endpoint, suggesting a 3-1-2 trajectory. Male speakers' Yinping demonstrates a standard, clear 3-1

falling pattern. However, this difference appears to stem more from individual speaker variation: male speakers produce lower, crisper tones, while female speakers' final tones show pitch recovery and extension due to lengthening. This phenomenon resembles Mandarin' s third tone (214), where some speakers produce the standard 2-1-4 contour while others produce 2-1 directly, without affecting native listeners' perceptual judgment. Additionally, the pitch recovery and rise in female speakers shows no significant pattern, indicating that its presence or absence does not create phonological contrast, and thus these are unified under a single category.

2. Qusheng shows slight gender differences. Female speakers' realization more closely matches the averaged 42 value, while male speakers show higher start and end points, with the start approaching Yangping' s onset and the end near 4, yielding a contour closer to 53. This result is attributed to both male speakers having lower vocal ranges, making tonal distinctions in falling patterns less salient.

5. Disyllabic Tone Parameter Analysis

Based on the four monosyllabic tones, 16 disyllabic tonal combinations are possible. Analysis of the four speakers' tonal samples, arranged by the first syllable' s tone type and processed into semitone values, yielded the following results:

5.1 First Syllable as Yinping

Among the four tonal combinations with Yinping as the first syllable, three patterns emerge after sandhi. When the second syllable is Yinping or Qusheng, the first syllable' s Yinping changes both contour and value from falling to rising. Before Yinping, Yinping starts at the previous level (3) and ends at Yangping' s starting point (5). Before Qusheng, Yinping starts lower (2) and ends at the same point as Yinping' s onset in the second syllable (3).

When the second syllable is Shangsheng, Yinping changes from low falling to high falling, similar to monosyllabic Yangping (54). Before Yangping, Yinping undergoes no change.

5.2 First Syllable as Yangping

The figures show that Yangping as the first syllable never changes. The second syllable also remains unchanged, except that Shangsheng' s overall value is slightly lower, which does not affect perception and is considered a coarticulatory adjustment for distinction from the preceding high tone, requiring no modification of the base value.

5.3 First Syllable as Shangsheng

When the second syllable is Yangping, Shangsheng changes to a contour similar to monosyllabic Yinping (31). No changes occur in other contexts. The second

syllable remains unchanged, though Shangsheng' s overall value is slightly lower when following Shangsheng, likely for inter-syllable distinction. Additionally, the second syllable' s Yinping onset is higher than in monosyllabic Yinping, probably due to articulatory ease following Shangsheng' s final rise. Neither phenomenon affects perception and thus requires no adjustment.

5.4 First Syllable as Qusheng

When Qusheng appears as the first syllable in disyllabic words, its overall value rises to approximate monosyllabic Yangping (54). Meanwhile, Yangping as the second syllable manifests as a high level tone, transcribable as 55. No changes occur in other positions.

5.5 Summary

The complete disyllabic tone sandhi patterns are summarized below:

[Table of disyllabic tone sandhi]

6. Discussion of Monosyllabic and Disyllabic Tone Patterns

6.1 Monosyllabic Tones

Yishui dialect has four monosyllabic tones, all smooth tones: one level tone (Shangsheng/33/) and three falling tones—high falling Yangping/54/, mid falling Qusheng/42/, and low falling Yinping/31/.

6.2 Disyllabic Tones

Based on the above results, clear descriptions of tonal values in both positions of disyllabic words can be established. First syllable categories include: level tone 33; rising tones 35/23; and falling tones 54/31. The rising tone 23 occurs when Yinping precedes Qusheng, but perceptual comparison reveals minimal difference from Shangsheng before Qusheng, suggesting they belong to the same tonal position. This raises questions about whether Shangsheng undergoes tone change. While Shangsheng does show final rising in production, previous studies categorize it as level, and the perceptual effect is minimal. Therefore, it is uniformly transcribed as monosyllabic Shangsheng/33/, with detailed perception requiring further investigation. Second syllable categories include: level tones 33/55; falling tones 31/54/42; and no rising tones.

7. Conclusion

In summary, monosyllabic tones comprise four categories with the following values:

[Table of monosyllabic tones]

Disyllabic tonal combinations merge into 10 distinct patterns with the following values:

[Table of disyllabic tones]

Overall, Yishui dialect tone sandhi primarily involves changes in the first syllable, with well-patterned merging: Yangping and Qusheng merge when preceding Yinping; Shangsheng and Yinping merge when preceding Yangping; Yinping, Yangping, and Qusheng merge when preceding Shangsheng; Shangsheng and Yinping merge when preceding Qusheng; and Yangping and Qusheng merge when preceding Qusheng. The primary reason is Yishui dialect' s abundance of falling tones, which have gradually converged through phonetic development, showing tendencies toward similar or identical values. Specific merging results await further perceptual studies by future researchers to make reasonable judgments based on native speakers' auditory perception and preferences.

8. References

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