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An Experimental Study on the Tones of the Shaoxing (Keqiao) Dialect in Zhejiang

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Abstract: Building on previous dialectological research, this study investigates the tonal patterns of monosyllabic tones in the Shaoxing dialect through acoustic experiments and extraction of fundamental frequency parameters. The experimental results show that: (1) the Yin-register tones exhibit a tendency toward falling contours, while the Yang-register tones undergo complex restructuring; (2) the overall complexity of tonal patterns tends to simplify, though localized complications are observed; (3) the Ru tones retain their characteristic brevity, yet their tonal values undergo systemic simplification; and (4) gender differences are significant in tonal variation, displaying a pattern of modern generational change.

1. Introduction

Research on Wu dialects has a long history, while the application of modern linguistic methods began with Yuen Ren Zhao's *A Study of Modern Wu Dialects* [1]. Since then, numerous scholars have contributed to the field, making research on Wu dialects relatively comprehensive and well-documented among Chinese dialects. Experimental phonetic studies of Wu dialects, especially tone experiments, are also abundant, including *Experimental Studies on Wu Tones*, edited by Ru-Jie You and Jian-Qiao Yang, and *Shanghai Tone Experiment Records* by Xiao-Nong Zhu, among others [2,3].

Research on the Shaoxing dialect has so far been limited to traditional dialectology and dialect geography. Studies on Shaoxing dialect can be broadly divided into investigations of spatial distribution and diachronic evolution. In terms of spatial distribution, although there are accent differences within Shaoxing, mutual intelligibility is generally not affected. Preliminary studies by Tao Huan, Wang Futang, and Sheng Yimin suggested internal variation within Shaoxing speech, while Jin Chunhua conducted the first detailed regional survey of the Shaoxing dialect from a dialect-geographical perspective [4-8]. Regarding diachronic changes, Wu dialects are undergoing mergers of Yin and Yang tone categories, and Shaoxing dialect represents one such key site. For example, Qian Nairong described the phenomenon in which some New-Style Yang Shang tones in Shaoxing are realized as Yang Qu [9-10]; Jin Chunhua documented tonal simplification in the peripheral areas of Shaoxing; and Xiao Nengping observed, at a micro level, the separate mergers of Yin and Yang tone categories in the southwestern part of Shaoxing [11]. However, whether considering spatial distribution or diachronic evolution, most studies have relied on dialect-geographical surveys or traditional methods, with few experimental phonetic investigations. Therefore, this study first examines the tonal patterns of the Shaoxing dialect through acoustic phonetic experiments and, based

on these data, analyzes the diachronic evolution of tones.

2. Description of the Dialect Area

Shaoxing City is located in the north-central part of Zhejiang Province, on the southern shore of Hangzhou Bay, spanning 29°13′36″–30°16′17″ N latitude and 119°53′02″–121°13′38″ E longitude. It borders Hangzhou to the west, Ningbo to the east, Taizhou to the southeast, and Jinhua to the southwest, and faces Jiaxing across the Qiantang River to the north. Covering an area of 8,279 square kilometers, Shaoxing had a population of approximately 5.0026 million in 2011. The city lies at the junction of three major geomorphological units: the western Zhejiang mountains and hills, the eastern Zhejiang hills and mountains, and the northern Zhejiang plain. Its topography is diverse, with mountainous and hilly regions in the west, central, and eastern areas, and plains in the north. The landscape can be summarized as "four mountains, three basins, two rivers, and one plain," namely Kuaiji Mountain, Siming Mountain, Tiantai Mountain, Longmen Mountain, Zhuji Basin, Xinsheng Basin, Sanjie–Zhangzhen Basin, the Puyang River, the Cao'e River, and the Shaoyu Plain. The region is densely interlaced with rivers and dotted with numerous lakes, earning it the widely recognized designation of a "land of rivers and lakes" [8].

According to the *Atlas of Chinese Dialects* (2012), the Shaoxing dialect belongs to the Linshao subbranch of the Taihu Wu dialect group. As an important branch of Chinese dialects, the Shaoxing dialect has attracted considerable scholarly attention due to its deep historical roots and its representativeness within the Wu-speaking region. Research on the Shaoxing dialect can be divided into three periods: the Qing Dynasty, the Republican era, and the modern period. Early studies primarily include three Qing-era works: *Yueyu Kenfanlu* by Mao Qiling (Kangxi period), *Yueyan Shi* by Ru Dunhe (Qianlong period), and *Yueyan* compiled by Fan Yin (Guangxu period). Among these, *Yueyan* stands out for the comprehensiveness of its recorded materials and its far-reaching influence. In the preface, Fan Yin explicitly stated that the purpose of compiling the work was to achieve an effective correspondence between spoken and written language, thereby "enabling the refined to understand the present and the unrefined to learn the past." Although the work employed some self-invented characters and phonetic symbols to record the dialect, it rigorously followed the empirical tradition of Yang Xiong's *Fangyan*, avoiding the then-prevalent tendency toward overly textual scholarship. In his postscript, Zhou Zuoren specifically noted that Fan Yin's research method displayed distinct features of linguistic documentation, namely, "to record a word is to record a word," reflecting a rigorous fieldwork approach to dialect study.

Since modern times, the earliest study of the Shaoxing dialect using modern linguistic methods was conducted by the German scholar P. G. von Möllendorff in *The Ningbo Syllabary* [12]. The appendix of this work includes phonetic materials for approximately 4,000 characters each from Ningbo, Shaoxing, and Taizhou. Slightly later, Yuen Ren Chao's *Studies on Modern Wu Dialects* (1928) documented the initials, finals, and tones of numerous Wu dialect locations, including Shaoxing. In recent decades, research on the Shaoxing dialect has yielded substantial results. Notable works include Yang Wei and Yang Naijun's *Shaoxing Dialect*, Wang Futang's *Phonetic Record of Shaoxing Speech*, and *Research on the Shaoxing Dialect*, all of which provide a comprehensive and in-depth account of the phonological and tonal characteristics of the Shaoxing dialect [13-15].

Building on previous research, this study will provide a brief introduction to the tonal categories and pitch values of the Linshao subbranch, to which the Shaoxing dialect belongs.

3. Experimental Methods

3.1 Recording Conditions

The recordings were conducted from July 25 to August 5, 2025, in a quiet indoor environment. The recording equipment consisted of a laptop and a mobile phone, and the recordings were made using Praat software. The sampling frequency was set at 22,050 Hz with 16-bit resolution, and all files were saved in the .wav format.

3.2 Recording Materials and Speakers

Based on previous research, the Shaoxing Wu dialect contains eight tonal categories for monosyllabic words: Yin Ping, Yin Shang, Yin Qu, Yin Ru, Yang Ping, Yang Shang, Yang Qu, and Yang Ru. For each tonal category, two characters were selected, and each character was pronounced twice, following the tonal survey system outlined in Research on the Shaoxing Dialect (2015).

A total of 16 speakers participated in this experiment, divided into three age groups: young (20–35), middle-aged (36–60), and elderly (60 and above), with three males and three females in each group. All speakers were natives of Keqiao, Shaoxing, and their first language was the Shaoxing dialect. None of the speakers had lived outside Shaoxing for more than one consecutive year, and all participants mutually recognized each other's speech as representative of the local dialect.

3.3 Data Processing

All speech materials in this study were first segmented using the Chinese version of Cool Edit Pro 2.1 (version 2.0). In Praat (version 6.3.20), each speech sample was annotated in two tiers: the first tier marked the vowel segments, and the second tier marked the stable points within the vowels [16]. Acoustic parameters of the annotated vowel segments were then extracted using VoiceSauce, which employs the STRAIGHT algorithm to obtain fundamental frequency (F0) values [17,18]. Because of the substantial differences in F0 between male and female speakers, normalization was applied before plotting the tonal patterns. The T-value method was used for F0 normalization, with *min* representing the minimum and *max* the maximum values. Finally, the tonal patterns of Shaoxing Wu were visualized using Excel.

The five-point normalized value (T-value) is calculated as:

$$T=\frac{\log_{10}x\text{-}\log_{10}\min}{\log_{10}\max\text{-}\log_{10}\min} \quad (1)$$

Where x is the measured fundamental frequency (F0) of a vowel segment, and *min* and *max* represent the minimum and maximum F0 values for normalization, respectively.

4. Monosyllabic Tone Experiment

In this study, acoustic analysis was conducted to plot the tonal patterns of monosyllabic words for male and female speakers across different age groups in Shaoxing. The aim was to determine the tonal pitch values.

First, the data were obtained through analysis of the samples. Ten fundamental frequency (F0) points were extracted for each monosyllabic word. The F0 values for each word were then averaged, followed by averaging across all samples within the same tonal category. The durations of different words within the same tone were normalized to align F0 values with time. The resulting plots show the average F0 contours of monosyllabic tones for male and female speakers of different age groups in Shaoxing, as illustrated in the figure.

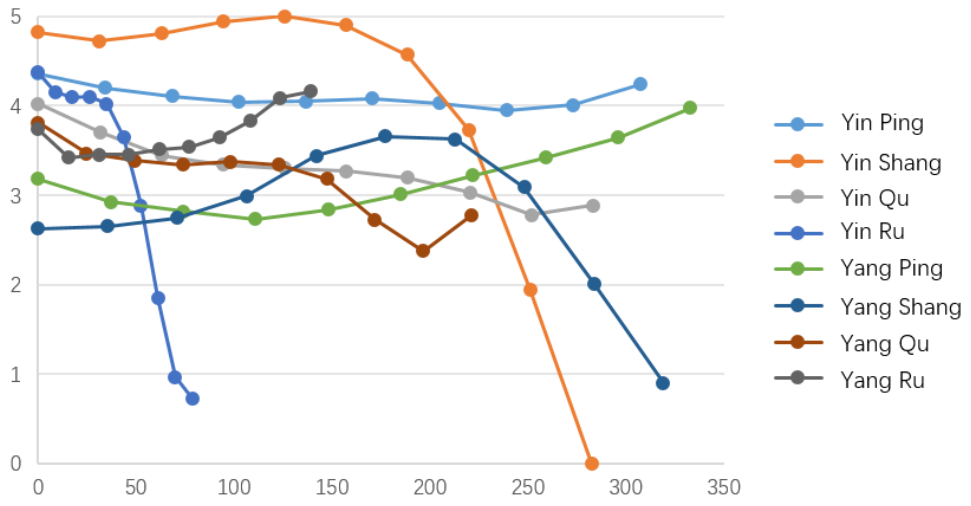

Figure 1 Tonal Patterns of Monosyllabic Words for Young Female Speakers

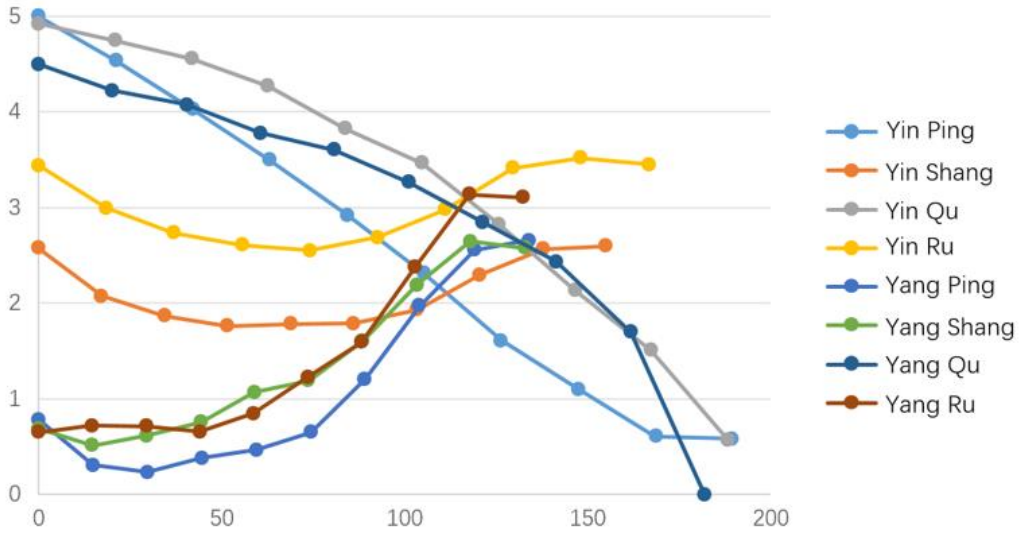

Figure 2 Tonal Patterns of Monosyllabic Words for Young Male Speakers

According to Figure 1, for young female speakers, the tonal values of the Shaoxing dialect monosyllabic tones are as follows: Yin Ping is level 55, Yin Shang is high-falling 551, Yin Qu is falling 43, Yin Ru is short 51, Yang Ping is rising 34, Yang Shang is convex 342, Yang Qu is falling 43, and Yang Ru is short 4.

According to Figure 2, for young male speakers, the tonal values of the Shaoxing dialect monosyllabic tones are as follows: Yin Ping is falling 51, Yin Shang is concave 323, Yin Qu is falling 51, Yin Ru is concave 434, Yang Ping is rising 13, Yang Shang is rising 13, Yang Qu is falling 51, and Yang Ru is rising 14.

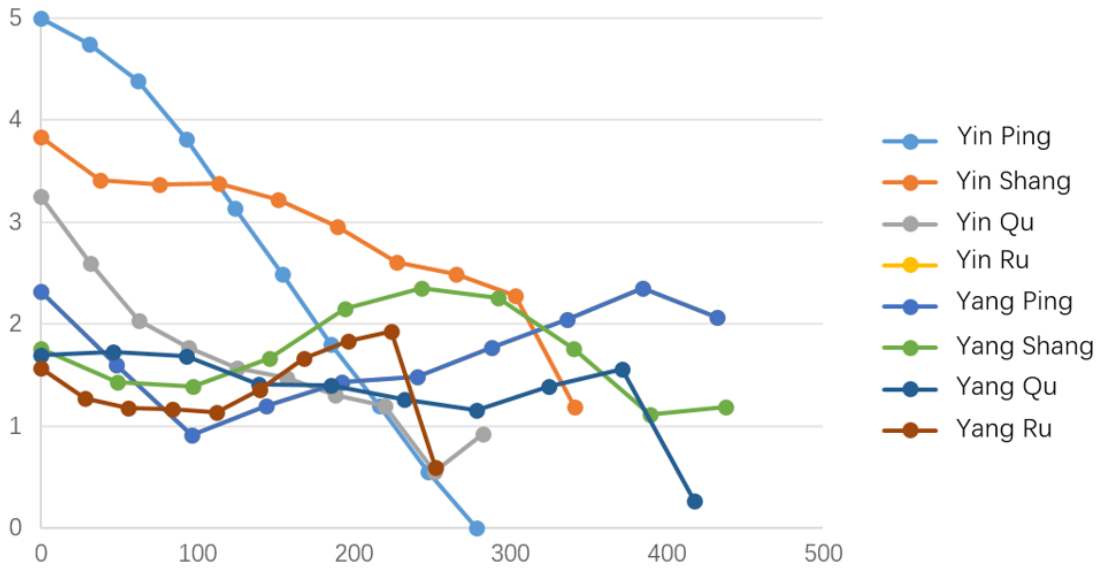

Figure 3 Tonal Patterns of Monosyllabic Words for Middle-Aged Female Speakers

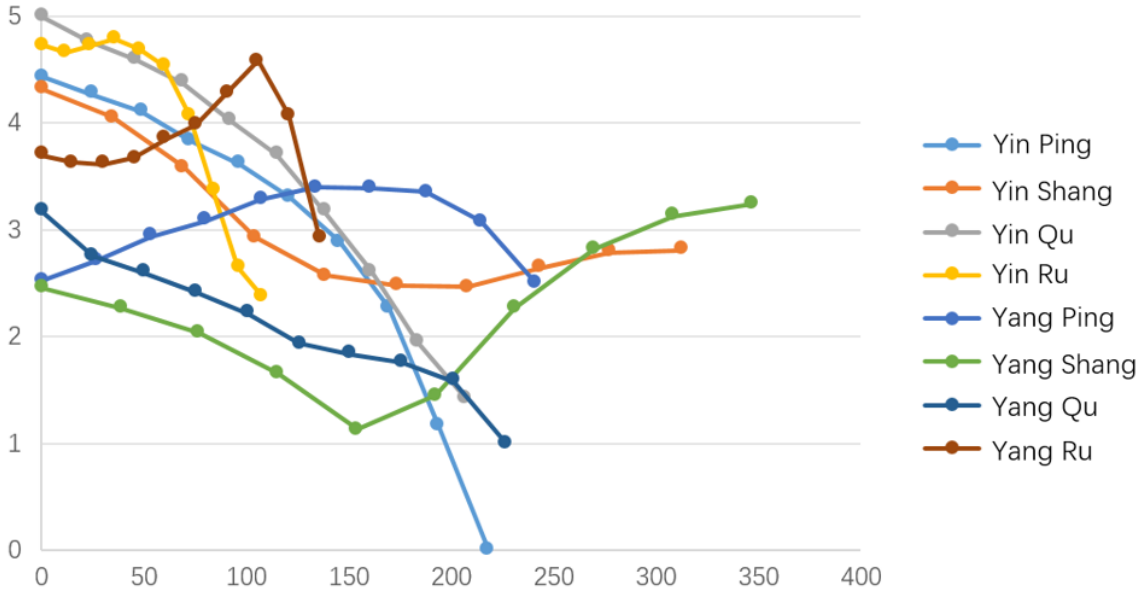

Figure 4 Tonal Patterns of Monosyllabic Words for Middle-Aged Male Speakers

According to Figure 3, for middle-aged female speakers, the tonal values of the Shaoxing dialect monosyllabic tones are as follows: Yin Ping is falling 51, Yin Shang is falling 42, Yin Qu is falling 41, Yin Ru is [not specified], Yang Ping is concave 323, Yang Shang is convex 232, Yang Qu is level 55, and Yang Ru is short 21.

According to Figure 4, for middle-aged male speakers, the tonal values of the Shaoxing dialect monosyllabic tones are as follows: Yin Ping is falling 51, Yin Shang is falling-rising 533, Yin Qu is falling 52, Yin Ru is short 53, Yang Ping is convex 343, Yang Shang is concave 324, Yang Qu is falling 42, and Yang Ru is short 4.

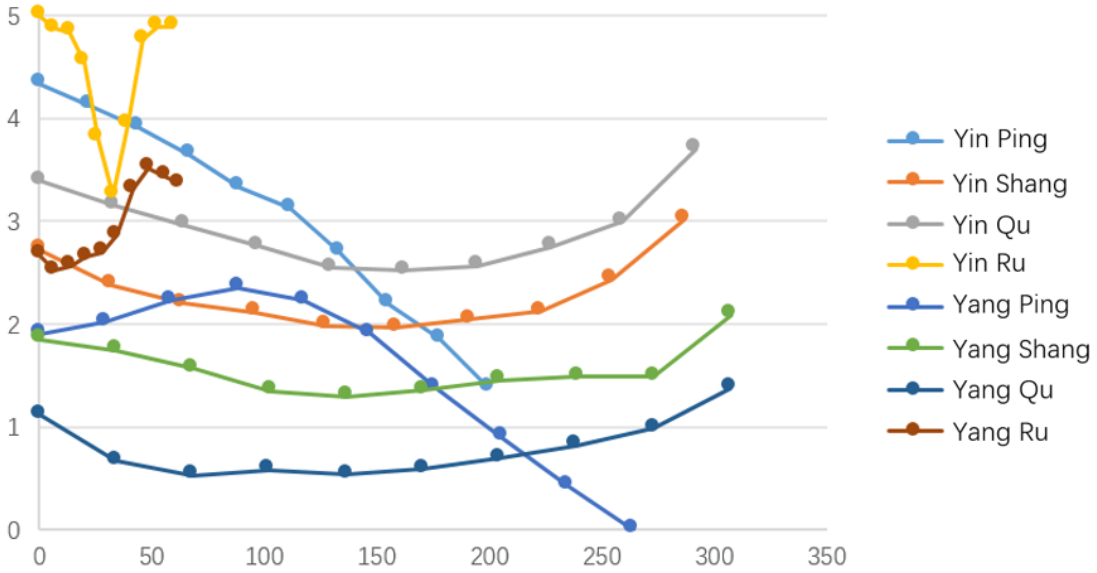

Figure 5 Tonal Patterns of Monosyllabic Words for Elderly Female Speakers

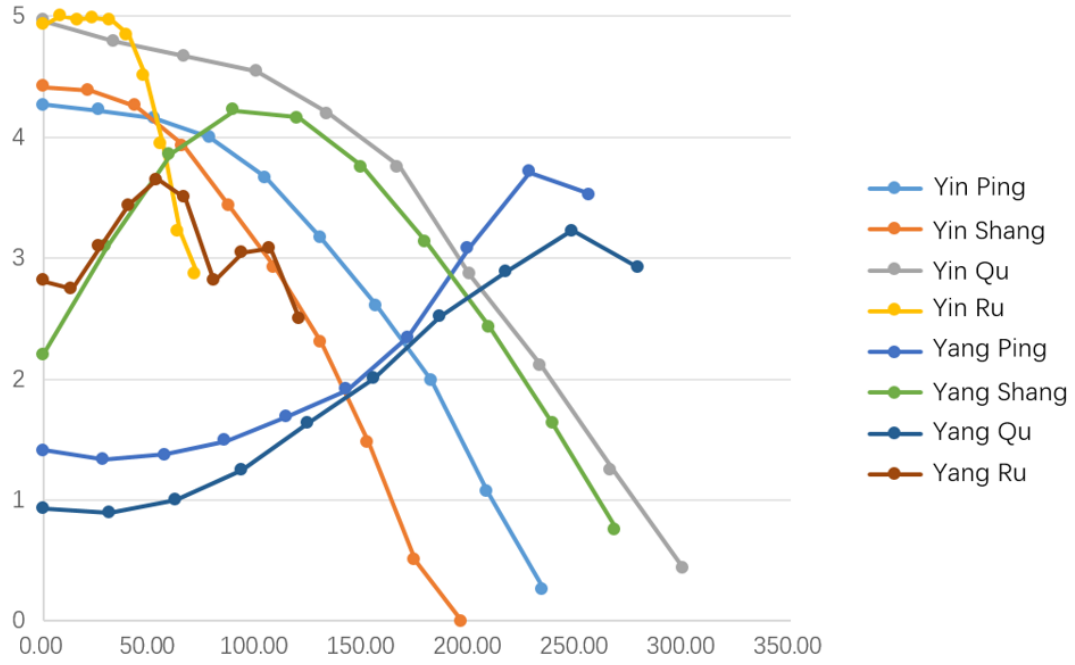

Figure 6 Tonal Patterns of Monosyllabic Words for Elderly Male Speakers

According to Figure 5, for elderly female speakers, the tonal values of the Shaoxing dialect monosyllabic tones are as follows: Yin Ping is falling 52, Yin Shang is concave 324, Yin Ru is short 5, Yang Ping is convex 231, Yang Shang is level 22, Yang Qu is concave 212, and Yang Ru is short 34.

According to Figure 6, for elderly male speakers, the tonal values of the Shaoxing dialect monosyllabic tones are as follows: Yin Ping is falling 51, Yin Shang is falling 51, Yin Qu is falling 51, Yin Ru is short 53, Yang Ping is rising 24, Yang Shang is convex 251, Yang Qu is rising 14, and Yang Ru is short 4.

5. Age-Related Variation of Tonal Categories

5.1 Variation in Yin Tones

The Yin tones show clear intergenerational differences across age groups. Among middle-aged and elderly speakers, Yin Ping generally exhibits falling contours (51/52), whereas for young female speakers, Yin Ping has shifted to a level contour of 55, while young male speakers retain the original falling 51. This difference may reflect the distinct roles of gender in language change, with young women often acting as innovators. The leveling of Yin Ping among young female speakers suggests that tonogenesis toward a level contour may represent the developmental direction of Yin Ping.

The variation of Yin Shang is more complex. Young female, middle-aged female, and elderly male speakers tend to produce a falling contour, whereas young male, middle-aged male, and elderly female speakers tend to produce a dipping contour. For female speakers, the pitch onset gradually rises while the pitch offset gradually falls, resulting in a shift from a dipping contour to a falling contour. In contrast, for male speakers, the pitch onset gradually falls while the pitch offset gradually rises, leading to a transition toward a dipping contour. This trajectory of variation indicates that Yin Shang is undergoing divergent changes across genders, a phenomenon that warrants further in-depth investigation.

Yin Qu remains relatively stable across all age groups, generally exhibiting falling contours (43/51/52), although young female speakers show a value of 43 compared to 51/52 in other groups. This difference may indicate that, due to its similarity to the contour of Yin Ping, Yin Qu is beginning to shift toward a level contour. Such a change could be further explored through perception experiments. The short duration characteristic of Yin Ru is well maintained across all age groups, but the specific tonal values evolve from 51 (female) and 434 (male) in the young group to 53 in the middle-aged and elderly groups, suggesting that the checked tone is also undergoing internal adjustments.

5.2 Age-Related Variation in Yang Tones

The variation patterns of Yang tones differ from those of the Yin tones. Among middle-aged speakers, Yang tones exhibit complex contours: concave 323 for females and convex 343 for males. In the elderly group, they manifest as convex 231 for females and rising 24 for males. In contrast, Yang Ping in the young group shows a simple rising contour (male 13, female 34). This pattern may reflect self-adjustment and simplification within the tonal system, and it may also be influenced by the rising contour of Yang Ping in Standard Mandarin.

The gender variation of Yang Shang is particularly pronounced. For female speakers, Yang Shang in the elderly group is a simple level contour 22; in the middle-aged group, the midsection rises, resulting in a convex 232 contour; and in the young group, both the onset and midsection rise further, forming a convex 342 contour. For male speakers, Yang Shang undergoes a transition from convex to concave and finally to a rising contour. These changes suggest that Yang Shang may be undergoing a process of tonal restructuring, with the greatest gender differences observed in the elderly group.

Yang Ru maintains its short duration across all age groups, but the tonal values evolve from 4 (female) and 14 (male) in the young group to 21 (female) and 4 (male) in the middle-aged and elderly groups. This indicates that the checked tone is also undergoing systematic adjustment, with male speakers retaining relatively higher pitch values.

5.3 Age-Related Evolution of Tonal Complexity

Analysis of tonal complexity across the six speaker groups reveals a clear age-related trend.

Overall, the young group exhibits the most complex tonal patterns, including level, rising, falling, concave, and convex contours. In the middle-aged group, tonal patterns begin to simplify, although some complex contours are still retained. In the elderly group, tonal patterns are further simplified, with certain innovative forms emerging, possibly under the influence of Standard Mandarin.

Of particular note is the distribution of contour tones (concave and convex). In the young group, females use more contour tones than males (female 3, male 1); in the middle-aged group, the number of contour tones used is roughly equal between genders (2 each); and in the elderly group, males use more contour tones than females (female 1, male 2). This pattern may reflect intergenerational changes in gender roles and social attitudes toward language.

The duration of checked tones also exhibits an age-related trend. In the young group, tonal values of checked tones show considerable variation (e.g., Yin Ru 434, Yang Ru 14), whereas in the middle-aged and elderly groups, the tonal values tend to simplify (mostly 5, 53, 4), and the tonal range narrows. This pattern is consistent with the commonly observed weakening of checked tones across the Wu-speaking region.

6. Mechanisms of Tonal Variation

6.1 Internal Factors and Structural Pressure

The age-related tonal variation in the Shaoxing Keqiao dialect primarily reflects the internal balancing mechanisms of the phonological system. When certain tones undergo changes, the system adjusts other tones to maintain functional contrasts. For example, as Yin Ping shifts from level 55 in young female speakers to falling 51 in other groups, Yang Qu evolves from falling 43 in young females to level 55 in middle-aged females and concave 212 in elderly females, forming a new pattern of tonal oppositions.

The simplification trend in the tonal system also conforms to the principle of economy in language evolution. Complex contour tones (e.g., 551 and 342 in young female speakers) are often simplified to level or simple falling tones in the middle-aged and elderly groups, reducing articulatory difficulty and perceptual load. However, in some cases, increased complexity occurs (e.g., Yang Ping evolving from 13/34 in the young group to 323/343 in the middle-aged group), which may serve to enhance the distinctiveness among tones.

6.2 External Influence and Language Contact

The promotion of Standard Mandarin is an important external factor influencing tonal variation in the Shaoxing Keqiao dialect. The four tones of Standard Mandarin (Yin Ping 55, Yang Ping 35, Shang 214, Qu 51) may affect the local dialect through code-switching by bilingual speakers. For instance, the shift of the dialectal Yin Ping toward 51 (aligning with Mandarin Qu) and the development of Yang Qu toward 55 (aligning with Mandarin Yin Ping) both reflect the influence of Standard Mandarin.

At the same time, the influence of neighboring Wu dialects should not be overlooked. The general pattern in northern Wu dialects, with high Yin tones and low Yang tones, is also reflected in the Shaoxing Keqiao dialect and remains relatively stable across generations. The retention and variation patterns of checked tones similarly resemble those in surrounding Wu-speaking areas, highlighting shared regional dialect features.

6.3 Social Factors and the Spread of Variation

Language change reflected in age differences is often closely linked to social factors. In the

Shaoxing Keqiao area, the social experiences of different age groups vary significantly: the elderly lived in a relatively closed agrarian society, the middle-aged experienced the development of township enterprises during the early period of economic reform, and the young grew up in a highly urbanized and globalized environment. These distinct social backgrounds have shaped their respective language habits and attitudes.

7. Conclusion

Through a systematic comparison of tonal patterns across different age groups in the Shaoxing Keqiao area, this study reveals the dynamic evolution of the tonal system in the northern Wu dialects. The main findings are as follows: (1) Yin tones show a trend toward falling contours, while Yang tones undergo complex restructuring; (2) overall tonal complexity exhibits a simplification trend, although localized increases in complexity are observed; (3) checked tones retain their short duration, but the tonal value system is simplified; and (4) gender differences are prominent in tonal variation and exhibit intergenerational patterns.

These findings not only enrich the empirical foundation of Wu dialect tonal research but also provide new cases for the study of language variation. The age-related variation in the tonal system reflects both external influences from language contact and internal structural adjustments within the phonological system. The interaction between these internal and external factors shapes the complex landscape of dialectal evolution.

Future research could be further developed in the following directions: (1) expanding the sample size and incorporating more social variables, such as education level and occupational background; (2) conducting longitudinal studies to distinguish between age-related differences and actual language change; (3) combining perception experiments to investigate the auditory basis of tonal variation; and (4) comparing similar phenomena in other Wu dialect sites to establish a regional model of tonal evolution.

The study of tonal variation in the Shaoxing Keqiao dialect holds not only theoretical significance for linguistics but also practical importance for language preservation and cultural heritage. In the context of rapid urbanization, systematically documenting and analyzing dialectal variation is crucial for maintaining local cultural diversity and sustaining linguistic ecological balance. This study provides a detailed case in point and offers a methodological reference for future research.

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