Synchronic Variation and Diachronic Evolution of Tone Patterns in Kunming Dialect

Yutong Kuang

***Abstract*—An acoustic experiment was conducted to analyze the tonal patterns of single characters in the Kunming dialect. The experimental results show that the Kunming dialect has a semi-high flat tone for the first tone, a low descending tone for the second tone, a high descending tone for the third tone, and a low tone for the fourth tone. The first and third tones are both high, while the second and fourth are both low tones, as opposed to the tonal patterns of "flat" and "low". The newer Kunming dialects show variation. The first tone starts and ends at a higher level, the third tone's bent section disappears, and the fourth tone starts and ends at a lower level, with a shorter tone duration. The variation in tone pattern starts in the middle-aged group in the old urban, and the degree of variation is female > male, old urban > old suburban, and the youth and middle-aged group > senior group, respectively. The female tone pattern has more similar vocal tone characteristics to those in the middle-aged and youth groups.**

***Index Terms*—Kunming dialect, single-character tones, tone pattern, experimental phonetics.**

I. Introduction

Concerning the zoning of the Kunming dialect, there has a consensus that the Kunming dialect belongs to the Southwest Official Dialect, based on the rule of assigning all of the ancient accents to the second tone. However, there are two types of subdivisions: one is *the Atlas of Chinese Language* (1987) [1], which places the Kunming dialect in the Kungui subdivision of Southwestern Mandarin. *The Chinese dialects of Yunnan Province* (1989) [2] and *the Study of Chinese Official Dialects* (2010) [3], place the Kunming dialect in the small subdivision of Yunnan, alongside the three subdivisions of South, West, and Northeast, in terms of the phonological system, auditory sense, and linguistic habits. The Kunming dialect is classified as a small part of Yunnan, alongside the three smaller parts of southern, western, and northeastern Yunnan.

Regarding the tones of the Kunming dialect, researchers have agreed mainly on the number of tones, namely that the Kunming dialect is a four-toned dialect, with the ancient incoming tones subsumed under the second tone. In terms of tonal values, researchers differ in their depictions.

Regarding the single character tones of the Kunming dialect, previous studies have suggested that the first tone is a semi-high flat tone; the second tone is a low-falling tone, and the third tone is a high-falling tone; the fourth tone is the most controversial, with different expressions of 212, 22, 21, 31, 41. In previous studies of Kunming dialect declension. X. Zhu (2012) [4] suggested that the 'pure low tone 'tonal type may have different variants at the co-temporal level, such as low flat, low concave, low rising, low concave, and low falling.

Thus, the views of the first three tones are generally different variants of the same tonal type, i.e., the fourth tone of the Kunming dialect is considered low. In contrast, X. Cai (2012) [5] experimentally formulated the tone value of the fourth tone as 41, which differs from its predecessors between high-falling and low tones.

Firstly, the survey of the Kunming dialect began in the 1930s and 1940s, leaving behind several historical documents such as *the Report on the Survey of Yunnan Official Dialects* (Chinese Part)(1969) [6] and the Kunming Dialect Journal(1990) [7] and the Modern Chinese Dialect Sound Database, recorded in the 1990s, has left behind valuable phonetic materials. This paper aims to examine whether and how the tonal pattern of the Kunming dialect has changed over the past seven decades through a longitudinal comparison at the epochal level and a horizontal comparison at the coeval level.

Secondly, K. Lu (1990) [7] argued that there are differences between the Kunming dialect spoken by older and middle-aged people and the Kunming dialect spoken by youth students. The differences between the old and new school Kunming dialects are intertwined, and this co-occurrence of variation tends to reflect the evolution of the language over time. The changes that have occurred in the monotonal pattern of the Kunming dialect are at both the co-temporal and the ephemeral levels.

Finally, the discussion focuses on the tonal value and the tonal pattern of the Kunming dialect's declension and explores the characteristics of the 'low concave tone '.

II. Description of the Experiment

A. Collection of Voice Samples

The recording software was Audacity and voices were sampled at 44100Hz, mono, and 16-bit. The survey was conducted from January 31 to February 24, 2021, in Kunming, Yunnan Province, with 14 speakers. To facilitate the comparison of experimental data, the speaker of the Modern Chinese Dialect Sound Database, R. Zhang, was added to the group (Table I).

K. Lu (1990) [7] suggested that the dialect of urban Kunming can be roughly divided into two types of accent: the old urban accent represented by the Wuhua and Panlong districts and the old suburban accent represented by the Guandu and Xishan districts. Since Dongchuan, Chenggong, and Jinning districts were abolished as counties after 2000,

Manuscript received July 26, 2022; revised November 22, 2022.

Yutong Kuang is with the School of Chinese Language and Literature, Lanzhou University, 222 South Tianshui Road, Chengguan District, Lanzhou, Gansu, China (e-mail: kuang_yutong@163.com).

doi: 10.18178/ijlll.2022.8.4.365

they are not included in the discussion.

TABLE I: SPEAKERS' GROUPINGS

	Age	Urban areas	
Male 8 persons	Senior Group (Over 55) 2 persons	Wuhua District, Panlong District	1 person
		Guandu District, Xishan District	1 person
	the Modern Chinese Dialect Sound Database 1 person	Wuhua District, Panlong District	1 person
	Middle-aged group (35-55) 2 persons	Wuhua District, Panlong District	1 person
		Guandu District, Xishan District	1 person
	Youth Group (under 35) 3 persons	Wuhua District, Panlong District	1 person
		Guandu District, Xishan District	2 persons
Female 7persons	Senior Group (Over 55) 2 persons	Wuhua District, Panlong District	1 person
		Guandu District, Xishan District	1 person
	Middle-aged group (35-55) 3 persons	Wuhua District, Panlong District	1 person
		Guandu District, Xishan District	2 persons
	Youth Group (under 35) 2 persons	Wuhua District, Panlong District	2 persons

B. Selection of Speech Samples

The pronunciation words used in the survey were chosen from the Dialect Survey Word List compiled by the Institute of Linguistics, Chinese Academy of Social Sciences in 2018. The design of the word list takes into account the frequency of daily use and the Middle Ages sources.

The characters used in the list were not selected from the cloudy vowels, zero vowels, and nasal vowels to avoid "bent-head" and "descending-tail" segments in the data curve. The words were divided into four groups: "the first tone", "the second tone", "the third tone" and "the fourth tone".

C. Processing of Speech Samples

The samples using the "Mini Speech Lab" speech analysis software to extract acoustic data, i.e., nine data points were selected overtime evenly on each tone curve, and the pitch Hertz value was calculated for each measurement point. The data obtained here cannot be used directly as the basis for judging pitch. The pitch Hertz values of different speakers are not comparable and are normalized using the T value formula $T=[(\log x-\log\min)/(\log\max-\log\min)]\times 5$ [8] . After the relative normalization process, the T value is used to calculate the mean, standard deviation, maximum and maximum values of a particular tonal pattern. The mean, standard deviation, maximum and minimum values of a given tonal pattern are calculated, and a given tonal pattern's main and limit distributions are plotted.

When analyzing the tones of the Kunming dialect, four main aspects are examined: tonal type, tone range, tonal value, and the characteristic points of the steady-state segment. Tone type refers to the height and variation of the tone curve and is commonly found in flat, rising, falling, and zigzag tones, which can be divided into convex and concave tones. The range is where the tone changes, the acoustic area between the maximum and minimum of the pitch in the tone. Tone value refers to the specific value of the pitch of the tone, and the processed T value ranges from 0 to 5 and can correspond to the fifth tone value. The steady-state segmental characteristic points refer to the measurement points in the data set of the tone curve, i.e., the parts of the curve where the standard deviation is less than 0.5.

III. ANALYSIS OF EXPERIMENTAL RESULTS

A. Analysis of the Distribution of the Main Body and Limits of the First Tones

In Fig. 1, in terms of the distribution of the main body, the first tone is a flat tone located in the upper middle of the tone range.

The mean T value at the beginning of the key is 3.26, the mean T value at the end is 3.10, and the span of the critical range is 2 degrees. The standard deviation of the first tone is smooth overall, with the largest at the beginning section and decreasing after the second measurement point, with standard deviations of less than 0.5 at the seventh, eighth, and ninth observation points.

The first tone is located in the limit distribution's upper middle of the tone range. At the beginning of the tone, the maximum T value is 4.08, the minimum 2.30, and the maximum T value at the end is 3.76, the minimum 2.23.

In terms of the tonal curve, the first tone is a flat tone with a falling end, with a range of 4-3 degrees in the acoustic space, the maximum value of which can be marked as 44 and the minimum value of which can be marked as 33.

The first tone is characterized by 'high 'and 'flat 'and is marked as 44.4.

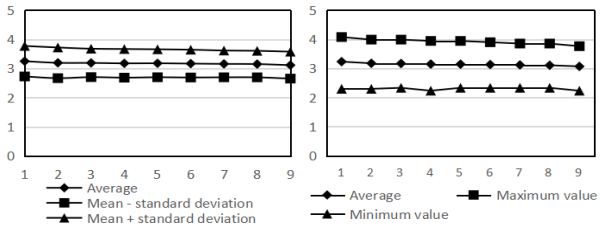


Fig. 1. The main distribution and limit distribution of the first tones.

B. Analysis of the Main Distribution and Limit Distribution of the Second Tones

In Fig. 2, regarding the distribution of the main body, the second tone is a descending tone located in the lower middle of the tone range. The mean T value at the beginning of the tone is 3.11, and the mean T value at the end is 0.71, with a span of 4 degrees. The standard deviation of the starting section is the smallest, at 0.31, and the standard deviation of the whole section is less than 0.5.

Regarding the limits distribution, the second tone is located in the lower central part of the tone range. The mean curve is closer to the maximum curve at the beginning and more relative to the minimum after the third measurement point, indicating that the second tone is falling fast. From the acoustic space, it is concentrated in the middle between 3 and 1 degree.

To sum up, the second tone is characterized by middle and down, which is marked as 31.

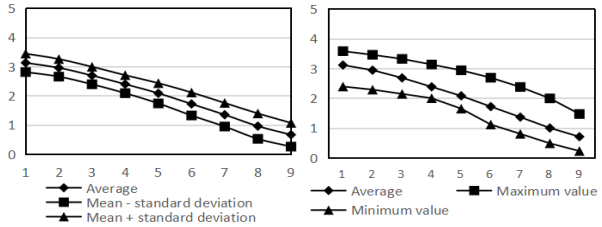


Fig. 2. The main distribution and limit distribution of the second tones.

C. Analysis of the Distribution of the Main Body and Limits of the Third Tones

In Fig. 3, the distribution of the main body shows that the third tone is a high falling tone, descending from the top of the tone range to the lower middle of the tone range. The maximum T value at the beginning is 5; at the end, the T value is 1.78, and the range spans 4 degrees. The standard deviation is the smallest at the front of the third tone and increases gradually at each subsequent point, with the largest standard deviation at the endpoint being 0.51.

Regarding the limits distribution, the third tone maintains the high and depressed tonal patterns. In terms of acoustic space, the third tone has a small span at the beginning and a large span at the end, at 1.72.

The third tone is characterized by 'high 'and 'low 'and is marked as 52.

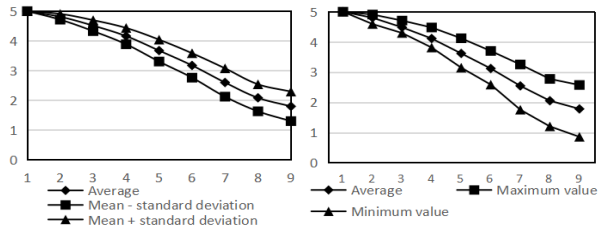


Fig. 3. The main distribution and limit distribution of the third tones.

D. Analysis of the Distribution of the Subject and Limits of the Fourth Tones

In Fig. 4, the distribution of the main body shows that the fourth tone is located at the bottom of the tone range, descending from the lower middle of the tone range to the bottom of the tone range, which is low and narrow. It drops at the starting point and tends to rise after the eighth measurement point. The T value at the starting point is the largest, 1.89, and the T value at the eighth measurement point is the smallest, 0.07, with concave character at the end and a span of 3 degrees, close to 2 degrees. The standard deviation at the beginning is 0.43, at the end 0.14, and at points 6, 7, and 8, the standard deviation is minimal, averaging only 0.13. The folding point is a characteristic point of the fourth tone.

The fourth tone maintains its 'low 'character regarding the limits distribution. In terms of acoustic space, the declension has a large span at the beginning and a minimum span at the eighth point, with a maximum value of 31 and the minimum value of 11. The minimum curve is similar to a low flat tone, while the mean curve is closer to the maximum curve, suggesting that the declension is not entirely flat but has a low, flat tone.

In summary, the characteristic of the fourth tone is a low tone and is marked as 11 or 21.

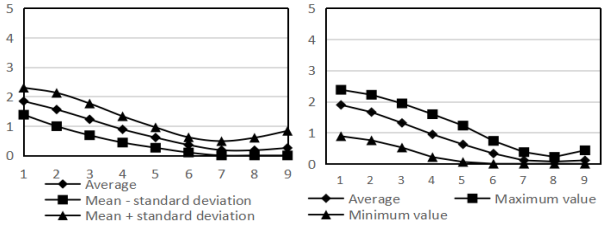


Fig. 4. The main distribution and limit distribution of the fourth tones.

IV. Statistical Analysis of Single-Character Tone Groupings in Kunming Dialect

A. Subgroup Statistics by Gender (in Fig. 5)

1) Gender differences in the first tones

The first tones in both the male and female groups are semi-high flat tones. The female group had a starting T value of 3.4 and an ending T value of 3.19, while the male group had a starting T value of 3.07 and an ending T value of 2.95. Both the starting and ending positions of the female group are higher than those of the male group, and the overall tone curve is above that of the male group.

2) Gender differences in the second tones

The second tones are descending tones in both the male and female groups. The main difference lies in the position of the starting point, with the curve for the male group lying below the curve for the female group. The starting T value for the male group is 2.98 and for the female group is 3.24.

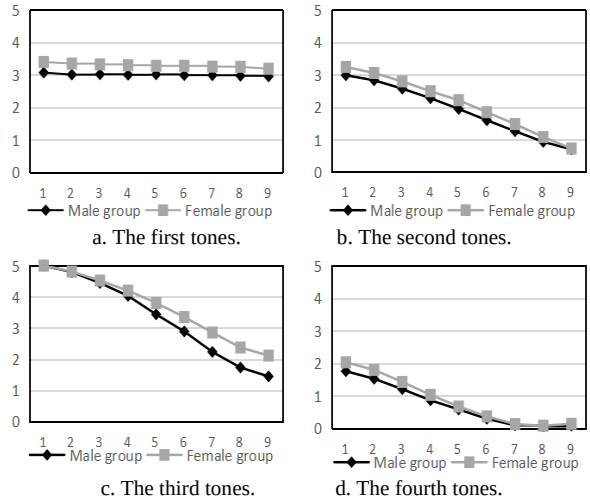
3) Gender differences in the third tones

The third tones are high falling tones with a starting point of 5 in both groups. In the male group, the third tone ends with a T value of 1.44, and the tone value is marked as 52; in the female group, the third tone ends with a T value of 2.11, and the tone value is marked as 53.

4) Gender differences in the fourth tones

The fourth tones in both the male and female groups are low-falling tones located at the bottom of the tone range, with a 'concave 'character at the end.

The male group had a starting T value of 1.75 and an endpoint T value of 0.08, while the female group had a starting T value of 2.03 and an endpoint T value of 0.14. The male group had a lower starting point.



a. The first tones. b. The second tones.

c. The third tones. d. The fourth tones.

Fig. 5. Comparison of different gender groups of monosyllabic tones.

B. Subgroup Statistics by Geography

1) Differences in monogram patterns in different areas

In Fig. 6, the average T value of the first tones in the old urban group is higher, starting at 3.43 and ending at 3.24, with a tuning value of 44; the first tones in the old suburban group are lower than those in the urban group, starting at 3.03 and ending at 2.92, with a T value of 33. The high immigrant population movement in the old urban area resulted in higher values of the first tone values in the urban area, probably due to the influence of Mandarin on the first tone 55.

Both the Old urban and the Old Suburbs have descended the second tones, with the starting point of the second tone curve in the Old urban at 3.24, slightly higher than the starting point of the second tone curve and the end positions almost coinciding.

The third tone curves of the Old urban and Old Suburbs almost overlap, both being high descents in the upper part of the tone range with a mean value of 52, with no significant differences in mean value, tone range, or tonal type.

The mean curves for both fourth tones are low at the bottom of the tone range, with a mean value of 21. The starting position of the Old urban curve is slightly lower than that of the Old Suburban, at 1.95. The end positions of the two curves almost coincide.

2) Urban differences in the monotone pattern of the middle age group

As shown in Fig. 7 below, there are significant differences between the middle age groups in the old urban and old suburban areas in the geographical groupings.

In the old urban, the curve of the first tone is higher than in the old suburbs; the second tone starts higher than in the old suburbs; the third tones have no gentle tuning, while in the old suburbs, the third tone has gentle tuning and are higher in pitch; the fourth tone is a low-falling tone, while it in the old suburbs has a 'concave 'section at the end of the tone.

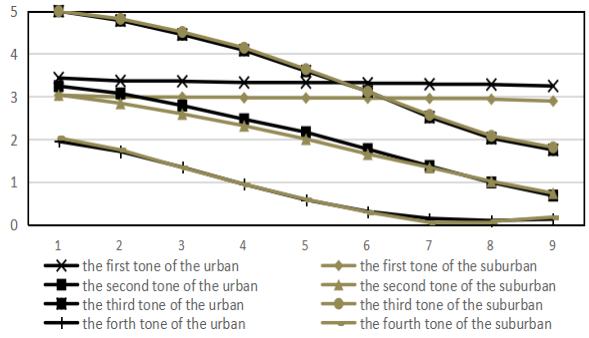


Fig. 6. Comparison of the tone patterns of the urban and suburban groups.

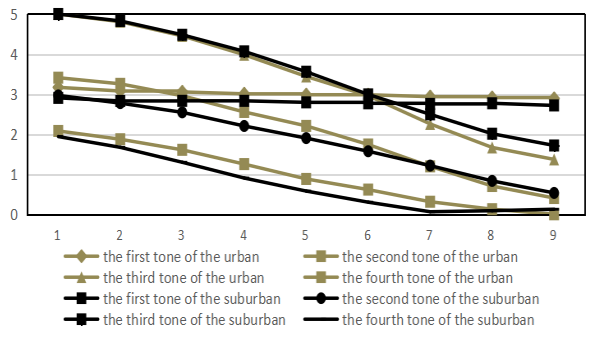


Fig. 7. Comparison of tone patterns in the middle-aged groups.

C. Subgroup Statistics by Age (in Fig. 8)

1) Age differences in the first tones

All four groups of speakers have a semi-high flat tone. However, the curves are slightly different: the youth and middle-aged groups show a downward trend, with a high starting position and a low ending position, and a span of 2 degrees; the senior group and the Modern Chinese Dialect Sound Database corpus show an upward trend, with a low starting position and a low ending position, and a span of 1 degree.

2) Age differences in the second tones

All four groups of the second tones are mid-descending, starting between 3 and 4 degrees and ending at 1. These four curves almost coincide in the middle, with a more discrete head and tail. The senior group has a gentle head of tone curve, while the youth and middle-aged groups and the Modern Chinese Dialect Sound Database do not, and the rate of decline is faster.

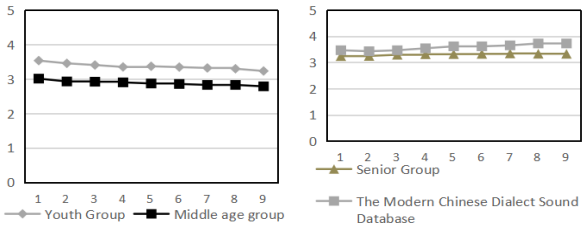
3) Age differences in the third tones

In addition, the second tone ending of the Modern Chinese Dialect Sound Database has a curved character, while the old, middle-aged, and youth groups do not.

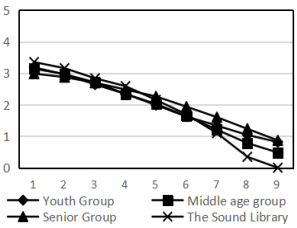
All four groups of third tones begin at the top of the tone range, with a highly concentrated starting point. The Modern Chinese Dialect Sound Database curve and the senior group are upward, with a gentle head and a higher tail, and the "convex" character is more pronounced. The middle-aged and youth groups have an overall lower curve, with a greater slope, a faster descent, and a lower tone tail, close to a straight descent, sharing a similar pattern with the Mandarin third tone.

4) Age differences in the fourth tones

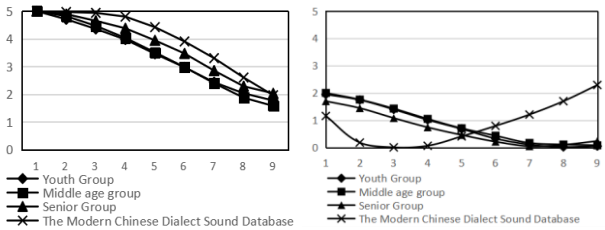
The patterns of the four groups of the fourth tones are different, but they all have a 'low 'character. In terms of starting position, the middle-aged and youth groups > the senior group > the Modern Chinese Dialect Sound Database，while *the Modern Chinese Dialect Sound Database* > the senior group > the middle-aged group, and the youth group in terms of the ending position. The Modern Chinese Sound Database has a typical fourth tone, with the folding point in front; the senior group has a concave end, which is a post-concave tone; the youth and middle-aged groups have a low-falling tone without a concave segment.



a. The first tones.



b. The second tones.



c. The third tones. d. The fourth tones.

Fig. 8. Comparison of the monosyllabic tones for the age groups.

D. Statistics on Age Grouping in Different Urban Areas (in Fig. 9)

1) Age differences in the first tones in different areas

Among the three groups in the old urban, the youth group has the highest starting point with a T value of 3.84, the middle-aged group has the middle starting point with a T value of 3.17, and the senior group has the lowest starting point with a T value of 3.08. The curve for the youth group is significantly higher than that for the middle-aged and senior groups. At the same time, the curves for the youth and middle-aged groups are on a downward trend, while the curves for the senior group are on an upward trend. The curve is flat for the senior group in the old suburbs, with a slight downward trend in the youth and middle-age groups.

2) Age differences in the second tones in different areas

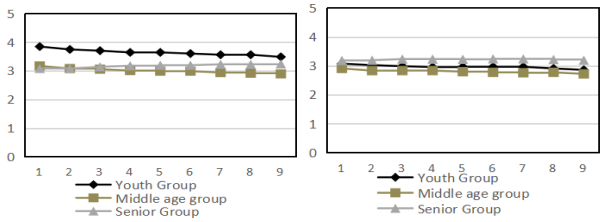
There is little difference between the old, middle-aged, and youth, the second tone curves in the old urban and old suburban areas. The results are the same as those for Kunming as a whole, with a gently shifting head in the senior group in the old urban area, a gentler, slightly 'convex 'head in the old suburban area, and no gently shifting head in the youth and middle-aged groups, with a greater slope and a faster rate of decline.

3) Age differences in the third tones in different areas

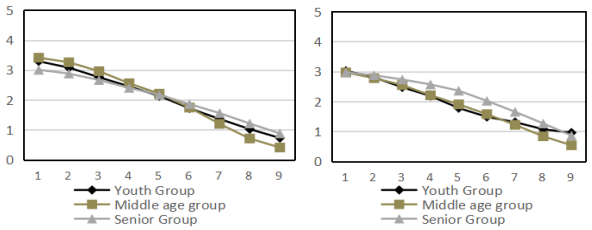
Both the old urban senior and the old suburban senior group have a flatter tonal head, and the senior group curves are higher than the youth and middle-aged group. Neither the old urban senior group nor the old suburban youth and middle-aged groups have a flatter tonality in the third tone, closer to a straight descending tone. The different age groups in the older suburbs have closer end positions, less internal variation, and smoother turnarounds in the senior groups.

4) Age differences in the fourth tones in different areas

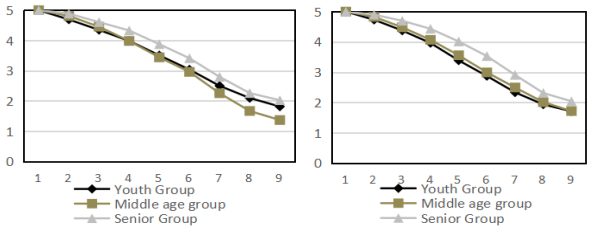
In the Old urban youth and middle-aged groups, the fourth tones start high and end low, with no concave section at the end of the tone, making it a low-falling tone. The senior group has a higher terminal point, and the curve tends to fall before the sixth measurement point, then rises after reaching the lowest point at the sixth point, making it a low concave tone. On the other hand, the three sets of declension curves in the old suburbs almost overlap and are all low-falling.



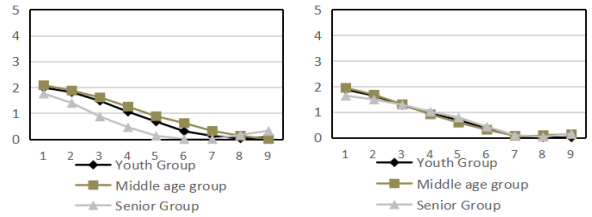
a. The first tones in the urban area and in the suburb



b. The second tones in the urban area and the suburb.



c. The third tones in the urban area and the suburb.



d. The fourth tones in the urban area and the suburb.

Fig. 9. Comparison of the monosyllabic tones for different areas.

V. Discussion

A. Variations in the First Tone of the Kunming Dialect

The old-school Kunming, the first tone, is a semi-high flat tone with a "low front and high back", and this pattern of the first tone is found not only in the Kunming dialect but also in other dialects of Southwestern official languages. The traditional notation of the first tone in the Chengdu dialect is usually marked as a high flat tone or a high rising tone with a mean value of 55/45. S. Shi (2007) [9] experimental results on the Modern Chinese Dialect Sound Database corpus also show that the tonic value of the first tone in the Chengdu dialect is 45. The tonic value of the first tone is 35, which is a medium-rising tonic. The same is true for the Guiyang dialect, traditionally notated as 55. However, recent experiments have shown that it is 35/45, differentiating between a high flat tone and a medium/high rising tone.

There are two trends in the first tone of the Kunming Youth, Women, and Old urban groups: the first is that the pitch becomes higher than before, and the second is that it changes from starting low and ending high to starting high and ending low.

F. Shi (2006) [10] experimental results show that the tonic value of the first tone in Mandarin is 55, with the largest T value at the starting point and the smallest T value at the ending point.

Whether the Mandarin first tone influence the variation of the Kunming dialect's first tone is worth further observation.

B. Variations in the Third Tone of the Kunming Dialect

X. Zhu (2012) [4] suggested that when there is opposition in the descending tones, they often have two or even three compounding distinctions, such as length, height, bend and straightness, and voicing patterns at the end of the tone. A

comparison of the second and third tones of the Kunming dialect, both of which are descending, shows differences between the third tone in terms of starting height, straightness of the bend, and duration of the tonic head.

A comparison of the age and gender groups reveals that the differentiating effect of the bent segment of the third tone head in the Kunming dialect is diminishing, with the bent feature of the senior group's tone head being significantly smaller than in the Modern Chinese Dialect Sound Database. In contrast, the third tone of the youth and female groups is not accompanied by the bent tone head feature.

It is worth observing whether the third tone modulation of Kunming has been influenced by the declension of Mandarin and has evolved further into a straight descending tone.

C. Variations in the Fourth Tone of the Kunming Dialect

There are three differences between the Modern Chinese Dialect Sound Database corpus and the old Chinese and youth group of the fourth tones.

1) The starting point position, the starting point of the fourth tone in the Modern Chinese Dialect Sound Database is significantly lower than the other three groups in the survey, close to 1. In comparison, the oldest of the three age groups has the lowest starting point, and the middle-aged and youth groups have a starting position of close to 2.
2) The position of the endpoints, the endpoints of the fourth tone in the Modern Chinese Dialect Sound Database are higher than the starting points, while the tone curves of the three age groups, although lacking the second half of the rising section of the curve in the Modern Chinese Dialect Sound Database, can be seen to be higher in the senior groups than in the middle-aged and youth groups. The total duration of the "Modern Chinese Dialect Phonology Database" is significantly longer than that of the old, middle-aged, and youth groups, at 406 ms, with the senior group having the most extended absolute duration of the declension at 140.75 ms, followed by the middle-aged group at 126 ms and the youth group at 113.6 ms. The main difference lies in part after the lowest point. The curve for the senior group, which has the most "concave" feature, has less than 20ms of rising after the nadir, whereas the nadir for the declension in the Modern Chinese Dialect Database is at a quarter of the tone, with 300ms of rising.
3) The standard for selecting speakers in the Modern Chinese Dialect Sound Database is middle-aged and elderly males who live in old urban. The tone curve of the Kunming dialect in the Modern Chinese Dialect Sound Database starts low and ends high. In contrast, the tone curves of all three age groups in the survey start high, and end low. F. Shi, P. Wang (2006) [10] experiments on the third tone in Beijing show that the third tone curve of old Beijingers is divided into two categories. Using the age of 40 as the boundary, with the tone pattern curve starting low and ending high above the age of 40, with the lowest starting point and highest ending point above the age of 50; the tone pattern curve for all three age groups below the age of 40 starts high and ends low All three age groups below 40 have a high starting point and a low-end point. From the chronological comparison with the Modern Chinese Dialect Sound Database and the longitudinal comparison of the three age groupings, the lowering of the starting and ending positions and the shortening of the tone duration will probably be the evolutionary trend of the fourth tone in the Kunming dialect.

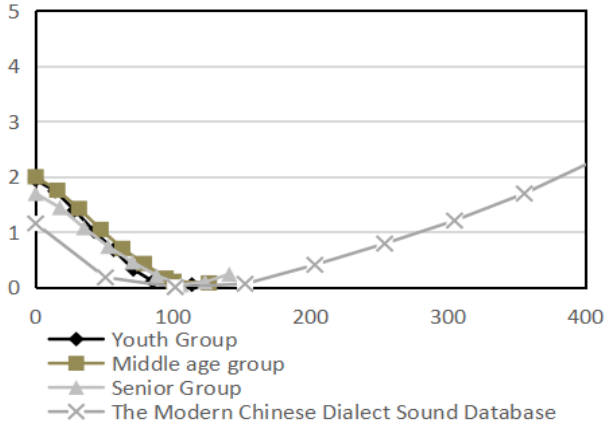


Fig. 10. Comparison of the absolute length (ms) of time fourth tones in the age groups.

VI. Conclusion

If the five-degree marking method is simplified to three degrees, the distinguishing features of the monosyllabic tones of the Kunming dialect, combined with the data from the main distribution and the limit distribution, are as follows:

The first tone: high-level tone.

The second tone: low falling tone.

The third tone: high falling tone.

The fourth tone: low-level tone.

The first and fourth tones are flat, while the second and the third tones are both descending, opposing the 'high 'and 'low ' tones. The first and third tones are both high, while the second and fourth are both low tones, with the tonal patterns 'flat 'and 'down'.

After a group acoustic experiment on the Kunming dialect in different gender, ages, and regions, the results show that the tone pattern of the Kunming dialect is changing. The first tone trend change as the front high and back low， the concomitant ecological trail disappearance of the third tone U-turn. The fourth tone tends to become a pure softer tone.

In terms of characteristics and trends of change:

1) The phonetic characteristics of the female speakers are closer to those of the youth and middle-aged group: high the first tone and high starting point of the declension.
2) The data for the different age groups of speakers in the old urban areas are scattered, with a significant variation in tone. In contrast, the data for the different age groups of speakers in the old suburban areas are concentrated, with slight variation.
3) The data for the senior and youth groups in the old urban and old suburban areas are close to each other, with significant differences in the middle-aged group. The data for the middle-aged group in the old urban area is closer to the youth group, i.e., the variation starts in the middle-aged group in the old urban area.

There are still some questions that need to be clarified,

such as why the changing trend of the first tone in the Kunming dialect does not be consistent with the overall evolution trend of the first tone in southwest Mandarin and with the disappearance of some ecological accompaniment features of Kunming dialect, how to distinguish between dropping tones. These are also the points for future research.

APPENDIX

TABLE A: EXPERIMENTAL DATA OF MONOSYLLABIC TONES IN KUNMING DIALECT

The first tone									
	A1	A2	A3	A4	A5	A6	A7	A8	A9
N	14	14	14	14	14	14	14	14	14
Mean	3.23	3.18	3.17	3.15	3.15	3.13	3.12	3.11	3.07
Standard deviation	0.56	0.56	0.52	0.52	0.50	0.50	0.47	0.46	0.46
Mean + standard deviation	3.79	3.74	3.69	3.67	3.64	3.63	3.59	3.57	3.53
Mean-standard deviation	2.67	2.61	2.65	2.63	2.65	2.64	2.65	2.65	2.60
MaXimum	4.08	3.99	3.99	3.94	3.94	3.90	3.85	3.85	3.76
Minimum	2.30	2.30	2.33	2.23	2.33	2.33	2.33	2.33	2.23
The second tone									
	A1	A2	A3	A4	A5	A6	A7	A8	A9
Mean	3.11	2.94	2.68	2.38	2.08	1.72	1.37	1.00	0.71
Standard deviation	0.32	0.31	0.31	0.32	0.36	0.41	0.41	0.42	0.38
Mean + standard deviation	3.43	3.25	2.99	2.70	2.44	2.13	1.78	1.42	1.09
Mean-standard deviation	2.79	2.63	2.37	2.07	1.72	1.31	0.95	0.59	0.34
MaXimum	3.58	3.46	3.32	3.13	2.94	2.69	2.38	2.00	1.47
Minimum	2.39	2.29	2.15	2.00	1.65	1.12	0.81	0.49	0.23
The third tone									
	A1	A2	A3	A4	A5	A6	A7	A8	A9
Mean	5	4.80	4.48	4.11	3.62	3.12	2.54	2.05	1.78
Standard deviation	0	0.09	0.15	0.22	0.32	0.37	0.45	0.46	0.51
Mean + standard deviation	5	4.89	4.63	4.33	3.93	3.49	2.99	2.51	2.29
Mean-standard deviation	5	4.71	4.33	3.90	3.30	2.75	2.10	1.59	1.26
MaXimum	5	4.91	4.71	4.48	4.12	3.70	3.25	2.77	2.57
Minimum	5	4.59	4.29	3.81	3.15	2.58	1.75	1.20	0.85
The fourth tone									
	A1	A2	A3	A4	A5	A6	A7	A8	A9
Mean	1.89	1.66	1.31	0.94	0.62	0.33	0.11	0.07	0.11
Standard deviation	0.43	0.43	0.44	0.40	0.36	0.24	0.12	0.07	0.14
Mean + standard deviation	2.32	2.09	1.75	1.34	0.98	0.57	0.23	0.14	0.25
Mean-standard deviation	1.46	1.23	0.88	0.55	0.27	0.09	0	0	0
MaXimum	2.38	2.22	1.94	1.59	1.23	0.73	0.37	0.22	0.43
Minimum	0.88	0.75	0.52	0.21	0.06	0	0	0	0

TABLE B: OLD URBAN DATA

Age range	Tone type	1	2	3	4	5	6	7	8	9
Youth group Under 30	first	3.84	3.75	3.70	3.64	3.64	3.60	3.56	3.56	3.48
	second	3.29	3.08	2.76	2.45	2.13	1.72	1.36	1.02	0.72
	third	5.00	4.69	4.35	3.98	3.51	3.04	2.50	2.10	1.82
	fourth	1.99	1.81	1.48	1.05	0.67	0.30	0.12	0.02	0.07
Middle-age group 30-55	first	3.17	3.08	3.05	3.01	2.98	2.98	2.94	2.91	2.89
	second	3.41	3.26	2.96	2.55	2.21	1.74	1.20	0.71	0.41
	third	5.00	4.81	4.45	3.98	3.44	2.96	2.26	1.67	1.37
	fourth	2.08	1.87	1.61	1.25	0.88	0.62	0.31	0.13	0.00
Senior Group Over 55	first	3.08	3.08	3.14	3.18	3.19	3.19	3.23	3.23	3.24
	second	3.00	2.88	2.66	2.40	2.17	1.86	1.56	1.21	0.88
	third	5.00	4.89	4.61	4.33	3.88	3.41	2.80	2.26	2.02
	fourth	1.76	1.39	0.87	0.46	0.13	0.00	0.00	0.16	0.32

TABLE C: OLD SUBURBAN DATA

Age range	Tone type	1	2	3	4	5	6	7	8	9
Youth group Under 30	first	3.07	3.02	2.96	2.91	2.96	2.96	2.96	2.91	2.86
	second	3.02	2.80	2.47	2.18	1.78	1.48	1.31	1.07	0.95
	third	5.00	4.73	4.37	3.96	3.39	2.87	2.33	1.94	1.71
	fourth	1.87	1.63	1.26	0.94	0.68	0.35	0.08	0.00	0.00
Middle-age group 30-55	first	2.91	2.83	2.83	2.83	2.79	2.77	2.76	2.77	2.72
	second	2.97	2.78	2.54	2.20	1.90	1.57	1.22	0.83	0.53
	third	5.00	4.83	4.48	4.07	3.56	2.99	2.50	2.01	1.72
	fourth	1.94	1.67	1.30	0.90	0.58	0.30	0.06	0.09	0.13
Senior Group Over 55	first	3.24	3.25	3.29	3.31	3.32	3.33	3.34	3.33	3.33
	second	2.99	2.88	2.70	2.48	2.26	1.94	1.60	1.24	0.87
	third	5.00	4.89	4.65	4.38	3.95	3.47	2.85	2.29	2.03
	fourth	1.69	1.44	1.07	0.74	0.46	0.21	0.04	0.09	0.23

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

The data used in the research were from field works, collected and analyzed by Yutong Kuang.

REFERENCES

[1] *The Atlas of Chinese Languages*, Co-edited by the Chinese Academy of Social Sciences and the Australian Academy of Humanities. Hong Kong, CHN: Longman Publishing (Far East) Limited, 1987, pp. 82-89.

[2] Yunnan Provincial Linguistic Society, *The Chinese dialects of Yunnan Province*, compiled by the Yunnan Provincial-Local History Compilation Committee, compiled by the Yunnan Linguistic Society, Yunnan, CHN: Yunnan People's Publishing House, 1989, pp. 15-19.

[3] Z. Qian, *The Study of Chinese Official Dialects*, Jinan, CHN: Qilu Book Society, 2010, pp. 257-258.

[4] X. Zhu, "Types of drops," *CNKI Trans. Language Studies.* vol. 32, no. 2, pp. 1-16, April 2012.

[5] X. Cai, "An experimental study of single-character tones in Kunming dialect," *CNKI Trans. Journal of Chongqing Electronic Engineering Vocational College*, vol. 21, no. 3, pp. 54-57, May 2012.

[6] S. Yang, *Report on the Survey of Yunnan Dialects (Chinese Part)*, Taiwan, CHN: Institute of History and Linguistics, Academia Sinica, Special Issue, no. 56, 1969, pp. 17-34.

[7] K. Lu, "Kunming dialects journal," *CNKI Trans. Journal of Yuxi Normal College*, no. Z1, pp. 74-226, January 1990.

[8] F. Shi, Q. Ran, and P. Wang, "On phonological patterns," *CNKI Trans. Nankai Journal of Linguistics*, no. 1. pp. 1-14, October 2010.

[9] S. Shi, "An experimental study on the tones of modern Chinese dialect phonology database," M.S. thesis, Dept. Language and literature. CHN., Nanjing Normal Univ., Nanjing, China, 2007.

[10] F. Shi and P. Wang, "Statistical analysis of Beijing dialect single-character phonetic tones," *CNKI Trans. Studies of the Chinese Language*, no. 1, pp. 33-40, January 2006.