THE STATISTICAL ANALYSIS OF TONES IN HONG KONG CANTONESE

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ABSTRACT

This paper investigated 120 subjects of Hong Kong Cantonese speakers. Based on the collected data of Hong Kong Cantonese citation form, we used the computer software to get F0 and T value and applied the statistical method to conduct the analysis. The paper also explored the current characteristics and intrinsic differences of Hong Kong Cantonese tones. Based on the skewness data, we found that Tone 2 and Tone 5, Tone 3 and Tone 6 are likely to merge. We also further predicted the evolution direction of Hong Kong Cantonese tones.

Keywords: Hong Kong Cantonese, tones, citation, statistical analysis, evolution direction

1. INTRODUCTION

Cantonese is one of the main dialects in China. For the past decade there have been many researches done on the phonology, lexicology and grammar of Cantonese. In terms of phonology, Chen [3], Bauer [2], Lin [5] and Wong [10] have analyzed the tones of Hong Kong Cantonese from different perspectives. Comparing the results drawn from Ball [1], Zhang [12] and Bauer [2], we found that the differences are the tone values.

Languages and dialects are changing constantly, so is the Hong Kong Cantonese. Zhang [11] pointed out that the evolution of Hong Kong Cantonese can be observed in phonology, lexicology, grammar and other aspects. This paper focuses on the analysis of citation form in Hong Kong Cantonese. Based on the phonetic analysis of data, the paper aims to unveil the current characteristics, intrinsic differences and evolution direction of Hong Kong Cantonese tones.

2. ANALYSIS METHOD AND STATISTICAL RESULTS

120 native speakers of Hong Kong Cantonese were investigated in this research. There were 60 female subjects and 60 male subjects. We selected 10 characters for each tone and there were 90 characters for nine tones. The characters were arranged randomly and the subjects were required to read each character twice. Each subject has 180 tokens and there were 21600 tokens in total. All the sound data were measured by the phonetic analysis software called Minispeech Lab. Usually the length of each syllable is about 200ms. To measure nine points can obtain the features of the tones. We first measured the F0 of nine points in each tone and converted the F0 to T value by applying the following generalization formula:

$$T = \frac{(x - \min)}{(\max - \min)} x5 \quad (1)$$

But for the large data, in order to eliminate the repression on maxim and minim values, Shi, Ran & Wang [8] replaced the min and max in the formula above by min minus SDmin and max plus SDmax. The formula for large tonal data is as follow:

$$t = \{\frac{[\lg x - \lg(\min - SD\min)]}{[\lg(\max + SD\max) - \lg(\min - SD\min)]}\} x5 \quad (2)$$

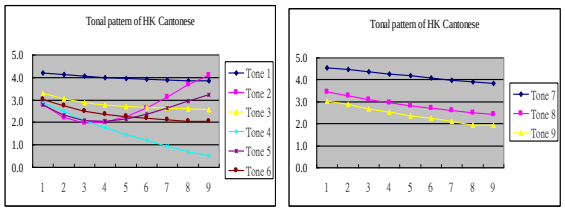
Based on the measurement and calculation of tonal data of each subject, we got the average T value and discrimination of nine points in each tone. The analysis results are listed in table 1.

Table 1: Analysis results of Hong Kong Cantonese tones.

	1	2	3	4	5	6	7	8	9	SD
T1	4.2	4.1	4.1	4.0	4.0	3.9	3.9	3.9	3.9	0.51
T2	2.8	2.2	2.0	2.0	2.3	2.6	3.1	3.7	4.1	0.54
T3	3.3	3.1	2.9	2.8	2.7	2.7	2.6	2.6	2.6	0.48
T4	2.9	2.5	2.1	1.8	1.5	1.2	0.9	0.7	0.5	0.43
T5	2.8	2.3	2.1	2.0	2.1	2.4	2.6	3.0	3.2	0.51
T6	3.0	2.7	2.5	2.4	2.2	2.2	2.1	2.1	2.0	0.55
T7	4.5	4.5	4.4	4.3	4.2	4.1	4.0	3.9	3.8	0.44
T8	3.4	3.3	3.1	2.9	2.8	2.7	2.6	2.5	2.4	0.45
T9	3.0	2.9	2.7	2.5	2.4	2.2	2.1	1.9	2.0	0.51

We can draw the tonal pattern of Hong Kong Cantonese using the analysis results listed above. In principle tones are changing from time to time. We can use the results of phonetic and statistical analysis to determine the stable parts and unstable parts in tones. Shi & Wang [9] pointed out that the points with the SD larger than 0.5 are unstable in standard Chinese. We assume the tones with relative high SD are relatively unstable.

Figure 1-2: The tonal pattern of Hong Kong Cantonese.



The feature of Tone 1 is high flat. The starting point is 4.2 and ending point is 3.9. The average SD of Tone 1 is 0.51. The SD of the first point and the sixth to the ninth points are larger than 0.50. We found that in Tone 1 the first point and the sixth to the ninth points are unstable. The starting point of Tone 4 is 2.9 and ending point is 0.5. Tone 2 is a falling tone. The average SD of Tone 4 is 0.43. The SD of the first point to third point are larger than 0.5 and they are unstable.

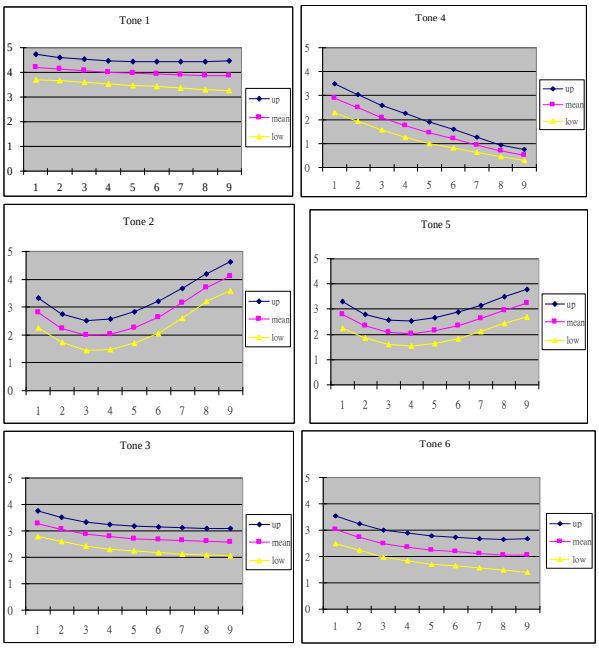
The starting point of Tone 2 is 2.8 and ending point is 4.1. The lowest parts are the third point and fourth point which are 2.0 in T value. The tone contour of Tone 2 is falling and rising. The average SD of Tone 2 is 0.54 and the SD of every point is larger than 0.5. That means Tone 2 is unstable and is at the stage of changing. The starting point of Tone 5 is 2.8 and ending point is 3.2. The lowest part is the fourth point which is 2.0 in T value. The tone contour of Tone 5 is also falling and rising. The average SD of Tone 5 is 0.51. The SD of the first point and fifth point to ninth point are larger than 0.5 and they are unstable. Tone 2 and Tone 5 are overlapping at starting segments. The difference is the ending where Tone 2 is one degree higher than Tone 5.

The starting point of Tone 3 is 3.3 and ending point is 2.6. The average SD of Tone 3 is 0.48. The SD of the eighth point and ninth point are larger than 0.5 and they are unstable. The starting point of Tone 6 is 3.0 and ending point is 2.0. The average SD of Tone 6 is 0.55. The SD of every point is larger than 0.5. Tone 6 is unstable.

The starting point of Tone 7 is 4.5 and ending point is 3.8. The average SD of Tone 7 is 0.44. The starting point of Tone 8 is 3.4 and ending point is 2.4. The average SD of Tone 8 is 0.45. The starting point of Tone 9 is 3.0 and ending point is 2.0. The average SD of Tone 9 is 0.51. The SD of the first point to third point, eighth point and ninth point are larger than 0.5 and they are unstable parts.

In terms of the tone value and register, the highest one is the starting point of Tone 7 with the T value of 4.8. Tone 1 occupies the top of the tone register. Tone 4 lies in the lower half of register and its ending point reaches the bottom of register with T value of 0.5. The features of Tone 2 and Tone 5 are dip tone in contour. Tone 1, Tone 3 and Tone 6 are level tone and so are the three tones with checked syllables. In summary, the tones in Hong Kong Cantonese are mostly level tones. There are two dip tones and one falling tone. In Hong Kong Cantonese the tone values of tones with voiceless initials are higher than the tones with voiced initials in level tone, rising tone, falling tone and entering tone. This characteristic is identical with the results of Shi [7] who studied the tones of Guangzhou Cantonese.

Figure 3-8: The tonal space of Hong Kong Cantonese.



SD reflects the synchronic characteristic and intrinsic divergence in tones. The tones with larger SD have bigger divergence. And their possibility of change is bigger than other tones. The tones with smaller SD have smaller differences and the possibility of change is smaller than other tones. From the viewpoint of intrinsic divergence, Tone 2 and Tone 6 have the largest discreteness with the SD of 0.55 and 0.54 respectively. Tone 2 and Tone 6 are very unstable. Tone 4 has smallest discreteness. For the other tones the unstable parts lie in the starting and ending parts.

Through the data analysis, we found that the tone value of each subject may not be identical with the mean value and it usually shows some divergence. Shi & Wang [9] proposed a method to explore the tonal feature of Standard Chinese. With the mean value listed above, we can add SD and

minus SD to get the dynamic space of Hong Kong Cantonese tones. This space implies that statistically for normal distribution 68% of native speakers will be distributed in the space. So we can say this space cover the main part of the tonal data. The tones with wider space indicate that they have large discreteness, whereas the tones with narrower space mean that they have small discreteness.

The starting point of Tone 4 is widest and the range reduces to the ending point gradually.

From the dynamic space graphs of Tone 2 and Tone 5, Tone 3 and Tone 6, we found that these two pairs of tones are overlaping. Peng & Wang [6] found that it is difficult to distinguish Tone 2 from Tone 5 and Tone 3 from Tone 6 either in tone recognizers or in perception. And they claimed these two pairs of tones are in the process of merge. The phonetic and statistical results of this paper supplement the conclusions of Peng & Wang [6]. The findings of Peng & Wang [6] and this paper unveil the synchronic characteristics of Hong Kong Cantonese tones from different perspectives.

The quantity of sound samples directly affects the analysis results. Large data can reflect the characteristics of Hong Kong Cantonese comprehensively. Labov [4] applied the method of skewness to investigate the social factors in language changes. This paper will adopt statistical method of skewness to reveal the distribution feature and evolution directions of Hong Kong Cantonese tones.

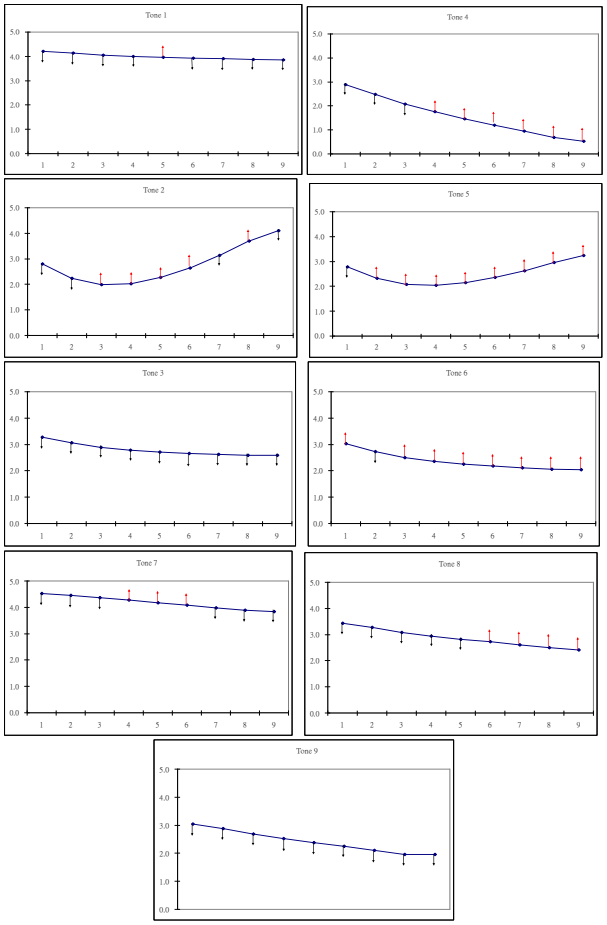
Table 2: Skewness data of Hong Kong Cantonese tones.

	1	2	3	4	5	6	7	8	9
Tone 1	-0.58	-0.64	-0.34	-0.21	0.14	-0.13	-0.03	-0.04	-0.18
Tone 2	-0.70	-0.15	0.08	0.19	0.20	0.16	-0.19	0.70	-1.27
Tone 3	-1.35	-1.18	-0.66	-0.24	-0.12	-0.08	-0.01	-0.02	-0.18
Tone 4	-0.50	-0.27	-0.09	0.07	0.02	0.21	0.43	0.81	1.22
Tone 5	-0.48	0.05	0.21	0.29	0.30	0.31	0.32	0.26	0.01
Tone 6	0.69	-0.11	0.27	0.54	0.77	0.87	0.99	0.70	0.43
Tone 7	-1.66	-1.46	-1.21	0.96	0.73	0.59	-0.39	-0.21	-0.27
Tone 8	-0.94	-0.87	-0.67	-0.36	-0.06	0.04	0.16	0.22	0.13
Tone 9	-0.92	-0.91	-0.65	-0.48	-0.36	-0.16	-0.05	-0.06	-0.13

The data of skewness reflects the feature of tonal distribution. The negative numbers indicate more subjects concentrate on the side which is smaller than the average tone value, whereas the positive numbers mean more subjects concentrate on the side which is larger than the average tone value. Based on the T value of tones, we applied the method of skewness to get the following results.

In principle the skewness figures which are larger than 0.5 or smaller than -0.5 indicate T value of the measured points diverge from mean value obviously. The skewness data of Hong Kong Cantonese shows that Tone 1(beside the fifth point) will move downward, especially the first two points. Therefore the tone value of Tone 1 will be reduced. The starting point and ending point of Tone 2 will move downward greatly. Every point of Tone 3 is located on the negative side, which means Tone 3 will move downward. The first three points of Tone 4 will move downward and other points will move upward. Every point of Tone 5 (besides first point) will move upward. Similarly, every point of Tone 6 (besides the second point) will move upward. The starting and ending points of Tone 7 will move downward. The first five points of Tone 8 will move downward and last four points will move upward. Tone 9 will move downward.

Figure 9-17: The evolution direction of Hong Kong Cantonese tones.



The graphs above show that Tone 5 and Tone 6 will move upwards, whereas Tone 2 (the starting points and ending points) and Tone 3 will move downwards. This evolution tendency gives an explanation of the intrinsic reasons concerning the mixture of these two pairs of tones in phonetics and perceptions. It also proves the conclusions proposed

by Peng & Wang [6], which are Tone 2 and Tone 5, Tone 3 and Tone 6 are likely to merge in the future.

3. CONCLUSION AND DISCUSSION

Through the phonetic and statistical analysis, we obtained the following conclusions. About the tone values, Zhang [12] studied the Hong Kong Cantonese and pointed out that in Tone 1 there are two types of tone value 55 and 53. Based on the phonetic analysis of six subjects, Bauer [2] proposed that there are two types of tone values in Tone 1, e.g. high flat and high falling. He also stated that the existence of falling tone is the distinction between Hong Kong Cantonese and Guangzhou Cantonese. In the investigation we found that only 6 subjects (3 male and 3 female) pronounce Tone 1 as falling tone entirely or partly. For Tone 2 and Tone 5 there is one degree difference at the ending point and the first four points are totally coincided. The tone value of Tone 2 is 35, which is identical with the result obtained by Ball [1] and Zhang [12]. About the tone value of Tone 5, Both Ball [1] and Zhang [12] proposed it is 13. According to the result of Bauer [2], the tone value of Tone 5 is 23. We analyzed the large data of the subjects. The result shows the tone value of Tone 5 is 34. The tone value of Tone 7 we obtained is the same as other scholars. However the tone values of Tone 8 and Tone 9 are slightly higher than the previous results. The difference may due to the different formula used.

In terms of tonal stability, the stable parts are the middle segments in Hong Kong Cantonese tones. The unstable parts are the starting points and ending points, e.g. the two ends of Tone 1, Tone 5 Tone 9 and the ending points of Tone 3. This feature is similar with the results obtained by Shi & Wang [9] on standard Chinese. The entire tone of Tone 2 and Tone 6 are unstable.

It is necessary to explore the tonal evolution of Hong Kong Cantonese when we study Hong Kong Cantonese. The data of skewness quantitatively indicates that direction of tonal evolution. Based on the skewness results, the tone value of Tone 1 will be lower and the ending points of Tone 2 will rise substantially. Zhang [11] concluded that Tone 2 and Tone 5 have the tendency of merge. The skewness data shows the starting points and ending points of Tone 2 is moving downwards and every point (besides starting point) of Tone 5 is moving upwards. Therefore we can predict that Tone 2 and Tone 5 will gradually move closer. Every point of Tone 3 will move downwards, especially the starting points. From the results we obtained, the standard deviation of nine points of Tone 3 is larger than 0.5, which means Tone 3 is unstable and has potential to change. Every point of Tone 6 (besides point 2) will move upwards, especially the starting points, the fourth point and eighth point. Tone 3 and Tone 6 also show the tendency of approaching closer. Peng and Wang [6] proposed that no matter it is in machine recognition or in perception there are some difficult for native speakers to distinguish Tone 2 from Tone 5 and Tone 3 from Tone 6. They believed that this reflects the features of tonal merging in process. From the view of language evolution, we think these two pairs of tones have possibility of merging due to the fact that their tone values are getting closer. The starting points of Tone 7 and Tone 8 will move downwards dramatically, Tone 9 will also move downwards. This is our prediction on the tonal evolution of Hong Kong Cantonese. We will also explore the other references to explain the directions of tonal changes in Hong Kong Cantonese.

4. REFERENCES

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