TAL2018, Sixth International Symposium on Tonal Aspects of Languages
18-20 June 2018, Berlin, Germany

Changes of entering tones in Mandarin Chinese revisited: From a corpus-based approach

Chihkai Lin[1]

[1]Tatung University, Taiwan

linchihkai@gmail.com

Abstract

This paper explores the dispersion of entering tones from Middle Chinese to modern Mandarin Chinese by using a corpus-based approach. With 2698 corpus examples, this paper looks into how the manner and place of articulation of initials are related to the dispersion. The results suggest that sonorants and voiced obstruents show more salient tendencies than voiceless initials do in the dispersion of entering tones. Sonorants are highly associated with *qùshēng*, and voiced obstruents with *yángpíng*. Besides, labial initials are significantly different from coronal and dorsal initials in *yángpíng*, *shǎngshēng* and *qùshēng*. The corpus data also reveal that there is a low rate of dispersing into *shǎngshēng* for entering tones, as entering tones are incompatible with *shǎngshēng* in height. Entering tones are non-low, whereas *shǎngshēng* is low.

Index Terms: entering tones, Middle Chinese, Mandarin Chinese, manner of articulation, place of articulation, low tone

1. Introduction

This paper investigates the changes of entering tones from Middle Chinese to modern Mandarin Chinese from a corpus-based approach, and argues that besides the manner of articulation of initials, there are two other phonological factors: the place of articulation of initials and the default height of entering tones. In traditional Chinese phonology, tones in Middle Chinese, in *Guǎngyùn* (1008 AD) for example, are classified as *píng* 'level', *shǎng* 'rising', *qù* 'falling' and *rù* 'entering', which refers to syllables ending in stops, -p, -t and -k. Later, the four tones split into eight tones depending on the voicing of initials, *yīn* 'voiceless' and *yáng* 'voiced'. From Middle Chinese to modern Mandarin Chinese, changes of entering tones are usually expressed by *rùpài sānshēng*, a phonological process that the stop codas of entering tones are deleted and then the entering tones are dispersed into the other three tones. For instance, *guó* 'country' is an entering tone ending in -k in Middle Chinese. After the coda drops, this word turns into *yángpíng*, its modern Mandarin Chinese as a rising tone 35.

The dispersion process of entering tones in Mandarin Chinese has been discussed by [1] – [5], and the initial outweighs main vowel and final. In [1] – [4], the dispersion of entering tones is constrained by the manner of articulation of initials. According to [2, pp. 311], nasal/lateral initials render *qùshēng* 'falling' (96%), and voiced obstruents lead to *yángpíng* (84 %). While sonorants and voiced obstruents are associated with how entering tones disperse into the other three tones, certain association can also be observed in voiceless obstruents. As suggested by [3, pp.107], half of voiceless aspirated obstruents turn into *qùshēng*, and quarter of voiceless aspirated obstruents become *yīnpíng*. Half of voiceless unaspirated obstruents turn into *yángpíng*, and one-third into *yīnpíng*. In addition to the tendencies in sonorants and voiced obstruents, the entering tones with aspirated initials tend to be *qùshēng* [1], and [2].

Xia [5], on the other hand, posits that entering tones are essentially not tones but different types of syllables. Entering tones have default tonal values corresponding to open syllables (CV) or closed syllables ending in nasals (CVN). The tonal values manifest different contours: level, rising or falling. How entering tones are dispersed into the other three tones after stop codas drop depends on the default tone. It is hypothesized that if an entering tone has a level tone as its default, the entering tone would also be level as well after coda deletion. For example, *xí* 'to learn, to acquire' ends in -p in Middle Chinese. [5, pp. 322] proposes to be a level tone, whose initial is a voiced obstruent. After the coda drops, the default level tone interacts with the initial. The voiced obstruent lowers the level tone of *xí* and renders *yángpíng* 35 in modern Mandarin Chinese.

This hypothesis, nevertheless, is challenged in this paper. I suggest that there are no default contours in entering tones. Instead, it is the height of entering tones that matters in the dispersion process, due to the fact that entering tones seldom turn into *shǎngshēng*.

As it is certain that the manner of articulation of initials is closely related to the dispersion process of entering tones, this paper takes another perspective by looking into the place of articulation of initials. To provide a general survey, it is of particular interest to adopt a corpus-based approach to the dispersion process. This paper establishes a corpus based on Luo's online wordlist, "http://210.240.193.39/loh/hanyu/" for the comparison of Mandarin Chinese and Middle Chinese. This paper not only reevaluates the manner of articulation of initials but also pays attention to whether different places of articulation of initials are associated with the dispersion of entering tones into Mandarin Chinese. The other issue in this paper is how default height of entering tones influences the dispersion process.

2706 examples are collected from the wordlist, in which 8 neutralized tones are not used. The distribution of the 2698 examples in terms of manner of articulation is summarized in section 2. Section 3 explores the effects of different places of articulation of initials on the dispersion of entering tones. Although the dispersion of entering tones is closely associated with initials, there is another tendency that entering tones do not favor *shǎngshēng*. Section 4 probes into the default height of entering tones. Section 5 concludes this paper.

10.21437/TAL.2018-38

2. Distribution of entering tones in modern Mandarin Chinese

In the corpus, there are 2698 examples, which are classified into six categories according to the manner of articulation of initials. The six categories are voiced stops/affricates, voiced fricatives, voiceless unaspirated stops/affricates, voiceless aspirated stops/affricates, voiceless fricatives and nasals/ lateral. Table 1 shows the distribution of the six categories.

Table 1: *Distribution of entering tones in modern Mandarin Chinese in six categories (manner of articulation).*

Initials / Tones	vd s/a	vd f	vls uas s/a	vls asp s/a	vls f	n/l	Total
yp	20	9	171	97	92	22	411
yap	296	120	356	39	31	14	856
ss	6	9	72	26	13	13	139
qs	88	38	234	210	203	519	1292
Total	410	176	833	372	339	568	2698

*vd = voiced, vls = voiceless, uas = unaspirated, asp = aspirated, s = stops, a = affricates, f = fricatives, n = nasals, l = lateral, yp = *yīnpíng*, yap = *yángpíng*, ss = *shǎngshēng*, qs = *qùshēng*.

Chi-square tests are conducted to check the differences between the six categories. The results suggest that there are no differences between voiced stops/affricates and voiced fricatives ($\chi^2 = 6.7$, *d.f.* = 3, $p = 0.08$), and between voiceless aspirated stops/affricates and voiceless fricatives ($\chi^2 = 3.1$, *d.f.* = 3, $p = 0.38$). Thus, voiced stops/affricates and fricatives are combined as voiced obstruents, and voiceless aspirated stops/ affricates and fricatives are merged into voiceless aspirated obstruents. Table 2 shows the new distribution of the four categories (obs = obstruents).

Table 2: *Distribution of entering tones in modern Mandarin Chinese in four categories (manner of articulation).*

Initials / Tones	vd obs	vls uas s/a	vls asp obs	n/l	Total
yp	29	171	189	22	411
yap	416	356	70	14	856
ss	15	72	39	13	139
qs	126	234	413	519	1292
Total	586	833	711	568	2698

Chi-square tests are conducted, and the results suggest that there is a significant difference between the manner of articulation of initials and the four tones in Table 2 ($\chi^2 = 1171.05$, *d.f.* = 9, $p < .05$). Table 3 shows percentage in the four tones.

The percentage in Table 3 conforms to Lin's [2] results. First, the majority of sonorant initials (nasals/lateral) (91%) are highly associated with *qùshēng*, and approximately 71% of voiced obstruents become *yángpíng*. In voiceless initials, there is a difference between unaspirated and aspirated initials. The majority of voiceless unaspirated stops/affricates are *yángpíng* (43%), and the majority of voiceless aspirated obstruents are *qùshēng* (58%).

Table 3: *Percentage of entering tones in modern Mandarin Chinese.*

Initials / Tones	vd obs	vls uas s/a	vls asp obs	n/l
yp	5%	21%	27%	4%
yap	71%	43%	10%	2%
ss	3%	9%	6%	2%
qs	22%	28%	58%	91%
Total	100%	100%	100%	100%

To account for the dispersion of entering tones in features, Ang and Huang [4] propose three phonological features: [voicing], [aspirated] and [sonorant]. Following Ang and Huang's [4] suggestion, the four categories in Table 2 are translated into three features: [±voicing], [±aspirated] and [±sonorant], as summarized in Table 4.

Table 4: *Features for the four categories.*

Places / Features	vd obs	vls uas s/a	vls asp obs	n/l
[voicing]	+	-	-	+
[aspirated]	-	-	+	-
[sonorant]	-	-	-	+

Voiced obstruents are marked as [+voi, -asp, -son], voiceless unaspirated stops/affricates as [-voi, -asp, -son], voiceless aspirated obstruents as [-voi, +asp, -son] and nasals/ lateral as [+voi, -asp, +son]. The changes of entering tones in terms of manner of articulation can be summarized as the follows. The voicing of initials is related to *yángpíng*; the aspiration and sonority of initials are associated with *qùshēng*.

The distribution in Table 2 also reveals that *shǎngshēng* is disfavored in the dispersion process. About half of the corpus examples are attested in *qùshēng* (48%, 1292/2698), followed by *yángpíng* (32%, 856/2698). 15% of the corpus examples are in *yīnpíng*. There are approximately 5 % of the corpus examples in *shǎngshēng*. The low frequency of *shǎngshēng* in the corpus will be discussed in section 4.

3. Different places of articulation and the dispersion of entering tones

In this paper, I also look into the distribution in the corpus from the place of articulation of initials. According to the place of articulation in Luo's wordlist, the 2698 corpus examples are divided into three categories: labial, coronal and dorsal. The category of labial initials consists of bilabial and labiodental consonants, and that of coronal initials contains alveolar, retroflex and palatal consonants. The category of dorsal initials includes velar and laryngeal consonants. The general distribution of the three places of articulation in the four tones is shown in Table 5 below. The result of Chi-square test suggests that there is a significant difference between the place of articulation of initials and the four tones ($\chi^2 = 47.1$, *d.f.* = 6, $p < .05$).

Table 5: *Distribution of entering tones in modern Mandarin Chinese in three categories (place of articulation).*

Tones \ Places	L	C	D	Total
yp	46	208	157	411
yap	138	406	312	856
ss	27	58	54	139
qs	217	600	475	1292
Total	428	1272	998	586

The three categories in Table 5 are further analyzed with the four manner of articulation in Table 2. Details are shown in Tables 6, 7, 8 and 9, respectively (L = Labial, C = Coronal, D = Dorsal). Chi-square tests are conducted to check whether there are significant differences in the four tables.

Table 6: *Distribution of voiced obstruents in different places of articulation.*

Tones \ Places	L	C	D	Total
yp	7	12	10	29
yap	77	213	126	416
ss	3	9	3	15
qs	39	55	32	126
Total	126	289	171	586

Table 7: *Distribution of voiceless unaspirated stops/ affricates in different places of articulation.*

Tones \ Places	L	C	D	Total
yp	20	73	78	171
yap	45	147	164	356
ss	12	19	41	72
qs	48	70	116	234
Total	125	309	399	833

Table 8: *Distribution of voiceless aspirated obstruents in different places of articulation.*

Tones \ Places	L	C	D	Total
yp	17	112	58	187
yap	14	36	18	68
ss	9	19	8	36
qs	27	239	130	396
Total	67	406	214	687

Table 9: *Distribution of sonorants in different places of articulation*

Tones \ Places	L	C	D	Total
yp	2	11	11	24
yap	2	10	4	16
ss	3	11	2	16
qs	103	236	197	536
Total	110	268	214	592

There is no significant difference between the place of articulation of initials and the four tones in voiced obstruents in Table 6 (χ^2 = 10.4, *d.f.* = 6, p = .11) and in sonorants in Table 9 (χ^2 = 8.7, *d.f.* = 6, p = .19). The two tables show regular tendencies. *Yángpíng* is the majority in Table 6, and so is *qùshēng* in Table 9.

There are significant differences in voiceless initials in Tables 7 (χ^2 = 17.9, *d.f.* = 6, p < .05) and 8 (χ^2 = 22.9, *d.f.* = 6, p < .05). As the p-value in Tables 7 and 8 is less than 0.05, post-hoc tests with Bonferroni correction are also conducted to find in which category there are significant differences. In Table 7, the results of post-hoc test suggest that although there is a significant difference between the three places of articulation and the four tones, there is no significant difference in proportion. Details are shown in Figure 1.

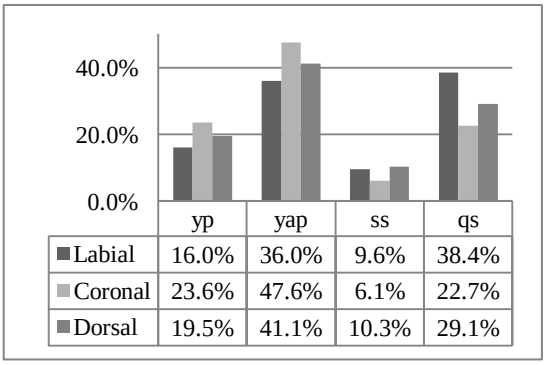

Figure 1: *Percentage of voiceless unaspirated stops/ affricates in four tones.*

In Figure 1, the highest percentage of labial initials is in *qùshēng*, whereas the highest percentage in coronal and dorsal initials is attested in *yángpíng*. In the three categories, the lowest is *shǎngshēng*. The percentage in the three categories does not deviate much from one another in the same tone.

In Table 8, on the other hand, labial initials in *yángpíng*, *shǎngshēng* and *qùshēng* are significantly different from coronal and dorsal initials in proportion, as shown in Figure 2.

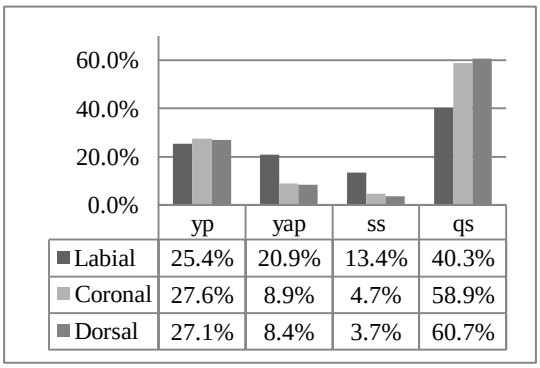

Figure 2: *Percentage of voiceless aspirated obstruents in four tones.*

The data in Figure 2 suggest that labial initials are more evenly distributed than coronal and dorsal initials are. Coronal and dorsal initials tend to be associated with *yīnpíng* and *qùshēng*. The biased distribution in coronal and dorsal initials indicates that the three places of articulation of initials differ in the dispersion process of entering tones.

4. Dispersion of entering tones into *shǎngshēng*

While most attention in the literature has been paid to how initials are associated with the dispersion of entering tones, one issue that is less discussed is that *shǎngshēng* is on the whole low in the distribution in Table 3, with only 139 corpus examples (5%). The low frequency of *shǎngshēng* in the dispersion of entering tones cannot be fully accounted for by different initials. It would be insightful by looking into the four tones in modern Mandarin Chinese. The tonal values of the four tones are *yīnpíng* 55, *yángpíng* 35, *shǎngshēng* 214 and *qùshēng* 51. The four tones in phonological notation are [+high] for *yīnpíng*, *yángpíng* and *qùshēng*, and [+low] for *shǎngshēng*. If the phonological notation is taken into account, it can be postulated that entering tones should be non-low tones, as they contradict *shǎngshēng* in height. The scenario is that when the non-low entering tones are dispersed into the other three tones, *shǎngshēng* becomes the least favored category, due to conflict in height.

The fact that *shǎngshēng* is disfavored in the dispersion of entering tones reveals that entering tones have default height that constrains the dispersion. Different height is contradictory in the dispersion process, and therefore entering tones seldom turn into *shǎngshēng*. Nevertheless, it should be noted that the default height proposed in this paper differs from the default contours of entering tones [5]. There is no corresponding level, rising or falling tones, but there is a difference between *shǎngshēng* and entering tones in height.

5. Conclusions

From a corpus-based approach, this paper examines the changes of entering tones from Middle Chinese to modern Mandarin Chinese. The results not only show that the manner of articulation of initials is associated with the changes of entering tones but also reveal that the place of articulation of initials is closely related to the dispersion of entering tones. In manner of articulation, nasal/lateral initials are highly close to *qùshēng* and voiced obstruents to *yángpíng* based on the tendencies (> 70% of the corpus examples for each tone). In place of articulation, significant differences are observed in voiceless initials. Among the three places of articulation, voiceless and aspirated labial initials significantly differ from coronal and dorsal initials, especially in *yángpíng*, *shǎngshēng* and *qùshēng*. Besides the manner and place of articulation, entering tones are proposed to be non-low tones, and the height of entering tones is also associated with the dispersion process. As entering tones are contradictory to *shǎngshēng*, which is a low tone, this gives a rise to low frequency in *shǎngshēng*.

Finally, the diachronic changes of entering tones from a corpus-based approach provide a foundation for phonetic investigation. While it has been widely investigated on how the manner of articulation of initials is associated with sound changes ([6] – [8] for the voicing of initials, and [9] – [12] for the aspiration of initials), few research has touched upon how place of articulation is related to sound changes. Lai *et al* [13] have suggested that in Taiwan Southern Min, velar initials are significantly higher than labial and coronal initials in the onset F_0. Further studies are needed to have a better understanding of this issue.

6. References

[1] D. Z. Bai, *Beiyin rusheng yanbiankao*. Beijing: Zhongguo da ci dian bian zuan chu, 1931.

[2] T. Lin, "Rupai shansheng bushi," in *Li Tao yuyanxue lunwenji* (A Collection of Li Tao's Linguistics Papers), pp.301-316, 2001.

[3] Z. F. Liu, "The rules governing the split of the entering tone in the Beijing dialect and the relationships between Northern dialects," *Studies in Languages and Linguistics*, vol. 24, no. 1, pp. 105-110, 2004.

[4] U. J. Ang, and Y. C. Huang, "Zhonggu rushng zai xiandai huayu de yanhua," in *The 24th National Conference on Chinese Phonology, October 27-28, Kaohsiung, Taiwan, Proceedings*, 2006.

[5] Z. Y. Xia, *Rushen Xianyi*. Chengdu: Bashu Book, 2009.

[6] P. Ladefoged, *Three Areas of Experimental Phonetics*. New York: Oxford University Press, 1967.

[7] B. Mohr, "Intrinsic Variations in the Speech Signal," *Phonetica* 23, pp. 65-93, 1971.

[8] J. M. Hombert, and P. Ladefoged, "The Effect of Aspiration on the Fundamental Frequency of the Following Vowel," *UCLA Working Papers in Phonetics* 36, pp. 33-40, 1977.

[9] M. S. Han, and R. S. Weitzman, "Acoustic Features of Korean /P, T, K/, /p, t, k/ and /p^h, t^h, k^h/," *Phonetica* 22, pp. 112-28, 1970.

[10] J. M. Hombert, *Towards a Theory of Tonogenesis: an Empirical, Physiologically and Perceptually-based Account of the Development of Tonal Contrasts in Language*. Doctoral Dissertation, University of California, Berkeley, 1975.

[11] E. Zee, "The Effect of Aspiration of the F0 of the Following Vowel in Cantonese," *UCLA Working Papers in Phonetics* 49, pp. 90-97, 1980.

[12] G. X. Xu, and Y. Xu, "Effects of consonant aspiration on Mandarin tones," *Journal of the International Phonetic Association* 33, pp.165-181, 2003.

[13] Y. W. Lai, C. Huff, J. Sereno, and A. Jongman, "The raising effect of aspirated consonant on F0 in Taiwanese," In *Proceedings of the 2nd International Conference on East Asian Linguistics, Simon Fraser University Working Papers in Linguistics*, 2009.