10th International Conference on Speech Prosody 2020
25-28 May 2020, Tokyo, Japan

Tonal Adaptation of Disyllabic Letter-Character Pattern in Mandarin Alphabetical Words

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Abstract

Mandarin Alphabetical Words (MAWs), which are Chinese words written partly or fully in roman letters, have been gradually included in the authoritative dictionary of Standard Chinese. However, no transcriptions for these loaned letters have been provided because it is not clear whether and how they should be adapted to the Mandarin phonological system. This study aims to investigate the tonal adaptation of the letter in the disyllabic hybrid word that consists of an English letter followed by a Chinese character, which is likely to be adapted to the Mandarin phonological system. We recruited 45 Chinese speakers aged 20 to 25 from areas of North and South China (Shanghai and Guangdong), who participated in an experiment with three tasks involving reading, listening and speaking. The results showed that Tone 4 and Tone 1 were most preferred by northern and southern speakers respectively, and Tone 2 and Tone 4 were ranked the second for speakers from Shanghai and Guangdong respectively. It has been found that tonal adaption of the English letters in such hybrid words varies significantly across different letters and dialectal areas, and it also depends moderately on the tonal category of the following syllable and speakers' familiarity with the MAW.

Index Terms: Alphabetical words, Mandarin Chinese, phonetic adaptation, tonal preference

1. Introduction

The adaptation of loan words provides important tests of the phonetic and phonological systems of a language, and it is well known that orthography plays a role in phonological adaptation [1, 2, 3]. However, what happens when orthography is also adapted has only scarcely been investigated [4, 5]. Mandarin Alphabetical Words (MAWs) is exactly such a case where individual English letters are borrowed and incorporated into Chinese character orthography to form new words [6]. MAWs have gained popularity in the last few decades and now form an established category in Chinese [7]. An appendix of 239 MAWs has been included in the authoritative *Dictionary of Modern Chinese* (现代汉语词典) [8]. And even several MAWs dictionaries have been published in recent years [9]. However, they only provide glosses but not pronunciations for MAWs, which awaits standardized transcription. And the phonological or phonetic value of the letters in MAWs needs to be investigated.

There are different views on how Mandarin alphabetical words should be pronounced. Some experts insist that MAWs should conform to the Chinese phonetic transcription of Pinyin [10], but Pinyin may deviate greatly from the real pronunciation of MAWs by Chinese speakers. Other scholars claim that English letters in MAWs should be read in the same way as they are pronounced in English ([11, 12]), but English pronunciations cannot be represented by the Mandarin phonological system. Moreover, Chinese speakers usually pronounce them with a certain Chinese accent [13], especially when English letters are combined with characters, Chinese speakers even try to attach a lexical tone to these roman letters.

On the one hand, examination of tonal assignments for roman letters in MAWs has received little attention [14], but on the other hand, standardization of tonal adaptation for these letters is important for speech technology as well as for lexicography. Our previous investigation in [15] revealed that the pronunciation of English letters in MAWs is dependent on numerous factors, including non-linguistic social factors [16] such as dialectal areas and English levels of the speakers and linguistic factors [17] such as the tones of neighbouring syllables.

In the current study, we have chosen university students who use MAWs more frequently in their speech as subjects, and employed disyllabic hybrid LC (Letter-Character) MAWs which consist of one English letter followed by one Chinese character as material for investigation. Moreover, we have selected those English letters that have similar pronunciation in Mandarin Chinese, because the adaption of this kind of MAWs to Chinese phonological system should be more probable than others. By controlling certain factors, we have focused our investigation on the following three variables: dialectal area (of the speakers), tone of the following syllable (in the MAWs), and familiarity (of the speakers with the MAWs). We aim to find out whether and how these factors have an influence on the tonal choice for English letters by Chinese subjects in their reading, listening and production of MAWs. Since production can demonstrate the actual tonal preference in practice, detailed examination will be reported in the production test.

2. Methods

An experiment containing three tasks was designed. The first two tasks were multiple-choice tests in reading and listening separately, and the third one was a production test.

2.1. Subjects

Forty five graduate and undergraduate students were recruited from Shanghai Jiao Tong University between 20 to 25 years old (23.70 ± 0.90 years) with 15 from each of the three dialectal areas of Guangdong (southern China) , Shanghai (eastern China), and Northern China. The reason for selecting these three areas was that our pilot study showed that speakers from these three areas demonstrated distinctive tonal preference in their pronunciation in MAWs. In order to control their English proficiency level, only those subjects who had passed the national English test in the People's Republic of China–College English Test (CET4) could be recruited. Their demographic information is presented in Table 1.

10.21437/SpeechProsody.2020-101

Table 1: *Demographic information of subjects*

Gender	Guangdong	Northern China	Shanghai	Total
Female	9	8	12	29
Male	6	7	3	6
Total	15	15	15	45

2.2. Stimuli

2.2.1. Selection of English letters

In order to focus on our research topic, we should choose disyllabic MAWs consisting of one English letter followed by one Chinese character. Moreover, the English letter should be pronounced similarly both in English and Mandarin Chinese. Therefore, the letter should be pronounced in (C)V, and the vowel ought to be uttered with one final in Mandarin, so that a lexical tone could be attached. Based upon these criteria, 13 letters were selected, including *A, B, D, E, T, K, O, G, U, V, R, Q, P*. Some of them were frequently used in daily communication, while others not, which was also worthy of investigation.

2.2.2. Selection of Mandarin characters

Since the tone of the following syllable was considered as an influential factor, each letter should be followed by four Mandarin lexical tones. For example, A 波, A 盘, A卡, and A队 formed one set for letter *A*. In order to provide sufficient data for statistics, three sets (e.g. 12 MAWs) with different Chinese characters were formed for each letter. In this way, 156 (156 = 13 letters $\times$ 12 characters) different MAWs were designed. Besides fulfilling the requirements of tones, we endeavored to choose more frequent MAWs according to the findings in [1].

2.3. Experimental procedures

This experiment consisted of three tasks. In the first task, participants were presented with one of the 156 MAWs in written text together with four choices of the tones, and they should choose one tone from four options for the letter in MAWs they thought most appropriate.

Then we prepared a recording of all the 156 MAWs in four different tones for the second task. We asked one native male speaker who spoke standard Mandarin to read all the MAWs as naturally as possible at a normal speaking rate. The recording of 44.1 kHz/16-bit format was then segmented into single MAW word and the intensity of each MAW sound file was normalized. The second task was similar to the first one, but the MAWs were uttered in four different tones and they were aurally presented to the participants together with the written form of MAWs in the multiple-choice task. The first two tasks were carried out with an online research software WJX.CN (https://www.wjx.cn/). There was no time limit for doing the two multiple-choice tasks, so that the subjects could have opportunities to think it over before making their final choice.

Finally, the participants were asked to read the list of the 156 MAWs with the most appropriate pronunciation that they would use. And they were required to read at a normal speaking rate and were encouraged to repeat or correct themselves whenever they felt necessary. Recordings were made separately one by one in a quiet room in the university with 44,1 kHz and 16 bit. The tonal categories of all the MAWs in their production were then evaluated by the authors in the analysis stage.

2.4. Data analysis

The data were collected on the subject's name, gender, age, English level, dialect, and his/her experimental results. Each subject had 156 rows, 4 columns of experimental results, and 5 columns of demographic information. The collected data were analyzed first across letters, dialectal areas and tasks to obtain an overview in comparison, then the relevant variables were entered into statistical models for the determination of influential factors. Since the dependent variable (choice of preferred tones) had more than two nominal unordered categories, multinomial logistic regression (MLR) was employed to examine whether and how the potential variables would influence the tonal choice for the letters in MAWs. To avoid the problem of unbalanced variance, the choice of Tone 3 was removed from the data due to its scarcity. Therefore in this multinomial logit analysis, the dependent variable of tonal choice had only three categories (Tone 1, Tone 2, and Tone 4), and the first independent variables *dialectal area* also had three categories (Guangdong, Northern China, and Shanghai), the second variable *tone of the following syllable* had four categories (Tone 1, Tone 2, Tone 3, and Tone 4), and the third variable *familiarity* contained five values (from 1 to 5). The mlogit function from the mlogit package [18] in R language [19] was used to evaluate the influence from variables of dialectal area, familiarity and following tone. Each of the 13 letters was run separately in the MRL model.

2.5. Results

2.5.1. Tonal preference across letters

The sum of choices in all three tasks of each letter is presented in Figure 1, in which the vertical axis stands for the number of selection of a specific tone by subjects from the three dialectal areas. Tone 1-4 are distinguished by different colours. The abbreviations "G N S" represent the dialectal areas of Guangdong, Northern China, and Shanghai respectively. And the distribution of tones is displayed for each letter separately with its name shown at the top in the Figure.

For each letter in each dialectal area, the total number of tonal choices amounted to 585 (15 participants x 3 tasks x 13 MAWs). The choices of preferred tones also varied across letters and dialectal areas. Generally speaking, Tone 1 was mostly preferred, while Tone 3 was least preferred.

2.5.2. Tonal preference across areas

The same data in Figure 1 were presented in percentage across dialectal areas in Table 2. Guangdong speakers preferred Tone 1 in all 13 letters because the proportion of Tone 1 exceeded 50% from *A* to *V*. However, speakers from northern China were inclined to Tone 4 rather than Tone 1, because the percentage of Tone 4 exceeded 50% for 7 (*B, D, E, G, K, P and T*) out of 13 letters and that of Tone 1 over 50% for only 5 letters (*A, O, Q, U, and V*). For Shanghai speakers, Tone 1 was also their first choice, for the percentage of Tone 1 was over 50% for 10 out of 13 letters (*A, E, K, O, P, Q, R, T, U, and V*), whereas Tone 2 also amounted to a large proportion in letters like *B, D, and G* with 52.8%, 54.3%, and 48% respectively.

2.5.3. Tonal preference across tasks

It can be observed in Figure 2 that in each task Tone 1 ranked the first, followed by Tone 4 and Tone 2, but Tone 3 was nearly excluded in their choice. The variance of four tones among the three tasks was similar, without statistical difference.

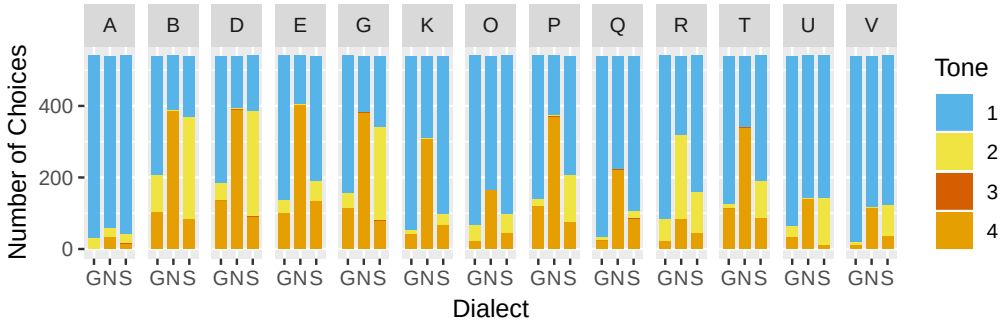

Figure 1: *Number of preferred tonal choices for each letter across different dialects in all tasks*

Table 2: *Proportion of preferred tonal choices for each letter across different dialects in all tasks*

	Guangdong				**Northern Area**				**Shanghai**			
Letter	Tone 1	Tone 2	Tone 3	Tone 4	Tone 1	Tone 2	Tone 3	Tone 4	Tone 1	Tone 2	Tone 3	Tone 4
A	**94.3**%	5.6%	0%	0.2%	**88.7**%	4.8%	0.2%	6.3%	**92.2**%	4.6%	0.2%	3%
B	**61.5**%	19.3%	0.2%	19.1%	28%	0.2%	0.2%	**71.7**%	31.5%	**52.8**%	0%	15.7%
D	**65.6**%	9.3%	0%	25.2%	26.7%	0.9%	0.2%	**72.2**%	28.5%	**54.3**%	0.4%	16.9%
E	**74.6**%	6.5%	0%	18.9%	25%	0.2%	0%	**74.8**%	**64.6**%	10.4%	0.2%	24.8%
G	**70.9**%	7.6%	0%	21.5%	28.7%	0.4%	0.2%	**70.7**%	36.7%	48%	0.6%	14.8%
K	**89.8**%	2.2%	0%	8%	42.4%	0.6%	0%	**57**%	**81.7**%	5.7%	0%	12.6%
O	**87.6**%	8.1%	0%	4.3%	**69.3**%	0%	0%	30.7%	**81.9**%	9.6%	0.4%	8.1%
P	**74.1**%	3.5%	0%	22.4%	30.6%	0.6%	0.6%	**68.3**%	**61.5**%	24.3%	0%	14.3%
Q	**93.5**%	1.9%	0%	4.6%	**58.3**%	0.4%	0.4%	40.9%	**80.2**%	3.7%	0.2%	15.9%
R	**84.4**%	10.9%	0%	4.6%	40.7%	43.5%	0.2%	15.6%	**70.6**%	20.7%	0%	8.7%
T	**76.5**%	2.4%	0%	21.1%	36.7%	0%	0.4%	**63**%	**64.8**%	18.7%	0.2%	16.3%
U	**88**%	5.6%	0%	6.5%	**73.5**%	0.2%	0%	26.3%	**73.5**%	24.3%	0.2%	2%
V	**96.1**%	1.7%	0%	2.2%	**78**%	0.6%	0.2%	21.3%	**77.2**%	15.7%	0.2%	6.9%
Sum	**81.3**%	6.5%	0%	12.2%	48.2%	4%	0.2%	47.6%	**65**%	22.5%	0.2%	12.3%

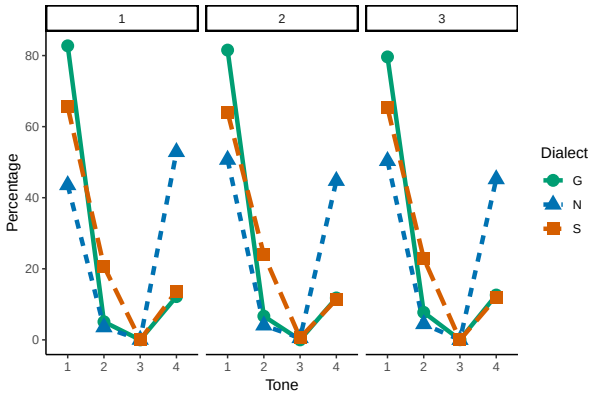

Figure 2: *Comparison of the proportion of preferred tonal choices for different dialectal areas across different tasks*

However, the proportion of the preferred Tone 1 for Guangdong speakers decreased in Task 3 compared to Task 1, and the proportion of the preferred Tone 4 for northern speakers also decreased in Task 3 compared to Task 1.

2.5.4. Dialectal influence in all tasks

Since there was no significant differences among the three tasks and the production in Task 3 could reflect their actual performance, we focused on the third task to further explore the influential factors in the preference of tones. Though the multinomial logistic regression (MLR) was run for each letter with three independent variables (dialectal area, familiarity, and tone of following syllable). Except for dialectal area, the other two variables (tone of following syllable and familiarity) also displayed significant influences in certain circumstances. Due to the complexity of the interaction, only a summary of the dialectal area is provided in Table 3. Arrows represent a significant increase or decrease in the odds of a particular Tone category (Tone 2 and Tone 4) relative to Tone 1 (set as the reference level in the MLR) in northern and Shanghai area compared to Guangdong.

Table 3: *Effects of dialectal areas on tonal selection in the MLR, where "***" "**" "*" represent that the significant levels of change are p<0.001, p<0.01, and p<0.05, respectively, while "-" indicates a nonsignificant effect.*

Letter	**Northern China**	**Shanghai**
B, V, Q, R	T4↑(***)	T2↑(*** or *)
K	T4↑(***)	T4↑(**)
D, G	T4↑(***)	T2↑(***) + T4↑(*)
P, T	T4↑(***)	T2↑(***) + T4↓(*)
E	T4↑(***)	-
O	T4↑(*)	-
U	-	T2↑(***) + T4↓(*)
A	-	-

The letters could be divided into three types: (1) the first included letters in the first five rows (*B, V, Q, R, K, D, G, P,*

T, E), where northern dialect increased the production of Tone 4 significantly at $p<0.001$; (2) the second included the letter in the sixth row (*O*), where northern dialect increased Tone 4 significantly at $p<0.05$; (3) the third included letters in the last two rows (*U, A*), where northern dialect caused no significant change compared to Guangdong dialect in Tone 4.

It can be observed that the pronunciation of Tone 4 was a special character of northern dialect. The percentage of Tone 4 in production is illustrated in Table 4. It is shown that the percentage of the following six letters *E, D, G, B, P, T* exceeded 60% in the the production of Tone 4.

Table 4: *Comparison of the proportion of Tone 4 in production across different dialectal areas*

Letter	Dialectal area		
	Guangdong	Northern China	Shanghai
E	18.5%	**76.4%**	21.5%
D	23.6%	**75.4%**	15.9%
G	18.5%	**72.8%**	16.4%
B	17.9%	**68.2%**	14.4%
P	24.6%	**64.1%**	11.3%
T	21.5%	**60.5%**	10.8%
K	4.1%	49.7%	12.3%
Q	2.6%	25.1%	16.9%
V	2.6%	15.9%	5.6%
O	4.6%	11.8%	5.6%
U	8.7%	10.8%	1.5%
R	4.1%	8.2%	7.7%
A	0.0%	3.6%	2.1%

2.5.5. Influential factors in production task of northern dialect

In order to explore the influences in the production of Tone 4 in northern dialect, we selected the data only from northern area, and run the MRL model separately for the letters whose percentage of Tone 4 exceeded 60%. Similarly, arrows represent a significant increase or decrease in the odds of a particular Tone category (Tone 1 and Tone 2) relative to Tone 4 (set as the reference level in the MLR) with the influence of tone of the following syllable and the familiarity of the speakers with each letter. The results are shown in Table 5.

Table 5: *Effects of the tone of the following syllable and familiarity on the production of Tone 4 in the MLR, where "***" "**" "*" represent that the significant levels of change are $p<0.001$, $p<0.01$, and $p<0.05$, respectively, while "-" indicates a nonsignificant effect.*

Letter	Tone of following syllable				Familiarity
	Tone1	Tone2	Tone3	Tone4	
E	-	T1↓(*)	-	-	-
D	-	-	-	-	-
G	-	T1↑(*)	-	T1↑(**)	T1↓(**)
B	-	-	T1↑(***)	T1↑(**)	-
P	-	-	-	T1↑(*)	-
T	-	T1↑(**)	T1↑(*)	-	-

It can be observed that compared to Tone 4, the changes only occurred in Tone 1, not in Tone 2 or Tone 3. If the following syllable was Tone 2, Tone 3, or Tone 4, the odds ratio of Tone 1 was increased significantly for many letters, only decreased for *E* when the following syllable was Tone 2. Familiarity decreased the odds of Tone 1 compared to Tone 4 in the production of letter *G*.

3. Discussion

This study has presented several new findings in the understanding of tonal choice for the English letters in LC MAWs.

Tonal preference changes across different tasks of reading, listening and production, but the differences are not significant. Preference difference in production may be explained by phonological or phonetic constraints in MAWs. It has been found that Tone 3 is least preferred in this study, which echoes the previous study, which claimed that Tone 3 is disfavored for the stressed position in initially-stressed disyllabic loans [20].

We have further found that tonal choices for the letter first depend on the type of letters. For some letters such as *A*, tonal preference is not influenced by dialects. For most letters, tonal preferences also depend on dialectal areas. Guangdong speakers predominately choose Tone 1, northern speakers mainly prefer Tone 4, while Shanghai speakers also choose Tone 2 except for Tone 1 and Tone 4.

The most interesting finding is that the six letters *E, D, G, B, P, T*, in which the proportions of production in Tone 4 exceed 60%, all have the Mandarin final [i]. That means this high front vowel [i] is most likely to be adapted and exposed to tonal changes according to special tonal preferences in different dialectal areas. Northern speakers prefer to attach Tone 4 to these letters, while Shanghai speakers can attach Tone 2 or Tone 4 to them. However, Guangdong speakers generally keep pronouncing them in Tone 1.

Mandarin Chinese is based on the spoken language of Beijing (northern Chinese) dialect, and Tone 4 represents actually the most salient character of Mandarin Chinese. It has also been observed that Tone 4 (falling tone) alone can produce the language difference between English and Mandarin Chinese [21]. It was found that Tone 4 ranks the first in Chinese literature works [22]. To produce the letters in Tone 4 is one sign of adaptation. Therefore, northern speakers have the tendency to adapt MAWs to Mandarin phonological system, while speakers from Guangdong and Shanghai, where their speech prosody does not sound so typical Mandarin, are reluctant to do so.

We have also found that familiarity with MAWs facilitates Tone 4 for northern speakers, which indicates that they would like to localize their familiar MAWs. However, the tonal adaptation of hybrid LC-MAWs are also influenced by the tone of the following character. For example, Tone 4 with a high onset in the following syllable will increase the possibility of production in Tone 1 for the previous syllable, so that the coarticulation from a high offset of Tone 1 to a high onset of Tone 4 is much easier than that from a low offset of Tone 4 to a high onset of Tone 4. Many influences from the neighbouring tone could be explained by phonological or phonetic constraints.

4. Conclusion

In conclusion, this study sheds some light on the tonal adaptation in the hybrid type of LC MAWs. We have shown that compared with speakers from southern areas, those from northern areas tend to adapt MAWs into Mandarin phonological system by attaching Tone 4 to these letters, especially for those that end with Mandarin final [i] in pronunciation.

5. Acknowledgements

This work is funded by the Hong Kong General Research Fund project (15608618) and the Major Programs of National Social Science Foundation of China (18ZDA293 and 13&ZD189).

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