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Effect of Orthography on L2 Production of Mandarin Tones

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Abstract

L2 production of tones has been widely discussed; however, the role of orthography in the learning process has received little attention. Previous studies suggested that the opaque orthography of Chinese characters plays an important role in both L2 production and perception. The present study further investigates the role of different orthographies (Pinyin vs. Chinese characters) in L2 production of Mandarin tones. Monosyllabic and disyllabic words were used as the test materials. The subjects were divided into two groups: high proficiency and low proficiency. The results showed that among the subjects of low language proficiency, Chinese character helps with L2 tone production; while among the subjects of high language proficiency, the effects of Chinese character and pinyin are comparable in L2 tone production. T2 and T3 have a very high chance to be confused across all the subjects, regardless of orthographies.

Index Terms: orthography; L2 tone production; Mandarin; Cantonese

1. Introduction

Both Mandarin and Cantonese are tonal languages in which tone is used to distinguish lexical meaning of a syllable (word). Mandarin has a four-tone system [1] while Cantonese has a six-tone system 2 [2, 3, 4] (the three checked tones of syllables with final stops are regarded as allotones of T1, T3 and T6 respectively). Table 1 shows the inventories and pitch values of the tones in Mandarin and Cantonese.

The orthography system of Mandarin Chinese includes Chinese character and Pinyin. Chinese character is the major writing system that has a history of several thousand years. Chinese characters are logographic and represent meaning directly but provide few cues for pronunciation. For example, the character 馬 (/ma/ with a falling-rising tone) means 'horse', giving no information about its pronunciation. In spoken Mandarin, each Chinese character carries a tone (except for some words that only carry the 'neutral tone'). In writing system, Chinese character gives no clue about tone. The word 馬 carries tone 3 (T3; falling-rising), but people cannot get the tone information from the character. Pinyin was only introduced in 1950s, with the aim to represent Mandarin pronunciation. Using Pinyin, the word 馬 is written as mǎ (/ma/ with a falling-rising tone) in which the symbol above the letters stands for the tone (T3). Therefore, tone information is transparent in Pinyin but opaque in Chinese character.

Nowadays, Pinyin is widely used, because all the first language and most second language learners have to learn Pinyin at the beginning stage, together with the characters. Moreover, people, especially Mandarin native speakers, commonly use Pinyin as input method to type Chinese characters when they communicate online or using mobile devices.

Table 1. *Mandarin and Cantonese tonal inventories and pitch values on a 5-point scale from low (=1) to high (=5)*

	Mandarin		Cantonese	
T1	55 (mā)	High-level	55	High-level
T2	35 (má)	Mid-rising	25	High-rising
T3	214 (mǎ)	Falling-rising	33	Mid-level
T4	51 (mà)	High-falling	21	Low-falling
T5	--	----	23	Low-rising
T6	--	----	22	Low-level

What is the role of orthography in second language acquisition? Some previous studies found facilitation effect of orthography in second language acquisition. For example, Young-Scholten and Archibald [5] found that orthography helps language learners to retain phonological information of words in memory; Silveria [6] used it to account for the pronunciation difficulties at the sublexical level. However, most of the previous studies focused on alphabetic writing systems, in which letter and phoneme have certain correspondence. It is thus not surprising to find that orthography can facilitate pronunciation in these languages.

What about languages with an opaque writing system like Chinese? Do the opaqueness of Chinese character and the transparency of Pinyin play different roles in second language acquisition? A pilot study by Zuo, Chen and Mok [7] investigated the role of Chinese character and Pinyin in L2 perception and production of Mandarin tones by Cantonese speakers. They found that the opaque orthography (Chinese characters) hinders tone production but facilitates tone perception. However, the results are only tentative because of the limited stimuli. Only 128 Pinyin tokens (2 monosyllabic words × 4 tones × 16 speakers) and 128 Chinese character tokens (2 monosyllabic words × 4 tones × 16 speakers) were used. The two words for Pinyin task are mi [mi] and na [na] and the two words for Chinese character task are ya [ja] and wu [wu]. These tokens were of simple structure: a consonant followed by a monophthong, so they can be correctly produced easily. Given that the Chinese Pinyin system can be more complex with diphthong and final consonant, a good understanding about the effect of Pinyin requires more comprehensive stimuli. Therefore, based on the pilot study of Zuo, Chen and Mok [7], the present study aims to further investigate the role of Chinese character and Pinyin in L2 production of Mandarin tones by Cantonese speakers.

Although Mandarin and Cantonese have two different phonological systems, they have some regular correspondence in terms of tones as shown in Table 2 [8]. For example, 93% of Cantonese T1 syllables are pronounced as T1 in Mandarin, and 89% of Cantonese T2 words are pronounced as T3 in Mandarin. The three checked tones are not listed here, as they do not have clear corresponding relationship with any particular Mandarin tones. Chu [9] conducted a series of experiments and stated that Cantonese learners of Mandarin

are aware of the tonal correspondence rules, and they use them in Mandarin word production.

Table 2. Cantonese-Mandarin tone correspondence [8]

Cantonese Tone	Mandarin Tone	%Correspondence
T1[55]	T1[55]	93%
T2[25]	T3[214]	89%
T3[33]	T4[51]	91%
T4[21]	T2[35]	93%
T5[23]	T3[214]	76%
T6[22]	T4[51]	94%

Despite having different phonological systems, Mandarin and Cantonese share the same orthography (Chinese characters). Chu [9] suggested that the shared orthography (Chinese characters) might be a source of negative transfer, because it may activate the L1 phonological representations. The opaqueness of the characters may cause the listeners unconsciously taking the homophones in their L1 (Cantonese) as homophones in their L2 (Mandarin), resulting in mispronunciations of Mandarin tones.

The present study investigates the effect of different orthography systems on the production of Mandarin tones by Cantonese speakers. Our research questions are: Given that Pinyin is more transparent than Chinese characters and it is not shared by the Cantonese orthography system, would Pinyin and Chinese characters affect L2 production differently? Does the shared orthography (Chinese characters) hinder L2 tone production across non-native speakers of different L2 proficiencies? If non-native speakers could unconsciously use the correspondence rules to retrieve L2 phonology, different L2 proficiencies may affect how successful they can be in retrieving the correct pronunciation.

2. Method

2.1. Subjects

In this study, we report the preliminary data from eleven subjects first. More subjects are still being recruited. All of the subjects are native speakers of Hong Kong Cantonese, and they are all university students studying at the Chinese University of Hong Kong. Most of them started to learn Mandarin through formal education from primary school, where pinyin was taught in Mandarin classes from the very beginning. However, since Mandarin is not a compulsory subject in public examinations in Hong Kong, there is no objective measure to assess their Mandarin proficiency.

All of the subjects have participated in our parallel study on the perception of Mandarin tones [10]. They were asked to judge the tones of a list of words that they heard. Based on their accuracy scores in the perception study, these subjects were divided into two groups: eight of them are of high proficiency (averaged accuracy 97.9%) and three of them are of low proficiency (averaged accuracy 88.5%).

2.2. Materials

The production experiment consists of two parts: a Pinyin task and a Chinese character task. Both monosyllabic words and disyllabic words were used in the two tasks. In the Pinyin task, two monosyllabic syllables with all four tones were selected as the target sounds, resulting in eight tokens (2 monosyllables × 4 tones). 96 disyllabic tokens were selected in which the tones of the first syllables Table 2. *Cantonese-Mandarin tone correspondence* [8]and the second syllables have been controlled: there are sixteen tone combinations and each combination had six items (4 possible tones for first syllable × 4 possible tones for second syllable × 6 items). All the monosyllabic and disyllabic tokens can stand alone as words in Mandarin. To sum up, there are 200 syllables (8 monosyllables + 96 disyllabic words ×2 syllables) in the Pinyin task, and each syllable carries a tone. The Pinyin token was presented to the subjects in the standard form of Pinyin (e.g. xīng), where the symbol above the letters represents the tone. In the Chinese character task, 34 monosyllabic words (10 T1 + 6 T2 + 8 T3 + 10 T4) and 96 disyllabic words (4 possible tones for first syllable × 4 possible tones for second syllable × 6 items) were selected, which resulted in 226 syllables (34 monosyllables + 96 disyllabic words×2 syllables), and each syllable carries a tone.

2.3. Procedures

The production experiment was conducted in a quiet room at the Chinese University of Hong Kong. The stimuli were presented to the subjects on paper. They were required to read the monosyllabic stimuli first and then the disyllabic stimuli. For both types of stimuli, the Pinyin tokens came before the Chinese character tokens. Three repetitions were recorded. The recordings were taken with a solid state recorder with a sampling rate of 44100Hz. Table 3 shows the details of the tokens collected from both groups of subjects.

Table 3. *Number of tokens collected in the Pinyin and Chinese character tasks*

	8 high proficiency subjects				3 low proficiency subjects			
	P_m	P_d	C_m	C_d	P_m	P_d	C_m	C_d
T1	48	1152	216	1152	18	432	81	432
T2	48	1296	192	1296	18	486	72	486
T3	48	1008	192	1008	18	378	72	378
T4	48	1152	216	1152	18	432	81	432

Note: P_m: Pinyin_monosyllabic; P_d: Pinyin_disyllabic; C_m: character_monosyllabic; C_d: character_disyllabic

The tones produced in all the recordings were transcribed by two native Mandarin speakers with training in phonetics. The agreed transcriptions were accepted as the actual tones produced by the speakers. For the tokens that the two transcribers could not agree on, a third transcriber was invited to give judgment. If the tokens could be agreed on by any two of the three transcribers, then they would be included for further analysis; otherwise, they would be excluded. In the Pinyin stimuli, only 1 token was not agreed by any two of the three transcribers; 3 tokens were considered by all three transcribers as not being any of the four Mandarin tones. In the Chinese character stimuli, 2 tokens were not agreed by any two of the three transcribers. These tokens were excluded for further analysis.

Speech rate was also calculated with the recordings of disyllabic words (number of syllable/second) to confirm the

difference in proficiency between the two groups. Three subjects who received the highest scores in the perception experiment were compared with the three subjects of low proficiency. Ten disyllabic tokens were randomly selected from the Pinyin stimuli and Chinese character stimuli respectively. The tokens used for analysis were the same across all six subjects. Duration of the disyllabic tokens was measured, and speech rate was then calculated.

3. Results

3.1. Overall error rates

Among all the subjects with high proficiency, 212 production errors were found among the 4799 tokens collected in the Pinyin task; 213 production errors were found among the 5424 tokens collected in the Chinese character task. Among the subjects with low proficiency, 483 production errors were found among the 1793 tokens collected in the pinyin task; 191 production errors were found among the 2032 tokens in the Chinese character task. Table 4 shows the two groups of subjects' overall error rates in the Pinyin task and the Chinese character task. It is found that the subjects with high proficiency perform better than those with low proficiency, with comparable error rates in Pinyin and character tasks; while the subjects with low proficiency made many more errors in the Pinyin task than in the character task.

Table 4. *Error rates in Pinyin and Chinese character tasks*

Subjects	Pinyin task	Chinese character task
H	4.4%	3.9%
L	26.9%	9.4%

Note: H: High proficiency; L: Low proficiency

3.2. Tonal error patterns

The error rates (%Err) and error pattern of tones of all the subjects are shown in Figure 1. For the tone pairs (x axis), '21' means the original tone is T2 and its realization in the recording is T1, and so on. There is a total of 12 tone error pairs.

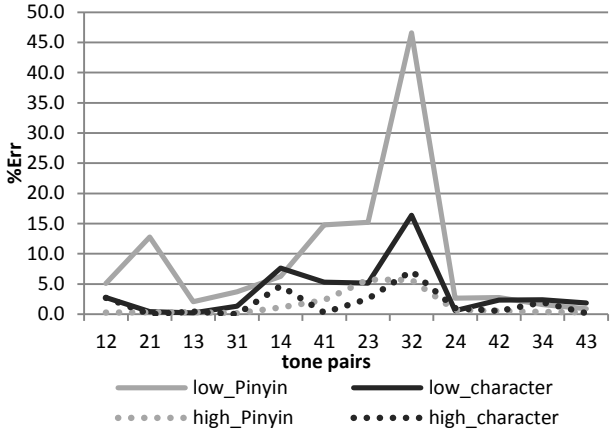

Figure 1: *Error rates (%Err) of all the confusable tone pairs of subjects with high and low proficiency*

The error rates are consistently higher in the subjects with low proficiency than in the subjects with high proficiency in both tasks. Repeated measure confirmed that proficiency has a significant effect on the error rates in the production experiment [$F(1,8)=119.94$, $p<0.001$].

Turning to tone errors, for both subject groups, T2-T3 is the most confusable tone pair, followed by T1-T4. It is worth noticing that the subjects with low L2 proficiency had obviously better performance in the Chinese character task than in the Pinyin task; while the subjects with high L2 proficiency had more comparable performance in the two tasks. ANOVA repeated measures were conducted with proficiency as between-subject factor, and orthography and tone pairs as within-subject factors. The result suggested a significant interaction effect ($F(1,8)=9.15$, $p<0.05$), showing that orthography had a significant effect ($F(1,8)=5.78$, $p<0.05$) on the error rates depending on the proficiency of the subject.

3.3. Speech rate

Speech rate was calculated to confirm the difference in proficiency between the two subject groups, as indicated in Table 5. The result shows that the subjects with high proficiency have a higher speech rate than the subjects with low proficiency. More importantly, it indicates that the subjects could process and read Chinese characters faster than Pinyin. Two-way ANOVA repeated measures confirm the result, showing a marginal effect of proficiency [$F(1,58)=3.98$, $p=0.051$] and a significant main effect of orthography [$F(1,58)=24.74$, $p<0.001$] on the speech rate of the subjects.

Table 5. *Speech rate of subjects (syllable/second)*

Task	High proficiency	Low proficiency
Character	2.19	1.89
Pinyin	1.91	1.76

4. Discussion

This study examines Cantonese speakers' production of Mandarin tones when they are presented with Pinyin and when they are presented with Chinese characters, aiming to investigate the effect of orthography in L2 tone production.

We found that the subjects with low proficiency made significantly more errors in the Pinyin task than in the character task, while the subjects with high proficiency had comparable performance in both tasks.

The subjects with low proficiency perform better in the character task than in the Pinyin task because of the facilitation of Chinese character, which could be accounted for by the Revised Hierarchical Model (RHM) [11] and the high correspondence between Cantonese tones and Mandarin tones [8]. RHM suggests that the L1 has privileged access to L1 lexicon, while the L2 requires mediation via the L1 translation equivalent until the bilingual has acquired high enough L2 proficiency to access to L2 lexicon directly. Based on RHM, the Chinese characters gave the subjects direct access to the entry in Cantonese (L1) lexicon, which resulted in the activation of Cantonese pronunciation. Since Cantonese tones and Mandarin tones have high correspondence [8], the subjects could unconsciously make use of the correspondence rules [9] to retrieve Mandarin tones. How well the subjects can successfully retrieve the L2 phonology through the correspondence rules depends on their L2 proficiency [11]. Therefore, in the present study, the subjects with low proficiency perform better in Chinese character task than the

Pinyin task because of the mediation effect of Cantonese tones; while they made more errors than the subjects with high proficiency, due to the lower L2 proficiency.

In contrast to Chinese character, Pinyin is not used in Cantonese orthography system. Pinyin thus cannot activate Cantonese lexicon as Chinese character does, so Cantonese pronunciation cannot act as mediation between Pinyin and Mandarin pronunciation. What is more, Pinyin is used much less often by Cantonese speakers than by Mandarin speakers, for example, most of them do not use Pinyin as online input method as Mandarin speakers do. During the recording, it was observed that the subjects, especially the ones with low proficiency, usually spent a lot of time recognizing the segments and spelling the syllable. They often practiced a few times for one syllable before making the final decision, and each time the syllable was produced with different tones. Based on this observation, it is possible that the subjects with low proficiency were focusing on the combination of various segments but paid little attention to the tones, resulting in many tone errors. Therefore, the unfamiliarity with Pinyin could be another main reason why the subjects with low L2 proficiency made a lot more tone errors in the Pinyin task than in the character task. This conclusion is also supported by the fact that the subjects could process and read Chinese characters faster than Pinyin (Table 5).

Another finding is that T2-T3 and T1-T4 are the two most confusable tone pairs both in the Pinyin and the character tasks, across the two subject groups, in accordance with previous findings [12 13 14]. As mentioned in previous paragraphs, according to RHM and Chu's assumption of correspondence rules [9], Chinese characters activate Cantonese pronunciation first, and the subjects unconsciously use the correspondence rules to retrieve Mandarin tones. For those syllables that cannot successfully help retrieve Mandarin tones, the subjects would mistakenly produce them with the tones in Cantonese. For example, according to Table 2, if a word carries T3 [214] (falling rising) in Mandarin, it is very likely to be originally produced as T2 [25] (rising) or T5 [23] (rising) in Cantonese, both of which sound quite similar to T2 [35] (rising) in Mandarin. Therefore, if the subjects failed in using the correspondence rules to retrieve Mandarin tones, there is a high chance for them to produce T3 as T2, which confirms with the error results in the present study. Similarly, according to the correspondence rules, Mandarin T2 [35] corresponds to Cantonese T4 [21]. In Mandarin, the pitch value [21] is an underlying form of T3 [214] (falling-rising) [15], because when T3 is followed by another non-T3-tone, the rising part is usually not produced. When the subjects are using the correspondence rules in Mandarin tone production, they tend to produce Chinese character with Mandarin T2 [35] as Cantonese T4 [21] that sounds like a Mandarin T3 [214]. That Mandarin T4 [51] is produced as T1 [55] can be explained in the same way.

In addition, why do Cantonese speakers often produce Mandarin T1 [55] as T4 [51]? Matthews and Yip [16] suggest that Cantonese T1 [55] (high-level) has an allotone [53] (high-falling), so Cantonese speakers do not treat the two realisations as contrastive in Cantonese. Therefore, under the L1 influence, the subjects tend to mix up T1 [55] (high-level) and T4 [51] (high-falling) in Mandarin.

The confusable tone pair T2-T3 in Pinyin task cannot be explained by the opaqueness of Chinese character, but are possibly due to L1 negative transfer. According to the Perceptual Assimilation Model (PAM) [17], L1 experiences affect L2 phonological acquisition, and L2 learners tend to assimilate the L2 phones to their native phonemes. Mandarin T3 [214] (falling-rising) has no equivalence in Cantonese, so the subjects may assimilate Mandarin T3 to either a falling tone T4 [21] or a rising tone T2 [25] in Cantonese. As suggested by [7], the presence of tone sandhi [18] in Mandarin and the acoustic similarities could also account for the T2-T3 confusion.

5. Conclusions

The preliminary results of the current study have shed some light on the effect of orthography in L2 tone production. In L2 production of Mandarin tones, the opaque Chinese character would firstly activate the L1 phonology, and Cantonese speakers may use the correspondence rules between the two tone systems to retrieve the L2 phonology. Therefore, compared to Pinyin, Chinese character has facilitation effect in L2 production of Mandarin tones, although the performance also depends on the non-native speakers' L2 proficiency. More data are currently being collected and hope they can corroborate the results here. In future studies, non-native learners at different learning stages could be recruited to further investigate whether and how the role of Pinyin and Chinese character would change in L2 learning process, and how they relate to native and non-native lexicon.

6. References

[1] Chao, Y. R. "Tone and intonation in Chinese." Bulletin of the Institute of History and Philosophy 4:121–134, 1933.

[2] Vance, Timothy J. "Tonal distinction in Cantonese", Phonetica 34: 93-107, 1977.

[3] Bauer, R. S., and Benedict P. K. Modern Cantonese phonology. Mouton de Gruyter, 1997.

[4] Kao, D. L. Structure of the Syllable in Cantonese. The Hague, Mouton, 1971.

[5] Young-Scholten, M. and Archibald, J., "Second language syllable structure", in J. Archibald [Ed], Second Language Acquisition and Linguistic Theory, 64-97, Blackwell, 2000.

[6] Silveria, R., "Investigating the role of orthography in the acquisition of L2 pronunciation: a case study", in M. A. Watkins, et al. [Ed]. Recent Research in Second Language Phonetics/Phonology, 270-290, 2009.

[7] Zuo, D.H., Chen, Q.Y. and Mok, P.P.K. "Does Orthography Affect L2 Tone Production and Perception?" In Proceedings of the Third International Symposium on Tonal Aspects of Languages (TAL 2012). Nanjing.

[8] Zhang, L., & Gao, S. "Putonghua zi yin ren ji xun lian 12 jiang", [12 Lecture series of the recognition and memorization of Mandarin pronunciation]. Joint Publishing Co. Ltd. 2000.

[9] Chu, P. C. K. "Towards a Model of Second Language Word Production and Recognition in Mandarin". Proceedings of the International Conference on Chinese Language Learning and Teaching in the Digital Age, Hong Kong, China, 2011.

[10] Xu, R. B., Li, J., and Mok P. P. K. "The Effect of Orthography on L2 Perception", submitted to The 4th International Symposium on Tonal Aspects of Languages, 2014.

[11] Kroll, J.F., Stewart, E. "Category interference in translation and picture naming: Evidence for asymmetric

connections between bilingual memory representations." Journal of Memory and Language. 1994;33:149–174.
[12] Lee, Y.-S, Vakoch, D. A., and Wurm, L. H. "Tone perception in Cantonese and Mandarin: a cross-linguistic comparison," J. Psycholinguist. Res., 25(5), 527–542, 1996.
[13] Hao, Y.-C. "Second language acquisition of Mandarin Chinese tones by tonal and non-tonal language speakers," J. Phon., vol. 40, no. 2, pp. 269–279, 2012.
[14] C. K. So and C. T. Best, "Cross-language Perception of Non-native Tonal Contrasts: Effects of Native Phonological and Phonetic Influences," Lang. Speech, vol. 53(2), 273–293, 2010.
[15] Duanmu, S. "The Phonology of Standard Chinese". Oxford University Press, 2007.
[16] Matthews, S., and Yip, V., Cantonese: a comprehensive grammar, 1994.
[17] Best, C. T., "A direct realist view of cross-language speech perception", In W. Strange (Ed.), Speech perception and linguistic experience: Issues in cross-language research, 171-204, 1995.
[18] Shih, C. "The Prosodic Domain of Tone Sandhi in Chinese". Ph.D dissertation, University of California, San Diego. 1986.