The Acquisition of L2 Mandarin Vowels in Context[*]

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Abstract

This study examined the effect of L1/L2 vowel phonetic similarity and L1 vowel inventory size on the acquisition of L2 Mandarin vowels in context. Thai and American English L2 learners and Beijing Mandarin speakers participated in this study. The findings of this study showed that L1/L2 vowel similarity could predict the learning of some vowels (i.e., similar, identical and different vowels), but not others and the predictability based on vowel similarity was L1 specific. It was also shown that an L1 with a larger vowel inventory had advantage in acquiring an L2 vowel system over another L1 with a smaller vowel inventory. It was argued that the involvement of more dimensions in an L1 with a larger vowel inventory size may have facilitated the L2 learners in the comparison L1 and L2 vowels as well as category (non-) establishment for L2 vowels. However, the specific mechanism for such advantage begs for future studies. The findings of this study showed that it was difficult to predict the learning difficulty in acquiring L2 vowels in that so many factors are intertwined together (L1/L2 phonetic similarity, L1/L2 sound inventory size, L2 learners' proficiency level, and even individual differences). Future SLA studies should take more factors into consideration.

Keywords: vowel acquisition, Thai, American English, vowel inventory, vowel similarity

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1. Introduction

When learning a second language (L2), learners process L2 through their native linguistic system. It is widely attested that L2 learners have difficulty in achieving native-like phonology, as can be seen in the phenomena of the so-called "foreign-accented" speech. The first language (L1) sound system has long been observed to influence the acquisition of L2 phonemes (Polivanov 1931). Trubetzkoy (1969) believes that the inadequate production of L2 sounds has a perceptual basis, arguing that the L1 sound system acts as a "phonological filter" through which L2 sounds are perceived and categorized. Escudero (2005:2) attributes the origin of a foreign accent to the use of language-specific perceptual strategies that are entrenched in the L2 learner and can not be avoided when encountering L2 sound categories.

The acquisition of L2 vowels is widely researched (Flege MacKay and Meador 1999; Flege and MacKay 2004; Iverson and Evans 2007, 2009; Vasiliev 2013; Elvin Escudero and Vasiliev 2014, among many others). These studies have examined the effects of acoustic similarity and L1 inventory size on the acquisition of L2 vowels. With respect to the acoustic similarity of L1 and L2 sounds, the contrastive analysis hypothesis (Weinreich 1953; Lado 1957) predicts that L2 sounds different from L1 pose most difficulty, the predictions of which were confirmed in some studies. For example, Shi and Wen (2009) showed that new/different vowels posed difficulty for English-speaking L2 learners of Mandarin Chinese. However, more recent L2 learning models make further distinction of L2 sounds. For example, in the Speech Learning Model (referred to as SLM hereafter) (Flege 1995), L2 sounds may be perceived as being new, similar or identical as compared to L1 sounds, and similar sounds, but not new one, pose most difficulty for L2 learners in the long run, in that the equivalence classification may prevent L2 learners from establishing a new category for similar L2 sounds.

As regard the effect of the L1 vowel inventory size on L2 vowel acquisition, there are mixed findings. Some studies showed that L1 vowel inventory size influences L2 perception (Scholes 1968; Fox et al. 1995; Bradlow 1995; Iverson and Evans 2007, 2009), as learners with larger L1 vowel inventory use more dimensions in their vowel production. Elvin, Escudero, and Vasiliev (2014), however, found that vowel inventory size (even when acoustic similarity is assumed) wasn't sufficient to predict L2 discrimination difficulty unless detailed acoustic comparisons (such as by the Euclidean distance between

target vowel contrasts and native vowels) are made.

Most previous research on L2 vowel acquisition in Mandarin Chinese examines the vowel production (and perception) in a word list or in very limited contexts, such as disyllabic words (Wang 2001; Shi and Wen 2009; Xie 2013). While experimental studies with highly restrained data have provided insight into the acquisition of L2 vowels and contributed to our understanding of the process of L2 speech learning, more attention should be directed at the vowel production in L2 spontaneous speech, at least in L2 speech which is close to spontaneous speech in that controlled experimental data may not reveal the actual realization of speech production, at both segmental and suprasegmental levels (Yang 2014). While spontaneous speech definitely contributes to our further understanding of L2 speech, the use of spontaneous speech in SLA studies, however, falls prey to some issues as well. One big challenge is that it is difficult to draw definitive conclusion based on the spontaneous speech due to the possible confounding factors in spontaneous speech. Even so, we argue that SLA studies using spontaneous speech or alike should be conducted to complement studies using highly controlled data in order to provide a thorough understanding of L2 acquisition mechanism.

It is in this spirit that this study was conducted. The study focuses on two learner groups of Mandarin Chinese, English and Thai L2 learners, and addresses the following questions:

(1) What is the variability of vowels in a reading passage produced by L2 American and Thai learners? What is the difference between these two learner groups and the native group?

(2) Are different types of vowels (identical, similar and new ones) acquired in the same manner in the two learner groups?

(3) What are the effects of acoustic similarity and L1 vowel inventory size upon L2 vowel acquisition?

2. Vowels in Mandarin Chinese, American English and Thai

Mandarin Chinese has 5 vowel phonemes, /i, y, u, ə, a / (Chao 1968; Cheng 1973; Duanmu 2000; Lin 2007; Shi and Wen 2009). /a/ has three allophones, [ɛ], [a] and [ɑ], and /ə/ has four allophones [e], [ə], [o], and [ɤ], in predictable phonological contexts (Lin

2007:76-78). In addition, there are two apical vowels, [ɿ] after dentals and [ʅ] after retroflexes in Mandarin Chinese (Karlgren 1915,1916). Chao (1968:24) and Duanmu (2000:36-37) consider the apical vowels to be syllabic voiced fricatives, namely, /ʐ̩/ after the post-alveolars and /ʑ/ after the dentals, whereas Lee and Zee (2003) consider the apical vowel to be a syllabic dental (alveolar) approximant after dentals, and syllabic post-alveolar approximant after post-alveolars. While we acknowledge that both views on Chinese apical vowels are reasonable and capture the nature of these vowels, this study includes one apical vowel in the analysis and treat it as an independent vowel, in that apical vowels tend to pose more difficulty for L2 learners.

American English has 12 monothongs /ɑ, ʌ, i, ɪ, u, ʊ, ɔ, o, ɜ, ə, æ, ɛ/ (Wells 1990). While seemingly Thai has a more complicated vowel system and has 18 vowels, namely, /a, aː, ɛ, ɛː, ɔ, ɔː, e, eː, ɤ, ɤː, o, oː, i, iː, ɯ, ɯː, u, uː/, there are only 9 vowels, which can be both short and long (Abramson 1974; Gandour 1984; Abramson and Ren 1990; Tingsabadh and Abramson 1993). In this sense, American English has a larger vowel inventory than Thai.

In these three languages, English vowels contrast for lax and tense, and Thai vowels contrast for length, while Mandarin vowels contrast for neither.

This study focuses on six Mandarin vowels, [i, ʐ̩, y, u, ɤ, a], namely, four high vowels, one mid vowel and one low vowel. For American English L2 learners, [i] is an identical vowel, [a, ɤ, u] are similar vowels, and [ʐ̩, y] are new vowels (Shi and Wen 2009; Wu and Shi 2012; Xie 2013). Note that Lin (2007:60) considered Mandarin [a] and [ɤ] to be new vowels for English L2 speakers in that Mandarin/a/ is front/central and low, whereas English [a] is back and low, and Mandarin [ɤ] only occurs in open syllables. Also Wu and Shi (2012) considered Mandarin [a] to be an identical vowel for English L2 learners. However, since both Mandarin [a] and [ɤ] may have counterparts in English, although not identical, they were considered to be similar to English vowels. As for Thai speakers, [i, u, ɤ] are identical vowels, [a] is a similar vowel, and [ʐ̩, y] are new vowels (Tumtavitikul 1996; Cai and Lee 2015).

The relationship between Mandarin vowels and Thai and English vowels is summarized in Table 1.

Table 1: Relationship Between Mandarin, English, and Thai Vowels

Mandarin vowels	American L2 group	Thai L2 group
Identical	[i]	[i, u, ɤ]
Similar	[a, u, ɤ]	[a]
New/different	[ɻ̩, y]	[ɻ̩, y]

Flege (1995) pointed out that the cross-language (dis-) similarity should be measured by L2 learners' perception of L2 sounds, as compared to L1 ones (i.e., to prepare pairs of L1 and L2 phones and ask L2 learners to judge their similarity), instead of the acoustic phonetic measurements, especially those derived from published studies of the L1 and L2 employing different techniques. It should be noted that the mappings of the vowels in the three languages in Table 1 were not based on such perceptual measurements.

In terms of vowel inventory size, both Thai and English have larger vowel inventory than Mandarin Chinese and Thai's vowel inventory size is closer. However, it should be pointed out that although Mandarin has 7 vowels, the allophones of some vowels may assume the phonemic status in Thai and English.

3. Studies on the Acquisition (Production) of L2 Mandarin Vowels

Previous studies have examined the acquisition of Mandarin vowels by L2 learners. Most of these studies work within the framework of SLM and test SLM's predictions on the learning of different types of vowels, such as the new, similar and identical vowel categories, by L2 learners. Shi and Wen (2009) found that the new vowels [ɻ̩, y] are the most difficult and the similar vowels [u, ɤ, a] are not as difficult as the new vowels. Meanwhile, the similar vowels also pose some difficulty. For example, [a] produced by the American learners is higher and [u] by the American learners is more front (Shi and Wen 2009). It should be noted that Shi and Wen (2009) did not indicate the proficiency level of the American L2 learners. Suppose that the L2 learners are at the beginning/intermediate stage, the findings were somewhat predicted (Flege 1995). By contrast, Wen (2010) found that new vowels were acquired better by American L2 learners at the more advanced level. Similarly, Xie (2010) found that similar vowels were acquired better in the beginning, but were not acquired as well as the new vowels at the high level. Xie (2013) argued that previous studies on the acquisition of L2 Mandarin vowels support Major's proposal (2001),

namely, in the beginning, similar vowels are acquired better; however, later new vowels are acquired better than the similar vowels, and the less marked new vowels are acquired better than the more marked new vowels, in that transfer plays a more important role in the initial state and markedness tends to exert more influence on L2 vowel acquisition at the later stage. Wu and Shi (2012), however, found that the third- or fourth-year English learners of Mandarin had difficulty with both the new vowel /y/ (higher F1 and lower F2, more similar to L2 /u/) and the similar vowels /a/ (which was produced as /ɑ/, a more back vowel) and /u/ (which was not as back as the one produced by native speakers and was not rounded sufficiently). To sum up, previous studies have not reached any definitive conclusion on the learning of the new and similar Mandarin vowels by American English speaking L2 learners.

Hao (2012), although not a production study, is worth mentioning. Hao (2012) examined the effect of L1 experience on the learning of Mandarin vowels, consonants and consonants by experienced, inexperienced and novice L2 listeners, through a series of experiments, such as assimilation, discrimination and categorization tasks. Hao's L2-L1 vowel assimilation task showed that experienced American English learners tended to predominantly assimilate Chinese [i] to English [i] (94%), Chinese [u] to English [u] most of the time (around 85%), Chinese [y] to English [u] often (81%), and Chinese [ɻ̩] to English [ɝ] half of the time (around 57%). Hao also found that L2-L1 assimilation patterns did not predict L2 discrimination; the assimilation, however, was found to be a good indicator of learning effect.

As compared to the studies on the American L2 learners' acquisition of Mandarin vowels, studies on Thai L2 learners are rather limited. In one study, Chen et al. (2012) found that Thai L2 learners produced [a, ɤ, y] similarly to native speakers, but their [u] was more similar to [y]. The Thai L2 learners also had difficulty in their production of apical vowels, which were widely dispersed in the vowel space and were inconsistent, e.g., the dental apical vowels were sometimes produced even after the post-alveolar apical vowel.

Although there are quite a few studies on the acquisition of Mandarin vowels by L2 learners, especially American L2 learners, most studies used monosyllables or disyllables in isolation or in a carrier sentence, no reading passage or spontaneous speech has been used. Meanwhile, the approaches of analyzing L2 vowels differ dramatically, rendering the findings in these studies hard to be compared and contrasted.

In this study, we focus on the vowel production of two L2 learner groups in a reading passage. The analysis of vowel production focuses on two most important acoustic parameters, F1 (which associates with the height of a vowel) and F2 (which associates with the frontness of a vowel). With the more objective measurement of L2 vowel production, it is expected that the effects of acoustic similarity and L1 vowel inventory size can be more objectively examined.

Based on the literature review and the comparison of the vowel systems in the three languages concerned, the following hypotheses are proposed:

Hypothesis 1: The two groups of L2 learners in this study were at the intermediate or advanced level. According to SLM (i.e., new and identical sounds may not pose difficulty for L2 learners), it is predicted that [i, ɻ̩, y] will be easier for American L2 learners, and [ɻ̩, y, i, u, ɤ] will be easier for Thai L2 learners. Drawing on Hao's (2012) finding, namely, the L2-L1 assimilation pattern is a better indicator of L2 learning, it is further predicted that [i] will be produced very well by the American learners, while [ɻ̩] not so well, and [y] the worst among these three vowels.

Hypothesis 2: According to SLM, similar but not identical sounds may pose more difficulty to L2 learners due to equivalence classification. Therefore, it is predicted that [a, u, ɤ] will be difficult for American L2 learners, and [a] will be difficult for Thai L2 learners. However, based on Hao (2012), [u] by American L2 learners will be produced very well by the American L2 learners, the reverse of the prediction based on SLM.

Hypothesis 3: In addition to the acoustic similarity between L1 and L2, the vowel inventory size in L1 influences the acquisition of L2 vowels. Therefore, it is predicted that L2 English learners with a larger L1 vowel inventory will acquire Mandarin vowels better than L2 Thai learners with a relatively smaller L1 vowel inventory.

4. Methodology
4.1 Participants

20 American English-speaking L2 learners and 20 Thai-speaking L2 learners of Mandarin Chinese participated in this study. 20 Beijing Mandarin speakers served as the

control group. The English L2 participants and the Beijing Mandarin speakers were recruited in a mid-western state university in the US, while the Thai L2 learners were recruited in a big university in Tianjin, China. Both groups of L2 learners were at the intermediate level or advanced level (having learned Chinese as a second/foreign language more than three years). More information about the participants is shown in Table 2.

Table 2: Demographic Information of the Three Groups of Participants

Group	Age (SD)	Duration of learning (SD)	Duration of study abroad (SD)	Gender	
				Male	Female
Native	23.15 (4.23)	n/a	n/a	7	13
American	24.25 (3.29)	4.4 (2.9)	1 (0.75)	16	4
Thai	24.55 (1.99)	5.3 (1.8)	2.13 (1.42)	15	5

4.2 Speech Stimuli and Recording Procedure

The speech material in this study was elicited by asking the participants to read a short passage that was adapted from an intermediate-level Chinese textbook for L2 learners (see Appendix for the passage). The passage was the first lesson in the textbook, meaning that the text was based on the first-year Chinese textbook. It was expected that L2 learners would have no or little difficulty in reading and comprehending such a passage. Prior to reading, the L2 learners read through the passage and could ask the researcher/assistant any character that they did not know (actually, only a few L2 learners did not recognize the character 拾 *shi* in 收拾 *shoushi* "to tidy up").   Then, they read the passage at normal speech rate and their reading was recorded.

The reading of the passage was recorded to a computer with a Samson C01U microphone in a recording studio or a quiet room at each venue. The program used for recording was Audacity. The recording input was digitized at 44.1 kHz with a 24-bit resolution.

The sound files were saved in .wav format for acoustic transcription measurement in Praat (Boersma and Weenink 2015).

4.3 Transcription and Measurement

The reading passage used in this study contained six monothongs of Mandarin Chinese, namely [a, ɤ, ɭ, i, u, y] as in 把 ba,和 he (one variant for the mid vowel), 時 shi, 已 yi,五 wu, and 去 qu. Each syllable occurred in the passage two or three times. Although these syllables do not occur in the unstressed syllables, they might surface as unstressed/unaccented in the context. Therefore, only stressed syllables (i.e., the vocalic intervals only) containing these six vowels were transcribed with Praat.

After transcription, the F1 and F2 values of each vowel were measured by running a Praat script, ProsodyPro (Xu 2013), with manual corrections, if any.
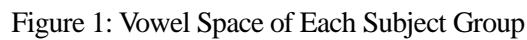
4.4 Data Analysis

Vowels of different speakers vary considerably, especially between different genders. Therefore, it is of great importance to normalize vowels produced by different participants. In this study, we adopted the z-score vowel normalization as proposed in Lobanov (1971). The normalization of F1 and F2 was conducted with the Vowels package in R (Kendall and Thomas 2010). Since each vowel was repeated two or three times by each participant, the Hertz values of F1 and F2 of each vowel were averaged prior to the normalization process.

With the normalized F1 and F2 values, different vowels were compared and contrasted across groups respectively.

5. Results
5.1 Vowel Space of the Three Groups

Figure 1: Vowel Space of Each Subject Group

Note: when plotting the vowels, the IPA of [ɤ, ɻ̩] can not be shown. Therefore, /e/ is used to represent /ɤ/ and /I/

for /ɻ̩/)

To visually examine the vowel space of the different groups, the normalized values of F1 and F2 for each vowel are plotted in Figure 1.

The upper left panel shows the vowel space of the native group. It can be seen that [i] is fronter and higher than [y], which, in turn, is higher and more forward than [ɻ̩]. The upper right panel and the bottom left panel show the vowel space of the American and Thai L2 groups. To compare the vowel space (i.e., the distribution of different vowels in the vowel space), it can be seen that the vowel system of the American L2 group is more similar to that of the native group than that of the Thai L2 group. For the Thai L2 group, it seems that their L2 Chinese vowels differ by the [high] and [low] features only in terms of

height. Specifically, [a] is low, while the other vowels are all high. By contrast, the vowels in the native group and the American L2 group contrast for three levels in height, namely, [high], [mid], and [low]. Another major difference between the Thai L2 group and the other two groups is the distribution of [i], [ɻ], and [y]. Different from the native group and the American L2 group, [y] in the Thai group is the most forward among these three vowels, and [i] and [ɻ] do not differ in terms of frontness. As a result, the [u-y] distance for the Thai group is longer than that in the other two groups, while the Thai group's [i-ɻ] distance is the closest among the three groups.

Also Figure 1 shows that the tongue position for the Thai L2 learners was lower than that for the Chinese native speakers and English L2 learners. It is speculated that this may be due to the first language (L1) influence. However, another study is needed to compare the tongue position of the three groups when they produce vowels in their L1s.

5.2 Statistical Analysis of F1 and F2 Across Groups

Analyses of variance were conducted on the normalized values of F1 and F2 of different vowels, with Group as the between-subject factor. When there was a significant difference, TukeyHSD tests were further conducted to examine the pairwise analysis. The ANOVA and TukeyHSD results are presented in Table 3.

Table 3: ANOVA and TukeyHSD results on F1 and F2 comparison across vowels and groups

Vowel		F and p	Pairwise comparison
[a]	F1	$F(2,57)=21.46$, $p < .001$	Thai > American, $p < .001$ Thai > Native, $p < .0001$
	F2	$F(2,57) = 3.41$, $p < .05$	Thai > American, $p < .05$
[ɤ]	F1	No significant difference	
	F2	$F(2,57) = 3.44$, $p < 0.05$	No significant difference
[i]	F1	$F(2,57) = 41.85$, $p < 0.001$	American > Native, $p = .074$ Thai > American, $p < .001$

			Thai > Native, $p < .001$
	F2	F(2,57)=39.73, p < .0001	American > Thai, $p < .001$ Native > Thai, $p < .001$
[ɻ̩]	F1	F(2,57) = 28.12, p < .001	American > Thai, p < .00 Native > Thai, $p < .00$
	F2	F(2,57) = 9.31, $p < .001$	Thai > American, $p < .01$ Thai > Native, $p < .01$
[u]	F1	F(2,57) = 3.242, $p < .05$	No significant difference
	F2	No significant difference	n/a
[y]	F1	No significant difference	n/a
	F2	F(2,57) = 7.682, p < .005	Thai > American, $p = 0.005$ Thai > native, $p = 0.01$

As shown in Table 3, two vowels [ɤ] and [u] are not statistically different across groups, while the other four vowels are significantly different in F1, F2 or both among the three groups. The difference of these four vowels in terms of height and frontness across groups is summarized below.

As for [a], the Thai [a] is significantly lower than that of the native and American groups, and is more front than that of the American L2 group, but not significantly different in frontness from the native group.

With respect to [i], the Thai [i] is the lowest, and the native [i] is the highest, and the American one lies in between. Furthermore, both the American and the native [i/] is more front than the Thai one.

With regard to [ɻ̩], both the American and the native [ɻ̩] is lower than the Thai one and the Thai [i] is more front than the American and native one.

As far as [y] is concerned, there is no significant difference in height across groups, but the Thai one is more front than both the native and the American counterparts.

The relationships of F1 and F2 in different vowels across groups can be schematically represented in Figure 2. As shown in Figure 2, the vowels by the American learners are very

similar to those by the native speakers. The distribution of [i, ɻ, y] by the Thai learners are very different from the other two groups, namely, the Thai [y] is more front than [i, ɻ], whereas [y] by the other two groups are more backward than [i, ɻ].
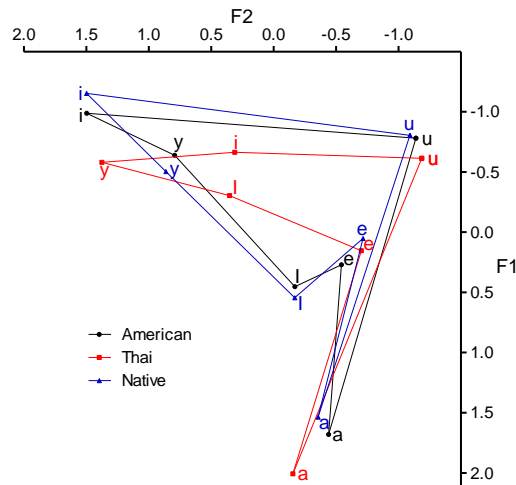

Figure 2: Vowel Space of the Three Groups

6. Discussions

6.1 Summary

The findings of this study were somewhat messy. While new vowels did not pose difficulty for the American learners, similar to Xie (2013), they posed difficulty for the Thai learners, echoing the findings in Shi and Wen (2009). With respect to identical vowels, the Thai L2 learners acquired two identical vowels [u, ɤ]; however, neither L2 group produced [i] in the same way as the native group.[1] Also the predictions based on Hao (2012) were not borne out in that both [ɻ] and [y] were produced very well by the American learners. Therefore, Hypothesis 1 was only partially confirmed. As for the similar vowels, the similar vowel [a] posed difficult for the Thai group, patterning similarly to Shi and Wen (2009), whereas none of the three similar vowels [u, ɤ , a] posed difficulty for the American L2 group. And the prediction on the production of [u] by the American L2 group based on Hao (2012) was confirmed. Therefore, Hypothesis 2 was also partially confirmed.

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[1] One reviewer provided one account for explaining some of the across-group difference found here, namely from the perspective of the relative positions of three vowels [i, u, a]. The high front vowel [i] and low back vowel [a] have relatively larger flexibility in articulation, whereas the high back vowel [u] does not have such flexibility. This difference seems to be able to explain why Chinese [u] was acquired better by both learner groups, [i] posed difficulty for both learner groups, and [a] posed difficulty for the Thai learners.

The analysis of F1 and F2 of different vowels showed that the American L2 group performed better and was more similar to the native speaker group in vowel production. Therefore, Hypothesis 3 concerning the effect of L1 vowel inventory size on L2 vowel acquisition was supported, namely, L2 learners with a larger L1 vowel inventory (i.e., American learners) acquired L2 vowels better than L2 learners with a smaller L1 vowel inventory (i.e., Thai learners).

6.2 General Discussion

6.2.1 Acoustic Similarity Versus L1 Vowel Inventory Size

The somewhat messy findings in this study show that neither acoustic similarity nor L1 vowel inventory size can singly predict L2 vowel acquisition. It seems that SLM, based on the acoustic similarity, predicts the difficulty of L2 vowel acquisition only to some extent. Meanwhile, the L2-L1 assimilation patterns did not predict the learning effect, either.　On the one hand, the identical vowel [i] in both learner groups was different from the native norm, whereas the Thai learners produced identical vowels [ɤ, u] in the same way as the native speakers. On the other hand, the American learners produced the similar vowels in the same way as the native speakers, while the Thai learners differed from the native speakers in the production of the similar vowel [a]. Even the new vowels did not present a uniform picture. With such interesting results, it is worth examining what may have underlined such results.

(1)　Acoustic (or phonetic) similarity

As mentioned above, Flege (1995) stressed that the cross-language similarity should be measured by perception, instead of through the comparison of the abstract phonological sound system of L1 and L2 or depending on the acoustic measurements of L1 and L2. The different interpretations of whether Mandarin [ɤ] and [a] are new or similar vowels for English L2 learners in the literature (Wu and Shih 2012; Lin 2007; Shi and Wen 2009) have showcased the difficulty of such a task. For an L2 sound to be similar to L1, it requires that the L2 learners will be able to find a counterpart in their L1 sound system for the L2 one; whether that counterpart is a close or a distant equivalent for the L2 sound is another story. Therefore, even for the so-called "similar" sounds, they may vary along a continuum ranging from being very similar to being very different.　The difficulty in

deciding the "similar" status will definitely add difficult to the predictions of any L2 learning theories, including SLM. The SLM's prediction that similar sounds pose more difficulty is based on the premise that the L2 learners could not hear the difference between L1 and L2 sounds so that they used the L1 counterpart to represent the L2 sounds, namely the equivalence classification. However, if the L2 sound is similar but not that similar, the L2 learners may just establish a new category for it, which is similar to the "new" scenario. Take Mandarin [a] for example. Mandarin [a] is a front, low vowel in [pa], whereas the English [ɑ] as in [ɑːnt] "aunt" is a low, back vowel. Except for the phonotactic difference (i.e., the phonological context for occurrence), how different [a] is from [ɑ] can vary from one person to another.

(2) L1 vowel inventory size

Hypothesis 3 on the L1-L2 vowel inventory size was confirmed. In the three groups of this study, Mandarin has 7 vowels, Thai has 9 vowels, and American English has 12 vowels. Therefore, the better performance of the American L2 group supports the advantage of an L1 with larger inventory size. However, this study did not address what led to the American L2 groups' advantage over the Thai L2 group. Such advantage may be due to the involvement of more dimensions in their vowel production, which may facilitate the L2 learners in the comparison L1 and L2 vowels as well as category (non-) establishment for L2 vowels

(3) L2 learners' proficiency level

As mentioned earlier, SLM's predictions on the similar and new sounds concern the later stage of L2 acquisition (Flege 1995), that is to say, they are more relevant to learners at the intermediate or advanced level. At the initial stage, however, new sounds often posed difficulty whereas the similar sounds do not (Flege 1995; Major 2001). An examination of some previous studies showed that some involved learners at the beginning level (Shi and Wen 2009), whereas others involved learners at the more advanced level (Wen 2010; and Xie 2013). In this sense, part of the discrepancy in this study and some previous studies (i.e., Shi and Wen 2009) can be explained by the difference in learners' proficiency level.

(4) L2-L1 assimilation

　　Hao (2012) found that the L2-L1 assimilation pattern can indicate the effect of learning. However, in the assimilation task, the L2 learners need to compare the L1 and L2 sounds consciously when making such assimilation. Whether such assimilation patterns were actually adopted by L2 learners in L2 speech production is another thing. More importantly, the L2-L1 assimilation patterns only speak to how L2 learners assimilate one L1 sound to L2 sound, and there is no telling whether the assimilated L1 sound is a good counterpart for the L2 sound. In actual L2 productions, L2 learners may not necessarily undergo such nuanced comparison between L1 and L2 sounds, hence the relationship between L2-L1 assimilation and L2 speech production is not as straightforward as Hao (2012) suggested.

7. Future Studies, Pedagogical Implications and Limitations

7.1 Future Studies

　　As mentioned above, the judgment of cross-language dis-similarity should be done through perceptual measures. Thus, future studies should determine the relationship between L1 and L2 vowel systems perceptually instead of basing on the phonological comparison or acoustic measures. As Elvin, Escudero and Vasiliev (2014) found, what really matters in predicting L2 vowel acquisition is the cross-linguistic acoustic properties/similarity, not just the vowel inventory sizes. Such studies will also help shed new light on what leads to the advantage for the L1 group with a larger vowel inventory than another L1 group with a smaller vowel inventory. Meanwhile, to examine the effects of different vowel inventory sizes on L2 vowel acquisition, L1s with a larger and a small inventory should be chosen instead. Also, while most studies on L2 Mandarin vowel acquisition focus on vowel production, it is of equal importance to examine whether listeners, both L1 and L2, can perceive such articulatory difference and whether such production difference between L1 and L2 contributes to the perception of foreign accent.

7.2 Pedagogical Implications

　　This study showed that the (relatively more advanced) American L2 learners did not have difficulty in producing L2 Mandarin vowels, while the Thai L2 learners had some difficulty, especially in the production of [ɻ, y, a, i]. Therefore, in teaching the Thai L2 learners, the acoustic features of these vowels should be emphasized (i.e., frontness, rounding and

height) by comparing the L1 and L2 vowel systems so that the L2 learners will learn to pay conscious attention to these features in their vowel production. It is expected that with these efforts, the L2 vowel production will be greatly improved.

7.3 Limitations

One limitation of this study is the non-homogeneity of the consonants preceding the vowels. Although the focus of this study was on the vowels, the preceding consonants influence the production of the following vowels as well as the relationship between different vowels in the vowel space. Another limitation is that there is no strict measurement of learners' proficiency level so that no correlation between vowel production and proficiency level can be made. A third limitation in this study is the non-homogeneity of L2 learners in that the American learners are foreign language learners, while the Thai learners are second language learners at the time of the recording. It should, however, be pointed out that the Thai L2 learners began their Mandarin leaning in Thailand before going to China for further study. Besides, all American L2 learners have studied abroad for some time. In this sense, the two L2 groups are more or less comparable.

8. Conclusion

This study examined the acquisition of L2 Mandarin vowels in context by two groups of L2 learners. It was shown that an L1 with a larger vowel inventory has advantage in acquiring an L2 vowel system over another L1 with a smaller vowel inventory. It was argued that the involvement of more dimensions in an L1 with a larger vowel inventory size may have facilitated the L2 learners in the comparison L1 and L2 vowels as well as category (non-) establishment for L2 vowels. However, the specific mechanism for such advantage still begs for future studies. The findings of this study also showed that it was difficult to predict the learning difficulty in acquiring L2 vowels in that so many factors are intertwined together (i.e., L1/L2 phonetic similarity, L1/L2 sound inventory size, L2 learners' proficiency level, and even individual differences). Future SLA studies should take these factors into consideration.

References

Abramson, Authur S. 1974. Experimental phonetics in phonology: Vowel duration in Thai. *Pasaa: Notes and News about Language Teaching and Linguistics in Thailand* 4: 71-90.

Abramson, Authur S., and Nianqi Ren. 1990. Distinctive vowel length: Duration versus spectrum in Thai. *Journal of Phonetics* 18: 79-92.

Boersma, Paul, and David Weenink. 2015. Praat: Doing phonetics by computer [Computer program]. Version 5.4.18, retrieved 10 September from http://www.praat.org/

Bradlow, Ann R. 1995. A comparative study of English and Spanish vowels. *Journal of Acoustical Society of America* 97: 1916-1924.

Cai, Yi-Wen, and Hugo Yu-Hisu Lee. 2015. A contrastive analysis of Mandarin Chinese and Thai: Suggestions for second language pronunciation. *Theory and Practice in Language Studies* 5.4: 719-728.

Chao, Yuen-Ren. 1968. *A Grammar of Spoken Chinese.* Berkeley, CA: University of California Press.

Cheng, Chin-Chuan. 1973. *A Synchronic Phonology of Mandarin Chinese.* The Hague: Mouton.

Duanmu, San. 2000. *The Phonology of Standard Chinese.* Oxford: Oxford University Press.

Elvin, Jaydene, Paola Escudero, and Polina Vasiliev. 2014. Spanish is better than English for discriminating Portuguese vowels: acoustic similarity versus vowel inventory size. *Frontiers in Psychology 5*: 1188. http://doi.org/10.3389/fpsyg.2014.01188

Escudero, Paola. 2005. *Linguistic perception and second language acquisition: explaining the attainment of optimal phonological categorization.* Unpublished Ph. D dissertation. University of Utrecht.

Flege, James E. 1995. Second-language speech learning: Theory, findings, and problems. *Speech Perception and Linguistic Experience*, ed. by W. Strange, 233-277. Timonium, MD: York Press.

Flege, James E., and Ian R. A. MacKay. 2004. Perceiving vowels in a second language. *Studies in Second Language Acquisition* 26: 1-34.

Flege, James E., Ian R. A. MacKay, and Diane Meador. 1999. Native Italian speakers' production and perception of English vowels. *Journal of the Acoustic Society of*

America 106: 2973-2987.

Fox, Robert A., James E. Flege, and Murray J. Munro. 1995. The perception of English and Spanish vowels by native English and Spanish listeners: a multidimensional scaling analysis. *Journal of Acoustical Society of America* 97: 2540-2551.

Gandour, Jack. 1984. Vowel duration in Thai. *Crossroads: An Interdisciplinary Journal of Southeast Asian Studies* 2.1: 59-64.

Hao, Yen-Chen. 2012. *The Effect of L2 Experience on Second Language Acquisition of Mandarin Consonants, Vowels, and Tones.* Unpublished Ph. D dissertation. Indiana University.

Iverson, Paul, and Bronwen G. Evans. 2007. Learning English vowels with different first-language vowel systems: Perception of formant targets, formant movement, and duration. *Journal of Acoustical Society of America* 122: 2842-2854.

Iverson, Paul, and Bronwen G. Evans. 2009. Learning English vowels with different first-language vowel systems II: auditory training for native Spanish and German speakers. *Journal of Acoustical Society of America* 126: 866-877.

Karlgren, Bernhard. 1915-16. *Etudes sur la Phonologie Chinoise* [Studies on Chinese Phonology]. Uppsala: K.W. Appelberg.

Kendall, Tyler, and Erik R. Thomas. 2010. Vowels: Vowel Manipulation, Normalization, and Plotting in R. R package, version 1.1. Software Resource: http://ncslaap.lib.ncsu.edu/tools/norm/

Lado, Robert. 1957. *Linguistics across Cultures: Applied Linguistics for Language Teachers.* Ann Arbor, MI: University of Michigan Press.

Lee, Wai-Sum, and Eric Zee. 2003. Illustrations of the IPA: Standard Chinese (Beijing). *Journal of the International Phonetic Association* 33:109-112.

Lin, Yen-Hui. 2007. *The Sounds of Chinese.* Cambridge: Cambridge University Press.

Lobanov, Boris. M. 1971. Classification of Russian vowels spoken by different listeners. *Journal of the Acoustical Society of America* 49: 606-08.

Major, Roy. C. 2001. *Foreign Accent*. Mahwah, NJ: Lawrence Erlbaum Associates.

Polivanov, Evgeniĭ D. 1931. La perception des sons d'une langue étrangère [The perception of foreign sounds]. *Travaux du Cercle Linguistique de Prague* [Works of the Prague Linguistic Circle] 4:79-96.

Scholes, ROBERT. 1968. Phonemic interference as a perceptual phenomenon. *Language*

and Speech 11: 86-103.

Shi, Feng, and Baoying Wen. 2009. Study on language transfer in vowel articulation by Chinese and American students. *Journal of Chinese Language Teachers Association* 44.2: 17-32.

Tingsabadh, Kalaya, and Authur Abramson. 1993. Thai. *Journal of the International Phonetic Association* 23: 24-28.

Trubetzkoy, Nikolai S. 1969. *Principles of Phonology*. Berkeley, CA: University of California Press.

Tumtavitikul, Apiluck. 1996. The Mid-central Vowel [ə] in Thai. *The Mon-Khmer Studies Journal* 26: 65-77.

Vasiliev, Polina. 2013. *The Initial State for Californian English Learners of Spanish and Portuguese Vowels*. Unpublished PhD dissertation. University of California, Los Angeles.

Wang, Yunjia. 2001. A preliminary analysis on the perception of Mandarin high vowels by Korean and Japanese L2 learners. *Language Teaching and Research* 6: 8-17.

Weinreich, Uriel. 1953. *Languages in Contact: Findings and Problems*. The Hague: Mouton.

Wells, John C. 1990. *Longman Pronunciation Dictionary*. London: Longman Group Ltd.

Wu, Chen-Huei, and Chi-Lin Shih. 2012. A corpus study of native and non-native vowel quality. In *Proceedings of the 2012 Speech Prosody*. Shanghai, China.
Retrieved 2 October 2015 from
https://pdfs.semanticscholar.org/74f5/ec7782e9e10eb5e60b3062c12beb8f94f104.pdf

Xie, Yan. 2010. The Chinese vowels acquisition by North American students: A comparative study between low and high level learners. *Journal of Chinese Language Teachers Association* 45.21-18.

Xie, Yan. 2013. The acquisition of Mandarin basic vowels by American students: the comparison of mono- and di-syllabic words and the effects of tones. *Journal of Chinese Language Teachers Association* 48.1: 91-108.

Xu, Yi. 2013. ProsodyPro--A Tool for Large-scale Systematic Prosody Analysis. In *Proceedings of Tools and Resources for the Analysis of Speech Prosody* (TRASP 2013), 7-10. Aix-en-Provence, France.

Yang, Chunsheng. 2014. Acquisition of Mandarin lexical tones: The effect of global pitch tendency. *Contemporary Foreign Languages Studies* 12.4: 81-95.

陳彧、徐海鵬、高曉穎。2012。泰國留學生漢語母音習得的實驗研究。《焦作大學學報》，第三期，108-111。 [Chen, Yu, Haipeng Xu, and Xiaoying Gao. 2012. An experimental study on the Thai L2 learners' acquisition of Mandarin vowels. *Journal of Jiaozuo University* 3: 108-111.]

溫寶瑩。2010.。美國學生漢語母音習得的實驗研究，《漢語學習》第三期， 95-104。 [Wen, Baoying. 2010. An experimental study on the acquisition of Mandarin vowels by American L2 learners. *Chinese Learning* 3: 95-104.]

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Appendix: Reading Passage

Chinese characters:
星期天早上剛五點鐘，王國明家裏人都已經起來了。因為王國明要坐早上八點鐘的火車到北京去，所以他家人都要到火車站去送他。 王先生幫著小王收拾行李，王太太特別給王國明做了很多吃的東西。 王太太想這兩天天氣熱，火車上的東西恐怕不乾淨。他們把行李收拾好了的時候，已經七點鐘了。王國明和家人坐出租車到火車站。他們到火車站的時候，別的同學都在那兒等著他呢。 王國明把他的同學介紹給他家人。 過了一會兒，王國明和他的 同學開始上車。王家人和王國明和他的同學說再見。

Pinyin Romanization:
Xīngqí tiān zǎoshang gāng wǔ diǎn zhōng, Wáng Guómíng jiālǐ rén dōu yǐjīng qǐlái le. Yīnwèi Wáng Guómíng yào zuò zǎoshang bā diǎn zhōng de huǒchē dào Běijīng qù, suǒyǐ tā jiārén dōu yào dào huǒchē zhàn qù sòng tā. Wáng xiānshēng bāngzhe xiǎo wáng shōushí xínglǐ, wáng tàitài tèbié gěi Wáng Guómíng zuòle hěnduō chī de dōngxī. Wáng tàitài xiǎng zhè liǎng tiān tiānqì rè, huǒchē shàng de dōngxī kǒngpà bù gānjìng. Tāmen bǎ xíngli shōushí hǎole de shíhòu, yǐjīng qī diǎn zhōng le. Wáng Guómíng hé jiārén zuò chūzū chē dào huǒchē zhàn. Tāmen dào huǒchē zhàn de shíhòu, bié de tóngxué dōu zài nà'er děngzhe tā ne. Wáng Guómíng bǎ tā de tóngxué jièshào gěi tā jiārén.Guòle yīhuǐ'er, Wáng Guómíng hé tā de tóngxué kāishǐ shàng chē. Wáng jiā rén hé Wáng Guómíng hé tā de tóngxué shuō zàijiàn.

English translation:
At five o'clock, Sunday morning, Wang's family are all up. Wang Guoming is going to take the eight-clock train to Beijing, so the whole family are going to see him off at the train station. Mr. Wang helps Little Wang with packing. Mrs. Wang cooks a lot of delicious food, because she thinks that the food on the train may not very clean since it is very hot these days. When they finish packing up, it is already seven o'clock. Wang Guoming and his family take a taxi to the train station. When they get there, his classmates are all waiting for him there. Wang Guoming introduces his classmates to his family. After a while, Wang Guoming and his classmates start to board the train. Wang's family say goodbye to Wang Guoming and his classmates.

語篇中元音的二語習得

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摘要

本文研究一、二語元音相似度以及一語元音數量對語篇中二語元音習得的影響。 母語為泰語和美式英語的二語學習者參加了該研究。 研究發現一、二語元音相似度只能預測某些元音的習得情況，而且這樣的預測也因一語而不同。研究同時發現元音數量多的語言使用者比元音數量少的語言使用者在習得二語元音時有優勢。本文認為元音數量多的語言需要在多維度上區分元音，因此有利於二語學習者對一語、二語的元音進行比較並確定是否需要為二語元音建立新的範疇。但是，這種優勢的具體機制還有待研究。 本文發現在二語元音習得中，因為在二語元音習得中很多不同因素交織在一起，因此很難精確預測元音習得的難易。後續研究應考慮更多的影響元音習得的因素。

關鍵詞：元音習得　泰語　美式英語　元音數量　元音相似性