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English and Thai Speakers' Perception of Mandarin Tones

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Abstract

Language learners' language experience is predicted to display a significant effect on their accurate perception of foreign language sounds (Flege, 1995). At the superasegmental level, there is still a debate regarding whether tone language speakers are better able to perceive foreign lexical tones than non-tone language speakers (i.e Lee et al., 1996; Burnham & Brooker, 2002). The current study aimed to shed some light on this issue. Specifically, 24 adult Thai and 21 adult English speakers, who had no knowledge on Mandarin prior to participation in the study, were recruited. The participants' accuracy in the perception of 4 Mandarin tones (T1, T2, T3, T4) was individually examined using an identification test. 288 stimuli of /ti/, /ta/, /tu/, /tʂhi/, /tʂha/, and /tʂhu/ produced in 4 Mandarin tones were prepared. The stimuli were embedded in a carrier sentence, and were produced by a female and a male native Mandarin speaker. According to the results, (1) none of the participants achieved 100% accuracy in any of the perception tests; (2) in the perception of Mandarin T1 and T4, the Thai speakers significantly outperformed the English speakers; (3) the Thai speakers and the English speakers displayed very similar degrees of difficulty in the perception of Mandarin T2 and T3; (4) the Thai participants' most serious confusion was in the discrimination of T2-T3, whereas the English participants showed significant confusion in the identification of T1-T2 and T2-T3. The findings suggest that tone language speakers may benefit more from their L1 in the perception of foreign lexical tones than did the non-tone language speakers. However, the degree of the beneficial effect identified was limited.

Keywords: lexical tone, tone sensitivity, foreign language, L1

1. Introduction

Language experience is frequently viewed as a significant factor that affects language learners' perception of non-native speech sounds (So & Best, 2010). Many previous studies have intensively investigated native language (L1) influences on language learners' perception of a non-native sounds at the segmental level (e.g. Best, 1995; Best & Tyler, 2007; Ying, 2014), whereas there is a paucity of empirical evidence available at the superasegmental level (i.e. stress pattern, quantity contrasts). The present study, therefore, investigated the influence of listeners' L1 on their perception of L2 lexical tones. Particularly, it examined whether tone language speakers are more likely to have an accurate perception of non-native lexical tones than non-tone language speakers. If this proved to be the case, the intention was also to establish to what extent tone language speakers could outperform the non-tone language speakers.

Some reports on non-native tone perception have suggested that tone language speakers are benefited from their L1 in the perception of non-native lexical tones more than non-tone language speakers. For instance, Lee et al. (1996) reported that native Cantonese speakers perceived Mandarin tones better than native English speakers did. Similarly, in a perception training study, Wayland and Guion (2004) found that native Mandarin Chinese listeners had better discrimination of Thai tones than native English listeners in their pre-test and post-test results. Moreover, native English speakers were revealed to focus on pitch height when perceiving tones, whereas tone-language speakers (i.e., Cantonese and Mandarin speakers) were revealed to focus on both pitch height and pitch direction in the perception of lexical tones (Gandour, 1983, 1984). In general, these findings may have suggested that listeners whose L1 is a tone language are better able to have accurate perception of non-native lexical tones than those whose L1 is a non-tone language.

Nonetheless, this point of view might be compromised if we take a further look at the study conducted by Lee et al. (1996), which reported that the Cantonese subjects had an extensive exposure to Mandarin, which may have

also benefited their perception of Mandarin tones. In comparison, the English subjects were not exposed to Mandarin to the same extent as the Cantonese. Moreover, it has been revealed that listeners who are musically trained generally showed a better performance on non-native lexical tone perception than listeners without a musical training background (Alexander, Wong, & Bradlow, 2005; Burnham & Brooker, 2002; Gottfried & Riester, 2000). Even in Gandour's (1983) study, Chinese speakers were found to place more emphasis on the dimension of pitch level than Thai speakers did, despite the fact that both Chinese and Thai are tone languages. Therefore, these studies suggest that it may be not always the case that tone language speakers are better able to perceive non-native lexical tones than non-tone language speakers.

To further investigate this issue, the present study examined tone and non-tone speakers' perception of non-native lexical tones. Native Thai and native English speakers' accuracy in the perception of Mandarin tones was tested. Mandarin, English and Thai have their unique features at phonetic and phonological levels. Both Mandarin and Thai are lexical tone languages, in which lexical tones signal different lexical meanings (Yip, 2002, p. 2; Tingsabadh & Deeprasert, 1997). Moreover, as shown in Figure 1 and Figure 2 below, their tone systems are different from each other in terms of variances in fundamental frequencies (*F0*). Mandarin has four tones (Bauer & Benedict, 1997; Duanmu, 2004; Hashimoto, 1972). They are *high level* (Tone 1; hereafter T1), *mid rising* (Tone 2; hereafter T2), *falling rising* (Tone 3; hereafter T3), and *high falling* (Tone 4; hereafter T4) (Chao, 1930). Thai (Note 1), however, has five tones—*mid, low, falling, high,* and *rising* (Tingsabadh & Deeprasert, 1997). It was reported that the *high* tone in Thai is lacking in Mandarin. The rest of the 4 Thai tones are found to have their counterparts in the Mandarin tone system. Specifically: *mid* ≈ T1; *low* ≈ T3; *falling* ≈ T4; *rising* ≈ T2 (Kwanrean, 2001). Nevertheless, it was revealed that Mandarin T2 and T3 have shorter duration than their counterparts—*low* and *rising* tones in Thai (Kwanrean, 2001).

In comparison, English is a non-tone language, or a "stress-accent language" (Beckman, 1986), thus it does not depend on lexical tones in the differentiation of lexical meanings. At the word level, its use of distinctive pitch is quite restricted. Stressed syllables typically differ from unstressed ones in vowel quality and length, which are more consistent and salient than *F0* variances (Beckman, 1986; Cutler & Otake, 1999; Fox, 2000; Gussenhoven, 2004; So & Best, 2010).

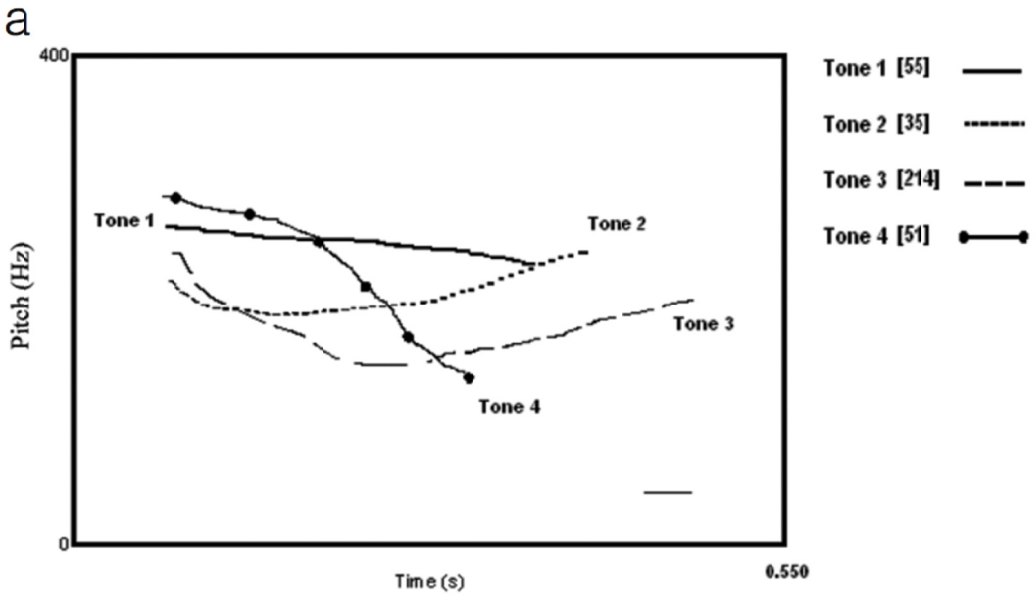

Figure 1. Naturally spoken examples of the pitch samples of the Mandarin tone systems (assessed from So & Best 2010)

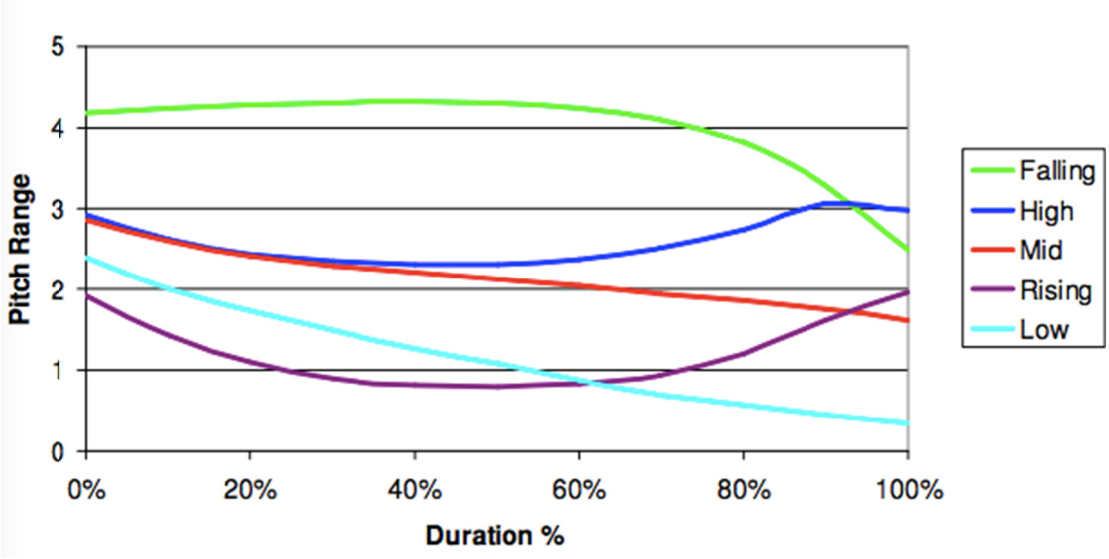

Figure 2. Naturally spoken examples of the pitch samples of the Mandarin tone systems (assessed from So & Best 2010)

In the present study, if the Thai participants outperform the English ones in the perception of Mandarin lexical tones, it will imply that L1 experience, specifically the participants' L1 phonological knowledge, underlies the perception of non-native lexical tones.

2. Methodology

2.1 Participant Selection

The criteria for the selection of the participants were that they had no knowledge of Mandarin tones prior to the study. Therefore, 24 native Thai participants from Bangkok (12 female, 12 male; age range: 21-29) and 21 native English participants from London and York (11 female, 10 male; age range: 19-30) were paid to join the study. All the participants were born and raised in their home countries (Thailand and U.K.). None of them had any knowledge on Mandarin, or any opportunity to contact with Mandarin speakers, nor had they been musically trained prior to or during the time of the study. A female (age=21) and a male (age=23) native Mandarin speaker were recruited to produce the stimuli used in the perception test. They were born and raised in Beijing China, and were in the process of completing her Bachelor's degree at a University in Beijing.

2.2 Stimuli

The stimuli used in the identification test were the same as those adopted by Gottfried and Suiter, 1997 and So and Best (2010). They were Mandarin syllables, *di, da, du, chi, cha, and chu*. In IPA (International Phonetic Alphabet), the syllables are pronounced as /ti/, /ta/, /tu/, /tʂhi/, /tʂha/, and /tʂhu/). Another 3 syllables were employed in the familiarization test: /ki/, /ka/, /ku/. The syllables were chosen because (1) the three 'point vowels' (/i, a, u/) weight differently from each other regarding their vowel space; (2) the consonants are unaspirated stops, thus could avoid aspiration; (3) these segments are available in both Thai and English, therefore the participants were expected to restrict their focuses only on tones (So & Best 2010).

The target words were embedded in the middle position of a carrier sentence in Chinese [把 X 标出来 (in English: Mark the X; in IPA: [pa] X [tu] [ts^{h}eu][laɪ]). The target words were put in between the vowel /a/ and the stop /t/ to avoid aspiration. Each stimulus sentence was spoken twice by a native male Mandarin speaker and by a native female Mandarin speaker. The recordings were carried out in a sound-proofed booth with a high quality recorder (Roland 03), and were saved as audio sound files in wav format on a PC laptop computer (MacBook Air). As was the case in the tests conducted by So and Best (2010), all the target words were excised from the stimulus sentence frame, and normalized to mean peak intensity with the Praat program (Boersma & Weenink, 2015). In the identification test, there were 96 stimulus sentences in total (6 syllables × 4 tones × 2 samples per tone × 2 speakers). Each sentence was repeated 3 times and randomized in the identification test, thus yielding a total number of 288 tokens. In the familiarization task, there were 24 tokens in total (3 syllables × 4 tones × 2 speakers). All the stimulus sentences in the identification test and familiarization task were randomized.

Before doing the test, the intelligibility of the tones of the stimuli was evaluated by 3 native mandarin speakers (see Guion, Flege, & Akahane-Yamada, 2000; Wang, Spence, Jongman, & Sereno, 1999). These comprised of Chinese students from Chiang Rai Rajabhat University (2 female and 1 male; mean age=20.42). The 3 participants were asked to do a four-alternative forced-choice task with the stimuli of the identification test and the familiarization task. As a result, all of the stimuli were correctly identified by each of the 3 participants.

2.3 Procedure

A familiarization task was carried out prior to the identification test. This was designed to enable the participants to learn the tone labels (Tone 1: ˉ, Tone 2: ˊ, Tone 3: ˇ, Tone 4: ˋ) of the 4 Mandarin tones in the task (see So & Best, 2010). In a quiet room, each participant was asked to sit in front of a desktop computer, and wear a headphone connected to the computer. The 24 tokens mentioned above in section 2.3 were employed as the stimuli. The stimuli were displayed on the computer screen, and were linked to the pronunciation. Once a stimulus token was clicked on, its audio pronunciation was played through the headphone the participants were wearing, with the tone label and name displayed simultaneously on the screen. It was a self-paced task. The participants were given 5 minutes to do the task. They were asked to listen to each of the speech samples as many times as they could within the allotted time.

After the familiarization task was completed, the participants were asked to do a four-alternative forced-choice identification task. An answer sheet (see Appendix) was handed out to individual participants, on which they were asked to select the right tone they heard by circling the answer, even if guessing. In the bracket next to each item, they were asked to show their degree of confidence regarding the correctness of their answers by given a score from 0 to 4 (0 = completely guessing; 4 = absolutely sure about the answer) (Best et al., 1998). The inter-stimulus interval (ISI) was 6 seconds. No feedback was given during the test. The investigator controlled the display of the recordings from a central computer in the room. After the identification test was completed, the investigator collected all the participants' answer sheets, and entered the individual participants' answers into the SPSS program for the statistical analysis.

3. Results

3.1 General Results

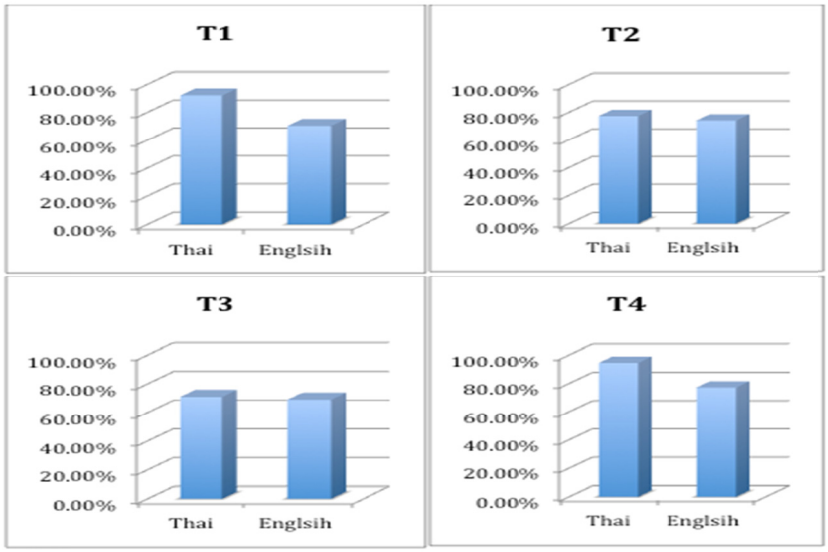

Figure 3. Thai and English participants' accuracy in the perception of the 4 Mandarin Tones in the identification test

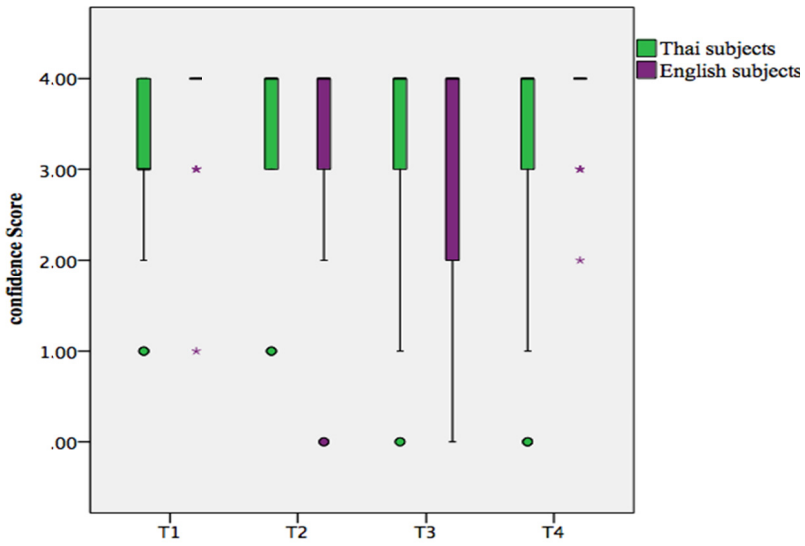

Figure 4. Thai and English participants' accuracy in the perception of the 4 Mandarin Tones in the identification test

As show in Figure 3, the overall results indicate that none of the participants achieved 100% accuracy in the identification test. The Thai participants' results showed a higher degree of accuracy in the perception of the 4 tones than the English participants. In particular, the Thai participants' degree of accuracy was much higher in the perception of T1 and T4 than English participants.

The subjects' 'confidence' score in the identification of the 4 tones showed that some of answers were guessed (see Figure 3.2). Therefore, there might be a chance of risks attached to the identification test results. The participants' responses, therefore, were further calculated into A-prime scores (*A'*) (Snodgrass, Levy-Berger, & Haydon, 1985; also see So & Best, 2010). As displayed in Table 1 and Figure 5 below, none of the participants' *A'* score was above 0.9. Some of them showed a near-by-chance result (around 0.5), which was consistent with their 'confidence' scores. Moreover, as was the case with the scores shown in Figure 4 above, the Thai participants' mean *A'* score was significantly higher than that of the English participants in the perception of T1 (Thai speakers: 0.89 vs. English speakers: 0.66) and T4 (Thai speakers: 0.71 vs. English speakers: 0.68) ($p<0.05$). The differences between their accuracies in the identification of T2 (Thai speakers: 0.66 vs. English speakers: 0.63) and T3 (Thai speakers: 0.87 vs. English speakers: 0.69), however, were revealed to be statistically non-significant ($p>0.05$).

Table 1. Descriptive Statistics of the participants' results in the identification test

Tone	Participant groups	Range	Minimum	Maximum	Mean	Std. Error
T1	English participants	0.39	0.51	0.80	0.66	0.03
	Thai participnats	0.18	0.78	0.96	0.89	0.01
T2	English participants	0.23	0.55	0.78	0.68	0.02
	Thai participnats	0.34	0.58	0.92	0.71	0.02
T3	English participants	0.38	0.55	0.73	0.63	0.04
	Thai participnats	0.20	0.58	0.78	0.66	0.03
T4	English participants	0.28	0.51	0.79	0.69	0.02
	Thai participnats	0.17	0.78	0.95	0.87	0.01

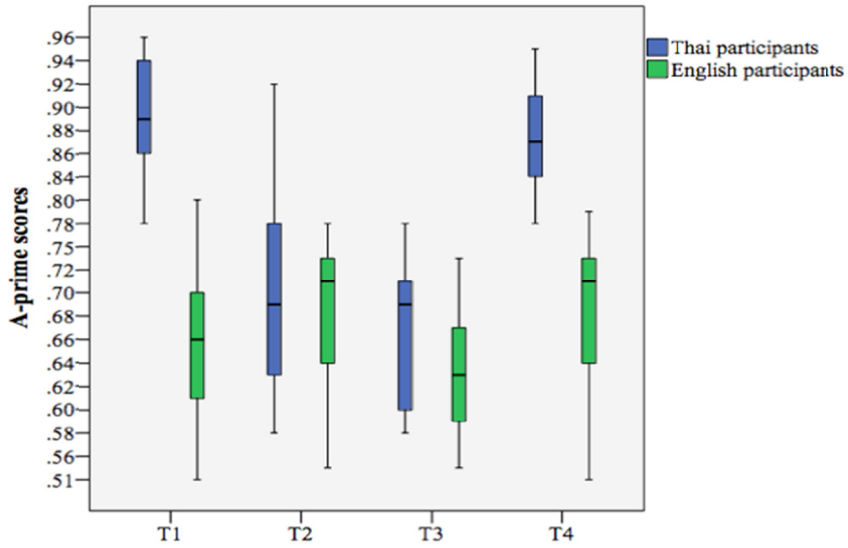

Figure 5. The Thai and English participants' A-prime scores in the identification test

To further analyze the participants' sensitivity to the 4 Mandarin tones, their *A′* scores were coded into the SPSS program and were analyzed with a *two-way ANOVA*. The *group difference* (Thai group and English group) was coded as a between-subjects factor. *Tonal difference* (T1, T2, T3, and T4) was coded as the within-subjects factor. It turned out that *tonal difference* (F (3, 60)=37.99, p<0.001) and the interaction between *tonal difference* and *group difference* (F(3, 129)=43.07, p<0.001) were all found to have displayed significant effect on the participants' *A′* scores (*Mauchly's Test of Sphericity*=0.518). Moreover, as a between-subjects factor, *gender difference* was found neither to be non-significant for the Thai participants (F(1, 19)=0.06, p=0.81) nor for the English participants' (F(1, 22)=0.37, p=0.55) *A′* scores.

An additional *Pairwise Comparisons* test indicated that the English participants' *mean differences* in the identification of the 4 tones were statistically insignificant (p>0.05). In contrast, however, the Thai participants were revealed to be more likely to perceive Mandarin T1 and T4 than T2 and T3. The *mean differences* between their *A′* scores in the identification of T1 vs. T4 and T2 vs. T3 were statistically insignificant (p>0.05) (see Table 2 below).

Table 2. Pairwise comparisons testing results

		Thai participants			English participants		
(I) Tone	(J) Tone	Mean Difference (I-J)	Std. Error	Sig.	Mean Difference (I-J)	Std. Error	Sig.
	T2	0.18	0.02	0.00	-0.02	0.02	0.23
T1	T3	0.23	0.02	0.00	0.03	0.02	0.10
	T4	0.02	0.02	0.21	-0.03	0.02	0.19
	T1	-0.18	0.02	0.00	0.02	0.02	0.23
T2	T3	0.05	0.03	0.07	0.05	0.02	0.00
	T4	-0.16	0.02	0.00	0.00	0.02	0.86
	T1	-0.23	0.02	0.00	-0.03	0.02	0.10
T3	T2	-0.05	0.03	0.07	-0.05	0.02	0.00
	T4	-0.21	0.01	0.00	-0.05	0.02	0.02
	T1	-0.02	0.02	0.21	0.03	0.02	0.19
T4	T2	0.16	0.02	0.00	0.00	0.02	0.86
	T3	0.21	0.01	0.00	0.05	0.02	0.02

3.2 Results of Tonal Confusions

The above results indicated the participants' tone sensitivity. Given that language listeners' L1 phonology system may display influence on their perception of foreign tones (So & Best 2010; Wayland & Guion, 2004; Lee et al., 1996), it would be necessary to investigate the participants' confusions on each tone. However, their answers (correct and incorrect ones) with a confidence score of 0 were excluded, because these responses were given by 'totally guessing'.

Table 3. Thai participants' confusion matrices in the identification test

	Responses (%)				
target	T1	T2	T3	T4	Total
T1	**82.01%**	6.40%	5.94%	5.65%	100.00%
T2	5.23%	**67.25%**	24.71%	2.81%	100.00%
T3	3.20%	29.03%	**60.98%**	6.79%	100.00%
T4	4.55%	6.77%	4.21%	**84.47%**	100.00%

Table 3.4 English participants' confusion matrices in the identification test

	Responses (%)				
target	T1	T2	T3	T4	Total
T1	**60.29%**	21.45%	9.97%	8.29%	100.00%
T2	18.50%	**64.08%**	15.33%	2.09%	100.00%
T3	9.34%	21.90%	**59.01%**	9.75%	100.00%
T4	8.83%	9.44%	9.53%	**72.20%**	100.00%

As show in Table 2 and Table 3 above, the Thai participants did not show serious confusion between T1 and the other 3 tones, as their confusions (incorrect responses) between T1 and T2, T1 and T3, T1 and T4 all counted around 6%. A similar phenomenon was found to occur between T4 and T1, T4 and T3. However, they displayed a comparatively much higher degree of confusion in the differentiation of T2-T3, as they incorrectly identified target T2 as T3 (incorrect response: 24.71%), and T3 as T2 (incorrect response: 29.03%).

For the English speakers, they incorrectly identified target T1 as T2 with a percentage of 21.45%, and target T2 as T1 with a percentage of 18.50%. Moreover, the English participants also incorrectly identified target T2 as T3 and target T3 as T2 with a percentage of 15.33% and 21.90% respectively. The rest of the incorrect responses were all below 10%. Generally, therefore, the English participants showed significant confusions in the identification between T1 and T2 as well as between T2 and T3.

4. Discussion

The present study examined whether tone language speakers could be better able to perceive foreign lexical tones than non-tone language speakers. The findings of the study provided somewhat complicated results. First of all, the overall results showed that the Thai participants outperformed the English participants in the perception of the 4 tones (see Figure 3 and Table 4). Therefore, it might be tempting to assume that tonal language speakers benefit more from their L1 experience in the perception of foreign lexical tones than do non-tonal language speakers. This finding is consistent with those presented by Lee et al. (1996) and Wayland and Guion (2004). However, the participant group showing better performance (Cantonese speakers) in Lee et al. (1996) had extensive exposure to Mandarin, while the Thai participants of the present study did not. In other words, compared to Lee et al. (1996), the Thai participants' perception performance in the present study may be better able to provide supporting evidence for the influence of L1 on the perception of foreign lexical tones. Regarding the Wayland and Guion's (2004) study, although the tonal language speakers (Chinese) outperformed the non-tone language speakers (English) in the perception of Thai tones both before and after being trained, they only tested the speakers' identification of 2 Thai tones (mid tone vs. low tone).

The second finding was that the Thai participants significantly outperformed the English participants in the

identification of T1 and T4. Unexpectedly, n the perception of T2 and T3, the English participants' *A'* scores were only slightly lower than that of the Thai participants. Although the Thai participants' good performance in the perception of T1 and T4 can be explained by the similarities between Mandarin and Thai tones, their low accuracy in the identification of T2 and T3 can hardly be attributed to this factor. However, this latter result could be explained by the fact that Mandarin T2 and T3 show shorter duration than their counterparts in Thai tones (Kwanrean, 2001). Moreover, So and Best (2010) suggests that T2-T3, T1-T2, T1-T4 are more confusable in terms of identification than other pairs, because they share some similar phonetic features.

Another significant finding was that the two groups of participants showed different confusion patterns among the 4 Mandarin tones. Thai participants' most significant confusion levels occurred in the identification between T2 and T3. The English participants, however, displayed serious confusions in T1-T2 and T2-T3. As discussed above, due to phonetic similarities, the 2 pairs of tones (T1-T2, T2-T3) are generally suggested to be more difficult to identify than the other tone pairs (So & Best, 2010). Moreover, the Thai participants' confusion may be caused by the durational difference between T2, T3 and their counterparts in the Thai language.

In addition, none of the participants achieved 100% accuracy in the identification test. In other words, even if the Thai participants were benefited by their L1, the degree of the benefit was limited. One of the limitations of the present study was that it lacked phonetic analysis, thus no evidence showed whether the English and Thai participants relied on the same acoustic cues in the identification test. As reported by Gandour (1983, 1984), English speakers identify lexical tones through the perception of pitch height, whereas Cantonese and Mandarin speakers rely on both pitch height and pitch direction. Therefore, it may be able to argue that in the present study, the acoustic cue(s) that the Thai participants rely on were different from those employed by the English participants.

5. Conclusion

The present study investigated the influence of L1 influence on the perception of foreign lexical tones. The Thai and English participants' perception of Mandarin tones was compared. The findings indicated the Thai participants' overall accuracy of perception was higher than the English speakers. The Thai participants' most serious confusion was in the identification between T2 and T3. The English participants, on the other hand, displayed significant difficulty in the identification of tone pairs T1-T2 and T2-T3. The findings suggested that L1 does affect language listeners' identification of foreign lexical tones. Specifically, tone language speakers might be better able to perceive foreign lexical tones than non-tone language speakers. The unexpected finding of the study, which may shed some light on the topic of lexical tone perception, was that the English and Thai speakers displayed similar accuracy in the perception of Mandarin T2 and T3. In other words, the beneficial effect of tone language as an L1 is limited for the listeners' perception of foreign Lexical tones.

One of the limitations of the present study is that it did not examine whether the Thai and English participants relied on the same acoustic cues in the perception of the 4 Mandarin tones. Moreover, only Thai and English speakers' perception of lexical tones was tested. It would be interesting to examine the perception performance of speakers of other languages in future studies.

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Note 1. In the present paper, Thai refers to Bangkok Thai.

Appendix

Stimulus sentences used in the identification test

1. 把 di 标出来 (T1) (English meaning: Mark the di) (T1)
2. 把 di 标出来 (T2) (English meaning: Mark the di) (T2)
3. 把 di 标出来 (T3) (English meaning: Mark the di) (T3)
4. 把 di 标出来 (T4) (English meaning: Mark the di) (T4)

5. 把 da 标出来 (T1) (English meaning: Mark the da) (T1)
6. 把 da 标出来 (T2) (English meaning: Mark the da) (T2)
7. 把 da 标出来 (T3) (English meaning: Mark the da) (T3)
8. 把 da 标出来 (T4) (English meaning: Mark the da) (T4)

9. 把 du 标出来 (T1) (English meaning: Mark the du) (T1)
10. 把 du 标出来 (T2) (English meaning: Mark the du) (T2)
11. 把 du 标出来 (T3) (English meaning: Mark the du) (T3)
12. 把 du 标出来 (T4) (English meaning: Mark the du) (T4)

13. 把 chi 标出来 (T1) (English meaning: Mark the chi) (T1)
14. 把 chi 标出来 (T2) (English meaning: Mark the chi) (T2)
15. 把 chi 标出来 (T3) (English meaning: Mark the chi) (T3)
16. 把 chi 标出来 (T4) (English meaning: Mark the chi (T4)

17. 把 cha 标出来 (T1) (English meaning: Mark the cha) (T1)
18. 把 cha 标出来 (T2) (English meaning: Mark the cha) (T2)
19. 把 cha 标出来 (T3) (English meaning: Mark the cha) (T3)
20. 把 cha 标出来 (T4) (English meaning: Mark the cha (T4)

21. 把 chu 标出来 (T1) (English meaning: Mark the chu) (T1)
22. 把 chi 标出来 (T2) (English meaning: Mark the chu) (T2)
23. 把 chu 标出来 (T3) (English meaning: Mark the chu) (T3)
24. 把 chu 标出来 (T4) (English meaning: Mark the chu (T4)

Stimulus sentences used in the familiarization task:

1. 把 ki 标出来 (T1) (English meaning: Mark the ki)(T1)
2. 把 ki 标出来 (T2) (English meaning: Mark the ki)(T1)
3. 把 ki 标出来 (T3) (English meaning: Mark the ki)(T1)
4. 把 ki 标出来 (T4) (English meaning: Mark the ki)(T1)

5. 把 ka 标出来 (T1) (English meaning: Mark the ka)(T1)
6. 把 ka 标出来 (T2) (English meaning: Mark the ka)(T1)
7. 把 ka 标出来 (T3) (English meaning: Mark the ka)(T1)
8. 把 ka 标出来 (T4) (English meaning: Mark the ka)(T1)

9. 把 ku 标出来 (T1) (English meaning: Mark the ku)(T1)
10. 把 ku 标出来 (T2) (English meaning: Mark the ku)(T1)
11. 把 ku 标出来 (T3) (English meaning: Mark the ku)(T1)
12. 把 ku 标出来 (T4) (English meaning: Mark the ku)(T1)

Sample of the answer sheet used in identification test:

Name: _____ Gender: _____ Age: _____

1. a. Tone 1: ˉ b. Tone 2: ˊ c. Tone 3: ˇ d. Tone 4: ˋ
2. a. Tone 1: ˉ b. Tone 2: ˊ c. Tone 3: ˇ d. Tone 4: ˋ
3. a. Tone 1: ˉ b. Tone 2: ˊ c. Tone 3: ˇ d. Tone 4: ˋ

:
:
:
:

287. a. Tone 1: ˉ b. Tone 2: ˊ c. Tone 3: ˇ d. Tone 4: ˋ
288. a. Tone 1: ˉ b. Tone 2: ˊ c. Tone 3: ˇ d. Tone 4: ˋ