THE EFFECTIVENESS OF ACOUSTIC TRAINING ON TONE ACQUISITION BY HONG KONG LEARNERS OF MANDARIN

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ABSTRACT

Pronunciation of Mandarin tone has become one of the most important elements in teaching Mandarin in Hong Kong schools with the implementation of Biliteracy and Trilingualism language policy. Nowadays, pitch contours of Mandarin tones can be visualized with help of acoustic phonetic software such as *Praat*. The tool can also be used as a tool to help learners improve their pronunciation accuracy. The main purpose of this study is to examine learners' pronunciation of Mandarin tones before and after acoustic training. The study consisted of three inter-related parts: pre-test, tone visualization training, and post-test. Six female Hong Kong learners of Mandarin were invited to read and listen 24 monosyllabic words and 40 disyllabic words in tests. During the tone visualization training, the participants were involved in five on-campus training sessions and two online self-learning sessions using the acoustic phonetic software *Praat*. The graphical representations such as the duration, pitch height and pitch contour of each tone and permutation were instructed. Overall, the acoustic training improved the participants' pronunciation of Mandarin tones. The findings can help develop an effective tone training scheme for L2 Mandarin learners.

Keywords: Acoustic, Mandarin, Prosody, Second language acquisition

1. INTRODUCTION

Multilingualism is prevalent in Hong Kong, where most residents have Cantonese as first language (L1), and English and Mandarin as second (L2) or third language (L3). Since the handover of Hong Kong to Mainland China in 1997, Mandarin have been promoted in Hong Kong. With the encouragement of the Biliteracy and Trilingualism language policy and the growing social needs of using Mandarin, teaching Mandarin pronunciation has become one of the most essential issues for language teaching in Hong Kong schools. Although the use of vocabulary is similar in Cantonese to Mandarin, mutual intelligibility can be caused by the large differences in pronunciation. Accuracy of Mandarin tone pronunciation is particularly a challenge for both Mandarin teachers and learners in Hong Kong.

1.1. Mandarin acquisition by Hong Kong learners

There are four lexical tones (5-5, 3-5, 2-1-4, and 5-1) and a neutral tone in the Mandarin tone system. Similarly, there are also level, rising, and falling tones (5-5, 3-5, 3-3, 2-1, 2-3, and 2-2) in Cantonese, and Hong Kong learners of Mandarin could rely on the tone system in their L1[1]. Hao [8] also suggests that learners whose L1 is Cantonese have different tonal inventories from natives speakers of Mandarin. It is predicted by the speech learning model (SLM) that it is more difficult for learners to acquire new sounds in a language than sounds that are similar to counterparts in their L1, since the counterparts in the target language can influence the learnability of sounds [7]. Several studies investigated Mandarin tone perception by learners whose L1 was Cantonese and found that differentiation between Mandarin Tone 1 (5-5) and Tone 4 (5-1), and Tone 2 (3-5) and Tone 3 (2-1-4) are difficult (cf. [9, 10, 11]. In the study conducted by Li et al. [9], results indicate that Cantonese speakers identified Mandarin Tone 1 with the highest accuracy, whereas they identified Tone 4 with the lowest accuracy.

1.2. Mandarin tone training

Numerous studies have shown that the perceptual patterns of L2 learners can be modified with help of intensive laboratory-based training (e.g. [12]). Plenty of studies have investigated the effect of perception and production in L2 acquisition relating to learners' L1 segmental learning of a language [2, 3]. However, the research on the

training of prosodic acquisition of L2 tones is limited. Most learners are more familiar with the graphical representation (-, /, v, and \) than the numerical representation (1, 2, 3, and 4) of Mandarin tones [8].

One related study done by Chun et al. [6] had 35 learners of Mandarin in an American university do weekly practice with Praat to create pitch curves of tones of Mandarin words they produced and compare their pitch curves with samples from native Mandarin speakers to practice their pronunciation of Mandarin tones. The participants' pre-test and post-test performances were analysed aurally and acoustically, and the results showed both that the participants' tone accuracy improved through the training and that two-thirds of them found the training process helpful to their Mandarin tone acquisition. This study only focuses on the effectiveness of tone visualization training on Mandarin learners, regardless of their first language backgrounds, Mandarin language proficiency and their tonal learning experience. Wang et al. [13] trained American learners to perceive and produce Mandarin tones and observed that there was an improvement for all four tones when perception training transferred to the learners' tone production. Following the abovementioned research studies, this study was designed to shed light on the Mandarin tone acquisition by Cantonese speakers before and after acoustic training.

2. METHOD

Six female participants from a local university whose L1 was Cantonese and aged from 18 to 23 were recruited for the study on a voluntary basis. Since the participants were assessed according to their own growth from before to after training, there are no restrictions on participant gender, major, or Mandarin language proficiency.

Participants recorded themselves reading a list of 24 monosyllabic words and 40 disyllabic words using Audacity in a computer laboratory. The word list was designed based on the position of the tone within each word. The monosyllabic words cover words with all four Mandarin tones (as shown in Table 1, with 6 sets of monosyllabic words), and the disyllabic words include combinations of the four Mandarin tones and the neutral tone (as shown in Table 2, with 2 sets of disyllabic words). Participants were provided with Pinyin but not characters to avoid the situation in which they might pronounce words relying on memory of the characters instead of knowledge of the Mandarin tones.

Table 1: Rationale for monosyllabic reading design

Tone 1	Tone 2	Tone 3	Tone 4
jiā	láo	kuǎ	shì

Table 2: Rationale for disyllabic reading design (combinations of Tone 1 in the first position as examples)

Pinyin	Tones
xī guā	1+1
jiān chí	1+2
hūn lǐ	1+3
gān jìng	1+4
shū fu	1+0

According to [10], Cantonese speakers pay more attention to average height of a pitch contour because pitch contours are flatter in Cantonese than in Mandarin. Therefore, pitch height was regarded as one of the essential measurements for the participants to measure. In the acoustic training for Mandarin tone, the participants were involved in seven weekly training sessions, including five face-to-face group on-campus sessions (45 minutes each) and two online self-learning sessions. Throughout the on-campus sessions, the participants were instructed how to record themselves reading words following the female native speaker's samples, listen to their recordings and create their own pitch curves in order to analyse their average pitch height, pitch range, and duration; they repeated such process to practice the four tones in monosyllabic words and disyllabic words. In addition, the participants used the resources from the Mandarin spoken learner corpus and Praat Beginner's Manual [5] to practice Mandarin tones with reference to learner errors with a focus on speech data produced by female speakers.

The participants recorded themselves reading the same word list in the post-test as in the pre-test. They will then note down the tones of the 24 monosyllabic words and 40 disyllabic words from the word list that they hear in random order on a worksheet.

3. RESULTS

In general, accuracy of Mandarin tone production based on auditory judgement by two native speakers was higher in the post-test than in the pre-test. In the pre-test, the participants pronounced

86.81% and 83.33% of tone in monosyllabic and disyllabic words correctly, while in the post-test, accuracy rates of tone pronunciation in monosyllabic and disyllabic words were 94.44% and 93.33% respectively. The most frequent error patterns in the pre-test were the confusion between Tone 2 (3-5) and Tone 3 (2-1-4) and the lack of contrast between Tone 1 (5-5) and Tone 4 (5-1) for the monosyllabic words, and the application of Tone 3 sandhi rule, in which tone of the first word shifts from Tone 3 (2-1-4) to Tone 2 (3-5), was the most difficult for disyllabic words. In the post-test, there were only two instances of the confusion between Tone 1 and 4 and Tone 2 and 3 for monosyllabic words; the application of Tone 3 sandhi rule was successful for disyllabic words by each participant.

To further investigate the effectiveness of the acoustic training on the quality of tone pronunciation, one word from each Mandarin tone was randomly selected to be acoustically examined for both monosyllabic and disyllabic words. Praat [4] was used to measure F0 values of the participants' production of Mandarin tones. F0 values were measured at every 10 percent of the entire duration of tone-bearing units from the start to the end, with a total of 11 data points for each tone contour. To compare the pitch curves produced by the participants in the pre-test and post-test with a reference, speech data of the four words was collected from a female native speaker of Mandarin. For each word, data points of the six participants were compared with the female native speaker's data points in hierarchical linear model (HLM) using R package.

Figure 1 presents pitch curves of Mandarin tones in monosyllabic words from pre-test and post-test in solid lines and dotted lines respectively and Table 3 shows statistical comparison amongst a native speakers and the participants' performance in pre-test and post-test. For Tone 1, pitch curve in the post-test become more leveled and closer to the native speaker's model; pitch curve of Tone 2 show rising trend after acoustic training; the falling and rising trend of Tone 3 become more dramatic in the post-test; and pitch curve of Tone 4 is more falling and similar to the native speaker's model in post-test than in pre-test.

Figure 1: Pitch curves of Mandarin tones in monosyllabic words from pre-test and post-test

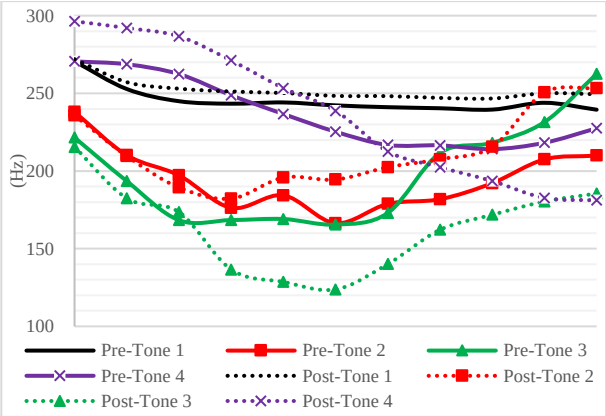

Table 3: HLM analysis results for Mandarin tones in monosyllabic words from pre-test and post-test

word	test	mean pitch height	trend
jia1	native	253.64	13.31
	pre	245.67	-19.65
	post	252.12	-15.52
zhuo2	native	194.99	186.82
	pre	194.79	-14.64
	post	212.43	35.16
huang3	native	170.77	-7.808
	pre	170.38	54.27
	post	135.72	-9.14
lin4	native	343.477	-201.09
	pre	236.85	-58.79
	post	237.25	-133.78

Figure 2 illustrates pitch contours of Mandarin tones when they are in the first position of disyllabic words from pre-test and post-test, and Table 2 presents statistical analysis of pitch heights and trends of the participants' pitch points compared with the native speaker's model. The figure and statistical result indicate that Tone 1 in the first position of the disyllabic word did not become more leveled after acoustic training; rising trend of the Tone 2 curve is more dramatic in post-test than in pre-test; unlike the falling and rising trends in the monosyllabic word, rising trend for Tone 3 in the first syllable of a disyllabic word is usually omitted, while the pitch curve did not turn to be more similar to the native speaker's model; pitch curve of Tone 4 become more dramatically falling in the post-test.

Figure 2. Pitch curves of Mandarin tones in the first position of disyllabic words from pre-test and post-test

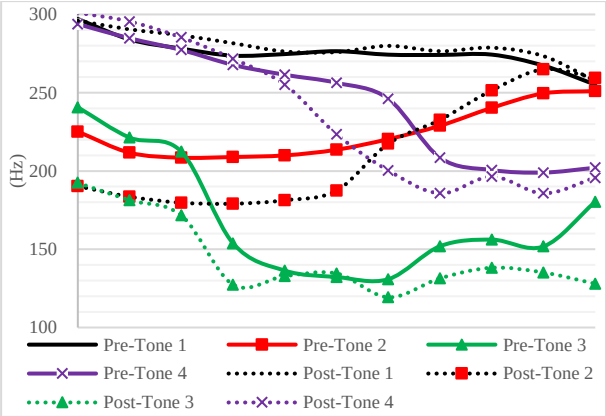

Table 4: HLM analysis results for Mandarin tones in the first position of disyllabic words from pre-test and post-test

word	test	mean pitch height	trend
hun1	native	272.08	4.48
	pre	275.40	-26.18
	post	279.37	-26.45
shi2	native	171.83	50.26
	pre	224.36	38.80
	post	211.57	93.63
jiao3	native	170.37	-107.09
	pre	139.23	-68.89
	post	130.42	-55.73
bao4	native	343.41	-145.88
	pre	245.25	-106.02
	post	236.40	-135.13

Figure 3 shows pitch curves of Mandarin tones in the second position of disyllabic words and Table 5 states HLM results for the four tones. Pitch curve of Tone 1 is more leveled after acoustic training; whereas pitch curve of Tone 2 in the post-test did not become more rising or closer to the native speaker's model; pitch contour of Tone 3 is more similar to the native speaker's model and closer to the 2-1-4 trend; Tone 4 pitch curve become more dramatically falling and closer to the native speaker's model after training.

Figure 3: Pitch curves of Mandarin tones in the second position of disyllabic words from pre-test and post-test

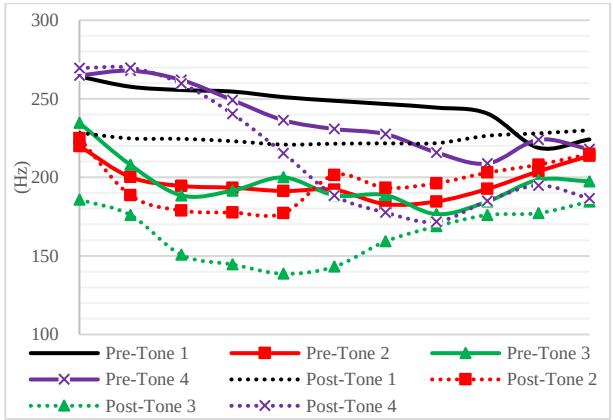

Table 5: HLM analysis results for Mandarin tones in the second position of disyllabic words from pre-test and post-test

word	test	mean pitch height	trend
fang1	native	258.50	3.295
	pre	246.03	-38.66
	post	224.61	2.30
he2	native	193.49	49.54
	pre	197.19	-4.34
	post	196.73	14.03
zhi3	native	154.04	3.95
	pre	184.97	-25.19
	post	148.24	13.07
lian4	native	277.94	-103.033
	pre	236.81	-58.67
	post	214.44	-101.25

4. CONCLUSION

In general, the acoustic training successfully improved accuracy of Mandarin tone pronunciation by the participants whose L1 is Cantonese and eliminated the confusion between Tone 1 and Tone 4, and Tone 2 and Tone 3. Acoustically, the training improved the quality of Mandarin tone pronunciation by the six participants except for Tone 3 in the first position of a disyllabic word and Tone 2 in the second position of a disyllabic word. The acoustic training approach used in this study have significant implication on the teaching and learning of prosody.

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