L2 tone processing as revealed by the incidental learning of tone-segment mappings

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Background: Tone languages (e.g. Cantonese, Thai, Mandarin) employ contrastive pitch patterns (i.e. lexical tones) to distinguish word meaning. Most previous research on L2 tone acquisition has focused on explicit processes such as L2 tone discrimination/identification [e.g. 1,2,3], and whether learners' tonal background and prior musical training may facilitate L2 tone perception [e.g. 4,5]. However, the ability to identify/discriminate L2 tones does not entail the ability to form abstract tone categories at the syllable level, and using tone categories as lexical cues [cf. 6]. This contribution is motivated by the hypothesis that, for learners whose native language is non-tonal, a long-term difficulty in tone learning concerns repurposing pitch patterns from intonation cues to the formation of abstract tone categories at the syllable level. This hypothesis was tested with an experiment on the incidental learning of tone-segment mappings (constraints by segments on the tone a given word can carry). The learning of these mappings hinges on the encoding of pitch patterns as abstract tone categories at the syllable level.

Subjects: 80 subjects participated (20 Cantonese musicians, 20 Cantonese non-musicians, 20 English musicians, and 20 English non-musicians)[1].

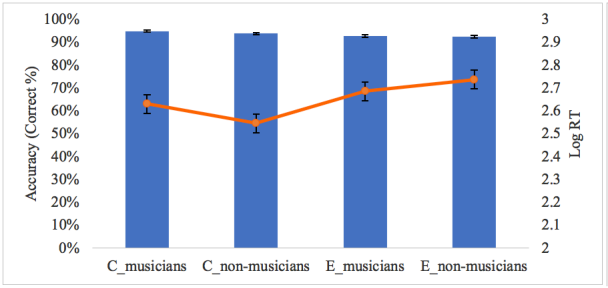
Learning targets: i) Words beginning with an aspirated stop (e.g. /pʰ/, /tʰ/ or /kʰ/) carry a rising tone; ii) words beginning with an approximant (e.g. /l/, /w/ or /j/) carry a falling tone.

Procedure: All stimuli were monosyllabic nonce words generated by the Salika speech synthesizer. Subjects first completed an AX discrimination task, which tested if they could distinguish the two target tones. The AB pairs differ only in the tone the words carry. Subjects then completed a word learning task adapted from [7,8]. In the training phase, they listened to a nonce word and repeated it aloud in each trial. This incidentally trained the subjects on the learning targets (i.e. they attended to the segments and tones but were not told their connections). In the testing phase, subjects were presented with two possible words and asked to decide which one sounded better. Subjects' learning of the target tone-segments connections was assessed by determining whether they could transfer the knowledge they acquired from the training to novel items in "critical trials" and "extension trials". Items in the critical trials had the same consonants used in the training along with new vowels, whereas those in the extension trials had a new aspirated stop/approximant onset. Sound pairs for the critical and extension items (differed only in terms of the tone they carried (e.g. /pʰɯːmR/ vs. / pʰɯːmF/). As such, it was when participants possessed knowledge of the target tone-segment mappings that they would show a preference for words which follow the target rules (e.g. /pʰɯːmR/ in the case above).

Results and Discussion: Figure 1 shows the average accuracy and log-reaction time (logRT) of the four groups for the AB pairs in the AX discrimination task. The four subject groups performed similarly well on distinguishing the two tones perceptually. Figure 2 shows the average accuracy of the four groups for the critical items and extension items. 95% confidence intervals were generated to determine whether individual group performed significantly above chance level (i.e. showing a learning effect). Results are presented in tables 1 and 2. For both critical items and extension items, the 95% confidence intervals of both Cantonese musicians and non-musicians do not contain the chance level value (50% accuracy), revealing that they performed significantly above chance. However, the 95% confidence intervals for English musicians and non-musicians contain the chance level value, meaning that they showed no learning effect. In sum, despite similar ability to distinguish tones perceptually, Cantonese learners could learn the target tone-segment connections but English learners could not, potentially because English learners failed to repurpose

[1] Subjects with six years or more formal musical training and have played music/sang regularly in the past two years were classified as musicians; those with less than 2 years of casual musical experience and have not played music/sang regularly in the past 2 years were classified as non-musicians.

pitch from intonational cues to forming tone categories at the syllable level [2]. Also, the fact that musical training did not facilitate the target incidental learning provides evidence for the separation of music and speech. More details on the statistical analyses will be presented in the conference.



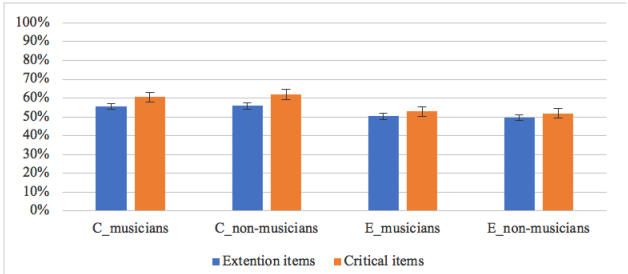


Figure 1 (left): Accuracy and log-transformed reaction time of the four groups for the AB pairs in the AX discrimination task. (C=Cantonese, E=English; error bar = 1 SE)

Figure 2 (right): Accuracy of the four groups for the critical items and extension items in the pronunciation judgment task. (C=Cantonese, E=English; error bar = 1 SE)

Group	Accuracy on critical items (%)	Upper Bound	Lower Bound
Cantonese musicians	60.80	65.17	56.26
Cantonese non-musicians	62.22	66.53	57.70
English musicians	52.99	57.56	48.37
English non-musicians	51.85	56.44	47.24

Group	Accuracy on extension items (%)	Upper Bound	Lower Bound
Cantonese musicians	55.65	59.89	51.33
Cantonese non-musicians	55.94	60.17	51.62
English musicians	50.28	54.60	45.96
English non-musicians	49.58	53.89	45.26

Tables 1 and 2: Accuracy (% correct) and 95% confidence intervals (from upper bound to lower bound) for the prediction of each participant group based on generalised linear mixed-effects models of the critical items (top) and extension items (bottom) (chance level = 50%).

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