INDIVIDUAL DIFFERENCES IN THE DISTRIBUTIONAL LEARNING AND OVERNIGHT CONSOLIDATION OF LEXICAL TONES

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This research examines how musical aptitude, pitch aptitude, Mandarin vocabulary size, and working memory (uniquely) account for individual differences in the distributional learning and consolidation of the Mandarin level-falling (T1-T4) tone pair by L1-Cantonese speakers. Distributional learning of phonetic categories is defined as learning through implicit exposure to probability distributions of stimuli (e.g., bimodal or unimodal) along a phonetic continuum (Maye & Gerken, 2002). In tonal learning studies, musicality and pitch aptitude have been implicated in the learning of L2 tones by non-tonal speakers (Wong & Perrachione, 2007). Vocabulary size was also implicated in the distributional learning of segments for L1 learners (Colby et al., 2018). However, whether pitch aptitude and musicality predict distributional learning of L2 tones for *L1-tonal* learners, and whether vocabulary size predicts distributional learning in an L2 setting, remain unknown. Moreover, newly learned tonal categories need to be consolidated[1] through overnight sleep for better retention outcomes. Working memory might play a role in the overnight consolidation of explicit declarative L2 learning by strengthening learned associative traces during sleep. It remains to be established whether working memory benefits distributional learning after overnight sleep where the training is implicit statistical in nature.

32 adult L1-Cantonese speakers (age range: 18-35; 15 males) were recruited for a distributional learning experiment on the Mandarin T1-T4 tone pair. Initial screening ensured that participants, with Mandarin proficiency self-reported as intermediate-level or below, had less than 9 years of Mandarin learning. Participants completed a pre-test, training, post-test procedure, where they were tested on the discrimination of Mandarin T1-T4 on novel carrier syllables in an ABX task, and were distributionally trained by listening to a two-peak **bimodal** continuum. After post-training test, participants were asked to come back 12 hours later for a second round of post-test (i.e post-sleep test) to measure their performance after overnight consolidation. Crucially, a battery of tests was given prior to the experiment to assess ID factors: musical aptitude was measured with the Montreal Battery of Evaluation of Amusia; pitch aptitude was measured with the pitch threshold task (just-noticeable differences of pitch contour); Mandarin vocabulary size was measured with the Peabody Picture Vocabulary Test; working memory was measured with Operation Span task.

Pearson correlation analysis ensured that there were no multi-collinearity issues among the factors. Results indicate a numerical trend of improvement following training, and significant improvement after sleep. Linear mixed-effects models were performed on learners' accuracy. Crucially, the results of posttest1-pretest revealed that pitch threshold (z=-4.03, p<.001) and Mandarin vocabulary size (z=2.04, p=.04) predicted immediate learning improvement, but not musical aptitude (see Fig. 1). The findings may imply that better lower-level psychoacoustic pitch processing abilities resulted in more effective auditory exposure during training, and that a richer L2 lexicon may have forced learners to create more detailed representations of L2 tonal categories during training. Furthermore, it shows that any effects of musicality may have been overridden by L1-tonal experience in a statistical learning setting. The results posttest2-pretest showed that working memory (z=2.02, p=.044) predicted improvement after consolidation. This finding implies that working memory may play a role in the consolidation of implicit statistical knowledge.

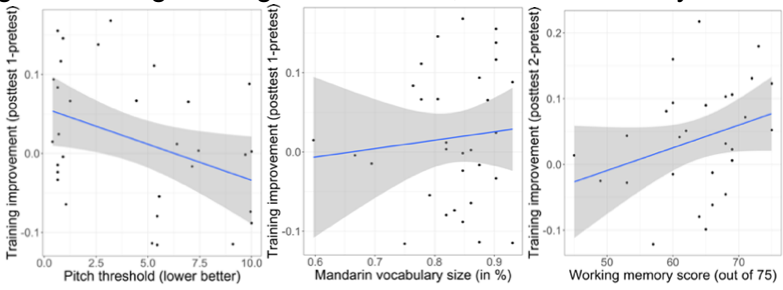

Fig. 1. Immediate training improvement (i.e. % increase in response accuracy) of individuals with different pitch thresholds (left) and Mandarin vocabulary size (middle). Improvement after consolidation of individuals with different working memory scores (right)

[1]Memory consolidation refers to the stabilization of newly learned memory traces by transformation into long-term memory.