Statistical learning of tone is constrained by native language experience

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Background: Different language users may weigh prosodic cues differently depending on which cues their native languages rely on the most (van der Bij et al., 2017). This native-language-dependent feature of phonological perception has been proven flexible in infants (Liu & Kager, 2017) and adaptive in adults (Ong et al., 2015). Given these previous studies, a question worth investigating is whether or not the adaptive non-native tone perception can be generalized to a statistical learning setting with highly variable speech stimuli. With this question, we can infer how abstract non-native tone perception could be.

Method: Two experiments were conducted to answer the above research question. In experiment 1, we created an artificial tonal language where 2 tone contours (i.e., a rising tone and a falling tone) were conditioned on 32 CVC frames. We had 24 non-tonal language speakers in the non-native group and 23 Mandarin Chinese speakers in the native group. Both groups were first familiarized with the artificial tonal language for 10 minutes, and then they were tested with speech stimuli that were either identical (legal items) or contrary (illegal items) to the tonal CVC frames they learned. Our hypotheses for experiment 1 were: (1) the native group would be more likely to accept the legal items in the first half of the test, and (2) the non-native group would show a preference for legal items in the second half of the test. To further demonstrate to what extent tone perception could be different between non-native and native tonal language speakers, we carried out experiment 2 to measure the sharpness of categorical perception of a rising versus a falling tone contrast. We fit the data with a logistic regression model and took the slope of the function as the dependent variable. There were 20 non-native tonal language speakers (Dutch speakers) and 18 native tonal language speakers (Mandarin speakers) who participated in experiment 2. We hypothesized that the native group would show a steeper slope of categorical boundary in tone perception compared to the non-native group.

Result: We split the test trials in experiment 1 into two halves and found that participants in the native group were more likely to accept legal items in the first half part (Fig. 1). Such difference was not shown in the non-native group. However, in the second half part, no difference was observed either between groups or between responses to stimuli. Experiment 2 discovered that non-native tonal language speakers perceive tones differently from tonal language speakers. More specifically, non-tonal language speakers had a shallower perceptual slope when perceiving a tone contrast (Fig. 2).

Conclusion: Distributional learning of tones in adults cannot be generalized to statistical learning that employed more variable stimuli. Our finding in experiment 1 implies that statistical learning of tone is constrained by native language experience in a top-down way. This conclusion is further supported by the results from experiment 2, demonstrating that there is a difference in categorical tone perception between non-native and native tonal language speakers.
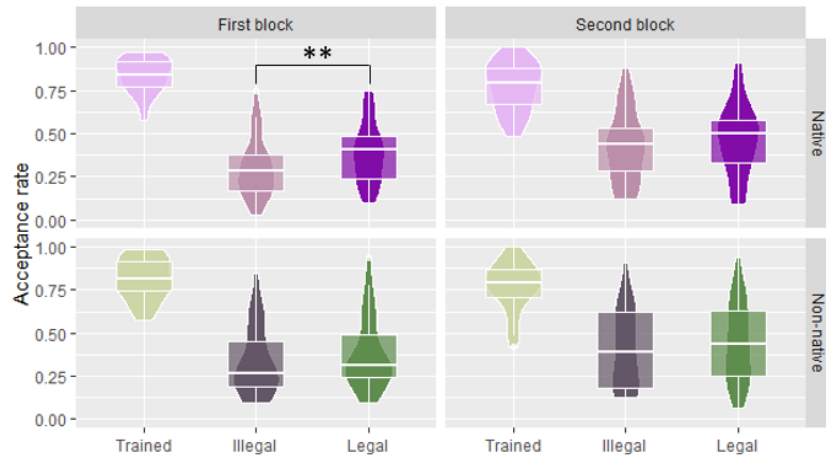
Fig. 1: The acceptance rate for the three types of test items. Data are shown in four panels along the variables of block order (first block vs. second block) and groups (native vs. non-native). ** denotes $P < 0.01$.
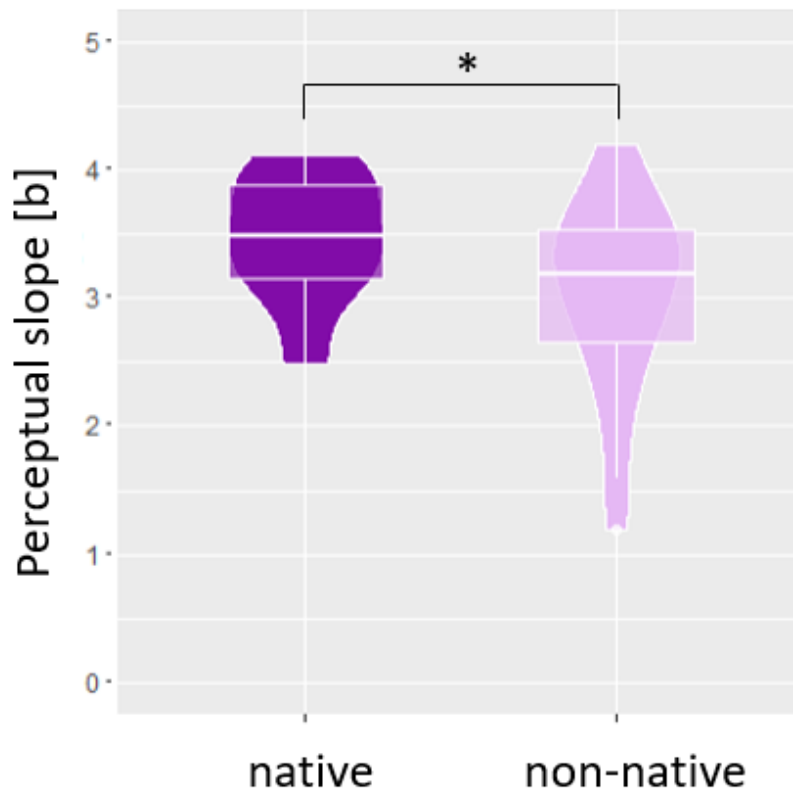

Fig. 2: The between-group difference on the perceptual slope of identifying the rising vs. falling tone pair. * denotes $P < 0.05$.

References

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