# Cross-language effects on the perception of non-native tonal contrasts

*Yung-hsiang Shawn Chang, Yao Yao, Becky Huang*

National Taipei University of Technology, Hong Kong Polytechnic University, University of Texas at San Antonio

shawnchang@ntut.edu.tw, ctyaoyao@polyu.edu.hk, becky.huang@usta.edu

Cross-language lexical tone perception studies generally find that non-tone language speakers, compared to their native tone language counterparts, maintain different weightings of the perceptual dimension of tone, and thereby exhibit poorer performance in tone perception tasks. In comparison, it is less clear whether speakers of a tone language have an advantage over those of a non-tone language in the perception of tones from another language. On the one hand, tone language speakers' outperformance of non-tone language speakers in perception of an unfamiliar language's tones is evidence of the facilitatory effect of linguistic experience on tone perception (Liang & van Heuven, 2007; Qin & Mok, 2011; Wayland & Guion, 2004). On the other hand, no significant difference between performance of tone and non-tone language speakers has also been reported (Francis et al., 2008; Lee et al., 2006; So & Best, 2010). In addition to different complexities of tone inventories, different controls of speaker variability and speaker normalization effects in the aforementioned studies may have also rendered the cross-study results incomparable.

To provide unambiguous evidence for the effects of linguistic experience with lexical tones on the perception of non-native tonal contrasts, the present study examined the identification of three Cantonese level tones by Cantonese, Mandarin (one level tone) and English (no lexical tones) listener groups (15 participants per group). Since the contour tones are characterized by the interaction of F0 direction and height, the level tones (high, mid, low) were chosen because they contrast only in F0 height, which renders the cross-linguistic perception results easier to interpret. The stimuli, following Lee et al.'s (2011; 2014) experimental paradigm, were constructed and presented in ways that avoid listeners' familiarity with an individual speaker. The stimuli were: 1) produced by a large number of speakers; 2) specifically arranged in blocks that were balanced across gender and used each speaker no more than once; and 3) presented in isolation such that no external F0 information was available to listeners.

The identification accuracy was analyzed using a mixed-effects logistic regression model. The results showed that both the Cantonese and Mandarin groups had significantly higher overall identification accuracy than the English group. That is, experience with a tone language facilitated the perception of non-native tones. Identification accuracy varied across speaker gender and tone height (Table 1). While all groups had the highest accuracy when identifying acoustically more distinct tones (i.e., high tones produced by females and low tones produced by males), only the Cantonese group was able to identify all types of stimuli at an above chance level. The Mandarin group identified high tones produced by males at chance level, while the English group identified high tones produced by males and low tones produced by females at chance level. The reaction time data (log-transformed; only correct responses were included) were analyzed using a linear mixed-effects model. The results showed that all listener groups took longer to respond to mid-level tones than to the other tones. The post-hoc analysis that explored the significant tone height × speaker gender interaction effect indicated that reaction time was shortest for high tones produced by female speakers and low tones produced by male speakers. That is, tones produced at the extremes of speakers' F0 range were easier to identify, which is consistent with the accuracy analysis. Group performance similarities and differences

are further discussed in terms of general auditory perception and whether (and how) tones are contrastive in their native languages.

| Group | Speaker gender | Tone | Accuracy | t(14); p value | Reaction time |
|---|---|---|---|---|---|
| Hong Kong (Cantonese) | female | high | 61.1 (15.2) | 7.18 (p<.001) | 1310 (475) |
| | | mid | 56.4 (12.2) | 7.43 (p<.001) | 1571 (759) |
| | | low | 54.7 (11.7) | 7.21 (p<.001) | 1495 (720) |
| | male | high | 46.7 (19.7) | 2.69 (p<.01) | 1437 (628) |
| | | mid | 51.4 (9.8) | 7.27 (p<.001) | 1579 (750) |
| | | low | 61.9 (9.3) | 12.06 (p<.001) | 1413 (708) |
| Taiwan (Mandarin) | female | high | 64.2 (15.3) | 7.91 (p<.001) | 1362 (816) |
| | | mid | 58.9 (16.6) | 6.05 (p<.001) | 1688 (1024) |
| | | low | 45.3 (20.7) | 2.3 (p<.05)) | 1586 (1069) |
| | male | high | 33.3 (23.1) | 0.06 (p=.48) | 1850 (2047) |
| | | mid | 46.7 (12.8) | 4.13 (p<.001) | 1709 (1036) |
| | | low | 69.7 (15.1) | 9.44 (p<.001) | 1271 (937) |
| US (English) | female | high | 58.9 (10.7) | 9.4 (p<.001) | 1361 (945) |
| | | mid | 50.8 (10.7) | 6.52 (p<.001) | 1670 (1090) |
| | | low | 28.9 (8.1) | -1.97 (p=.97) | 1637 (893) |
| | male | high | 20.6 (12.6) | -3.81 (p=0.99) | 1804 (1397) |
| | | mid | 40 (12.3) | 2.21 (p<.05) | 1874 (1612) |
| | | low | 65.8 (13.7) | 9.25 (p<.001) | 1480 (1067) |

Table 1: Mean accuracy (in percent with SD) and reaction time (in ms with SD) of Cantonese level tone identification for the Cantonese, Mandarin and English listeners. Results from t-test evaluating whether the identification accuracy was above the chance level (33.3%) were also included.

## References


Francis, A. L., Ciocca, V., M., L., & Fenn, K. (2008). Perceptual learning of Cantonese lexical tones by tone and non-tone language speakers. *Journal of Phonetics*, *36*, 268–294.

Lee, Y.-S., Vakoch, D. A., & Wurm, L. H. (1996). Tone perception in Cantonese and Mandarin: A cross-linguistic comparison. *Journal of Psycholinguistic Research*, *25*(5), 527–542.

Lee, C.-Y., Lee, Y.-F., & Shr, C.-L. (2011). Perception of musical and lexical tones by Taiwanese-speaking musicians. *Journal of the Acoustical Society of America*, *130*, 526–535.

Lee, C.-Y., Lekich, A., & Zhang, Y. (2014). Perception of pitch height in lexical and musical tones by English-speaking musicians and nonmusicians. *Journal of the Acoustical Society of America*, *135*, 1607–1615.

Liang, J., & van Heuven, V. J. (2007). Chinese tone and intonation perceived by L1and L2 listeners. In C. Gussenhoven & T. Riad (Eds.), *Tones and Tunes, Volume 2: Experimental studies in word and sentence prosody* (pp. 27-61). Berlin; New York: Mouton de Gruyter.

Qin, Z., & Mok, P. (2011). Perception of Cantonese tones by Mandarin, English and French speakers. In *Proceedings of the 17th International Congress of Phonetic Sciences* (ICPhS), 1654-1657.

So, C. K., & Best, C. T. (2010). Cross-language perception of non-native tonal contrasts: effects of native phonological and phonetic influences. *Language and Speech*, *53*(2), 273–293.

Wayland, R. P., & Guion, S. G. (2004). Training English and Chinese listeners to perceive Thai tones: A preliminary report. *Language Learning*, *54*(4), 681–712.