Observing Pitch Gestures Facilitates Delayed L2 Lexical Tone Categorization and Discrimination in Novel Words

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Introduction. In tonal languages such as Mandarin, lexical tones distinguish between word meanings. Perception of Mandarin tones poses a challenge to speakers of atonal first languages (L1s) such as English [1]. Observing gestures based on a vertical conceptual metaphor of pitch enhances L2 lexical tone acquisition, demonstrating the efficacy of cross-modal training [2-3]. This is in line with the integrated systems hypothesis, which claims that gestures and speech interact mutually and obligatorily, affecting language processing [4]. The efficacy of training promoting L2 lexical tone acquisition can be measured via two types of tasks: categorization, in which accuracy of sorting lexical tones by type is assessed, and discrimination, in which sensitivity to differences between lexical tones is assessed [5]. The impacts of observing pitch gestures when learning L2 lexical tones on subsequent categorization and discrimination have not been directly compared. This work fills this gap by revealing the extent to which the integrated systems hypothesis explains the impacts of observing pitch gestures on categorization and discrimination of L2 lexical tones.

Methods. L1 American English speakers with no tonal language knowledge (n = 32) were exposed to 28 quartets of Mandarin monosyllabic words. One of 4 lists of 7 quartets served as learned words, which were presented in the pre-test, learning, immediate post-test, and delayed post-test. The other 3 lists served as novel words, with 1 list each presented in the pre-test, immediate post-test, and delayed post-test. List assignment was counterbalanced across participants. In learning trials, audio clips produced by an L1 Mandarin speaker were presented with videos of an actor of the same gender either producing pitch gestures conveying their lexical tone contours (n = 16) or keeping their hands still (n = 16; see Fig. 1). In the categorization task, stylized images of the pitch contours of lexical tones were presented, and participants categorized the lexical tone of each word (k = 56) by selecting the corresponding image. In the discrimination task, participants were presented with a pair of words and indicated whether their lexical tones were the same or different (k = 64). The order of these tasks in tests was counterbalanced across participants. The pre-test, learning phase, and immediate post-test were administered on the first day, followed by the delayed post-test 24 hours later.

Results. Categorization accuracy was analyzed via linear mixed effect models, and discrimination sensitivity (*d'*) was analyzed via probit mixed effects models. Both included tests, learning condition, and word type as fixed factors and participant and item as random factors, with the maximal random effect structure justified. Lexical tones learned with pitch gestures were categorized and discriminated between in novel words not encountered during the learning phase, but not learned words encountered during the learning and test phases, as accurately in the delayed posttest as the immediate posttest. By contrast, lexical tones learned without gestures were categorized and discriminated between in novel, but not learned, words less accurately in the delayed posttest than the immediate posttest (categorization: B = -.12, SE = .05, z = -2.39, p = 0.02, Fig. 2A; discrimination: B = -.49, SE = .25, z = -1.97, p = 0.04; Fig. 2B).

Discussion. The results reveal that observing pitch gestures when learning L2 lexical tones prevents a decrease in categorization accuracy and discrimination sensitivity in novel, but not learned, words over time following learning. These findings are consistent with previous research highlighting the benefits of observing pitch gestures for learning L2 lexical tones [2-3]. Thus, they indicate that observing pitch gestures similarly affects identification and discrimination of L2 lexical tones, and that the integrated systems hypothesis applies to both.

References. [1] Wang et al. (2006). *Cambridge U. Press.* [2] Baills et al. (2019). *SSLA*. [3] Morett et al. (2022). *Cognition.* [4] Kelly et al. (2010). *Psych. Sci.* [5] Farran & Morett (2024). *Front. Educ.*

Table 1. Pinyins of Mandarin word stems used in each list.

List 1	**List 2**	**List 3**	**List 4**
cai	zhai	dui	shan
ba	hua	jiao	wo
ying	xing	ke	zai
mo	guo	lei	xun
piao	nao	qian	ge
chi	ci	rong	hong
fu	tu	sa	rao

Figure 1. Screenshots of videos from the two learning conditions with Mandarin words and superimposed arrows representing hand motion.

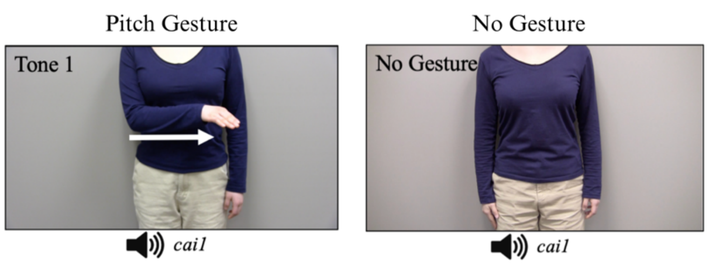

Figure 2. Categorization accuracy (A) and discrimination sensitivity (B) by test, condition, and word type.