Observing gestures at learning aids phonological and semantic L2 lexical processing

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Introduction. Lexical tone refers to the use of pitch to differentiate between word meanings in many languages, such as Mandarin. Observing gestures conveying the meanings of words (semantic gestures) from unfamiliar L2s at learning enhances their recall [1-2]. Likewise, observing gestures conveying lexical tone pitch contours (pitch gestures) aids differentiation between L2 words by atonal L1 speakers [3-4]. Moreover, L1 words accompanied by semantic gestures with incongruent meanings elicit a larger N400 event-related potential (ERP) than L1 words accompanied by semantic gestures with congruent meanings, reflecting increased semantic integration effort [5]. These findings are consistent with the integrated systems hypothesis, which posits that gesture and speech mutually and obligatorily interact, affecting sentence processing [6-7]. At present, it is unclear whether observing pitch and semantic gestures at learning differentially affects phonological and semantic L2 lexical processing. This work fills this gap, justifying expansion of the integrated systems hypothesis to the relationships between sound and meaning.

Methods. L1 English speakers with no tonal language knowledge (n = 42) learned six pairs of Mandarin words differing minimally in lexical tone (Table 1) repeated across three blocks. In learning trials, Mandarin words were presented aurally with videos of an L1 speaker producing pitch gestures conveying lexical tone contours (n = 13), semantic gestures conveying word meanings (n = 15), or no gestures (n = 14; see Fig. 1), followed by English translations presented as text. Subsequent trials featured the other Mandarin word in the pair to emphasize the difference in lexical tone between them. Word presentation order in pairs was counterbalanced and pair presentation order was randomized across participants within each block. Following learning, lexical tone discrimination and meaning discrimination tasks were completed, counterbalanced in order across participants. In the lexical tone discrimination task, learned Mandarin prime words and different learned Mandarin target words with either the same (k = 72) or different (k = 72) lexical tones were presented aurally. In the meaning discrimination task, learned Mandarin prime words were presented aurally followed by English target words that were translations of either prime words (k = 72) or Mandarin words paired with prime words (k = 72) presented as text. N400 responses to target words were analyzed using linear mixed effect models.

Results. In the lexical tone discrimination task, we observed significant interactions of match with no gesture vs. pitch and semantic gesture (B = -14.40, SE = 1.89, z = -7.61, p < .001) and no gesture and pitch vs. semantic gesture (B = 9.82, SE = 1.56, z = 6.28, p < .001). Estimated marginal means revealed that target words with lexical tones mismatching those of prime words elicited larger N400s than target words with lexical tones matching those of prime words for pitch gesture (p < .001), but not semantic gesture (p =.15) or no gesture (p =.85; see Fig. 2). In the meaning discrimination task, we observed significant interactions of match with no gesture vs. pitch and semantic gesture (B = -20.07, SE = 2.48, z = -8.11, p < .001) and no gesture and pitch vs. semantic gesture (B = 5.71, SE = 2.07, z = 2.76, p = .006). Estimated marginal means revealed that target words with meanings mismatching those of prime words elicited larger N400s than target words with meanings matching those of prime words for pitch gesture (p < .001) and semantic gesture (p =.001), but not no gesture (p = .49; see Fig. 3).

Discussion. The results reveal that observing pitch gestures when learning L2 Mandarin words differing in lexical tone enhances L1 English speakers' differentiation between their lexical tones and meanings. Moreover, they reveal that observing semantic gestures when learning such L2 Mandarin words enhances L1 English speakers' differentiation between their meanings. These findings support expansion of the integrated systems hypothesis to account for the relationships between semantic and phonological information conveyed via gesture and speech.

References. [1] Allen (1995). *Mod. Lang. J.* [2] Kelly et al. (2009). *Lang. & Cog. Processes.* [3] Bailles et al. (2019). *SSLA.* [4] Morett & Chang (2015). *LCN.* [5] Kelly et al. (2004). *Brain & Lang.* [6] Kelly et al. (2010). *J Cog. Neuro.* [7] Kelly et al. (2010). *Psych. Sci.*

Table 1. Pairs of Mandarin words differing minimally in lexical tone with English translations.

Word 1		Word 2	
Mandarin Pinyin	English	Mandarin Pinyin	English
hui1	to wave	hui2	to return
bao1	to pack	bao3	full
chou1	to pump	chou4	to stink
xiang2	to surrender	xiang3	to think
tiao2	to shift	tiao4	to jump
duo3	to hide	duo4	to chop

Figure 1. Screenshots of videos from each learning condition with Mandarin word and English translation, with arrows representing hand motion (face blurred in figure only).

Figure 2. ERP waveforms and topographic plots for matching (blue) and mismatching (red) word pairs learned in the pitch gesture, semantic gesture, and no gesture conditions in the lexical tone discrimination task (gray shading indicates N400 time window).

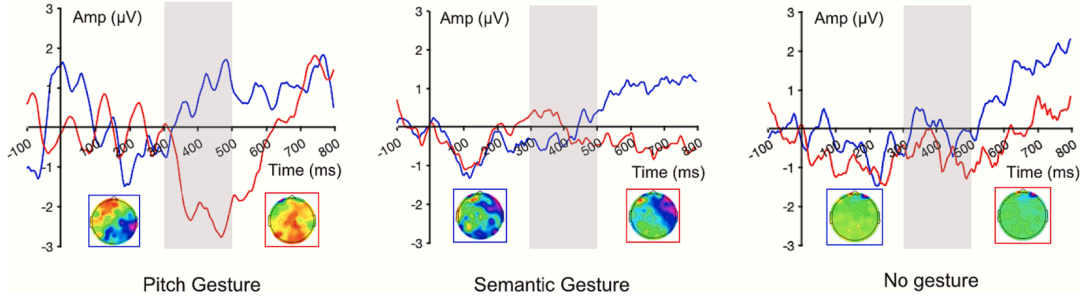

Figure 3. ERP waveforms and topographic plots for matching (blue) and mismatching (red) word pairs learned in the pitch gesture, semantic gesture, and no gesture conditions in the meaning discrimination task (gray shading indicates N400 time window).