An ERP study of the beneficial effects of gesture on associative memory formation

Stanley H. West*, Brianna E. Cairney, & Heather D. Lucas

Psychology Department, Louisiana State University

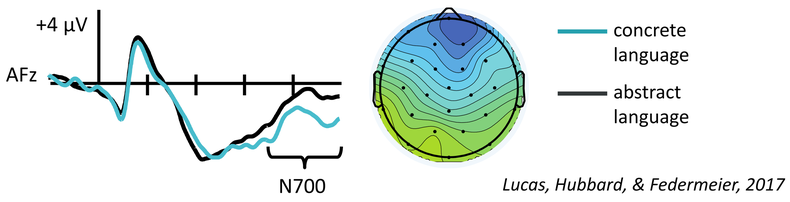
*Correspondence to swest19@lsu.edu

How does co-speech gesture affect memory?

- Gesture is an integral part of human communication that has been shown to benefit language comprehension and memory.
- Co-speech gestures can include:
  - ***Iconic gestures***: hand movements that mimic speech
  - ***Beat gestures***: small hand movements for emphasis[1]
- Gestures may benefit memory by:
  - ***Dual coding:*** providing a visual representation of information, which may enhance imagery[2] and/or
  - ***Attentional highlighting***: calling attention to parts of speech[3]
- While both iconic and beat gestures can enhance memory via attentional highlighting, only iconic gestures can support dual coding.
- To compare these accounts, we recorded study-phase ERPs and tested recall for unrelated word pairs with the first words (W1s) paired with iconic, beat, or no gestures.

Hypotheses

- If gesture benefits memory via **Attentional Highlighting:**
  - both iconic and beat gestures will improve memory
- If gesture benefits memory via **Dual Coding:**
  - only iconic gestures will improve memory
  - iconic-gestured pairs may be perceived as more imageable
  - Iconic-gestured pairs may elicit greater N700 amplitudes, an ERP component linked to concreteness and imagery in prior work[4]



Lucas, Hubbard, & Federmeier, 2017

Methods

Participants

- N = 30 young adults, 23 female
- Mean age = 20 yrs (range = 18-27)
- All native speakers of English

Stimuli & Procedures

- Participants watched videos of an actor reciting 108 sentences ending in unrelated verb-noun (W1-W2) pairs:
  - 36 with iconic-gestured verbs
  - 36 with beat-gestured verbs
  - 36 with non-gestured verbs
- Stimuli presented in 3 blocks of 36, followed by a free recall test
- After viewing each video, participants had 4 seconds to rate from 1-6 how easy it was to generate mental images of the word pairs
- Continuous EEG recorded from 32 electrodes

1. McNeill, D. (1992). Hand and mind: What gestures reveal about thought. University of Chicago press.
2. Paivio, A. & Csapo, K. (1973). Picture superiority in free recall: Imagery or dual coding? *Cognitive Psychology, 5,* 176-206
3. Biau, E., & Soto-Faraco, S. (2013). Beat gestures modulate auditory integration in speech perception. *Brain and Language*, *124*, 143-152.
4. West, W. C., & Holcomb, P. J. (2000). Imaginal, semantic, and surface-level processing of concrete and abstract words: an electrophysiological investigation. *JoCN*, *12*, 1024-1037

Stimuli

Iconic gesture

He thought about *the narrowing* *turtle*

(W1) (W2)

Beat gesture

He thought about *the narrowing* *turtle*

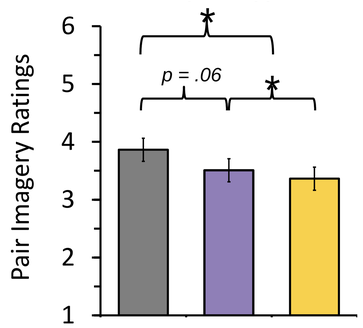
No gesture

He thought about *the narrowing* *turtle*

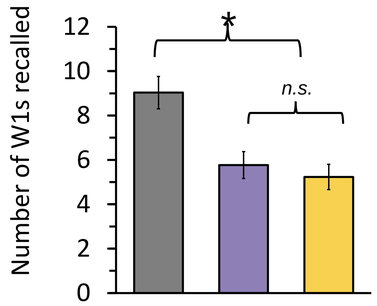
Mean W1-W2 SOA = 1714 ms (range = 1519 – 1917); SOA & ISI held constant across conditions.

Behavior: W1 gestures enhanced imageability ratings; only iconic gestures enhanced recall

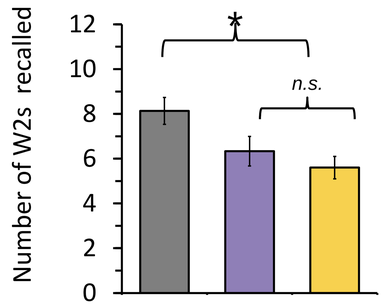
Ease-of-imagery ratings for all word pair types

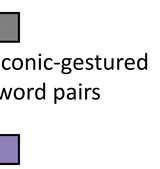


Recall of co-gestured W1s



Recall of W2s *paired with* co-gestured W1s



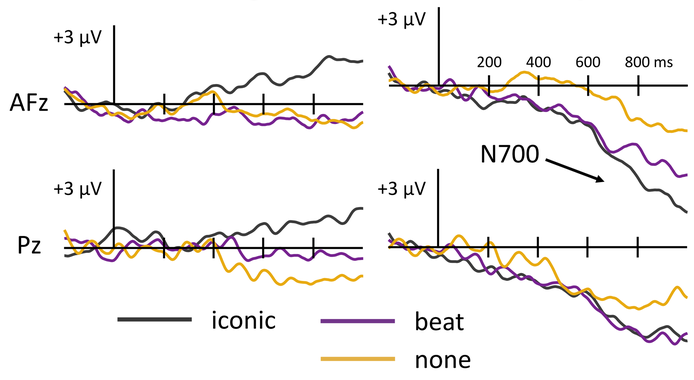


ERPs: W1 gestures enhanced W2 N700 ERPs, suggesting facilitated associative imagery.

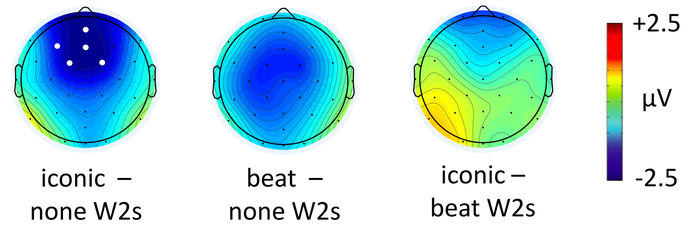
- Analyses focused on ERPs elicited by the non-gestures W2s (e.g., narrowing ***turtle***) so as to examine the impact of the co-W1 gesture on brain activity while holding sensory input constant.
- Factorial mass univariate analyses revealed differences in five frontal electrodes (in white) from 790-1000 ms, consistent with N700.

Co-gestured W1s: ***narrowing*** *turtle**

Non-gestured W2s: *narrowing* ***turtle***



Scalp distributions from 790-1000 ms



- N700s for W2s with iconic gestures > no gestures [$t(29) = 4.48$, $p < 0.001$]
- Significant difference between beat > no gestures [$t(29) = 2.96$, $p = 0.006$]
- No difference between iconic and beat gestures [$t(29) = 1.56$, $p = 0.13$]

* W1 ERPs are provided for display purposes only and were not formally analyzed.

Conclusions

- Iconic gestures, but not beat gestures, enhanced recall for unrelated word pairs, suggesting that these memory benefits stemmed from the presence of semantic content rather than attentional highlighting.
- Both trial-by-trial imagery ratings and imagery-related ERPs (N700) were largest for word pairs accompanied by iconic gestures, suggesting that mental imagery may mediate the relationship between gestures processing and enhanced memory.
- However, imagery and ERP effects of beat gestures were not distinguishable from those of iconic gestures, leaving open the possibility that beat gestures can also be effective at enhancing imagery.
- These results tentatively support a dual-coding based theory of the beneficial effects of iconic gestures on memory.