Gesturing intentionally during encoding: Effects of fluid intelligence and spontaneous gesture rate

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Introduction

How effective are hand gestures as an **intentional** encoding device?

Little research has examined how **gesturing during encoding** of new information affects later recall, and even less has examined whether **intentional** use of gestures as an encoding device or mnemonic is effective.

- Gesturing could aid encoding more than verbal repetition simply because it provides an additional representational format. It may encourage generation of internal visual imagery (Alibali et al., 1999; Cook et al., 2010; de Ruiter, 2008; McNeill, 1992; Melinger & Levelt, 2004), as well as simulated action (Hostetter & Alibali, 2008).
- Following **incidental encoding**, surprise memory for events benefitted from gestures produced during verbal narrations compared to verbal description alone. Gestures produced spontaneously or by instruction were both effective (Cook, Yip, & Goldin-Meadow, 2010).
- Following ***intentional encoding***, cued-recall memory for unassociated word pairs benefitted from gestures produced during encoding compared to verbal repetition alone (Foraker, 2011).
  - **However, gesturing during intentional encoding was *less effective* than using internal mental imagery to encode the word pairs.**
  - Gesturing may be less familiar, less practiced, and in general more difficult to produce than mental imagery. Are there individual differences that contribute to how easy or effective gesturing is?

Predictions

For whom might gesturing be less effortful and/or more effective than mental imagery as an encoding strategy?

The first modulator examined was **spontaneous gesture rate**, as those who naturally gesture more may produce more effective gestures on demand. We predicted a **Strategy X Gesture Rate interaction**: when assigned to the Gesture Strategy instructions, a higher Gesture Rate could produce more effective gestures, which should support higher memory accuracy. Gesture Rate was not predicted to have any influence on memory for those using the Imagery Strategy.

The second modulator examined was **fluid intelligence**, which is positively associated with producing kinematic, movement gestures (Sassenburg et al., 2011; Wartenburger et al., 2010). In addition to an overall memory advantage for higher fluid intelligence, we predicted a **Strategy X Fluid Intelligence interaction**: for those assigned the Gesture Strategy instructions, higher Fluid Intelligence scores should produce a relatively greater memory advantage. Fluid Intelligence should not show as steep an effect for those assigned the Imagery Strategy.

Method

Materials: 30 unassociated word pairs, concrete nouns that could be imagined or gestured

- normed associative rating, mean = 1.30 (1-7 scale)
- e.g., cat-hose, door-kite, statue-zipper, lava-carrot, jar-sock

Learning phase: word pair learning task

- **Imagery**: "repeat the words over and over in your mind and ***form an image*** in your mind of those two things in some relationship"
- **Gesturing**: "repeat the words over and over in your mind and ***illustrate or act out*** each of the words in some relationship with your hands and body, like in charades"
- 20 secs to encode each pair   2 practice trials, with modeling

Test phase: cued recall

- Immediate (minutes later) & Delayed (2 days later)   no instruction at recall

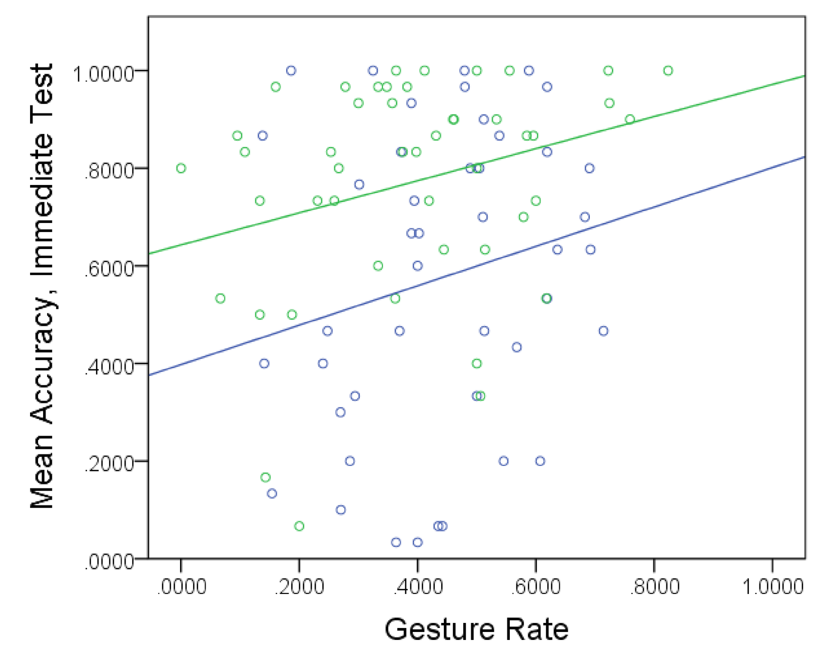
Gesture Rate: spontaneous gesture rate measured independently – done first on day 1 for all participants

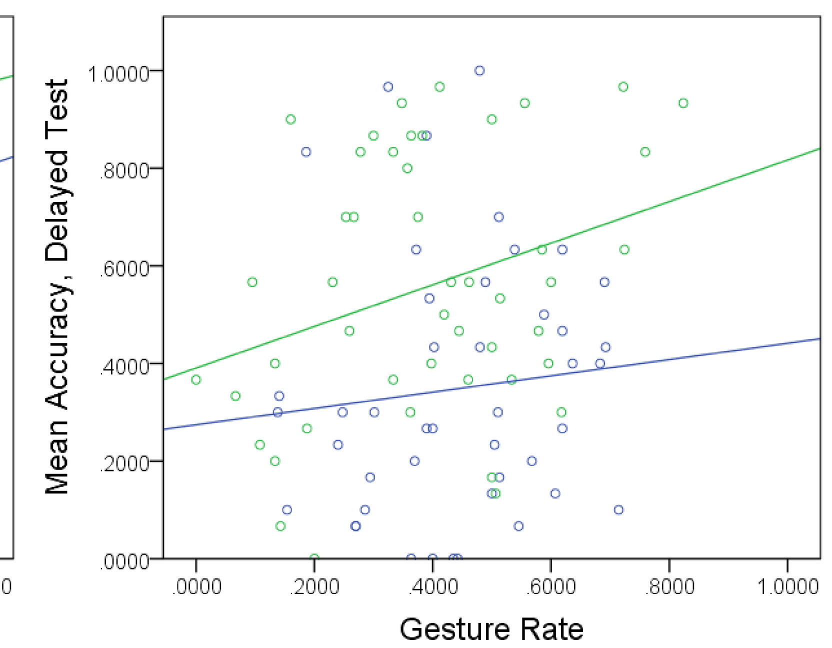
- subjects described how to wrap a gift
- iconic gestures were coded from videotape, and gestures per minute was calculated
- Inter-rater reliability: 92%
- Models using gesture rate calculated from a cartoon narration (SpongeBob Square pants) produced similar results.

Fluid Intelligence: measured independently with Ravens Progressive Matrices – done last on day 3 for all participants

- Models using raw number correct and percent correct/number attempted produced similar results.

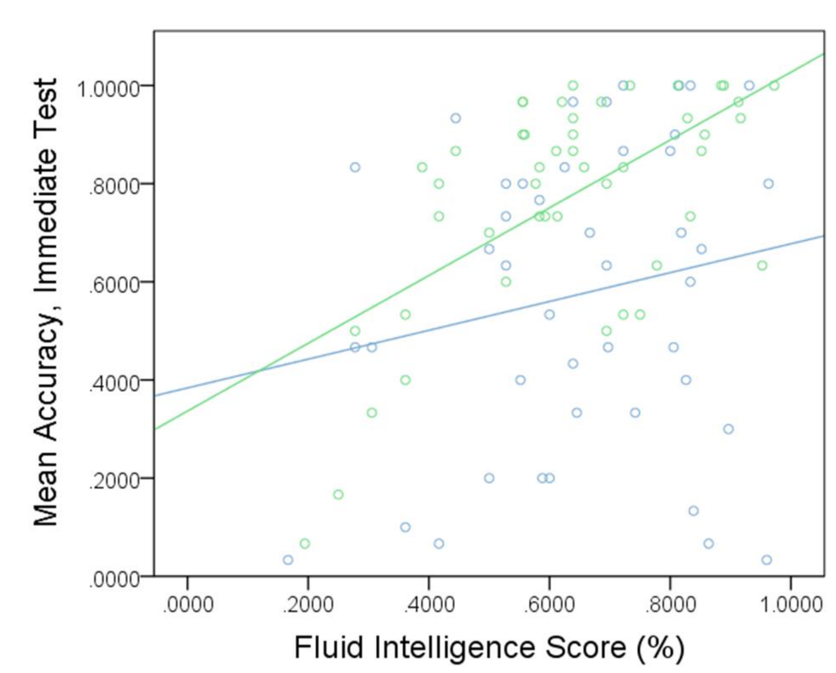
Results

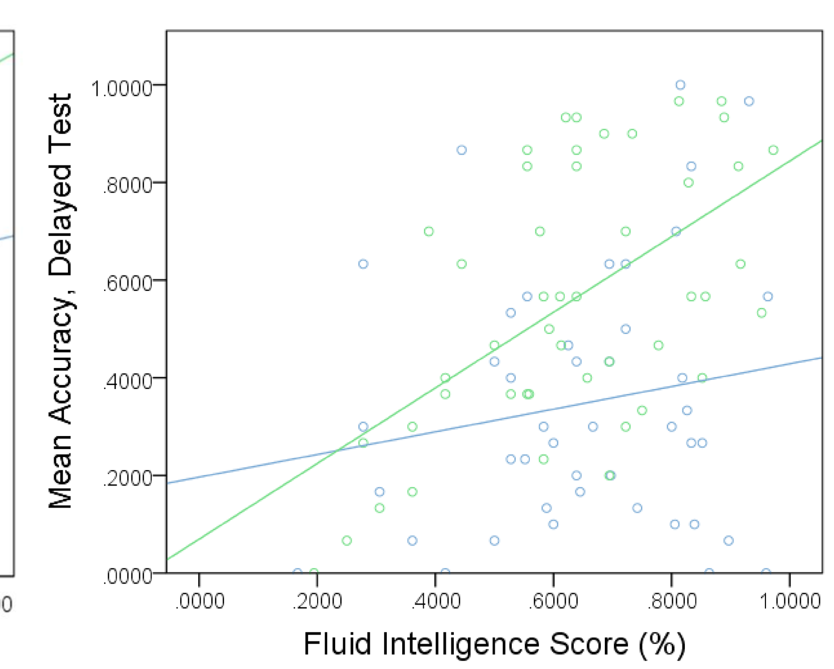




Overall, memory accuracy was higher for the immediate test (.67, *SE* = .03) than delayed test (.45, *SE* = .03). The interaction of Time X Gesture Rate indicates that gesture rate predicted memory accuracy more strongly for the immediate test than for the delayed test.

Additionally, memory accuracy was higher for the imagery strategy (.66, *SE* = .04) than gesture strategy (.46, *SE* = .04). Counter our prediction, we found no statistical evidence of a Strategy X Gesture Rate interaction; higher gesture rates did not appreciably increase memory accuracy for those assigned gesture vs. imagery.



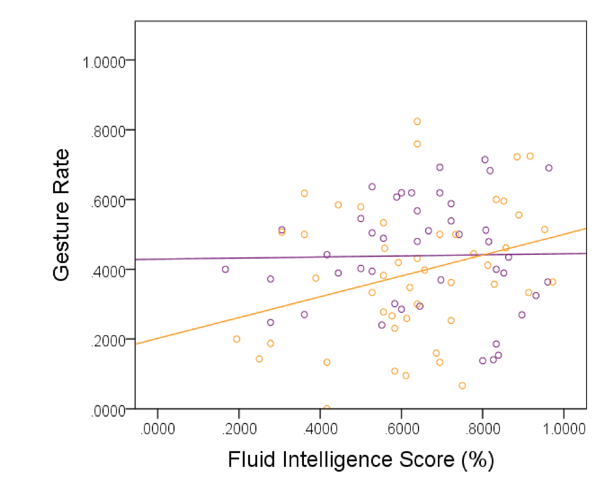


Overall, memory accuracy was higher for those with higher fluid intelligence. In addition, the interaction of Strategy X Fluid Intelligence was not significant. Descriptively, the pattern was the opposite of what we hypothesized, with Fluid Intelligence accounting for memory accuracy more strongly for the imagery strategy than for the gesture strategy.

	df	*t*-value	
Intercept	5361	21.88***	
Time (Immediate vs. Delayed)	**5361**	**-13.84*** **	
Strategy (Imagery vs. Gesturing)	**83**	**-4.44*** **	
Fluid Intelligence	**83**	**3.60*** **	
Gesture Rate	83	.89	
Time X Strategy	5361	.24	
Time X Fluid Intelligence	5361	.45	
Time X Gesture Rate	**5361**	**-1.93**	**(p = .053)**
Strategy X Fluid Intelligence	**83**	**-1.55**	**(p = .12)**
Strategy X Gesture Rate	83	.46	
Gesture Rate X Fluid Intelligence	83	.03	
Time X Strategy X Fluid Intelligence	5361	-1.06	
Time X Strategy X Gesture Rate	5361	-.66	
Time X Gesture Rate X Fluid Intelligence	5361	.58	
Strategy X Gesture Rate X Fluid Intelligence	5361	.55	
Time X Strategy X Gesture Rate X Fluid Intelligence	5361	.04	

- N = 91, 47 imagery, 44 gesture
- Linear mixed effects regression
- best fit model with maximal fixed effects factor structure
- random intercepts, and random slopes per subject for Time and Strategy

- In our total sample, the **Gesture Rate** did **not differ** for the Gesture (.44, *SE* = .16) vs. Imagery (.39, *SE* = .19) strategy groups, $t(89)=1.33$, $p = .19$.
- As well, the **Fluid Intelligence** measure did **not differ** between the Gesture (.65, *SE* = .19) vs. Imagery (.63, *SE* = .19) groups, $t(89) = .54$, $p = .590$.



In our total sample, Gesture Rate was marginally correlated with Fluid Intelligence score, $r(91) = .18$, $p = .082$. Broken down by Strategy, for those assigned the Imagery strategy, the correlation was significant, $r(47) = .30$, $p = .041$, while for those assigned the gesture strategy, this correlation was not evident, $r(44) = .02$, $p = .901$. It is unclear if this occurred by chance (likely) or whether the strategy assigned somehow modulated the relationship between these two measures.

Discussion

1. We found that an individual's spontaneous **Gesture Rate** did contribute to better memory accuracy. However, the facilitation was **limited** to the immediate test, and was **not specific** to those assigned the gesture strategy.
2. Those assigned the imagery strategy showed better memory accuracy than those assigned the gesture strategy (Foraker, 2011). Whether Fluid Intelligence may account for more of the accuracy score in the imagery group than gesture group should be further investigated.
3. The range of Gesture Rate and Fluid Intelligence measures were equivalent between the two strategy groups, but the relation between the two factors differed for the groups. We currently have no principled explanation for this.

Future Directions

We are investigating additional accounts for why and when gesturing may be less effective as an intentional encoding strategy than imagery. First, representational gestures likely are less detailed and distinctive than mental images, so may produce relatively impoverished encoding and potential retrieval cues. Therefore, generating appropriate gestures for a novel association may demand more from resources available for encoding. As well, additional practice with producing self-generated gestures may increase their utility, perhaps increasing their distinctiveness and decreasing the mental resources needed to produce them.

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