The Effect of Individual Differences on Gesture Learning in Adults

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Gestures are hand movements that accompany speech and convey meaning. Decades of research have shown that gesture benefits learning – both adults and children show increased understanding and retention of material when instruction includes gesture. However, not all individuals benefit equally. Here, we explore individual differences that may influence one's likelihood to benefit from gesture instruction in the context of mathematical equivalence.

Specifically, we look at how individual differences in working memory (visuospatial and verbal) and spontaneous gesture rate influence one's likelihood to learn from gesture instruction.

Method

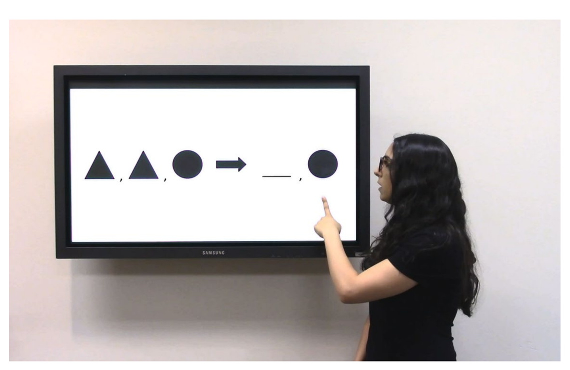
Participants: 50 undergraduate students (18-23 yrs; *M* = 18.88 yrs, SD = 1.15 yrs; 34 females, 13 males)

Procedure:

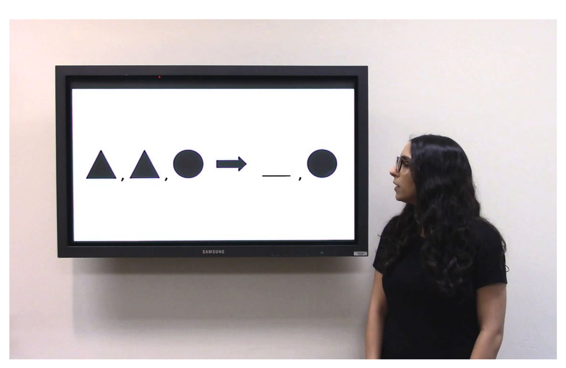
Math Equivalence Task

Participants completed an abstract math equivalence task under one of two conditions: gesture (n = 30) or no gesture (n = 30). Participants watched instructional videos and completed practice problems. Learning was assessed with a posttest.

*"**Triangle** combined with **triangle** makes **circle**, and **circle** combined with **circle** makes **triangle**, so one side reduces to make triangle. I already have a **circle** on the other side, so **what** combines with circle to make triangle? The answer is circle."*



Gesture Condition: the instructor used pointing gestures that aligned with spoken instructions

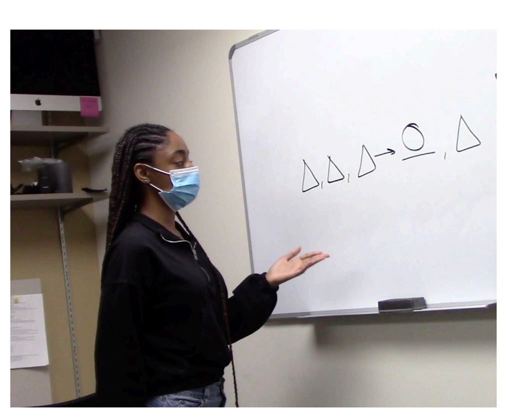


No gesture condition: the instructor used only spoken instruction

Gesture Elicitation Tasks

Context Dependent:
"Can you please explain to me how you got [circle]?"

Context Independent:
"Can you please describe the actions you would take to wrap a package the size and shape of a shoebox in wrapping paper? Please describe your actions with as much detail as possible."



IQ Measures

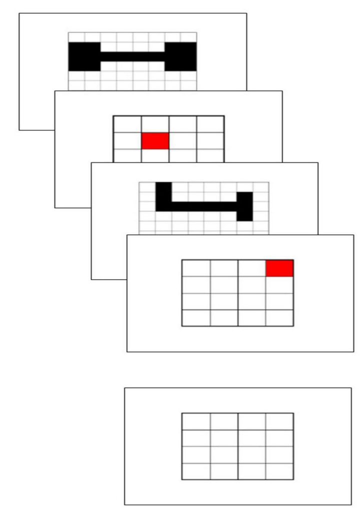
Fluid Intelligence: Raven's Advanced Matrices

Crystallized Intelligence: Vocabulary Task

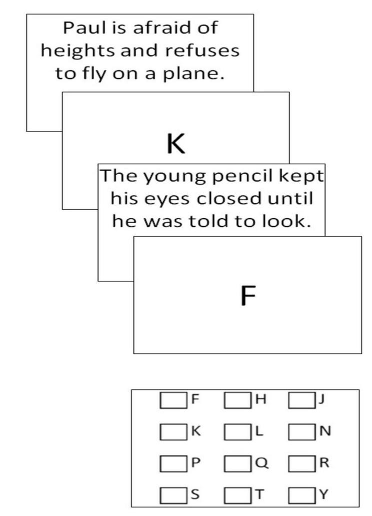
Methods (cont).

Working Memory Measures

Visuospatial Working Memory: Symmetry Span Task



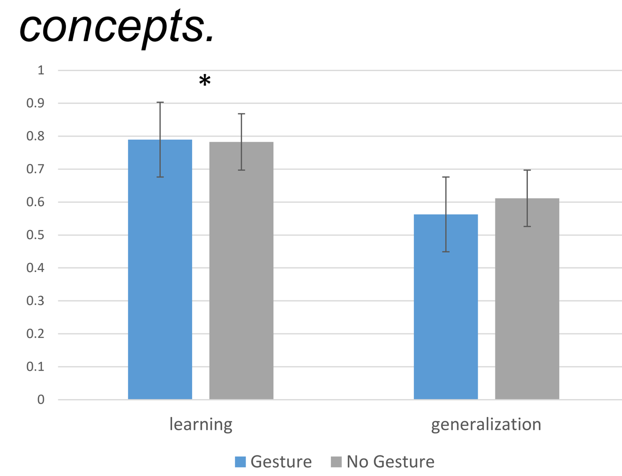
Verbal Working Memory: Reading Span Task



Results

Do participants benefit more through gesture instruction than no gesture instruction?

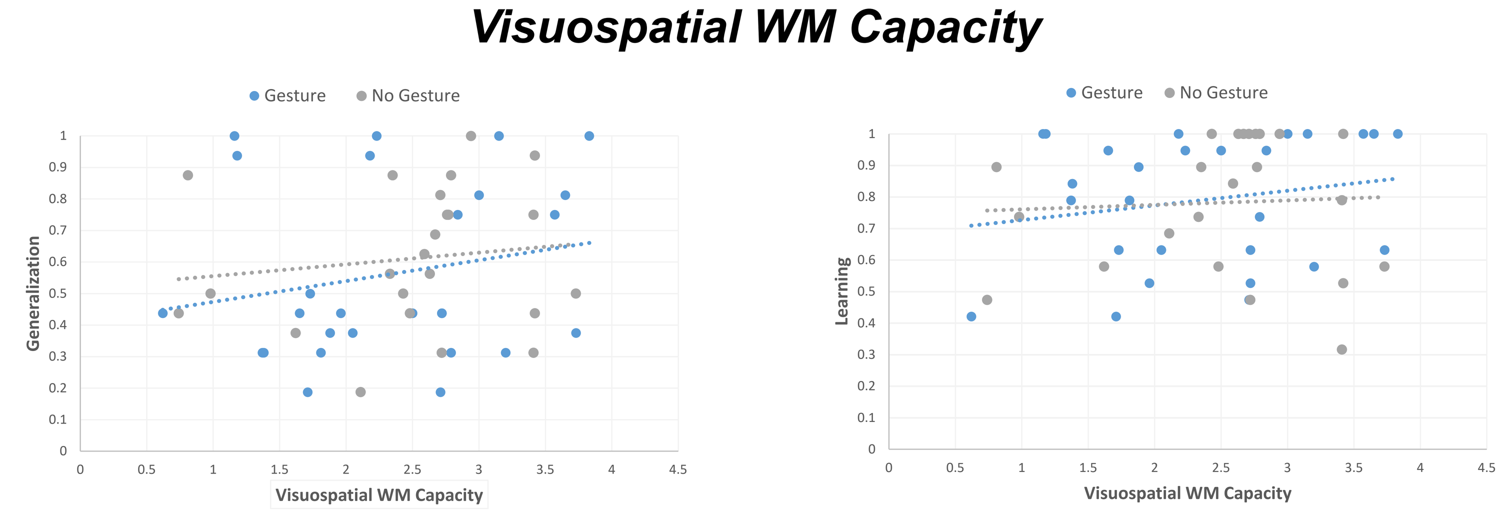
Learning was measured based on posttest performance. Learning refers to concepts explicitly taught during instruction. Generalization refers to more difficult concepts not explicitly taught and require application of learned concepts.



- Condition did not predict performance on learning or generalization problems
- All participants performed better on learning than generalization problems, replicating Aldugom et al. (2021).

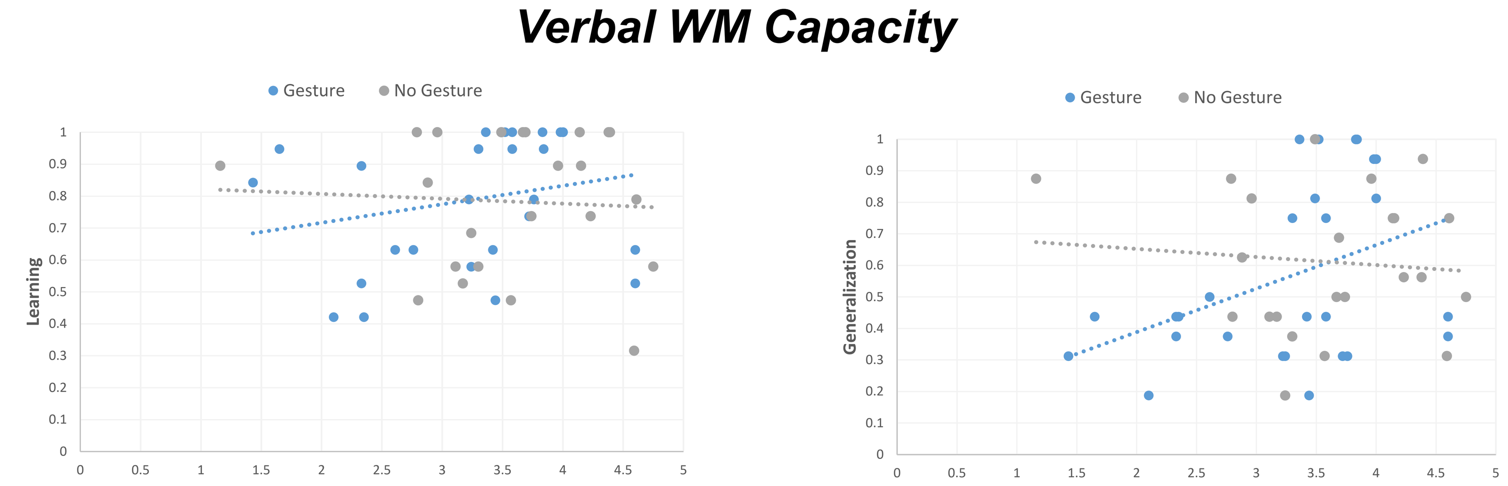
Do participants show differences in propensity to learn from gesture instruction based on working memory (WM) capacity?

Visuospatial WM Capacity



- Visuospatial WM capacity did not predict learning or generalization for participants in either condition

Verbal WM Capacity

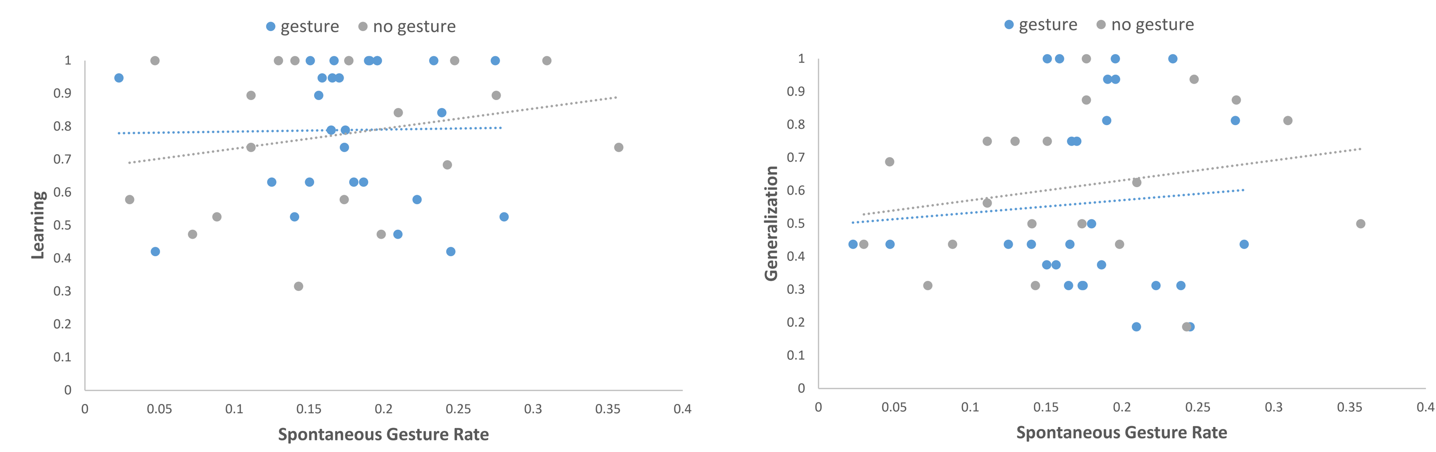


- We found a significant interaction between condition and verbal WM that predicted generalization but not learning
- Verbal WM predicted performance only with gesture instruction

Results (cont).

Do participants show differences in propensity to learn from gesture based on spontaneous gesture rate?

Spontaneous gesture rate was determined by the total amount of gestures used in each task divided by the total number of words.



- Spontaneous gesture rate did not predict learning or generalization for either condition

Summary

Both gesture and no gesture instruction equally predicted learning

- The task demands of the learned math equivalence paradigm were not high enough to show an effect of condition.
- The main function of deictic gestures is to draw attention to a referents. While these may be useful, gesture's power to support learning above and beyond speech alone may come from its ability to represent information. We may have found that iconic gestures would better support learning.

Individuals with higher verbal WM capacity benefit more from gesture instruction than those with lower verbal WM capacity

- Participants with high working memory generalized information more when instruction included gesture than speech alone.
- Verbal WM capacity refers to the extent to which one can hold verbal information in their mind, thus participants with higher WM are better able to hold spoken instructions in their mind.
- These results suggest that by providing information in a second modality, gesture may function to recruit additional cognitive resources allowing those with higher WM to benefit more than those with lower WM.

Spontaneous gesture rate equally predicted learning and generalization in both conditions

- This finding is surprising because previous work suggests that spontaneous gesture indicates a develop motor representation of a specific topic which is in turn helpful for recalling information (Congdon et al. in prep).
- Participants' spontaneous gesture rates on each task were not correlated between tasks.
- Participants used primarily deictic gestures on the math task (context-dependent) and primarily iconic gestures on the package task (context-independent).

References & Acknowledgements

Aldugom, M., Fenn, K., & Cook, S. W. (2020). Gesture during math instruction specifically benefits learners with high visuospatial working memory capacity. *Cognitive Research: Principles and Implications*, *5*(1), 1-12.

Alibali, M. W., & Goldin-Meadow, S. (1993). Gesture-speech mismatch and mechanisms of learning: What the hands reveal about a child's state of mind. *Cognitive Psychology, 25*, 468-523. https://doi.org/10.1006/cogp.1993.1012..

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