

# Using Diagrams and Gestures to Think and Talk about Insight Problems

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**Keywords:** gesture; diagram; problem solving; spatial cognition

## Introduction

Gesture occurs not only in the context of speech but also in the absence of speech (e.g., McNeill, 1992). Prior work suggests gestures may serve like an embodied diagram, offloading working memory (Kessell & Tversky, 2005). Here, participants were videotaped while solving and explaining the solutions to spatial insight problems with or without paper. The expectation was that some problems would elicit gesture or diagramming in the service of solving the problems. A comparison of the use of gestures and diagrams should provide insight into similarities in function. In particular, the present study explores the following questions: Do people use gestures versus diagrams differently for thinking versus communicating? When using a diagram to communicate, where and how do people gesture?

## Method

Forty-four Stanford undergraduates (21 females) solved six spatial insight problems. Pen and paper were provided to half of the participants. Participants were videotaped both while silently solving the problems and while explaining the solutions to the camera.

## Results

All deictic and representational gestures were counted. Beat gestures were ignored. During explanation, all problems elicited gestures from a majority of participants. During solution, however, only two problems elicited both gestures (No Paper condition) and diagrams (Paper Available condition) from a majority of participants. These two problems had high spatial working memory demands. While solving these problems, participants used gestures and diagrams similarly.

For one of the high spatial working memory problems, the Six Glasses problem, a detailed analysis of the conceptual content of the gestures produced was carried out. Each gesture was coded as one of two types. *Scene creation* gestures conveyed the spatial positions and properties of objects in the problem (e.g., point to the position of one of the glasses). *Enactment* gestures mimed solution actions (e.g., simulate pouring the water out of one glass into another).

As expected, the No Paper group produced more gestures overall than the Paper Available group. There was a

significant interaction of type of gesture by condition ( $F(1, 42) = 4.97, p = .03$ ), with more enactment gestures being produced by the No Paper group (Figure 1). Surprisingly, there was no difference between groups in the number of scene creation gestures produced.

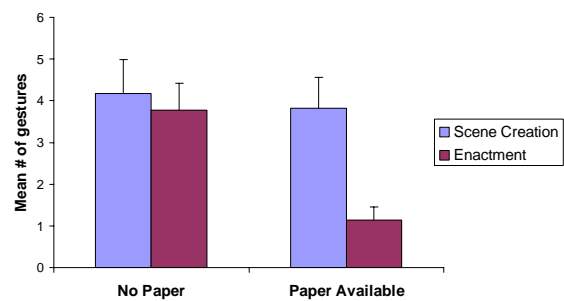


Figure 1: Mean number of gestures produced while explaining the solution to the Six Glasses problem.

Nineteen of the 22 participants in the Paper Available group produced a diagram. During solution explanation, enactment gestures were more frequently produced *off* than *on* the diagram.

## Discussion

The parallel use of gestures and diagrams primarily in solving problems with high spatial working memory demands suggests that both serve to offload working memory. During the explanation stage, however, all problems reliably elicited gestures, even when a diagram was available to help illustrate the solution, suggesting that the gestures carried additional information or served a function not fulfilled by the diagram. Indeed, having a diagram available during explanation did not reduce scene creation gestures. Rather, the diagrams appeared to suppress enactment gestures only. In this way, diagram use changed the conceptual content of the gestures produced. Finally, although an equal number of scene creation gestures were produced on the diagram as off, enactment gestures were more frequently produced off the diagram.

## References

- Kessell, A. M., & Tversky, B. (2005). Gestures and diagrams for thinking and communicating. *Proceedings of the 27<sup>th</sup> annual meeting of the Cognitive Science Society*. Stresa, Italy.
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