The inter-relationship between spatial cognition and gestures

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Introduction

One of the most interesting and frequent questions within cognitive science is "What type of mental representation is used when people solve problems/make decisions/think/etc.?" This symposium will explore the issue of mental representation within the area of spatial cognition by examining how people gesture within the context of a spatial task (e.g., mental animation, scientific analysis, construction, etc.).

Spatial Transformations and Gestures
(Greg Trafton, Susan Trickett, and Cara Stitzlein)

How do experts think about complex data spaces? We examined experts in three domains (meteorology, submarine, fMRI) as they solved a difficult domain problem. We found that, consistent with previous research, they created complex spatial mental representations (e.g., mental models) and used spatial transformations to mentally manipulate these representations. When we examined the gestures that these experts spontaneously made, we found that many of their gestures occurred while performing spatial transformations. We suggest that these gestures were outward manifestations of what they were thinking that facilitated their problem solving.

Gesture use while thinking about Machines
(Mary Hegarty, Sarah Mayer and Sarah Kriz)

We examined the use of gestures while people solved "mental animation" problems in which they have to predict the motion of a mechanical device from static diagrams. In "think aloud" experiments, participants gestured on more than 90% of problems (although they were not instructed to gesture), and their gestures communicated information that was not stated in words.

In another experiment, participants were asked to think aloud while solving problems (communication group), just solved the problems (control group), or solved the problems while tapping a spatial pattern (dual task group). Although the communication group gestured the most, gestures were also frequent in the non-communicative situation experienced by the control group.

The dual-task group had poorer performance than the control group, suggesting that prevention of gesturing impaired performance. These preliminary results suggest that gestures function both in the process of inferring motion from static diagrams and in communicating the results of this inference process.

Gestural Models for Self and Others (B. Tversky, H. Taylor, K. Emmorey, J. Heiser, & S. Lozano)

Three paradigms show that gestures can convey spatial information effectively both for self and for others. People's oral spatial descriptions include gestures that reflect the perspective taken on the space; they also provide a model of the space for the listener. The information in the words is not sufficient without the gestures. Listeners, too, gesture while hearing spatial descriptions from unobservable speakers; these gestures appear to help establish a spatial mental model for the listener. People's explanations of how to put something together include gestures that convey the structural relations of the object and actions needed for assembly, information that facilitates performance of communicator and receiver.

The role of gestures in a theory of spatial representation
(Chris Schunn, Lelyn Saner and Tony Harrison)

In many complex problems, there is a significant visual or spatial component to the problem solver's representations. Neuropsychological and cognitive work has suggested that there are several fundamentally different ways in which problem solvers can represent visual/spatial information---flat vs. 3-dimensional, near vs. far, approximate vs. detailed. Each of these differences can have a strong influence on problem-solving behavior. We have a theory, ACT-R/S (Harrison & Schunn, 2001), for how these features are strongly correlated in one of three possible visual/spatial representations, how the representations are selected, and how the representations influence behavior. We have been using analyses of gestures to diagnosis their representation choice. Our talk will illustrate how our theory of spatial representation influences our use of expert and novice problem solvers's gesture data to infer representations beyond previous analyses and how our theory of spatial representations has been changed by the gesture data.

The Consequences of Spatial Gestures (Justine Cassell)

Evidence from house descriptions, route descriptions, and the description of complex objects jives with earlier studies showing that roughly 50% of gestures convey content that is not redundant with the content of speech. These complementary gestures have consequences for later speech in that they may be referred back to – both via gesture and via speech – by both the speaker and the listener. I address a number of questions about the role of gesture in the semantics of ongoing talk, and their role in spatial cognition: how do we predict what aspects of spatial scenes will be described in gesture vs. speech, the form that these spatial descriptions will take in gesture, and how these features are represented by the participants in a discourse in such a way as to serve as the context for later speech.