Comparing Gestures And Diagrams

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Abstract

Gestures have many forms and serve many roles, some expressive, some communicative, some for gesturer, some for listener. One role they serve is to express and communicate ideas, simple ideas in forms like points, lines, and sweeps, and complex ideas in models. A gesture model is an integrated sequence gestures that represent a situation. Gestures share these representative features with diagrams, but have an added layer of meaning through action.

Keywords: gesture; model; diagram; semantics; action; representation.

Some Ways Diagrams Create Meaning

Gestures come in many forms and serve many roles, for those who make them and for those who view them, sometimes several roles at a time (e. g., McNeill, 1992; Goldin-Meadow, 1994). Gestures can be expressive, they can be communicative. They can represent a range of ideas, simple and complex, concrete and abstract, vague and precise. Gestures can promote thought, both for gesturers and for viewers. Gestures share these features with other forms of visual expression and communication, especially diagrams (e.g., Tversky, 2011 a, b, c). In the sketching world, drawing actions are referred to as "gestures," and diagrams can be seen as the consequence of gestures. Diagrams, in contrast to gestures, are static. Their permanence allows scrutiny and revision, by individuals and groups. But they require a surface that can be inscribed. Gestures are dynamic and we carry the tools for making them with us at all times, but gestures are fleeting. Considering the similarities and differences in how diagrams and gestures express and communicate concrete and abstract ideas is enlightening.

Diagrams have been widely used and published by communities over generations. Perhaps for this reason, they have developed some conventional forms. Some of these forms have emerged from natural correspondences between meanings and external representations of meanings, correspondences that appear in language as well (e.g., Cooper and Ross, 1975; Lakoff and Johnson, 1980; Talmy, 1983). Among other things, diagrams use icons, simple geometric forms, and place in space to convey ideas (e g., Tversky, 2011a, b, c). Of course, diagrams typically add language, as does gesture. Icons often bear resemblance, literal or figural, to what they represent. Icons appear not just in diagrams; they also appear in road signs that have picnic tables or leaping deer and computer apps that have scissors and file folders. Their meanings become clear in context, much like word meanings. Simple geometric forms expand the vocabulary of diagrams, forms like dots, lines, blobs, and arrows. These forms also convey meanings that can be readily grasped in context. Think of networks, of roads or ideas. Networks can be regarded as minimal diagrams, two (or more) ideas connected. Networks consist of nodes of zero dimensions and edges or links of one dimension. The nodes can represent a range of ideas, such as places or concepts, and the lines can represent a range of connections, links between the places or relations between the concepts.

More complex diagrams, charts, and graphs introduce other simple meaningful elements. Arrows are a special kind of line that represents an asymmetric relationship. Boxes or blobs or bars in tables, maps, or graphs are containers, collecting many different points into the same value, making a set. These forms are not the only meaningful forms that are used in a broad range of diagrams, but they form the core. Moreover, the common meanings described do not exhaust the meanings of the forms.

The basic forms are abstractions in the sense that they are free of content. As such, they differ from analogies or metaphors which map content to content. Think again of networks. Although they are content-free, the context, whether route map, semantic, computer, or social, supplies the content; that is, the same network can represent different content.

Diagrams also use place in space to convey meaning. On the whole, good things like preference, value, and power are higher and their opposites lower. There are multiple foundations for this correspondence: people (and other animals, plants and buildings) get stronger as they get taller, healthier people stand upright, piles of money grow higher. Reading or sentence order also confer spatial asymmetries, with greater agency, power, and speed but lower values initially (Chatterjee, 2001; Maass, Pagani, and Berta, 2007: Tversky, Kugelmass, and Winter, 1991).

Altogether, diagrams use elements in space and spatial relations to convey a range of meanings. In addition, diagrams integrate elements to make models, from molecules to maps to machines. Effective diagrams facilitate thinking, both in those who make them and those who use them (e. g., Mayer, 2001; Tversky, 2011). The same holds for gesture (e.g., Goldin-Meadow, 2003). This should be no surprise. It is taken for granted that language facilitates thinking, in both those who speak and those who hear. Yet meaning can be carried far more directly by visual communication modes like diagram and gesture than by language, which bears only symbolic relationships with meaning.

Some Ways Gestures Create Meaning

What do people do when they don't have paper? They use props, saltshakers, coffee cups, and silverware, whatever is at hand. But primarily, people use gestures. As noted, gestures have many forms and play many roles. An important subset of gestures, often referred to as representational gestures, carries meaning, whether deictic, iconic, enactive, or metaphoric. These can create virtual diagrams in the air, with elements analogous to the icons, points, lines, arrows, and containers of diagrams that express analogous abstractions. As for diagrams, an integrated sequence of gestures can create a model. However, gestures have an added dimension, action, and can use the action per se to create and modulate meaning. And because gestures can be made with many parts of the face and body, they have far more variability than lines, made by the point of a pencil on a flat surface. We draw on our research and that of others to illustrate some of the similarities of forms and meaning as well as some of the consequences of the added layer of action.

Points, Lines, Regions

In one task, dyads worked together to find a rescue route on a map (Heiser and Tversky, 2004), the dominant gestures were points to places, lines for routes between places, and "sweeps" to indicate regions. These are zero, one, and two-dimensional gestures, like their diagrammatic counterparts, dots, lines, and containers, and analogous to Talmy's analysis of *at, on*, and *in*. As such, they are content-free abstractions that can be widely applied. In another task, participants, alone in a room, read descriptions of spatial problems, attempted to solve them, and then turned to a camera to explain their solutions (Kessell and Tversky, 2006). Here is the easiest problem: *there is a row of 3 empty glasses and 3 full ones. By moving only one glass, make the arrangement empty, full, empty, full, empty, full*. In attempting to solve the problem, most participants gestured. Many extended three fingers of each hand horizontally on the table, one hand for empty, the other for filled; others made two groups of three points horizontally. These participants used gestures both to individuate the glasses by pointing and to group them by separating them spatially, another diagrammatic feature. Interestingly, when illustrating the solution, some participants pointed to the middle glass of the filled set, then made an arc with that finger to the middle glass of the empty set, essentially drawing a diagram of the transfer in the air. Others appeared to imagine the scene more concretely. They enacted the solution; that is, they positioned their hand as if holding the middle filled glass, lifting it, and pouring it into the middle empty glass.

Models

The previous problem solvers made gesture models of the problem structures. Making models with coordinated gestures turns out not to be unusual. In another study, participants studied maps of a range of environments, a town, an amusement park, and a convention center, and then made videos explaining the environments so that someone else would know where everything is (Emmorey, Tversky, and Taylor, 2000). Although some participants relied entirely on words, others used gestures profusely. Some made a virtual blackboard to their sides, easily seen by viewers, sketching the environment globally with their hands, and then systematically using gestures, predominantly points and lines, to locate each landmark and path. Creating these models took as many as 15-20 consecutive integrated gestures. People use integrated sequences of gestures, actions in space, to create and edit virtual diagrams of abstract relations, kinship relations (Enfield, 2003). Participants also create models of situations for themselves. In another study, participants read descriptions of similar environments for later testing, alone in a room (Jamalian, Giardino, and Tversky, 2013). The majority gestured while studying, and later, while answering questions about the environments. Their gestures were integrated sequences that made models of the environments. When they gestured, either at study or at test, they remembered the environments better than when they did not, and than others who did not gesture. Thus, as for diagrams, using gestures to make virtual diagrams promotes memory.

Action: A special role for gesture?

Diagrams are static. Showing action, change, behavior, or process, has been a challenge for diagrams (e. g., Heiser and Tversky, 2006; Tversky, Morrison, and Betrancourt, 2002). Even animated diagrams have rarely been successful as explanations (e.g., Tversky, et al., 2002). Gestures are actions, so they should be especially effective in representing action. Indeed, action gestures are spontaneously adopted in solving mental rotation or gear tasks (e.g., Kendon, 2004; Chu and Kita, 2008; Schwartz and Black, 1996; Wexler, Kosslyn, and Berthoz, 1998; Wohlschlager and Wohlschlager, 1998). In explanations, participants animate diagrams using gestures (Engle, 1998).

As noted, although diagrams are effective in conveying structure, they are less effective conveying action. Yet, information about action is exactly what new learners most need to learn (e.g., Tversky, Heiser, and Morrison, 2013). Some explainers seem to know this. When people are asked to explain complex systems to novices, they spontaneously use many action gestures, far more than they use in explaining to experts (Kang, Tversky, and Black, 2013). Do the action gestures help convey information about the dynamics of a situation? Yes. In another study, participants studied videos of a person explaining how a four-stroke engine works (Kang, Tversky, and Black, 2012). The videos had a diagram of the structure of the engine superimposed. Half the participants viewed a video with gestures that gave information about the shapes and locations of the parts of the system, that is, the structure. The others viewed a video with gestures that demonstrated the actions of the parts of the system, but did not give information about the locations or shapes of the parts. The verbal script was the same for both videos, and was sufficient for passing the post-test. Nevertheless, those who saw action gestures were more accurate on questions about action. After the post-test, participants made diagrams of the workings of the engine and then made videos explaining the workings of the engine so that someone else could understand. Those who had seen the action gestures depicted more action in their diagrams than those who saw the structure gestures. Similarly, those who had seen action gestures used more action words and more action gestures in their video explanations than those who had seen the structure gestures. Importantly, the gestures participants used were not mere copies of what they had seen but rather their own inventions.

Gestures and Thought

In documenting some of the ways that gestures create meaning, we have also documented some of the ways that gestures aid thinking, in those who make them and in those who view them. Many others have reported benefits of gestures to thinking, by representing semantic content, by help in word-finding, by off-loading working memory, and more (e.g., Carlson, Avraamides, Cary, and Strasberg, 2007); Cartmill, Beilock, and Goldin-Meadow, 2012; Cook, Yip, and Goldin-Meadow, 2012; Goldin-Meadow, and Beilock, 2010; Goldin-Meadow, Cook, and Mitchell, 2009; Goldin-Meadow, Nusbaum, Kelly, and Wagner, 2001; Hosetter, and Alibali, 2008; Jamalian, and Tversky, 2012; Krauss and Hadar, 2001). Here, we have shown that gestures, like diagrams, use simple content-free geometric forms like points, lines, and regions, to create a range of meanings across many contexts. Like diagrams, they use an integrated sequence of gestures to create models of complex environments or systems.

These features of gestures and diagrams illustrate the relative advantages visual expressions of meaning have over purely symbolic verbal ones: they use elements in space and spatial relations to convey meanings quite directly. Diagrams have an advantage over gestures in their permanence, allowing inspection, contemplation, and revision. But, as has been seen, gestures are actions, and as such, have an advantage over diagrams in representing action, and other aspects of thought. The pragmatics of diagrams, permanence, on a page, and published, encourage standardization. By contrast, gestures are created on the spot in varying contexts, and remain more idiosyncratic.

We propose here, along with others, that gestural actions can augment thinking directly, by arousing spatial-motor imagery, rather than or in addition to arousing visual imagery (e g., Beilock & Goldin-Meadow, 2010; Goldin-Meadow & Beilock, 2010; Cartmill, Beilock, & Goldin-Meadow, 2012; Hoeseter & Alibali, 2008). Spatial-motor imagery underlies touch-typing, navigation in the blind and also the sighted, playing the cello and tennis, getting dressed, dancing, and more. Those who gestured while reading spatial descriptions rarely looked at their hands, but gesturing improved their memories (Jamalian, et al., submitted). The sequence of spatial-motor gestures simultaneously represented the environments and embodied them. When asked what angle to tilt a glass to pour the liquid, participants performed better when blindfolded and imagining tilting the glass than when imagining watching the glass tilt (Schwartz and T. Black, 1999). Spatial-motor imagery was more effective than visual imagery. Gesture transforms spatial-motor actions to representational actions, that is, to thought, and as such, can facilitate thought.

Together, the evidence reviewed suggests that both gesture and diagrams can augment thinking by abstracting essential information and expressing it in simple congruent forms and by integrating elements into models, but that gesture adds another modality that facilitates thought by creating embodied spatial-motor representations of the information.

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