Representational Permeability and Physical Imagery

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People can imagine physical dynamics. Physical imagery is analytically distinguishable from spatial imagery. Imagine running in an airy room versus running in a water-filled pool. Although many of the relevant spatial properties are identical, the effects of imagined resistance are introspectively manifest.

Physical imagery needs a flexible representational system. Whereas complexes of spatial relations are often invariant, physical ones often are not. The occlusion of one ball by another, for example, is an invariant correlate of relative depth. Consequently, one may posit a representational system in which the inference from occlusion to depth is inherent (e.g., short of lying, one cannot even *imagine* the alternative). In contrast, the surface of a painted ball is not reliably diagnostic of its bounce; paint could be covering cork or rubber. Therefore, for physical imagery, one should not expect a representational system in which percepts and inferences are rigidly coupled.

The implication here is that physical imagery should be permeable: Unfolding physical information and one's belief states should influence one's imagination of dynamic events (e.g., one learns the ball is a "superball"). Research relevant to physical imagery, however, has typically explored imaginations that are impenetrable -- no coaxing can change one's visible or imagined percept. This research cannot explain how people manage to imagine the variable, or context-sensitive, aspects of the physical world.

To investigate the use of context-sensitive information in imagery, I work from the model of mental depiction (Schwartz & Black, 1996). In a mental depiction, there are two phases. In the construction phase a model is composed from beliefs, memories and percepts. The resulting representation includes a set of constraints that coordinate relative rates of change between imagined objects. In the dynamic phase, one imagined object is put into motion, and as a result of embedded constraints, a second object dynamically responds.

This simple model makes several predictions about places of successful and unsuccessful permeability. [B1] Beliefs can successfully introduce imagined physical constraints during the construction phase. [B2] But, beliefs about the outcome of an event should be destructive to model dynamics because they dictate model outcomes rather than letting them emerge through imagined rates of interaction. [C1] Contextual data need not influence the construction phase. (It is one's imagination after all.) [C2] But, context information that conflicts with the constraints necessary for running the model should destroy model dynamics. [C3] Unfolding, environmental rate information can inform model dynamics.

The predictions were tested with a task for which people do not have correct beliefs but do have correct physical imagery. Imagine two glasses of identical height and levels of water. The difference is that one glass is wider than the other. If the two glasses are tilted at the same rate, will the water touch the rims at the same or different times? Most people answer this comparative question incorrectly. Alternatively, people hold an empty glass with a black line and imagine that there is water to the level of the line. Their task is to close their eyes and tilt each glass in turn until the imagined water just reaches the lip. In this case, people correctly tilt a narrow glass further than a wide glass.

The following results supported the 5 hypotheses. [B1] People imagined the glasses filled with either molasses or water. Although, when asked afterwards they said water and molasses should be tilted the same amount, people tilted the molasses glasses further. [B2] People either tilted the glasses first and then made the comparative judgment, or they made the judgment and then tilted the glasses. In the former case, people correctly tilted the glasses and made the incorrect comparative judgment. In the latter case, people made the incorrect comparative judgment <u>and</u> incorrectly tilted the glasses. [C1&2] People either held a glass (a) upright or (b) sideways and imagined that it was upright. They were asked to rate the water-image quality prior to and during tilting. Pre-tilting image quality was good for both upright and imagined upright. During-tilt image quality was good for upright, but bad for imagined upright. Confirming this latter difference, people tilted the glasses very inaccurately when going against gravity, but were fine when going with gravity. [C3] People tilted the glasses, imagined tilting the glasses, or tilted glasses with weighted bottoms. The manual and imagined tilts were identical, whereas the weighted glasses led to systematic under-rotations. People thought the water was changing at a faster rate the farther the glasses were rotated (because of the increasing torque due to the weighted bottom).

In sum, physical imagery is permeable to beliefs, spatial information, and on-going physical data, but it is not reducible to these sources of information.

References

Schwartz, D. L., & Black, J. B. (1996). Analog imagery in mental model reasoning: Depictive models. <u>Cognitive Psychology, 30</u>, 154-219.