How Consequences of Physical Principles Influence Mental Representation: The Environmental Invariants Hypothesis

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The remembered position of a target is usually displaced from the actual position of that target, and the pattern of displacement is usually consistent with the operation of invariant physical principles (for review, see Hubbard, 1995, 1998). For example, memory for the final position of a moving target is often displaced forward and downward, and these patterns have been referred to as *representational momentum* and *representational gravity*, respectively. The magnitude of this displacement is diminished with increases in implied friction, a pattern referred to as *representational friction*. Also, memory for a target moving along a circular orbit is displaced toward the focus of the orbit, a pattern referred to as *representational centripetal force*.

Environmental Invariants Hypothesis

The *environmental invariants hypothesis* proposes that effects of invariant physical principles are incorporated into mental representation; in other words, perception and memory systems respond as if the representation of an object were subject to the same physical principles that influenced the original object.[1] This incorporation takes the form of an automatic extrapolation in which memory is displaced in ways consistent with those principles.

A New Second-Order Isomorphism

The "as if" nature of displacement suggests a new second-order isomorphism between mental representation and the physical world. Much as imagery reflects a second-order isomorphism between properties of physical objects and properties of images of those objects, so might displacement reflect a second-order isomorphism between properties of physical principles and properties of mental representation. Accordingly, properties of invariant physical principles may have been incorporated into the functional architecture of mental representation.

Implications and Consequences

The environmental invariants hypothesis has implications and consequences for several areas of investigation.

Naive Physics Findings from "spiral tube" experiments suggest observers do not have veridical knowledge of physical principles; however, Hubbard (1996) suggested how such findings might instead reflect operation of accurately incorporated physical principles.

Boundary Extension Representational momentum and boundary extension may reflect a more general mechanism that biases memory in ways consistent with experience.

Art Paintings are perceived as unbalanced when larger objects are higher in the picture plane, and stationary targets higher in the picture plane exhibit greater representational gravity. These patterns may result from an interaction of size-distance constancy scaling and representational gravity.

Implicit Processing Dissociations of representational momentum and explicit knowledge suggest displacement may reflect implicit knowledge of physical principles.

Evolutionary Psychology Any organism that could automatically extrapolate the effects of physical principles on a prey or predator could have a selective advantage, and so displacement should also be found in nonhuman animals.

Consciousness One function of consciousness may be to monitor performance and compensate for errors produced by displacement processes when a stimulus does not behave as expected (e.g., prey changing direction of flight).

A Representational Reflex Arc The notion of displacement suggests that mental representation does not portray the world-as-it-is, but rather portrays the world-as-it-soon-will-be. Displacement may help bridge the gap between an organism's initial perception of a stimulus and that organism's subsequent response to the stimulus.

[1]The claim that mental representations respond "as if" influenced by physical forces does not endorse dualism. The point is more subtle: factors influencing a given object need not similarly influence or be present within a representation of that object (e.g., a videotape representation of a moving target would not experience the same momentum as the actual target).

References

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