On the Origin of Object Permanence: An Interactive, Computational Model

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Abstract

The representation of objects is a major epistemological development. The interactive model (Bickhard 1980a,b, 1993; Bickhard & Richie 1983, Campbell & Bickhard 1986, Morrison 1997) adopts an account of the representation of objects derived from Piaget (e.g., Piaget 1954). In this account, aspects of the properties of objects become incrementally represented over developmental time, beginning with properties of visual scanning and the role of motor coordination (see also Munakata 1997), and later representation of object permanence, conservation phenomena, and eventually abstract concepts about objects.

A common theme to all of these developments is a model of representation as fundamentally indications of interactive potentiality. Interactive indicators connect internal states with actions and anticipated outcome states. Such indicators may be embedded within a web or network of interactive indicators, and representation of objects emerges as topological properties of such webs, such as closure over interactive properties and invariance of those interactive properties over kinds of transformations on objects. Identification of these properties and incorporating them into further indications allows for representation of object permanence – even if the object isn't current visible, the system knows the object can be "reached" by following a path of interaction until visual contact is again achieved.

I will present an architecture for the acquisition of object permanence concepts in a simulated agent interacting with its environment, based on the interactive representation framework. The starting point for the design is Gary Drescher's schema mechanism (Drescher 1991) and takes inspiration from subsequent models based on Drescher's work (Ramstad 1992, Foner 1994, Cohen *et. al.* 1997, Stojanov *et. al.* 1997). The base representational control structure common to each of these models is the schema, which serves as a computational proxy for an interactive indicator. Drescher's marginal attribution algorithm, augmented by Foner's attentional strategies, is used to learn sets of schemas that serve as the building-blocks for the agent's representation of the current situation. These building-blocks are used to construct and update webs of potential interactions based on the current state of the agent (including its sensory state). This construction process, intended as a model of interactive apperception (Bickhard 1980b), takes place in a blackboard architecture (Hayes-Roth 1995). The web on the blackboard is then analogous to the agent's situation image (Bickhard 1980b; also similar to Glenberg 1997). Topological properties of the network itself serve as the foundation for the discovery of environmental categories, such as differentiation of manipulable object interactive properties from other properties of the environment (e.g., walls and floors). I will also discuss the idea that synthetic item construction (Drescher 1991) constitutes a primitive form of reflective abstraction (Morrison *et al.* 2001).

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