Cognitive Representation as Emulation of Perception and Behavior: Theory and Robot Models

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Abstract

Mental models and representations have always played a crucial role in theories of cognition. The modern concept of a mental model has been strongly influenced by Kenneth Craik who in his 1943 book *The Nature of Explanation* wrote:

> If the organism carries a "small-scale model" of external reality and of its own possible actions within its head, it is able to try out various alternatives, conclude which is the best of them, react to future situations before they arise, utilize the knowledge of past events in dealing with the present and future, and in every way to react in a much fuller, safer, and more competent manner to the emergencies which face it.

Craik himself had relatively little to say about the exact form of the internal representations or the processes manipulating them (cf. Johnson-Laird, 1989). Nevertheless, he influenced several decades of cognitive-scientific discussions and theories by suggesting that there are three crucial steps in an agent's having such a "small-scale model": (1) the translation of stimuli into internal representations by sensory/perceptual processes, (2) cognition as the manipulation of such internal representations and the production of new ones, and (3) their translation back into action. Both cognitivist/symbolic and connectionist theorists subscribed to this idea and consequently largely focused their work on step (2), in particular questions of the exact nature of those internal representations and the processes manipulating them.

More recently this view of cognition and representation as relatively independent of perception and action has come under heavy attack from theories of situated and/or embodied cognition, and not least interactivist theories (e.g. Bickhard & Terveen, 1995). However, while there is much agreement that traditional notions of representations, in particular symbolic theories, are in error, there is much less agreement on exactly what the alternative is. In particular existing alternative theories, both representational and anti-representational ones, although convincing in theory, have so far failed to provide concrete models and robotic implementations that scale up to much more than reactive behavior and sensorimotor processes of limited complexity (cf., e.g., Pfeifer, 1995; Clark & Grush, 1999).

This paper presents some of our own work based on what Hesslow (2002) called the 'simulation hypothesis', i.e. the idea that it might be possible to abandon/skip Craik's step (2) and understand cognition (and representation) in terms of emulation or simulation of perception and behavior instead (cf. Clark & Grush, 1999; Hesslow, 2002). Both experimental work from our lab (e.g., Jirenhed, Hesslow & Ziemke, 2001; Ziemke, Jirenhed, Hesslow, subm.), still in its early stages, and theoretical issues, such as the relation to interactivist theories of representation, will be discussed.

References

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