Embedding the Process of Science in Cognitive aand Representational Processes

Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 18(0)

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Publication Date
1996

Peer reviewed

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It seems to be an accepted fact that science, scientific theories, and scientific processes are the result of cognitive processes. The question is, however, how are these scientific processes embedded in cognitive/neural processes? Churchland (1995) or Giere (1994) give some hints, how this interaction between these two domains could be realized. This paper will illustrate two links which connect the scientific realm with the cognitive realm: (i) *epistemological link*: the concept of *representation* seems to be the focus of both domains; both are interested in an adequate representation, description, prediction, manipulation, explanation, etc. of the environment. (ii) *Methodological link*: as neural processes are the foundation of any representational process, the approach suggested by computational neuroscience or connectionism seems to offer a method and a conceptual level (of explanation) which is of interest for both the cognitive and the scientific domain.

Structural similarities can be found between cognitive and scientific processes – both are adaptational and constructive feedback processes . These similarities cannot only be found on a structural level, but also on an *epistemological* level: both aim at developing an adequate representation of the environment; the representational relationship between the environment and its (cognitive/neural or theoretical) representation is not a relationship of mapping, but of *functional fitness* (Glasersfeld 1995). Processes of construction, trial-&-error, and adaptation are responsible for acquiring new knowledge and changing existing representations. The claim of this paper is that cognitive science and computational neuroscience can provide interesting insights in these processes.

As is shown in Peschl (1994), the environment is not mapped iso-/homomorphically to the neural substratum. The goal is no longer to map the environment as accurately as possible to the neural substraum, but to incrementally construct and adapt such a neural transformation structure that is capable of generating functionally fitting behavior which ensures the organism's survival. As scientific theories are also developed and represented by the nervous system, a similar representational relationship between an aspect of the environment and its theoretic representation can be found: the latter functionally fits into the structures of the environment. This implies that not only a single theory can account for an environmental phenomenon, but a number of different theories; i.e., all theoretical descriptions which fit into the environmental constraints and which are successful with respect to predicting and manipulating the environmental dynamics are adequate.

In this sense, theories evolve in a "theory space" which is directly embedded in the neural representation space. Developing a theory can be understood as a *search process* in which a point moves around in the theory space until an equilibrium (of functional fitness) between the representation (i.e., the theory) and the environment is found. This euqilibrium is characterized by stable relationship between the predictions and success of the theory and the environmental dynamics. In other words, the theory functionally fits into the environmental constraints like a key fits into a lock. The result is not so much a "positive description", but a strategy how to *successfully cooperate* with the environmental dynamics.

Concepts from computational neuroscience (e.g., learning in the weight space) can be directly applied to this process of developing theories. Evolutionary mechanisms play an important role for paradigmatic shifts (Kuhn 1962) in this view – they are responsible for determining the dimensions of the representational/theory space. I.e., the space of possible theories and possible solutions which has to be searched by learning processes.

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