Chapter 9
Logic and Abstraction as Capabilities of the Mind:
Reconceptualizations of Computational Approaches to the Mind

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ABSTRACT

In this chapter the authors will investigate the nature of abstraction in detail, its entwinement with logical thinking, and the general role it plays for the mind. The authors find that non-logical capabilities are not only important for input processing, but also for output processing. Human beings jointly use analytic and embodied capacities for thinking and acting, where analytic thinking mirrors reflection and logic, and where abstraction is the form in which embodied thinking is revealed to us. The authors will follow the philosophical analyses of Heidegger and Polanyi to elaborate the fundamental difference between abstraction and logics and how they come together in the mind. If computational approaches to mind are to be successful, they must be able to recognize meaningful and salient elements of a context and engage in abstraction. Computational minds must be able to imagine and volitionally blend abstractions as a way of recognizing gestalt contexts. And it must be able to discern the validity of these blendings in ways that, in humans, arise from a sensus communis.

INTRODUCTION

Behind traditional computational approaches to mind we find the idea that we can simulate the mind as we think we might simulate a chess player by computer programs. This approach is assumes that the human mind is based on a symbolic processing model of cognition. Doing so, we overlook that the way a chess player and a computer approach chess playing are fundamentally different. The human player employs not only sequential logic and his

DOI: 10.4018/978-1-61692-014-2.ch009

symbolic processing capabilities, but also other capabilities that are described by a connectionist model of cognition. Rather than work through the numerous logical and sequential permutations of possible moves, the human player will recognize larger (i.e., schematic) patterns among the pieces of the chessboard and make his moves based on experience gained over a lifetime of playing. Human players will 'feel' what is the correct move for maintaining an advantage or overcoming a disadvantage, using their intuitive sense derived from schemas based on their long lasting practice.

Even if the machines built in this way that they show comparable results, it does not prove that the human mind and the symbolic machine work in the same way. Indeed human beings (and not only they) possess one fundamental capability that cannot be reduced to symbolic logic manipulation, i.e., abstraction or the capability to develop and employ schemas or recognize gestalt from concrete objects that they find in their environment. These schemas humans evolve through the repeated exposure to similar stimulus as part of our lived experience. Schemas have a duality about them —they are patterns of strongly connected elements of cognition that activate based on salient elements of a particular context and they serve as auto-completion processors, allowing us to perceive a gestalt. These capabilities become apparent in human abstraction. Although abstraction can be analyzed ex-post in terms of logic, e.g., looking for common features, we cannot reduce it to a formal logical process. Abstraction is fundamentally related to schema theory and gestalt theory.

However, the capability of abstraction even goes beyond what we can describe by schemas. We will illustrate this point by way of some examples and explain why it is nevertheless advantageous to work with such metaphorical images. One of our goals is to show the limitations of such images. To this end we will refer to relevance of embodiment and embeddedness and show the relevance of these concepts for the understanding of abstraction. Regarding the latter point we will discuss the works of Heidegger and Polanyi and their philosophical approaches contribute to this understanding. We will follow their analyses to elaborate the fundamental difference between abstraction and logics and how they come together in the mind. The interplay can also be explicated on the basis of paradoxes such as the heap paradox (Keefe, 2000, p. 56) where the approaches of schematic processing and symbolic processing conflict with each other. There are already approaches that rely on gestalt theory, however, they are mainly applied in robotics and not incorporated in the philosophy of mind or computational approaches to the mind.

We will explore how these fundamental processes of abstraction etc. on the one hand and logical inference on the other work together, referring to insights gained from Heidegger and Polanyi such as the distinction of *present-at-hand* and *ready-to-hand* and *focal* and *subsidiary awareness*, respectively. Each of their philosophical approaches facilitates recognition of context in which the salient element of focus is situated. It is the contextualized focal entity that is essential for and evokes meaning within cognition and, hence, understanding in a way that integrates schematic abstract thinking with sequential logic.

The two paradigms even work together in mathematics where we also find an extensive use of abstraction (in the sense that we use here). One example is the abstraction of topological structures, expressed by topological axioms, gained from the analysis of real numbers and other analytic structures. It was Frege (1882) who pointed out that the usage of symbols opens up particularly new ways of analyzing the developing structures, e.g., by gestalt-oriented abstraction. It is this particular capability to abstract from symbolic structure that make up the core of mathematics and not the application of logical rules to axioms and propositions.