Chapter 21
Embodying Cognition:
A Morphological Perspective

David Casacuberta
Universitat Autònoma de Barcelona, Spain

Saray Ayala
Universitat Autònoma de Barcelona, Spain

Jordi Vallverdú
Universitat Autònoma de Barcelona, Spain

ABSTRACT

After several decades of success in different areas and numerous effective applications, algorithmic Artificial Intelligence has revealed its limitations. If in our quest for artificial intelligence we want to understand natural forms of intelligence, we need to shift/move from platform-free algorithms to embodied and embedded agents. Under the embodied perspective, intelligence is not so much a matter of algorithms, but of the continuous interactions of an embodied agent with the real world. In this chapter we adhere to a specific reading of the embodied view usually known as enactivism, to argue that (1) It is a more reasonable model of how the mind really works; (2) It has both theoretical and empirical benefits for Artificial Intelligence and (3) Can be easily implemented in simple robotic sets like Lego Mindstorms (TM). In particular, the authors will explore the computational role that morphology can play in artificial systems. They will illustrate their ideas presenting several Lego Mindstorms robots where morphology is critical for the robot's behaviour.

FROM SYMBOLS TO BODIES

Artificial Intelligence (AI) can be approached just with an engineering frame of mind, looking for algorithms that work and are able to solve a problem. However, one can settle to a philosophical one too, and consider AI a conceptual tool to get better insight on what the mind is and how it works. Within this frame of mind, just solving problems is not enough: we want our theory to have, to a certain degree, psychological reality. We want our model to embed some of the earthly properties that human minds have. Currently, discussion is mainly around three main models concerning what the mind is: symbolic cognitivism, connectionism and the embodied mind. In this paper we adhere to the third model; in particular, to a special branch usually known as enactivism,

DOI: 10.4018/978-1-61692-014-2.ch021

to argue that (1) It is a more reasonable model of how the mind really works; (2) It has both theoretical and empirical benefits for AI; and (3) Can be easily implemented in simple robotic sets like Lego Mindstorms (TM).

Much has already been written about the differences between these three mind models, and which is the superior one. To our understanding, despite their success in creating models on subjects like mathematical reasoning, face recognition, visual perception or even creating artworks, both the cognitivist and the connectionist approaches have one major flaw which is of considerable philosophical importance: they cannot produce a credible account of the relationship between mind and world. Being local symbolic representations or distributed subsymbolic representations, both models are based on an abstract reconstruction of a specific domain of the physical world, both the selection and the way representations are connected to real life events and objects has been articulated beforehand by the cognitive system (Thompson 2007). Connectionism tries to generate a more plausible description of the mind, trying to better capture its neurological basis. This leads to a more dynamic account of representations: instead of being something stable, they are distributed along the whole system as well as self-organised, having certain co-variation with the environment. However, both symbolic cognitivism and connectionism consider the world and the mind as two completely different entities, with a very much regulated protocol of interaction.

The embodied mind shares some characteristics with connectionism. It also proposes a self-organised system and it is based on a dynamic approach. However, in this approach dynamicism has been extended to the correspondence between mind and world. Instead of having a simple co-ordinated correspondence between symbols (or subsymbols) and real life objects, the embodied mind paradigm is based in a non-linear causality system in which by means of sensorimotor integrations, brain, body and environment are continuously influencing one another, making it impossible to separate the three into clear-cut parts. In order to have such a system, it is basic that the cognitive entity has some sort of body that can obtain continuous information from the real world in order to co-vary and co-adapt with it (Thompson 2007). This is why the paradigm we are discussing is usually called the embodied mind. First of all we need to avoid the tendency to interpret the notion of embodiment in its weakest sense: that this, a mind needs a body. The embodied mind paradigm argues for something a lot stronger than that, that is, that mind is just the result of circular and continuous processes of causality between brain activity, body and environment, with no possibilities to make a clear distinction among then, nor a chance to build a theoretical model in which mind can be described autonomously from body and environment. (Pfeifer and Iida, 2005).

The particular reading of the embodied mind paradigm we adhere here, known as enactivism, is based on the following ideas (Varela, Thompson, Lutz, Rosch 1991):

1. Living beings are autonomous entities and are responsible for their own goals that are not just settled from the outside.
2. The nervous system is also an autonomous entity, which takes care and is responsible for keeping its own coherent and meaningful patterns.
3. Cognition is the skillful know-how that co-varies with environment and how it evolves. Every cognitive action is both situated and embodied.
4. Cognitive processes are not formally pre-specified, but relational domains continually coupling with the environment.

A large amount of the literature takes living beings as the main metaphor. In their seminal book, Varela et al (1991) developed most characteristics of their model by analysing the way cells behave and represent environment. Nev-