

The living organism: Strengthening the basis



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ABSTRACT

In spite of the considerable amount of literature dedicated to the living organism, it retains its mysteries. One of the most discussed aspects nowadays is whether the term “cognition” can be attributed to all classes of organisms, or whether it only refers to a metaphoric use of one human reality. Our approach consists of retaining the term “cognition” and making it a technical term, in order to propose a generic model. In this way, cognition becomes what finally characterises an organism as an autonomous agent. This perspective eliminates some misplaced questions, and helps to reframe old ones. The cognitive dimension can be apprehended indirectly only through its appearances. These direct us towards a modular model of cognition and orientate research towards the clarification of specific modules for each class of organisms.

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1. Introduction

The question of the nature of life, or more concretely, the nature of the living organism, was variously formulated, inter alia, by Alexander Oparin (1929) in his book *Origin of Life*, Erwin Schrödinger (1944) in his famous little book on precisely *What is Life?* and in Robert Rosen's critical reading of Schrodinger's approach to *Life itself* (1991). This is still a very “hot topic” judging by the number of publications that it triggers. Through these publications, we notice that at least three obstacles slow down progress towards clarification of the living organism. The first one relates to psychology, in other words to the anthropocentric vision of the living agent. The second is metaphysical, and refers to the persistency of dual-aspect monism in the imagination of researchers. The third is experimental, and evinces the difficulty in the re-creation of a living organism as it could be with *in vitro* or *in silico* approaches (Bedau et al., 2000). The latter would result in validating some hypotheses from theoretical biology. At any rate, an increasing number of scholars explores an approach which tries to overcome at least the first two obstacles by maintaining an open question, i.e. “what *could* an organism be” rather than restricting to the closed question “what *must* an organism be”.

Along this line, many of the characteristics of the organism are brought to light, although none is enough to characterise it fully,

such as transformation, autopoiesis, metabolism, homeostasis, genome, reproduction, evolution, and interaction with the environment (Deplazes-Zemp, 2012). Other scholars propose some fundamental pillars to define it, as in Koshland's seven proposals: program, improvisation, compartmentalisation, energy, representation, adaptability, and selection (Koshland, 2002). However, the sum of these traits is not sufficient to confirm the uniqueness of the organism.

Among these features, some are subject to debate, because of their status, and because of their definition or their situation in the history of evolution. Such is the case in the notion of cognition.

The definition of this term inevitably undergoes the influence of the ontological link that we establish between the brain and the mind. Secondly, it alludes to the links between mental activity and decision-making, learning, memory, anticipation, mobility, etc. As such, human cognitive abilities constitute the standard template or the reference point for evaluating cognition in a non-human organism (Shettleworth, 1993). The collateral effect of this evidence is to leave the world of microorganisms and plants outside the cognitive paradigm. Their behaviours are quickly qualified as stereotyped and their capacities are pre-programmed.

However, since “The Power of Movement of plants” (1880), published by Darwin together with his son Francis (Darwin, 1880), and today with advances in plant biology, a growing body of publications tend to open the world of microorganisms and plants to a new view of sensory and communicative organisms (Baluška et al., 2009; Westerhoff et al., 2014). The “root-brain” hypothesis experiences a certain revival, and is perceived as the “organ”

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of plant cognition, even if the specific cognitive mechanisms in plants remain to be identified. The vocabulary used to highlight the plant realm as a cognitive organism tends to follow methodological anthropocentrism, and views plants' aptitudes in metaphoric terms.

In this work, we propose a generic approach to organism, i.e., one which is applicable to the entire living world, from microorganisms to higher mammals, so as to refer to a conventional classification. The model is based on an approach to cognition that structures and specifies the nature of the organism. Accordingly, our proposal moves away from anthropocentrism to loosen the entangled relation between the term "cognition" and mental activity, by making cognition a universal technical term. As a result, to avoid any misunderstandings on the nature of the organism, our proposal takes place within a monistic framework, in which the various potentialities of the living world can express themselves.

2. Three core properties plus one

Despite the inevitable controversy about the notion of organism, there is a rough consensus about the three core properties that have heretofore characterised it. Every organism stands out from the environment by a boundary it autonomously (i) creates (ii) sustains through the synthesis of building blocks by harvesting energy and raw materials from the environment, and (iii) reproduces and evolves, through inheritance with a variation of reproducible internally stored information that can activate and control its crucial functions (Rasmussen et al., 2009).

Other properties of the living system result from these three criteria. These are underlined by other authors of the same volume, and include autonomy, homeostasis, robustness, adaptability and the ability to learn from the environment (Bedau et al., 2013). However, the three core properties constitute a minimal basis upon which we can develop an understanding of the living and try to complete it.

Bedau et al. (Bedau et al., 2013) assume that "something is alive only if it has all life's core properties". We notice that cognition is not part of other characteristics such as the capacity to learn or to adapt. It does not result from a secondary emergence from the three core properties' orchestration, in particular in complex organisms. With this idea, we propose to define the living organism precisely as the manifestation of cognition. In other words, an entity endowed with the three core properties is alive if cognition comes forward. If our approach to the living beings is fruitful, then cognition must apply to all organisms and become apparent in a specific way, according to the class and to the complexity of the living beings.

A first definition enables us to delimit the concept. Cognition is displayed by the way the organism experiences its environment. This definition triggers several remarks. In the first place, by experience, we should not just think that our sensory perception gives us only sensory data, but that it indicates also the real existence of tangible objects. By experience, we allude to the term "prehension", a word used by the mathematician and philosopher Alfred North Whitehead (1865–1947) to refer to a type of perception. This transcends classical perception, and raises questions such as belonging, feeling of self, meaning, etc. For Whitehead, sensory perceptions represent a secondary mode of perception derived from a non-sensory mode of perception called "prehension" (Whitehead, 1928). Prehension enables Whitehead to affirm the expression of qualia and to conceptualise these in mathematical and logical forms.

According to Whitehead's apprehensive doctrine of perception, prehension is the most fundamental way of grasping things, by taking them in, by incorporating them, i.e. a non-sensory mode. It goes from the perception of an object, a quale, up to its physical incorpo-

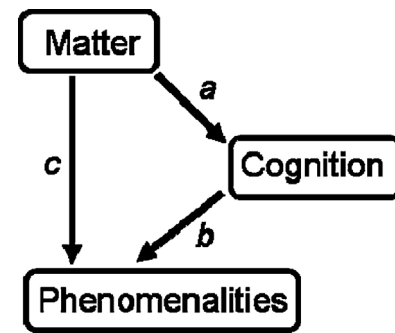


Fig. 1. Diagrammatic approach to the organism from the cognitive perspective. The arrows *a*, and *b* map the three core properties (Matsumo, 2000) of the living. The object "matter" embodies the environment as the initial elements and its active role in the emergence of the living organism. The object "cognition" is acting inside the very process of appearance of the living, and not as a mere emergence after its final constitution. The arrow *c* is the result of the entire process leading to the object "phenomenalities" which is an autonomous agent, i.e. the expression of cognition.

ration (food) or its mental aspect (an internal motion). This is why we distinguish several types. There are physical prehensions, these are material things; abstract prehensions, i.e. possible entities; and propositional prehensions, etc. (Whitehead, 1928). Prehension is a means of perception that is wide enough to embrace all types of organism in their modes of experiencing the environment. Consequently, according to the Whiteheadian view, all living beings have experiences because to be actual amounts to experience; therefore, the living world is composed of experiencing organisms. The notion of experience could also be retrieved from the enactive approach. In this paradigm, it is intertwined with being alive and immersed in a world of significance (Di paolo et al., 2014).

The second consequence of this approach to cognition is that the organism is normally adapted to its biotope, i.e. the environment is inherent in its mode of appearance. In other words, the relations between the constituent elements, cognition, and the manifestations as an organism are commutative (Fig. 1). The diagram shows that the organism is a new state of matter. By comparison, enactivism has also an embodied and situated approach to cognition. It relies on the Cartesian view of embodiment in its separation between mind and body, or the former as the controller and the latter as controlled. The body is the ultimate source of significance, and not a puppet controlled by the brain (Di paolo et al., 2014).

In this light, many authors argue that cognition, according to its classical meaning, may no longer be seen as an exclusive property of the brain. It does not refer either to the functionalities traditionally attributed exclusively to the brain. These complex functions seem to be performed by other parts of the body as well (Caluwaerts et al., 2013). However, there are two major aspects of our proposal. First, our notion of cognition, as a technical term, is not specifically related to the brain. Second, we do not use the terminology "body" which is traditionally opposed to "mind"; instead, we refer the word "organism" to a living system as a whole.

To better estimate this dynamic, we can find, by comparison, a parallel logic *ceteris paribus* in other paradigms. For instance, in linguistics, we can recall the following set: words, syntax, semantics. Here, the extrinsic environment involves the cultural and linguistic areas of the listener/reader, while the intrinsic environment refers to the way the subject integrates her culture and her language in such a way as to play with them as it pleases him/her. In this case, the meaning of a proposal emerges only in a precise cultural context (Fig. 1).

In the diagram (Fig. 1), cognition incorporates the notion of environment, this is the reason why it appears in the diagram. The second core property already incorporated a notion of environment, but a passive one in the constitution of the organism. In the

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