

Consciousness and Agency: The Importance of Self-Organized Action

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Abstract. Following the tracks of Ryle and based upon the theory of complex systems, we shall develop a characterization of action-based consciousness as an embodied, embedded, self-organized process in which action and dispositions occupy a special place. From this perspective, consciousness is not a unique prerogative of humans, but it is spread all around, throughout the evolution of life. We argue that artificial systems such as robots currently lack the genuine embodied embeddedness that allows the type of self-organization that is relevant to consciousness.

Sommario. Seguendo la linea tracciata da Ryle e basata sulla teorie dei sistemi complessi, svilupperemo una caratterizzazione della coscienza basata sull'azione come un processo incarnato, situato e auto organizzante nel quale le azioni e le disposizioni occupano un ruolo decisivo. Da questo punto di vista, la coscienza non è una prerogativa esclusiva degli esseri umani, ma è diffusa nel mondo naturale grazie ai processi evolutivi. Noi sosteniamo che i sistemi artificiali come i robot attualmente sono carenti del tipo di relazione con la corporeità e con l'ambiente che consente quel tipo di auto-organizzazione indispensabile per l'emergenza della coscienza.

1 Introduction

Cognitive Science brought about a kind of Copernican revolution in the studies of the mind by investigating the hypothesis that intelligence is not the unique prerogative of living organisms (human or non-human), but could also be a characteristic of computational systems like artificial neural networks or traditional symbol systems. Artificial systems can perform complicate tasks, and, as in the case of chess programs, they are sometimes more efficient than humans. Few, however, would be willing to argue that currently existing artificial systems are conscious. A question to be investigated here is: why is this the case?

Part of the answer to the above question can be found in the Western intellectualistic philosophical tradition (Plato, Descartes, Kant, among many others), consciousness has been viewed as an internal – and fundamental - property of the mind. In this tradition, the human mind has an inner characteristic and conscious human beings, living in a particular and personal world, are the only ones to access, directly through

Consciousness and Agency

private introspection, their own mental states. Consciousness, especially in its self-reflexive mode, was considered to be a unique prerogative of humans.

This tradition, which Ryle (1949) calls “the official doctrine”, gives birth to the dogma of “the Ghost in the Machine” according to which mental terms refer to events and episodes occurring in a separate realm about which the individual knows with certainty. As Ryle (1949, p. 14) says: “In his consciousness, self-consciousness and introspection he is directly and authentically apprised of the present states and operations of his mind. He may have great or small uncertainties about concurrent and adjacent episodes in the physical world, but he can have none about at least part of what is momentarily occupying his mind”.

In contrast to the official, internalist, doctrine Ryle proposes an approach to the mind (and consciousness) in terms of dispositions. In Ryle’s view, the mind is characterized in terms of “...abilities, liabilities, and inclination to do and undergo certain sorts of things, and of the doing and undergoing of these things in the ordinary [external] world” (199, p. 190). In this scenario, consciousness is part of a public, not private, history of actions and interactions that unfold in the dynamic ordinary world.

Following the tracks of Ryle and based upon the theory of complex systems (Bertalanffy, 1968; Weinberg, 1975; Jensen, 1998; Haken, 1999; Gregersen, 2003), we shall develop a characterization of consciousness understood as an embodied, embedded, self-organized process in which action and dispositions occupy a special place. From this perspective, consciousness is not a unique prerogative of humans, but it is spread all around, throughout the evolution of life. The question to be addressed in this context is: can this action-based consciousness reach the domain of complex artefacts like robots?

In order to answer this question it is important to make it clear that our investigation about consciousness is situated essentially in the domain of action; we are concerned with active embodied systems like organisms and not with abstract “ghost like” types of self-reflexive consciousness. Fundamental to this approach is the contrast between *animate* and *inanimate* properties of open systems.

As Bertalanffy stresses in his explanations of the dynamic organization of complex systems such as living organisms: “...even without external stimuli, the organism is not a passive but an intrinsically active system. (...) The stimulus (i.e., a change in external conditions) does not *cause* a process in an otherwise inert system; it only *modifies processes in an autonomously active system*” (1968, p. 208-209).

In his *General System Theory*, Bertalanffy criticises the model of the mind that characterises man as a passive computer responding mechanically to external stimuli. He suggests that, in evolution, purely reactive mechanisms were superimposed upon rhythmic-locomotor activities, responsible for the behaviour of complex open systems. The problem with the mechanistic (robot-like) view is that it does not take into consideration the notion of *autonomy*, which he considers a fundamental characteristic of intelligent behaviour. Autonomous activity, as Bertalanffy stresses it, “is the most primitive form of behaviour (...) it is found in brain function (Hebb, 1949) and in psychological processes (...) All such behaviour is performed for its own sake, deriving gratification (...) from the performance itself” (p.209)

Even though ‘autonomy’ does not constitute the main topic of the present paper, it is relevant to address it in order to approach the question (previously formulated)

about the (im)possibility of consciousness to reach the domain of complex artefacts like robots. In so far as these artefacts are passive instruments that react automatically to external stimuli, they seem to lack the systemic way of acting, proper of complex open living systems. In this sense, it is difficult to see how they could incorporate any degree of autonomy in their behaviour. Bertalanffy does not address this question, given that his main interest is to explain the dynamic organization of living organisms. However, the difference between systemic *action* – which unfolds from the dynamic structure of the organism – and purely localized *reaction* to stimuli – as occurring with most of the artefacts – is of great relevance for the present study.

In what follows we are going to inquire into the distinction between action and localized reaction to stimuli in the domain of embodied embedded systems, in order to explain the connections between consciousness, autonomy and dispositions. To start with, we argue that it is through rhythmic activities, and proper mechanisms of adjustment, that the emergence of a basic kind of consciousness occurs - as in a dance of the body and the environment. By using the metaphor of a dance, we want to stress that the *temporal aspects* of the active (not merely reactive) interaction between body and environment are of considerable importance to the emergence of consciousness. In complex self-organizing systems, the rhythm of the interaction between organisms and environment plays a crucial role in the formation of conscious phenomena.

One hypothesis to be further explained is that an important function of this type of basic consciousness is the maintenance of the main parameters of the organisms in order to enhance its autonomy and to preserve life. In this basic sense, consciousness directs goal related behaviour, creates dispositions and modifies habits mutually shaping the environment through bi-directional mechanisms of adjustments.

Finally, we shall argue that consciousness, understood in this basic, action-related sense, is not an exclusive property of humans, but it is a common element of all organisms. Reflexive consciousness, probably limited to humans and relatively few other complex organisms, should be understood as posterior to autonomous action and not as a pre-condition of it. Consciousness is not a pre-condition for action and thought, but rather an emergent product of self-organized action, which integrates sensory experiences, volition, emotion and memory, producing a unified informational field.

2 The Complex System approach to consciousness

So far we have introduced a preliminarily hypothesis on the nature of a basic, embodied, kind of consciousness understood as a self-organizing process in which action and disposition to grasp relevant information occupy a special place. In this section, we are going to develop further this hypothesis, explaining in which sense a self-organized process could characterize a basic kind of consciousness and we are also going to explain the role occupied by dispositions in such a process.

To start with, a notion of self-organization was initially proposed by Ashby (1962), Foerster & Zopf (1962), Bertalanffy (1968) and others as a part of a general system theory, developed more recently by Weinberg (1975), Debrun (1996), Jensen (1998), Haken (1999), Gonzalez (2000), Gregersen (2003). The complex system theory (CST) presupposes the existence of an order in the empirical, macroscopic, world,

Consciousness and Agency

experienced in every day life, that can be described by information of a more general category (of a second order). In other words, out of a great number of complex interactions between components at a microscopic level a macroscopic order can emerge, that unifies an immense amount of information in a comprised form. Such a unifying order cannot be reduced to the summation of its constitutive parts, but involves global, new, characteristics emergent from the interaction between individual parts of complex systems. In this context, a system is considered complex in the sense that its evolution involves interactions between elements existing in different temporal and spatial scales (Jensen, 1998, p.1). An intriguing characteristic of complex systems, as stressed by Jensen is that even though the micro-level behaviour of these systems is complex, their macro-level behaviour can be described, in many cases, in simpler ways.

One of the main dreams of researchers in CST (as admitted, for example by Weinberg, 1975) is to find a unified general law (of third order) that governs the process of generation of laws (of second order). Despite of its naïve appearance, this dream does not reflect the ignorance concerning the immense complexity inherent in the conjunction of physical, biological and social worlds. On the contrary, complexity is the starting point of the systemic analysis; it was mainly in biology that the systemic view developed its investigations of the intricate dynamic of life, and it was in biology that the CST found its natural place.

In biology, the CST developed out of the ‘vitalism *versus* mechanism’ dispute that took central place among early attempts to explain the nature of living organisms. Vitalism was blamed of introducing a mystical, unacceptable, hypothesis in the explanation of life, and the mechanistic approach, in turn, was criticized by neglecting what Bertalanffy called the ‘organismic conception of life’. This organismic conception emphasizes considerations about the organism as a whole or as an integrated system, and looks for the principles of organization of life at its various levels (Bertalanffy, 1968, p. 12). The systemic theory emerged out of a scenario of oppositions, proposing a holistic alternative to *both* vitalism and mechanismism, in order to describe the intrinsic complexity inherent in the behavior of organisms. We feel that this approach constitutes a turning point for our scientific and philosophical views on the nature of complex processes.

The concepts of emergence and self-organization play a particularly important role in the CST. Specifically, the concept of emergence is notoriously tricky (see for some useful taxonomies: El-Hani & Emmeche, 2000; Stephan, 2000). For the present purpose, however, an emergent property can be described as a global, holistic, or systemic property of open systems that arises out of the dynamic interactions amongst the system’s elements and that shapes or modifies their possibilities to interact (cf. Haselager & Gonzalez, 2002). Such a characteristic does not exist in each of the isolated parts, but it can only be identified in the whole system. Emergent properties can be observed in a wide variety of self-organizing systems. Self-organization, in turn, can be defined as a spontaneous (i.e. not coordinated by a central controller or external, pre-established, rules) process of order generation. The order emerges out of the interactions amongst the elements of the system and its interaction with the environment (Debrun, Gonzalez & al. 1996). Self-organization may lead to the development of dispositions.

Dispositions can be understood as the inclination of a system to produce specific behaviour upon encountering adequate conditions. To say, for example, that a chunk of salt is soluble, or that it has the disposition to dissolve, is to say that if it would be immersed in a certain liquid, it would dissolve. Referring to dispositions, Ryle (1949, p. 43) remind us further that: “to possess a dispositional property is not to be in a particular state or to be in a particular change; it is to be bound or liable to be in a particular state, or to undergo a particular change, when a particular condition is realized”. In this sense, dispositions constitute causal propensities. Moreover, when these propensities are repetitively actualised, they give rise to habits, which shape the behaviour of embodied organisms.

Thus, it is from the perspective of the CST that we characterize consciousness as an embodied, embedded, self-organized process in which actions and dispositions to grasp relevant information for the maintenance of the organism occupy a special place. Actions, in this context, should be distinguished from merely reactive behaviour. Actions incorporate an intricate web of dispositions that are susceptible of corrections and adjustments. Under proper conditions, these dispositions give place to habits responsible for the enhancement of the system’s ability to deal with tensions and fluctuations of its own body and of the environment. As we are going to explain in a later section, it seems to be the spontaneous ability to “dance” with the flow of internal and external tensions that is constitutive of the action-related type of consciousness, which distinguishes intelligent from merely mechanic behaviour. First, however, we will examine some recent views suggesting that the brain is not, as traditionally thought, the central controller of action, but is only one player among several, and participates in, rather than controls the process of self-organization.

3 Consciousness and neurodynamics

Chiel & Beer (1997) provide many examples indicating the importance of the body for cognition. They point out that this is logical given that the body and the nervous system co-evolved during the evolution of a species, and develop together during the lifetime of a specific organism. Moreover, it would be misleading to see the body as merely providing the receptors of information to be processed in the brain because the body is actively involved in sensory (pre)processing. As they indicate, crickets, frogs and other animals that must discriminate sounds whose wavelength is small relative to their body size, use whole body structures to provide additional phase and amplitude information (Chiel & Beer, 1997, p.553). Similarly, the body does not merely execute brain commands, but actually transforms neuronal motor output. For example, muscles filter out high frequency components of neural output, and the tendons that connect muscle to bones are greatly affected by different degrees of stiffness of the tendon as well as by the level of activation of the muscle. Just like the brain constrains the potential behaviour of the body, so does the body constrain the activities of the nervous system. What the body cannot perceive cannot be processed by the brain, just like impossible movements are unlikely to be ‘commanded’. Less obvious, perhaps, is the role of the body in the simplification of neural processing problems. A well-known example here is the spring-like nature of the human leg that greatly simplifies the problem of coordinating the movements of the legs involved in walking. Finally,

Consciousness and Agency

the continuous feedback that the body and environment provides an essential part of neuronal activity, and without this feedback the nervous system's activity may not be very effective in producing behaviour (Chiel & Beer, 1997, p.555). The brain does not give orders to be executed but provides a contribution to the ongoing dance between the body, brain and environment.

Recent research into the neurodynamics of consciousness indicates the importance of temporal synchronizations between brain processes related to the current state of the body and brain processes related to the current interaction with the environment. For example, Parvizi & Damasio (2001) argue that core consciousness (the most basic form of consciousness) consists of the interaction between (a) neuronal activity patterns concerned with object interaction, (b) neuronal activity patterns concerned with the bodily state of the organism and (c) neuronal activity patterns that constitute the relationship between (a) and (b) (p.139). They stress that the neuronal patterns that map the physical state of the organism are aimed at ensuring the homeostatic balance of a living organism (p.135).

Likewise, Edelman & Tononi (2000) indicate that primary consciousness (comparable to Parvizi & Damasio's core consciousness) consists of the integration of information about the present interaction with the world (e.g. perceptual categorization, shaped by current actions) with value-laden information about previous interactions with the environment. Hence, they speak of primary consciousness as a 'remembered present' that detects features of the present environment in the light of past experiences to produce actions (or habits) that contribute to determine the future.

They specifically focus on a temporary subset of neuronal groups that constitute an integrated (i.e. being part of the same conscious process) yet differentiated (i.e. providing different contributions to the conscious scene) temporary unity (p.131). Such a subset of strongly interacting elements that is functionally demarcated from the rest of the system is called a functional cluster (p.120). Importantly, the functional clusters only have a temporary existence and are not repetitive but change continually over time.

Similarly, Bressler & Kelso (2001) speak about cortical areas that arrange themselves quickly in changing but coordinated configurations of varying sizes. The resulting large-scale cortical networks achieve temporally strong coordination by means of relative phase relationships between the different brain areas (p.30).

All three approaches claim that it is not primarily the location of brain areas that is important in understanding consciousness, but rather the interaction between neuronal groups among different and changing regions. Our interpretation of these findings is that the brain is recruiting resources in order to engage in a rhythmic interaction with the world. That is, in an adaptive response to bodily interaction with the world, parts of the brain self-organize into a 'system' that exists only temporally and functions to keep up with the interaction. In terms of the dance metaphor, then, the main function of consciousness is to adjust to the rhythm of the dance (i.e. the temporal patterns of the bodily interaction) with the environment. If we accept this hypothesis, then the following question presents itself: can this action-based type of consciousness be found in all living organisms and, maybe, in complex artifacts like robots?

4 Habits, dispositions and consciousness

In *The concept of mind*, Ryle distinguishes habits from efficient or intelligent capabilities. According to him, “it is of the essence of merely habitual practices that one performance is a replica of its predecessors. It is of the essence of intelligent practices that one performance is modified by its predecessors. The agent is still learning” (Ryle, 1949, p. 42). As an illustration of this distinction, Ryle presents the case of walking. Under normal conditions, we walk on pavements on the base of habits, without bringing consciousness to what we are doing; there is no need for care or vigilance. This habit of automatic walking is contrasted with the ability of a mountaineer walking over ice. “... a mountaineer walking over ice-covered rocks in high wind in dark does not move his limbs by blind habit ... he is ready for emergences, he economize in effort, he makes tests and experiments ... If he makes a mistake, he is inclined not to repeat it, and if he finds a new trick effective he is inclined to continue to use it and to improve on it. He is concomitantly walking and teaching himself how to walk in conditions of this sort” (Ryle, 1949, p. 42).

For our present investigation, the distinction between blind habits and intelligent capabilities help us to characterize consciousness as a process that incorporates not only blind habits, but also, and mainly, efficient capabilities. These capabilities, in the case of organisms, constitute one of the basic elements responsible for the survival of the individual organism (and of the species to which he belongs) in his interactions with a dynamic environment.

Another important difference between habits and efficient capabilities, emphasized by Ryle, is related to the notion of disposition, explained earlier. No doubt, a trained artificial neural network or robot could acquire dispositions to respond to stimuli from the environment in specific ways. However, it is a complex web of heterogeneous and unlimited variety of dispositions that distinguish actions from simple habits, such as the single-track dispositions created by a trained neural network.

We do not wish to claim that the more heterogeneous manifestations of dispositions, that Ryle (1949, p.44) thought to be distinctive of ‘higher-grade’ dispositions are beyond the capacities of neural networks and robots, as this is clearly an empirical issue and not something to be settled a priori. Rather we want to emphasize that in organisms, even in the case of very simple unicellular organisms, the web of dispositions seems to be an emergent property of their interaction with the environment throughout their evolutionary development. In the case of robots or neural networks, there is not yet such a genuinely embodied emergence, and neither a comparable evolutionary process (Haselager, 2003).

Regarding the first point of embodied emergence, one may observe that the bodies of current robots are constructed from sets of, often pre-created, components that are put together by engineers. Robots are constructed from the ‘outside in’, by connecting prearranged parts (like a robot-arm or an optical censor) to a central unit. The development or evolution of organisms, however, follows what von Uexküll (1982, p.40) called, ‘centrifugal’ principles; they develop from the *inside out*. Moreover, the interaction between the components lacks the complexity of the codependent, systemic, functioning of the body parts of an organism. Even in the case of single-cell organisms like amoebas there is already an autopoietic quality (cf Maturana & Varela,

1987) that seems to be lacking in robots. Kheperas, LEGO-bots and other plastic and metal based robots lack any form of bodily self-organization, most likely because the type of matter out of which they are made does not provide the required interactive plasticity to support this. In these robots, self-organization, if existing at all, is restricted to their control systems, i.e. artificial neural networks. This makes it difficult to see how a complex web of dispositions can emerge out of the self-organized interaction between body, brain and environment, as the bodies of robots miss the capacity for flexible interaction that self-organization and emergence require.

Secondly, most robots currently are created by designers and lack a genuine evolutionary history. This reliance on human design implies a significant restriction on the autonomy of robots and may restrict the complexity of the dispositions within reach of the robot. A consideration of a very interesting recent research in evolutionary robotics (Nolfi, 1998; Nolfi & Floreano, 2000) may illustrate what is at issue here. Nolfi (1998, p.167) defines evolutionary robotics as “the attempt to develop robots and their sensorimotor control systems through an automatic design process involving artificial evolution.”

Of specific interest to our present purposes is the co-evolution of robots. This involves the ‘internal’ co-evolution of the body and the control system (i.e. an artificial neural network) and the ‘external’ co-evolution of the robot with its environment and other robots (with for example predator-prey relations). Although this work shows that the evolved artificial systems can develop a repertoire of dispositions of unexpected complexity, it is fair to say that these systems are not embedded in any genuine sense of the words, because they are simulated, instead of real, robots. Moreover, the emergence that is observed lies in the interaction between the simulated robots and their simulated environments (e.g. Nolfi, 1998, p.169), but not, importantly, in the interaction between (parts of) the body and its brain and environment.

It is the embodied, embedded and evolved web of dispositions that, in the case of organisms, provides conditions for the enhancement of autonomy and survival. As in a chain, evolution seems to provide mechanisms for a continuous generation of dispositions, which - in the flow of real time - give place to habits modifiable according to the rhythms of the different interactions with the environment that organisms engage in. In this chain of organisms physically interacting with their environment, consciousness, in its basic, action-related sense, emerges and evolves. In our view, so far robots lack a genuine embodied embeddedness, precluding the emergence of action-based consciousness.

5 Conclusions

Analyzing the self-organizing principles from which biological complexity emerges, Gregersen (2003, p.8) stresses autonomy as one of “the most baffling property of biological complexity – the well known ability of living systems to quite literally take on a life of their own and behave as autonomous agents rather than as slaves of the laws of physics and chemistry. How does this come about? How does a physical system harness physics and chemistry to pursue an agenda? Somewhere on the spectrum from a large molecule through bacteria and multicelled organisms to

human beings something like purposeful behavior and freedom of choice enters the picture”.

We believe that this “something” referred to by Gregersen could be equated with the basic notion of consciousness sketched here. In our terms, purposeful behavior can be described as incorporated action, through the history of evolution, of autonomous complex systems. Autonomy, in turn, according to the systemic view, is a self-organizing property of organisms in their attempt to preserve themselves. Differently from robots, organisms not only acquire the ability to deal with tension resulting from temporal changes in the environment, they also incorporate and benefit from tensions in their own bodies. The apparent dynamical equilibrium of the organisms is not the mere expression of a passive response to external stimuli, but rather of a very complex dance to adjust themselves, at different macro and microscopic levels, to the dynamics of action.

In short, organisms are essentially active systems, and great part of their activity seems to come from their attempt to deal with forces often hostile to their survival. This indicates that living organisms maintain a fluctuating but stable tendency to equilibrium through which they increase their strength and degree of organization by dealing with “noise” or disturbances. From the systemic perspective, organisms are not just machines, but as Bertalanffy suggests, they can become machines to a certain extent; particularly when their action comprises a great amount of habits used as instruments in battles to deal with tension. There are many circumstances in which it becomes difficult to distinguish conscious actions from blind mechanic habits. However, the evolutionary survival of currently existing organisms testifies of a capacity to dance with disturbances that current robots yet have to accomplish.

In this paper we sketched some hypotheses concerning a basic kind of consciousness understood as an embodied, embedded, self-organized process in which action and dispositions are incorporated in complex systems in order to allow them to deal with tension and changes in the environment. We tried to indicate, first of all, that consciousness is a systemic, self-organizing process that out of which a complex web of dispositions emerges. From its beginning, consciousness has been related to bodily action in the world aimed at furthering survival and procreation. Secondly, the dynamic interaction between body and world is a fundamental element of this emergent process. Third, in the case of human beings and other animals with nervous systems, the self-organization of neuronal groups into temporary functional clusters processes, enhances the capacity for adaptive bodily interaction with the environment. The importance of the brain lies in its potential to allow for more complex possibilities for action, and for memory shaped modification of dispositions. Fourth, we argued that robots currently lack a genuine embodied embeddedness that allows the type of self-organization found in the evolutionary development of organisms. Basic, action-related forms of consciousness evolved out of the continuous dance of bodies with their environments. In cognitive science we all still have much to learn about dancing.

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Eunice Gonzalez, Mariana Broens e Pim Haselager

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Consciousness and Agency