Sensorial Information and the Roots of Cognition in Evolution

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Abstract

Trying to understand when and how the cognitive phenomena arise in evolution continues being a hard problem of confronting. Another important issue is referring to find the explanatory framework which integrates the different observations and data in neuroscience investigations. These situations lead us to ask a question in regards to whether there are underlying general principles to the so-called neural code: What might the relationship be that is established between the neuronal responses and the sensory signs or signals that these supposedly represent? In fact, one important task is to find the ways in which we will be able to arrive at those explanations that will enable us to understand how living beings put together perceived sensory information as well as how they represent it. In this brief paper, we address some conceptual questions involved in the relationships between sensorial information perceived by brains and its representational capacities. Specially, we propose that it is possible to defend the physical origin of Information. Therefore, we will study the implications to use the information notion as an ascribed concept and its relationships with using this same notion like denoting something in the reality.

Introduction

When we say the brain has the capacity to make some kind of representations, with these we are saying that, the brain produces certain information processes types from the data or signals from the exterior. And following, this processes "some how" produce an integration in such a way that it is generated a coherent and coordinated answer as a results of the neuronal activities.

This representation could be an image, a sound, a flavour, an idea. In other words, we are in front of the so called "binding problem" (Kahneman, Treisman and Gibbs 1992; Ungerleider and Haxby 1994; von der Malsburg 2001, 2002).

In this way, one basic problem is to explain the relationship between the actions of interconnected set of cells specialized in receive and transmit

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information with the production of some kind of answers mediated by the representational capacity of this cells aggregations.

We found in the brain, the existence of different centres with the task to process certain types of signals (for example, visuals at the moment to observe a table or a book) and we realize that there are many neuronal connections in synchrony (Milner 1974; von der Malsburg 1995; Varela 1995; Kreiter and Singer 1996).

At one moment, it presents a tune between synchronic neural fires in one part of the brain with other brain portions that are activated in synchronic ways.

Until now, we do not know how to find a design –in laboratories and in computational simulations- that would resolve the implications derived to approach integrally the spatial and temporal coordination of all the processed signals which produce a coherent resultant, as the obstacle identification for us.

We approaches to this problem, with the proposal that the "low level" mental phenomena are not totally explained by virtue of mechanisms, functions and computations exclusively.

In other words, we claim that it is needed to deepening on the information notion, and to connect it with the emergence notion, with the capacity of neurons structuring and with future scaling-developments in evolutionary terms.

Our working hypothesis proposes installing the questions in the most basic mental phenomena. With the final goal, to track until last consequences the origin of these capacities greatly extended in the living realm.

Our research proposal has the central objective to construct a theoretical approach (conceptually and with the possibility to design reliable algorithms), which will open the door to an overall comprehension of the successive steps, for the emergence of mental levels.

Integration of Sensorial Information

Imagine an ordinary situation: a person, walking through a park, begins to clap his hands; suddenly, the birds on the grass around him take off in flight. We can ask ourselves, "How did the birds perceive these claps?" Further, if there were another animal in the area, such as a cricket or a mouse, how would it perceive them?

These situations lead us to ask a question in regards to whether there are underlying general principles to the so-called neural code: What might the relationship be that is established between the neuronal responses and the sensory signs or signals that these supposedly represent?

It is important to understand that the terms "stimulus" and "response" include within them an extremely large group of components, such as the different ways for receiving a determined type of sensory information living beings possess or the various and multiple forms in which this specific type of sensory information flows through a determined group of reception centers (smell, taste, sight, etc.) for that information. A typical case is what happens in the different dynamics that are observed in the predator-prey interaction, for example.

An interesting discussion of these topics is one we find in a recent work on the behavior of bats as they are hunting their prey (Ghose et al. 2006). It seems that on a wide scale evolutionary basis the constant bearing (CB) strategy is the one most often used. This strategy is the optimal way for a predator to capture its prey or a moving object, following a straight line or a predictable trajectory (Olberg et al. 2000; Shaffer et al. 2004).

Nevertheless, in the case of bats, the authors propose that the most efficient strategy of this type of predator-prey interaction is not the CB but the CATD strategy (constant absolute target direction). This strategy predicts a bearing that would be defined by the absolute direction between the predator and the prey. In their studies, the researchers find that the bat would capture its prey by adjusting the direction of its flight path and its speed of pursuit. And so, it would consistently maintain the absolute direction to its target throughout the pursuit: "…When the bat converges to (and maintains) the optimal bearing, the absolute direction to the target does not change. The CATD strategy produces a trajectory which, from the viewpoint of the target, makes the pursuer ''appear'' stationary against a distant background, and vice-versa." (Ghose et al. 2006, pp. 0006).

In fact, one important task is to find the ways in which we will be able to arrive at those explanations that will enable us to understand how living beings put together perceived sensory information as well as how they represent it.

Emergence of Information

Focusing our attention for a few moments on a controversy that is produced among the consequences that are derived from the laws of quantum physics and the physics of black holes, we have, on one hand, the former, which states that information (in a similar manner to energy) "cannot be created or destroyed." On the other hand, in a black hole, "information cannot escape." This is known as the "black hole information paradox " (Danielsson and Schiffer 1993; Susskind 2003).

It is possible for us to have the following situations: first, we ask for the information that is contained in a determined object, for example, a CD player. Secondly, we wonder about the information that would be needed to produce in a random sort of way somewhere in the universe all the necessary phenomena of physics in order for the parts of a watch to "spontaneously assemble". And, the third situation is one of the possibility of measuring the information content that is necessary for an ant colony to explore the required strategies for detecting, finding, and transporting a source of sugar to their nest that lies some distance away from said source.

We have to ask ourselves if, in these cases, whether the term “information” is being used in the same way. If what we are talking about is the way in which we can formalize the measurement of the information content in these situations, then the answer is probably yes.

Nevertheless, it seems that for the case of the ants there are some extras to the notion of information that are not found in the other situations. We can affirm that among the phenomena produced in the ant colony, it must have been possible for them to transmit certain information among each other so as to be able to produce the coordinated behaviors as a whole that we observed.

This is something that we cannot state with certainty in the other two cases. So, it seems that we are faced with two uses of the notion of information; the first use has something to do with the way in which “we ascribe” a certain information content that is susceptible to being treated in formal terms by some suitable information theory for that particular case. The second case has more to do with the “*production of information*” that is used by entities, which are adaptive, dynamic systems, and that, likewise, may be susceptible to being treated in formal terms. What difference have we found between these two cases?

A first approximation is to propose that this difference among the uses of the notion of information (in the cases we set out above) is not casual. Instead, it could be revealing a problem that ultimately makes us question the composition and the interaction of the most basic things of the world (Godfrey-Smith 1998; Rouvray and Bonchev 2005).

It might be a problem that establishes the difference between using a notion through ascription (imposed by us for the purpose of deepening the understanding of determined phenomenology) and using this same notion as indicating its existence in physical terms for certain entities of the world.

The second use could be making us understand that the notion of information *exists in the world*; it is a capacity, a property, or a characteristic of certain things in the world. In other words, the term “information” has a physical reference in reality.

The first use could indicate that some notions (for example, the notion of information) might be susceptible to being largely abstracted and, therefore, used on “a wide-scale basis” to almost anything in the universe.

Hence, the first use (the “wide-scale approach”) has its theoretical and applicable legitimacy since we have discovered that it is real. An important consequence that is derived from our earlier reasoning, therefore, is that it might be possible to propose that there was a time when information appeared in the universe, that ***information had an origin***.

The central question within this analysis refers to the causes that have occurred during evolution for the appearance of the production of interpretations (meanings) in the brains of these animals from the sensory information they receive. It would be interesting if we could discover that biological information (understood in a wider sense) already carries a certain “meaning” (a basic semantic) and is perhaps associated with the molecular processes that generate the biological functions within a network of processes. Thus, it would not seem so illogical to think that the search for the origins of cognition will take us directly to a deepening of the notions of biological information and biological functions as well as to the possible relationships that take place between them.

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