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## Biological organization and causality: A constructivist approach

Biological systems are special examples of complex systems where some peculiar behaviors come up. Their circularity presents a self-referring structure that is different from a physical selforganization. The central epistemological difference lies on a teleological aspect of biological selfmaintenance. The presently received view attempts to naturalize teleology. According to this view, teleological explanation has to fit with efficient causation. In this paper, we aim to address this problem by a constructivist approach. We propose teleology as a special causal principle, as an alternative to efficient causal principle, that gives rise to a specific and fruitful form of explanation for biology: organization.

In complex and organized living systems, the epistemological relevance belongs to those elements and interactions that allow the conservation, the proliferation, the transformation, the adaptation of the whole system; finally its life. Therefore, this teleological aspect involves a special logic of the relationship between the whole and the parts. The teleology and the normativity of this special self-maintenance radically challenge the common notion of efficient causation and its associated explanation. In the history of life sciences, many philosophers, since Aristotle, have highlighted the insufficiency of efficient causation in the explanation of living systems. Moreover, the relevance of teleology in this context has gone hand in hand with that. Yet, teleology raises a metaphysical problem because it seems to introduce some project in nature. This is in contrast with the naturalistic vocation of life science. That is why, the main project regarding this problem is to restore efficient causation. Biologists and philosophers of biology generally attempt to find some theoretical instruments that allow to assimilate teleological explanation to efficient causation. Thus, in order to restore the efficient causation, and make innocuous the teleological aspect. Several different forms of this naturalistic project have arisen. For instance, the analysis of functions gives rise to some very different solutions to naturalize teleology. In another context, François Jacob considered that the notion of genetic program finally would give a natural and legal status to teleology. Jacques Monod preferred to hide it under the term teleonomy. However, all this propositions

show some weakness. In some cases, they completely devalued the teleological aspect. The price to pay is an important loss in term explanatory power. In other cases, they save the teleological explanation, but teleology remains hard to naturalize. Among these solutions, organizational frameworks take a very relevant place.

The philosopher Kant clearly understood the proximity between teleology and biological self-organization. Inspired by Kant, the autopoietic system of Varela and Maturana is the first modern and naturalistic formulation of a biological organization as a differentiated and closed system. Starting from this very first proposition, some others organizational perspectives appeared. These perspectives vary in the way they correlate properties of the system. For instance, they can give more importance to a property of closure, from which they derive self-maintenance, or vice versa. Nevertheless, they seem to be a privileged theoretical environment in order to take in account teleology, circularity and normativity in the biological complex systems. That is because the causal structure of organization is precisely a special teleological circularity. According to the partisan of the naturalistic organizational perspective, organization naturalizes teleology. That is to say, by showing that teleology and normativity derived from the organizational structure of the system, they save these aspects from metaphysical consequences and restore the efficient causation.

Here, we question the relationship between this special circularity of self-maintenance and the efficient causation. Particularly, we challenge the idea that teleology and normativity can be derived from organization. On the contrary, by adopting a constructivist approach, we argue that organization is a special form of explanation derived from a particular form of causation that is teleology. We propose a previous hierarchy between causal principles and explanations, inspired by the philosopher Ernst Cassirer. Indeed, we argue that a causal principle is a regulating principle that gives rise to a specific form of explanation. We claim that efficient causation is one of the causal possible principle in science, but not the only one. By showing the role of regulating principle of causation in general, and therefore also of efficient causation in physics, we ascribe the status of a specific principle to teleology. Taking inspiration from the Kantian definition of teleology, but with a critical conceptual extension, we interpret teleology as a principle that allows the determination of a specific explanation in biology. Since teleology is a constitutional part of the formal and conceptual structure of organization, its metaphysical aspect is neutralized.