Two Functional Approaches to Anticipation in Biology

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Abstract
Biologists appeal to "functional explanation" as an ubiquitous explanatory strategy for understanding anticipation to environmental demands. However, functional explanation remains one of the most controversial issues in philosophy of biology: two main philosophical approaches address biological functions from disparate views. In this paper, I sketch out how neither etiological approaches nor systemic approaches pay enough attention to functional explanation as used in biological practice. I suggest that a detailed comparison of mechanisms in both accounts may be fruitful in identifying common problems and suitable solutions.
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1 Introduction

There is hardly a more important term in biology than function. Biological functions constitute norms for the "what for…?" questions, maybe the most persistent questions in the history of biology. Considerable achievements in physiology, molecular biology, evolutionary biology, ecology, and other sub-disciplines are based on this sort of questions. However, functional explanations have often been regarded as a suspicious unscientific teleological way of talking: design, backward causation or external mental agents are terms historically associated to teleological talk, and expelled from legitimate scientific discourse. As a consequence, while biologists are extremely reluctant to use explicit terms associated to teleology, they appeal to expressions describing directed behavior, adaptations, or regulative dynamics in functional terms. Additionally, philosophers of science have argued that neither mental agents nor backward causation are implied in functional explanations as used in biology.

Over the past decades, two philosophical traditions devoted to understanding functions in biology have been specially influential[1]. Etiological views and systemic views analyze functions either as historic results of natural selection or as contributions to a specific capacity in a containing system. Darwinian evolution through natural selection is the base of etiological accounts[2]. Functional bearers are understood as types resulting from a causal historical process of recent (Godfrey-Smith, 1994), or ancient natural selection regimes (Bekoff, & Allen, 1995;Griffiths, 1993;Millikan, 1984;Neander,

[1] See Perlman (2004) for a brilliant and exhaustive taxonomy of theories on function and teleology.

[2] Interestingly, the original enunciation of the etiological account does not confine historical causes of functions to natural selection (Wright, L. 1973).

1991a). In contrast, systemic approaches attribute functions to components causally contributing to a current capacity in a containing system (Cummins, 1975, 2002).

Several authors endorse pluralism in giving an account of biological functions. Kitcher (1993, p.395), for example, writes: "Philosophical discussions of function have tended to pit different analyses and different intuitions against one another without noting the pluralism inherent in biological practice." This seems sensitive to the heterogeneous application of functional explanation strategies in biology. What exactly does a physiologist mean when he explains that the heart's function is pumping blood? Is it the same meaning used by an ecologist talking about plant leaves designed for draining water? What about an evolutionary biologist claiming that the functional design of feathers in birds is to make them suitable to fly?

Yet, despite my sympathy for pluralism, I claim that most of philosophical accounts overlook the common mechanistic grounds operating in functional explanations in biology. The first and the second sections of this paper explore the progressive philosophical attempts to capture functional explanations in biology by an overview of some paradigmatic authors. I will then suggest how functional systemic and etiological views can be approached by exploring their mechanical dimension. It is my contention that a subsequent development of this approach may be useful to understand the methodological problems and failures of mechanistic philosophy to understand biological usage of function.

2 Looking for the History: Etiological View

Etiological approaches seek to answer why the function bearer is there. Thus, the existence of a function bearer is explained by the function the bearer does. Additionally, functions emerge as effects of historical processes. However, etiological approaches are not homogenous: significant differences rely on the purpose to which different etiological theories are supposed to serve. Some authors use a specific etiological theory to explore conspicuous philosophical problems like teleology, intentionality, desire, beliefs or language. Other authors focus on the current usage of the concept in biological research.

Wright's work (Wright, 1973, 1976) is considered the point of departure of etiological theories. He attempt to naturalize teleological functions as effects operating in pragmatical explanatory contexts (Godfrey-Smith, 1994). Although Wright does not limit his theory to biological functions, the importance of his contribution in functional explanation in biology can be hardly overestimated. Drawing on the work of Wright, Ruth Millikan (1984, 1989) introduces natural selection as the mechanism *par excellence* to explain biological functions as results of a determinative causal history. She coined the term "proper function" to provide a stipulative definition of function appealing to historical causal processes molded by natural selection. From a biological viewpoint, the main advantage of this approach is that it suits quite well to what most biologists identify as adaptation, one of the most important concepts in Evolutionary biology (Sober, 1993 p.86; Allen and Bekoff, 1995, pp.612-613). Besides this, the etiological view restricts narrowly function ascription: in order to a trait have a function, the trait must have been selected because it performs that function.

However, Millikan pretends to gather together several phenomena under the category of a theoretical concept rather than analyze functional explanation in biology. Proper functions would be the grounds for a naturalist philosophy of mind. Phenomena like intentions, beliefs, and mental states would go hand to hand with biological laws. She does not intend to capture teleology or functional talk in biological practice. Actually, she actively refuses "conceptual analysis" as "a confused program, a philosophical chimera, a squaring of the circle, the misconceived child of a mistaken view of the nature of language and thought." (Millikan, 1989, p 290).

Neander brings function discussion back to the field of biological explanation (1991a, 1991b). She clearly defends conceptual analysis as an important enterprise devoted to understand the accurate criteria of application of proper function as grasped by the scientific community. She does so by removing any implication in terms of "meaning" from conceptual analysis. In her view, conceptual analysis is restricted to searching for the criteria applied while biologists use the term function. The analysis of such a criteria can be worthwhile in understanding well articulated scientific theories (Neander, 1991b). This move transforms her "selected effects functions" into an etiological approach much more sensitive to the character of functional explanations in biology.

Griffiths (1993) offers an etiological version that seems to come even closer to biology. Griffiths tries to accommodate canonical system functions by Cummins and the etiological view as used in evolutionary biology. What is significant is that he paid attention to several biological phenomena like vestigial traits, fitness as an operative relative concept, intragenomic conflicts and phenotypic traits as functions for other individuals. The idea of proper function, eventually, started to deal with the problematic landscape of biological concepts.

An important turning point came when (Godfrey-Smith, 1994, p .345), "Guided more by the demands of the role the concept of function plays in biology", restricted even more the function ascription to traits with a recent selective history. In this way, this author is able to deal with the puzzling problem of function attribution to exaptations posed by Gould & Vrba (1982).

This sketched summary of over thirty five years of etiological theories shows that an understanding of teleology and function in naturalist terms resulted in approaches increasingly more aware from crucial concepts in evolutionary biology. However, I postulate that, besides the fortunate attention conceptual analysis has received, much less attention has been paid to the mechanical strategies used to provide functional explanations. I think that systemic accounts are, in this regard, in a better position.

3 Looking for the Contribution: Systemic View

The main question systemic accounts seek to answer is not to explain the existence of a function bearer, but how the bearer performs its function. Cummins (1975) sets up the basis of this approach: function ascription is appealed to in explaining the capacities of a containing system. Function bearers are described in terms of their causal contributions to a complex capacity decomposed into simpler capacities within a multilevel system[3]. Systemic accounts through functional analysis are context dependent and a-historical approaches. The context of the system depends of our own research interest without regarding the causal history of the system itself.

The liberal character of this view makes it a very flexible position to apply in several biologic explanations. Specifically, Amundson & Lauder (1994) show how this approach is essential in functional anatomy. Surely, plenty of other biological sub-disciplines address functional explanation in a similar way.

Paradoxically, the liberal character of systemic accounts is also its main drawback. While any kind of contribution can be analyzed depending only of our research interest, systemic approaches ascribe functions to purely physical systems as well. Theoretically, we may ascribe functions to the planets' capacity to revolve around the sun in giving an analytical account of the solar system.

This sounds not entirely satisfactory to the ears of biologists. The gist of the problem is that systemic accounts are inherently incapable of discriminating between functions and accidents (Griffiths, 1993;Kitcher, 1993;Millikan, 1989). Consequently, there is nothing in systemic accounts that helps us to understand how the functionally relevant aspects in an organisms are defined in a functional explanatory strategy. This is devastating for the application of systemic accounts in biological practice: functional explanations in biology are important precisely because they describe aspects of living organism considered as relevant. If biologists cannot identify relevant aspects in an organism, how can biologists identify possible functional traits? Actually, how can biologists identify organisms at all?

Millikan in particular points out that any systemic explanation starts from a paradigmatic example to analyze functions (Millikan, 2002). How is this paradigmatic example defined? Millikan says any systemic account appeals to historical types to recognize its object of study. In this way, for Millikan, systemic views depend on normal types determined in an etiological way. But the debate over this continues; derived versions of the original systemic formulation have provided good insights to describe conceptually the causal mechanisms involved in functional explanations (Craver, 2001; 2007a).

In what follows, I will sketch out how functional explanations have been supplemented with mechanism to describe the explanatory character of systemic and etiological accounts of functions. Finally, I will suggest that neither systemic accounts

[3] Cummins called "functional analysis" to this specific way of providing functional explanations (Cummins, 1975,2002).

nor etiological accounts can provide an autonomous solution for the problem of relevance definition.

4 The History and the System Looking for Mechanisms

Several authors attempt to conciliate or at least to make compatible etiological and systemic approaches (Kitcher, 1993; Walsh, 1996a; 1996b; Arp, 2007; Mossio, 2009). Nonetheless, other authors concur with (or at least concede) a desirable pluralism in functional biology (Amundson, 1994; Godfrey-Smith, 1993; Hull, 1998; Millikan, 2002). Most of these attempts have achieved relevant insights into what functional explanations are, by the means of the analysis of relevant concepts in biological function. However, I suggest that a more careful analysis on the nature of mechanisms may be fruitful in identifying the common problems to all functional explanations as used in biological practice.

Craver (2007b), Machamer et al.(2000) and Glennan (1996, 2002) provide a substantive basis in understanding explanatory mechanisms. I suggest that merging these accounts may be a promising strategy in embracing functional explanations and mechanisms[4]. Machamer *et al.*'s account sets explicitly the elements intervening in a mechanism: "Mechanisms are entities and activities organized such that they are productive of regular changes from start or set-up to finish or termination conditions." Thus, a mechanism involves activities and entities that can be properly specified leading to a "privileged end point". This point is the non-deterministic result of all processes implicated in the intermediate stages. In the simplest case, the stages of a mechanism are organized linearly, but they also may be forks, joins, or cycles.

The processes from stage to stage are described by Machamer *et al.*'s in a way that seems too strong to embrace stochastic mechanisms: "they work always or for the most part in the same way under the same conditions" (Machamer *et al*, 2000, p. 3). A better work is made by Glennan's account (1996, 2002) of regularity in terms of activities as direct, invariant, change-relating generalizations. Thus, functional general processes from stage to stage may be described by means of invariant causal regularities (Woodward, 2000), which are significantly less stable than regularities in Physics and Chemistry (Mitchell, 2000). This move relaxes the conditions of regularity in mechanisms and may allow mechanistic accounts to address functions in phenomena like natural selection.

There has been recently some discussion about if this updated version of mechanisms is capable to grasp the phenomenon of natural selection. The debate is focused on the level on which natural selection acts (individuals vs. population) and the kind of causality involved. Despite this debate (which I don't pretend to resolve here), there is a common agreement that natural selection can be framed in mechanistic terms

[4] I follow some of the suggestion made by Skipper & Millstein (2005) in order to explore a general conception of mechanism. Barros (2008) has followed a similar strategy in order to analyze natural selection on the frame of neo-mechanism (see below). I think this strategy can be generalized to grasp the essence of all mechanisms.

paying attention to its stochastic and population dimensions (Skipper & Millstein, 2005). The version suggested above may be a good candidate to accomplish this aim. In addition, Barros (2008) shows how it is possible to use the dualistic schema by Machamer *et al.* (2000) to frame the individual-level mechanisms underlying the population-level processes in selective regimes. In conclusion, if natural selection is susceptible to be described as a mechanism, etiological theories of function would be much closer to systemic accounts than expected.

Assuming that the core of etiological explanations, namely natural selection, may be described in mechanical terms by neo-mechanisms or any other variant of mechanical approach, the important question of trait relevance raises with increased force. Craver says explicitly: "The failure to address constitutive relevance is a major lacuna not just in Cummins's model of explanation, but also in the systems tradition generally, in recent discussions of mechanistic explanation (including my own)" (Craver 2007b, p.140). Without solving this problem, even the sophisticated version of the systemic functions in terms of mechanisms seems still deficient. Craver suggests that a manipulative schema can be useful: "My working account of constitutive relevance is as follows: a component is relevant to the behavior of a mechanism as a whole when one can wiggle the behavior of the whole by wiggling the behavior of the component and one can wiggle the behavior of the component by wiggling the behavior as a whole. The two are related as part to whole and they are mutually manipulable." (Craver, 2007b, p. 153). However, it seems not obvious how to generalize this model to all functional explanations including natural selection explanations.

Maybe the lesson that we should learn from this exercise is that all versions of analytical accounts (conceptual analysis and functional analysis) are unable in giving an autonomous account of relevant traits and hence of biological functions. Are there are other suggestions to give sense to functional explanation without falling into the analytic seductions of mechanisms? It is my contention that an affirmative answer should transcend the purely analytical mechanical approach. For example, McLaughlin (2001) points out the contribution of every component to a "welfare" criteria of reproducing systems. Other promising approaches appeal to design as a unifying concept capable to articulate mechanisms and to provide substantive basis to functional explanations (Kitcher, 1993; Millikan, 1984; Neander 1991a). However, these approaches emphasize design in the context of etiological explanation and only vaguely refer to systemic functions. In contrast, some recent attempts pointed out that any idea of design should focuses on global structure (Christensen and Bickhard, 2002) or ontogeny (Krhos, 2009). Finally, it seem that even functional mechanisms plead for something more than mechanisms.

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