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Collaborative explanation, explanatory roles, and scientific explaining in practice

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ABSTRACT

Scientific explanation is a perennial topic in philosophy of science, but the literature has fragmented into specialized discussions in different scientific disciplines. An increasing attention to scientific practice by philosophers is (in part) responsible for this fragmentation and has put pressure on criteria of adequacy for philosophical accounts of explanation, usually demanding some form of pluralism. This commentary examines the arguments offered by Fagan and Woody with respect to explanation and understanding in scientific practice. I begin by scrutinizing Fagan's concept of collaborative explanation, highlighting its distinctive advantages and expressing concern about several of its assumptions. Then I analyze Woody's attempt to reorient discussions of scientific explanation around functional considerations, elaborating on the wider implications of this methodological recommendation. I conclude with reflections on synergies and tensions that emerge when the two papers are juxtaposed and how these draw attention to critical issues that confront ongoing philosophical analyses of scientific explanation.

1. Introduction

Scientific explanation is a perennial topic in philosophy of science (Woodward, 2011), but the literature has developed from a coherent body of key papers and examples into a tangled skein of specialized discussions in different scientific disciplines with tenuous linkages. Instead of debating the relation between prediction and explanation in the deductive-nomological (D-N) model's handling of the flagpole-shadow counterexample, a contemporary reader is confronted with molecular mechanisms of long-term potentiation in neural structures (Craver, 2007) or the thermodynamic complexity of discontinuities found in the formation of liquid drops (Batterman, 2005). Driving this transformation in the literature is a broader trend in philosophy of science: the increasing attention to scientific *practice*. Close scrutiny of the actual reasoning and material investigative practices of scientists "in the wild" has encouraged philosophers to engage in a kind of parasitic disciplinary specialization, following after those distinctive and heterogeneous patterns found in various subdisciplines of the sciences.

Although this is a salutary development in many respects, it has put pressure on the presumed criteria of adequacy for philosophical accounts of explanation, usually demanding some form of pluralism (i.e., there is no single metric for what counts as an explanation). Particular types of explanation from the physical sciences, where much of the 20th century debate about the nature of scientific explanation was forged, are no longer considered appropriate templates for analyzing how explanation operates elsewhere, such as in contemporary molecular biology. The papers by Fagan and Woody represent the leading edge of work on explanation and understanding in scientific practice, though each approaches these issues from a different angle. Fagan's paper starts from the trenches of systems biology to develop a new account—constitutive mechanistic explanation—that illuminates how collaborative interactions among component parts explain a system's working. Woody's paper operates at a meta-level and asks how analyses of explanation in practice might reorient

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philosophical endeavors to characterize and justify scientific explanation. In Section 2, I examine Fagan's concept of collaborative explanation, highlighting its distinctive advantages and expressing some concerns about a few of its assumptions. In Section 3, I analyze Woody's argument to reorient discussions of scientific explanation around functional considerations, such as the activity of explaining or the explanatory roles instantiated in different disciplinary communities, and elaborate on some of the implications of this approach. In closing, I offer some reflections on synergies and tensions that emerge when the two papers are juxtaposed and how these point toward critical issues that confront ongoing philosophical analyses of scientific explanation.

2. Collaborative explanation and biological mechanisms

2.1. From complex constitution to collaborative mechanistic explanation

Although debates about the nature of scientific explanation continue to smolder unresolved, there is widespread agreement that the sciences are routinely engaged in some form of *causal* explanation. Despite a lack of consensus about its structure, as competing accounts indicate (Strevens, 2009; Woodward, 2003), this agreement forms a presumption in the literature on mechanistic explanation—mechanistic explanations are causal explanations (Craver, 2007). The crux of Fagan's argument is to show that this presumption has led philosophers to overlook key aspects of how mechanistic explanations operate.

Starting from three minimal conditions for a mechanism—causality, multilevel structure, and complexity—Fagan (2015) distinguishes two kinds of mechanistic explanation (mEx)—causal and constitutive—where mEx consists in the description of some phenomenon of interest (the *explanandum*) and a description of the "mechanism" underlying this phenomenon in terms of complex organized interactions among component parts (the *explanans*). Causal mEx (mEx_{causal}) gives priority to causality and constitutive mEx ($mEx_{constitutive}$) gives priority to multilevel structure, which is manifested in differing relations between *explanans* and *explanandum*: for mEx_{causal}, it is a relation that interprets multilevel structure causally; for $mEx_{constitutive}$, it is a relation that interprets multilevel structure in terms of constitutive complexity. Although the *explanans* is shared by both mEx approaches ("the organized working parts of the overall system"), there is a difference in how the *explanandum* is conceptualized: for mEx_{causal}, it is the effect of the mechanism (cause → effect); for $mEx_{constitutive}$, it is how the mechanism works (parts → whole). The prevailing view among philosophers is mEx_{causal}, interpreted in terms of a manipulability theory of causation (Woodward, 2003). Fagan uses a case study of cellular differentiation drawn from systems biology to show five critical steps in the development of $mEx_{constitutive}$, only the first of which is addressed by mEx_{causal}: (i) a detailed description of the molecular mechanism, (ii) an abstracted wiring diagram of component interactions, (iii) a mathematical model or system of equations that can account for changes in component interactions over time, (iv) solutions to these systems of equations, and (v) a mapping of solutions for the interactions among components of the system onto the behavior of the overall system within a shared representation (a landscape in a state space). Importantly, different research communities undertake these steps in collaboration, which demonstrates the inherently social character of the explanatory endeavor.

Fagan's account represents a real achievement in the context of questions about scientific explanation (see also Fagan, 2013). In conjunction with other recent work on mathematical modeling and mechanisms (e.g., Bechtel, 2011; Brigandt, 2013), it advances the philosophical analysis of mEx. Crucially, it does so out of the motivation of scientific practice. A major appeal of mEx is its ubiquity in the reasoning of biologists. The account of $mEx_{constitutive}$ is derived from the practices of systems biology where it appears and therefore actual explanatory reasoning—not a philosophical presupposition—is in view. These practices act as constraints on the account constructed and therefore we better understand how science works as a consequence. Part of this illumination derives from yoking explanation and understanding through the idea of *jointness*, which clarifies the explanatory role of component interactions, the systematic relation between levels, and the unification derived from being able to switch between perspectives (i.e., system as a whole versus its organized components). The "working together" of the parts to constitute the whole is accounted for in terms of a global "meshing" of component properties to produce the system behavior. Overall, the account is labeled (appropriately) "collaborative explanation." In particular, the discussion of jointness and meshing is penetrating and shows how unification operates locally in a way that differs substantially from earlier discussions (e.g., Kitcher, 1981).

In addition to this achievement, Fagan's typology clarifies different kinds of mEx and their features (see also Ylikoski, 2013). This is especially true with respect to the difference between constitution (or composition) and causation, which has been noted elsewhere outside the context of mEx (Hüttemann and Love 2011; Love and Hüttemann 2011), and also with respect to the subtle differences in *explananda*: the overall working of a system versus the phenomenon brought about by the system's working. One can no longer discuss mEx *simpliciter* without doing violence to the variation in philosophical accounts and how they do or don't track various scientific practices.

2.2. Critical reflections: methodological and substantive

That prioritizing the causal dimension of mechanisms has led to a neglect of scientific practices related to $mEx_{constitutive}$ is clearly demonstrated by Fagan. Methodologically, this is a complementary treatment of mEx (one of two types), not an argument for the superiority of one type over the other.[1] But since the procedure for building a $mEx_{constitutive}$ includes mEx_{causal} (i.e., a detailed description of the molecular mechanism), the claim of pluralism may not meet the standard of truth in advertising. One could interpret the situation as $mEx_{constitutive}$ being a more encompassing explanation than mEx_{causal}. Fagan stresses that mEx_{causal} advocates are interested predominantly in the discovery of mechanisms and initial formulation of mEx: "the collaborative account begins where [mEx_{causal}] leaves off, explicating in terms of jointness how these models explain once constructed" (Fagan, 2015).[2] But is mEx_{causal} deficient explanatorily? Fagan's analysis suggests that the formulation of mEx_{causal} is only a preliminary step in the multi-step process of producing $mEx_{constitutive}$, which shows how the mechanism works in terms of constitutive relations (parts → whole); when multilevel structure is cashed out in terms of constitutive complexity, the result is *more* explanatory. This no longer sounds like pluralism and complementary explanations but a theory of mEx where the constitutive element delivers the explanatory heft.

We can further explore the purported complementarity by asking whether mEx_{causal} and $mEx_{constitutive}$ might in some cases not

[1] "Collaborative explanation does not displace causal-mechanistic explanation. Instead, the two varieties of explanation are closely related, and complement one another" (Fagan, 2015).

[2] Notably, systems biology projects seem to emphasize discovery in a way that is not clear from Fagan's reconstruction of the reasoning (e.g., Karr et al., 2012).