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Causalism versus Propensionism in the Philosophy of Biology: A Case of Philosophical Underdetermination?

MIHAIL-VALENTIN CERNEA, Alexandru Ioan Cuza University of Iași, Iași, Romania

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This paper has two objectives: (1) to define philosophical underdetermination in contrast with the usual empirical underdetermination that has been invoked by so many philosophers of science, expanding on recent work in ethics regarding moral underdetermination; (2) to prove that the debate between the causalist and propensionist interpretations of causation in the structure of evolutionary theory is better understood when we consider the two positions philosophically underdetermined. This means that we cannot decide between the two interpretations of the notion of cause implied by natural selection by appealing to scientific practice. If philosophical interpretations of science are underdetermined in the way outlined in this paper, then the only way to move the debate forward is through more thorough philosophical work and theoretical refinements.

Keywords: philosophy of biology – causation – causalism – propensionism – underdetermination – moral underdetermination

Introduction

One of the more contentious issues in the philosophy of science is the problem of underdetermination, i.e., that multiple scientific theories can account for the same set of empirical data. This issue has both historical and theoretical importance, as we can find examples in the history of science of actual empirical underdetermination, but we can also build theoretical underdetermination scenarios for any scientific theory. While much has been written on underdetermination in science, this paper will explore whether it makes sense to transfer this problem to philosophical accounts of scientific theories – not only can scientific theories be underdetermined by data, but philosophical

views on scientific theories can be underdetermined themselves. The aims of this paper are twofold – the first is to attempt a definition of philosophical underdetermination in contrast with the usual empirical underdetermination that has been invoked by so many philosophers of science; the second idea is to apply this framework of philosophical under-determination to the debate between causalist and propensionist views on the causal structure of evolutionary theory. Thus, it will be at once placed both in the general philosophy of science and in the philosophy of biology.

The first part of the paper will explore the notion of philosophical underdetermination, extending Dietrich and List (2017) and Baumann's (2022) point about underdetermination in ethics back towards the philosophical exploration of science and philosophy in general. Here, my aim is to put forth a general framework of underdetermination in philosophy that can be applied to different philosophical debates, showing that just like scientific theories, some philosophical accounts can be underdetermined when the subject being theorized cannot be accurately used to decide between alternatives. The second part of the paper will attempt to transfer this framework to the debate between the causalist and propensionist views of causation in natural selection, showing scientific practice seems to be compatible with both accounts. Simply put, the way in which natural selection is used in practice to explain the differential reproductive success is compatible with both causalism and propensionism and it is, thus, not going to be useful in deciding which of these accounts is the correct one. The causal structure of evolutionary theory as it stands in the current debate is strictly a philosophical problem that arises from the different ways in which philosophers of biology have reacted to philosophical challenges to natural selection. This means that this debate will not be advanced through some better understanding of the scientific practice of biologists, but through the arduous work of reconciling the two approaches in the philosophical realm of inquiry.

I. Can Philosophy Be Underdetermined?

Roughly, when two rival scientific theories compete and observation data is compatible with both, philosophers of science ever since Duhem (1914) deem the theories to be underdetermined. The point being that there is no empirical way to determine which of the two theories provides a true description of the phenomenon or phenomena they are trying to explain. This kind of problem has been used across the history of the philosophy of science in different ways at different times, mostly as a knock-down argument for various versions of scientific realism or as a proof for the value-ladenness of science as a cultural

enterprise. There are multiple types of scientific underdetermination theorized in the literature as Park (2009) and Turnbull (2017) underline, each with different bearings on the discussion about both realism and scientific practice. There seem to be two ways in which this issue can arise: a theoretical way in which one can generate empirical alternatives to certain theories (see Kukla 1993, 1996), or a more practical approach, citing examples from real world scientific debates and interesting historical moments. The basic structure seems to be the same: be it temporarily or as a structural feature, different explanatorily incompatible ways to account for various empirical phenomena cannot be decided between in an empirical way – thus, alternative decision-making patterns must be found, either on more pragmatic grounds or based on epistemic values. The remainder of this section will try to answer whether philosophical theories can find themselves in a structurally similar situation.

A. From Moral Underdetermination...

In a recent slate of papers, Dietrich and List (2017) and Marius Baumann (2018a, 2018b, 2022) attempt to grapple with consequentializing[1] and Parfit's arguments in support of moral realism in an innovative way: by showing that the basic structure of underdetermination theory can be extended to ethical discussions.

They assert that the debate about underdetermination in science has a similar structure to what they deem underdetermination in moral theory. In Bauman's own words, "how do the two debates interrelate? I propose that they do so in virtue of them being a structurally analogous phenomenon in ethics, as in science: just as scientific theory can be underdetermined by empirical data, moral theories can be underdetermined by deontic verdicts" (Baumann 2018, 8). The way this is done is to take a basic formulation of the underdetermination of scientific theories and to replace "scientific theories" with "moral theories" and "empirical equivalence" with "deontic equivalence." Thus, if empirically equivalent scientific theories are under-determined, then deontically equivalent moral theories are underdetermined. While a comment on the validity of this argument against moral realism is outside the scope of this paper, it is worth investigating whether this approach can be extended to various other areas of inquiry in philosophical thought. What follows is such an attempt at proposing that issues in the philosophy of science can be underdetermined, i.e., scientific practice is of no help in deciding a philosophical debate about science.

[1] For any nonconsequentialist moral theory, a consequentialist counterpart can be constructed that will arrive at the same set of moral verdicts.

B. ...to Philosophical Underdetermination

1. Underdetermination Ain't So Bad

"For creatures with thin data in a robust world, epistemic or ontological underdetermination may indeed be an unavoidable fact of life," muses Nozick (2001, 113) when analyzing the phenomenon of underdetermination. Nozick's view is that this happens as a feature of humanity's position in the world. If our data were as thick as the world, there would be no underdetermination, but also no theorizing – our observations would describe the world perfectly. If our world were as thin as our data, then again there would be no similar enterprise to what we call science. This is why, between our thin data and our thick world, underdetermination provides some conditions to propel science forward. Based on Nozick's thought, one could argue that the moral underdetermination outlined in the previous subsection is not just a way to counteract moral realism, but a consequence of how thick the realm of moral behavior is and how thin our thinking can be. Rather than just seeing underdetermination as a way to formulate a skeptical argument, Nozick views underdetermination as a consequence of our epistemic condition, one that is part of the process of acquiring knowledge about the world. While underdetermination can truly impede progress both in science and the philosophical understanding of science, it is also a source of conceptual *growth*, so to speak. Rather than being led only by a Quinean tribunal of sense experience, we must also devise new ways to access said tribunal.

It is this functional view of underdetermination that can be extended with little issue to philosophical thought. If Nozick is right, and underdetermination is a feature of the epistemic relationship between human thought and the world, then it becomes plausible that at least certain areas of philosophical inquiry can be understood through the lens of underdetermination. The questions both regarding the source of underdetermination and what the philosophical implications of said underdetermination can only be answered locally. The thesis that can be extended to the whole of philosophy is quite humble – not philosophy is underdetermined in general, but that philosophy can have areas in which points of view can find themselves in such in relationship with direct or even indirect relevant evidence of some sort.

I think there is another way in which one can extend underdetermination to other areas of philosophy, as a model argument against various types of realism as in the previous example from ethics, but this is not in the scope of

the paper. My aim is to show that philosophy of science can be underdetermined in this more Nozickian manner.

2. Can Philosophy of Science Be Underdetermined?

The first question one should answer regarding the possible emergence of underdetermination in the philosophy of science is one about which particular elements underdetermine this area of inquiry. Philosophy of science, generally understood, is a large domain that attempts to explore all facets of scientific understanding, whether it is about the metaphysical claims that can be made in the foundations of science or about the historical and conceptual development of scientific thought. This is why it may be easier to try and answer this question by way of figuring out what may play a similar role to empirical data in scientific research. Can philosophers of science verify some of their claims in relevantly similar ways to scientists? I believe the answer here is yes, but with a caveat. Depending on the nature and scope of the claim, this verification may occur either indirectly, through empirical data refuting some background assumptions at play or the existence of some theoretical object, or it can serve as a way in which to inform philosophical thought. Some theoretical debates in the philosophy of science may be decided by scientific practice – for example, philosophers of science should not ascribe to fitness (as it is understood in the area of natural selection) causal powers or features that contradict the way in which biologists use fitness in their research. There may be two theses of underdetermination which could be formulated in the case of philosophy of science:

1. *Classical underdetermination of theories in the philosophy of science*: For every philosophical theory about an empirical result, there may be an alternative philosophical theory that accounts for the same empirical result.
2. *Underdetermination by scientific practice of theories in the philosophy of science*: For every philosophical theory about scientific theories, there may be an alternative philosophical theory that is just as supported by scientific practice as the other one.

Let us call the first thesis Underdetermination (C) and the second thesis Underdetermination (P).

Underdetermination (C) is a similar case of empirical underdetermination as the problem outlined in the relationship between scientific theory and empirical data. There is one difference relevant to philosophical contexts. While two philosophical theories may be underdetermined (C) in relation to some direct or indirect empirical data, this is not the same epistemic context

where we find ourselves unable to decide between the two theories. There may be alternative approaches, specific to philosophical inquiry, which may move the needle forward in the debate between the two theories. This kind of underdetermination is more likely to occur in philosophical interpretations of scientific results, such as those from quantum mechanics.

Underdetermination (P) is more interesting in the sense scientific practice need not be accounted for through data, as a philosophical analysis about the way a theoretical structure may work in scientific research or theory development may be enough to show that two philosophical theories are underdetermined. It could entail that new philosophical work, either conceptual or formal, is required in order to correctly capture the way scientific practice works in that case or there is a deeply problematic conceptual issue in the philosophical underpinnings of the analyzed scientific theory. This kind of underdetermination is more likely to occur in cases of philosophical accounts of metaphysical elements at the basis of scientific theories, such as the type of causation working in the background as we are about to see in the case of causalism and propensionism.

It must be acknowledged again that underdetermination in the philosophy of science, as in all philosophy probably, is not in any way fatal for debates to move forward. Philosophical modes of inquiry allow for progress in more abstract realms of thought. Clarifying the factors that underdetermine the different views at play may help orient the way forward.

3. Towards a General View of Underdetermination in Philosophy

While it is beyond the scope of this paper to account for all the ways in which philosophy can be underdetermined, it may be useful to put forward a few examples of how this might look like in practice. Theories in the philosophy of language may be underdetermined by linguistic practices or our own philosophical intuitions about how language works (see theories of meaning attribution in fiction – Bowker 2021). I do not mean to say that all philosophy is underdetermined, but that there are cases in which philosophical theorizing is at least indirectly empirical and thus can be indirectly underdetermined. Again, as opposed to scientific underdetermination, there may be no decisive future evidence to hope for, even though empirical evidence can sometimes indirectly make

philosophical theories obsolete[2]. Reasonably, one could hope for future philosophical theorizing that may be able to unify interpretations through appeal to some other related philosophical debate or some empirical data coming from a related scientific field. In the following section, I will attempt to show that this notion of philosophical underdetermination may bring clarity in the debate between causalism and propensionism regarding causation in evolutionary theory.

II. Causalism versus Propensionism

The debate between causalism and propensionism as philosophical interpretations of causation in the structure of evolutionary theory is a good example of philosophical underdetermination. The reason is, as I will show in this section, the appeal to scientific practice or some other biological facts will not help to decide whether causalism or propensionism is the right interpretation of causation in natural selection. Because both approaches seem compatible with results in evolutionary biology, we can say that this is a case of philosophical underdetermination and some other means of overcoming this debate will be needed.

When natural selection is conceived as moving directly from differences in traits to differences in reproductive output, I will call that view causalism (e.g., Hodge 1987, Godfrey-Smith 2007, Otsuka 2016, Jeler 2017) When natural selection is conceived as requiring probabilistic propensities to properly explain how differences in traits cause differences in reproductive output, I will use the term "propensionism" (e.g., Brandon 1978, Mills – Beatty 1979, Brandon 1990, Pence – Ramsey 2013).

Before going forward, some notes are necessary. I will be presenting the debate between causalists and propensionists from two perspectives: their reaction to Popper's misguided tautology objection and their reaction to the statisticalist challenge. It bears mentioning that this is far from an exhaustive take on the debate, and it should be seen as a way to make what is at stake between the two sides clearer to an audience less familiar with this issue. My objective is to show that the causalist and propensionist positions are underdetermined in relation to scientific practice. What follows is not an attempt to dismiss the statisticalist challenge, nor to show that in the debate between statisticalists and

[2] One example is the way in which contemporary physics makes at least some of the work of ancient philosophers in metaphysics false, even if it is still philosophically interesting. Or the way in which work in moral psychology may transform our understanding of the role of rationality in ethical judgements.

their counterparts can also be better understood through the lens of philosophical underdetermination, as the differences in that case seem to go much deeper (a more serious consideration of statisticalism may be one way to move forward the debates discussed in this paper).

A. A Puzzle about Tautology

Famously brought up by Popper (1976), the tautological charge against evolution by natural selection claims that Darwin's theory has no real explanatory power. Simplifying, if species do actually exist, then these species must be fit from a Darwinian standpoint, or they would not have survived. Thus, natural selection explains everything about species development all the time, which is another way of saying that it explains nothing. In Popper's own preferred terms, it is unfalsifiable because it can fit any real-world context.

While it is quite obvious that, in actual scientific practice, Popper's objection does not reach its mark in a theoretical landscape in which natural selection is joined by other means of population and trait distribution change like drift, the reactions to this objection in the philosophy of biology are based on two different and, at least at first glance, opposing tendencies to conceive causality in the theory of natural selection and the way it could be tested.

Overcoming the "tautological argument" requires us to specify the way in which natural selection could be tested and differentiated from other natural means in which population features could be altered. Based on the way in which the so-called tautology is accounted for we can distinguish between the two philosophical approaches to causation in natural selection, causalism and propensionism. It bears mentioned that these two approaches are not primarily about what to do with the problem of the tautological formulation of differential fitness (or adaptedness), but full-fledged accounts of the causal structure implied by evolutionary theory. In the context of this paper, the way they answer this problem is a neat way to summarize these two camps.

The approach one could call causalism is due to Hodge (1987) but has recently become more popular in the philosophy of biology (see Godfrey-Smith 2007 and Otsuka 2017). The reason is that the three conditions of natural selection alone are not sufficient to distinguish natural selection from drift, "the accumulation of any successive indiscriminate or random sampling errors in the same direction" (Hodge 1987, 250). Hodge sees two different errors one could make in dealing with this problem. Either one brings about a purely mathematical understanding of differential reproduction or one can try to solve the problem by appealing to differences in fitness conceived in a finalistic,

teleological manner. Both solutions lead us astray from "what is manifestly desirable: an explicit definitional insistence on causation itself, on, that is, its physical ingredients rather than on mathematical representations or teleological interpretations of its inputs and outputs" (Hodge 1987, 251). This means that the right interpretation of causality in natural selection must show that whatever traits taken to be selected are causally relevant for the differences in reproductive success, not just correlated with them. For this reason, Hodge prefers to name differences in reproductive success caused by natural selection as *nonfortuitous* rather than formalism-laden *non-random*. The point of natural selection is to show which physical properties contribute causally to individual organisms' survival and reproduction in a given environment. As long as we distinguish between natural selection and drift by appealing to an empirical question regarding fortuitous and nonfortuitous differential reproduction the problem underscored by the "tautological argument" simply does not arise. Or, as Otsuka claims, there is a fundamental misunderstanding regarding the explanatory aim of evolutionary theory (Otuska, 2016)[3] – formalisms are means, not ends.

Propensionism (Brandon 1978, Mills – Beatty 1979, Brandon 1990), however, accepts that there is a tautological risk in strictly causal and empirical accounts of differential reproduction. Brandon (1978, 108) clearly states that defining the law of differential reproduction as "*a* is better adapted than *b* in *E* iff a has more offspring than b in E."[4] The trouble with this naïve definition is its obvious circularity that, in Brandon's view, needs to be avoided by way of a statistical definition of fitness. Thus, "*a* is better adapted than *b* in *E* iff a is better able to survive and reproduce in *E* than is *b*" (Brandon 1978, 115), his proposed definition expressed non-formally, avoids tautology by introducing a probabilistic propensity to live and produce offspring between the difference in traits and the difference in reproductive output that stands at the heart of evolutionary theory. When the biologist tries to figure out whether or not natural selection has taken place, they will attempt to figure out the intrinsic traits biological individuals have, their expected ability to leave offspring behind as they go through their lives[5] and the actual number of offspring

[3] Another relevant distinction here is due to Godfrey-Smith and his view that we can try to summarize evolutionary theory, or we can try to give a recipe on how change occurs in evolutionary theory, but we cannot do both because of the role idealizations play in the recipes (Godfrey-Smith 2007, 515 – 516).

[4] *a* and *b* are two individual organisms, while *E* refers to environment

[5] This expected fitness is to be obtained through various scientific tools available in other branches of biology, with ecology becoming extremely important in this approach.

produced. The tautology Popper criticized so much is avoided, as the theory of natural selection will produce fertile explanations of the distribution of traits in a population ascribed to a given environment. The difference between expected fitness and actual reproductive success is seen in this approach as indicative of the occurrence of the process of natural selection or of drift for the population considered. While refinements to Brandon's view have been proposed (see, for example, Pence & Ramsey 2013), Brandon's main point, for propensionists at least, still stands: to avoid the charge of tautology and retain its explanatory power, natural selection must be linked to the propensity to produce offspring that individuals have. A central concern for individuals who seek to emulate Brandon's methodology is to determine an appropriate statistical framework that effectively encompasses the extensive range of phenomena observed in the natural world. By achieving this objective, it becomes possible to render Darwinian theory operational and comprehensively account for the remarkable diversity inherent in nature.

To conclude, propensionists accept that there is a problem of tautology in Darwinian thought and attempt to solve it through various formalisms aimed at capturing this probabilistic notion of fitness. Causalists deny that tautology is an actual problem and state clearly that evolution through natural selection is empirical and causal in nature.

B. Two Very Different Answers to the Statisticalist Challenge

Statisticalists argue that ascribing causal power to statistical notions like fitness or relative frequency in the distribution of traits is a mistake. We should, instead, distinguish between two kinds of natural selection (Walsh et al. 2017; Walsh 2007; Matthen – Ariew 2002; Ariew 1998): Darwinian selection (D-selection, henceforth) which is focused on the change in "lineage structure" when there is variation in what Walsh et al. (2017, 3 – 4) call *vernacular* fitness, more precisely the actual properties of an individual that influence their ability to survive and reproduce, and Modern Synthesis selection (MS-selection, henceforth) which works with traits and trait finesses and conceives evolutionary change as change in trait distribution within a population of conspecific individuals. For statisticalists, MS-Selection is not causally relevant, as it is only a statistical abstraction that is extracted from the actually occurring D-selection. To summarize, statisticalists restrict causality to the actual events that sum up the lives of individuals – what statisticalists deem as MS selection does not offer us causes of evolutionary change, as it has other epistemic uses.

A short terminological note here is necessary. In the scholarly literature regarding statisticalism, causalism and propensionism are sometimes taken to be two different sides of the Causalist coin (see, for example, Deulofeu 2023 and Pence 2021), which is then framed as the general view of causation in natural selection that is challenged by the statisticalist approach mentioned above. Thus, one should not conflate causalism as I use it throughout the paper with the Causalist position in the statisticalist debate. As Deulofeu (2023, 28 – 29) rightly mentions, this larger debate is "rather metaphysical" and is a debate about the level where one could find causal explanations in evolutionary theory. This is why underdetermination may be useful in understanding the differences between causalist and propensionists in the larger Causalist camp, but probably not useful when statisticalism is considered.

A propensionist answer to statisticalism will have to emphasize the pivotal role of probabilistic explanations as the sole means through which natural selection can effectively elucidate causal relationships and provide explanations that are free from tautology. Probabilities must be shown to have some form of causal relevance. One interesting way to do this is due to Abrams (2015) who establishes a concept of causal probability based on Woodward's (2003) manipulability conception of causal explanation. A thorough discussion of Abrams' view is outside of the scope of this paper, but the main point is that a probability is a causal probability if it has causal relevance in the future occurrence of its outcomes when the alteration of the values is done by "altering features of the chance setup that realizes them" (Abrams 2015, 13). This would manipulate the frequency of actualizing events that depend on it, to use Woodward's framework, Causation becoming salient in this case by intervention on causal probabilities. Fitness is a causal probability in this conception, which is why MS-selection, as Walsh et al. call it, can cause changes in population structures.

Causalists like Otsuka and Hodge, on the other hand, have a different strategy available: to reject, in a Quinean fashion, the clear dichotomy between a priori mathematical formulations and a posteriori investigation of empirical causes that is presupposed by statisticalists. Let us remember that statisticalists do not reject the whole of evolutionary theory as being causally inert, only the statistical treatment added during and after the Modern Synthesis. Darwin's original formulation is the one that captures the real causes of biological change, and of the diversity of forms life takes on our planet. Otsuka claims, for example, that

> Contrary to the claim that evolutionary changes are mathematical necessities, deriving predictive equations in population genetics requires not just probability theory but also causal models and assumptions. An empirical application of any of these equations is thus contingent upon the causal features of the target population (Otsuka 2016, 22).

The line between a priori statistical formulations of evolution through natural selection and a posteriori causes of evolution is quite thin in this interpretation and the formal models get their meaning, so to speak, only when related to actual causes residing in populations. In this view, the statisticalist distinction between MS-selection and D-selection does not hold water as it stands, at its best being a philosophically interesting distinction, but with little support in the actual science being done. Otsuka's own answer to statisticalism appeals to causal graphs to make the connection between the mathematical and the empirical sides of natural selection processes more apparent.

III. Conclusion. Is This a Case of Philosophical Underdetermination?

An application of the notion of philosophical underdetermination that I have outlined in the second section of the paper to the problem stated in the third section would look like this: causalism and propensionism are philosophically underdetermined because they are explanatorily incompatible, but they both are compatible with the way biological scientific practice explains the road from differences in traits to difference in reproductive success. The difference between the two positions is more about their reaction to the tautological challenges, to their attitude toward the role mathematics plays in evolutionary biology and the way in which they find the philosophical resources to attempt a rejection of the statisticalist challenge. It is this constellation of philosophical assumptions that explains the difference between the two positions rather than the way actual biologists employ the concept of cause in their work. Given the distinction between the two kinds of underdetermination that can arise in the philosophy of science, underdetermination (C) and underdetermination (P), I think this is a case of underdetermination by scientific practice. It cannot be underdetermination (C) because it would require the two approaches to be connected to some empirical result and they are not. I have not found any kind application of the theory of natural selection to natural phenomena where causalism or propensionism could provide a better explanation as to the type of causation involved. This is because the debate is about the metaphysics behind the theory of natural selection and not about empirical results obtained by biologists. This means that proponents of causalism and propensionism

cannot appeal to scientific practice to move their debate forward. The issue at play does not stem from how biological explanations occur in actual scientific work, but rather about how we conceive their implied causation. This either means that the statisticalist challenge is stronger than it may appear to its critics, for it seems proposes a different metaphysics for how biology accounts for population change, or it means that some new conceptual work is necessary that unifies certain aspects of both causalism and propensionism.

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Mihail-Valentin Cernea
"Alexandru Ioan Cuza" University of Iași
Bulevardul Carol I 11, Iași 700506
Romania
e-mail: mihai.cernea@man.ase.ro
ORCID ID: https://orcid.org/0000-0002-5285-1232

Bucharest University of Economic Studies
Piața Romană 6, București 010374
Romania