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Scientific progress: Knowledge versus understanding

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ABSTRACT

What is scientific progress? On Alexander Bird's epistemic account of scientific progress, an episode in science is progressive precisely when there is more scientific knowledge at the end of the episode than at the beginning. Using Bird's epistemic account as a foil, this paper develops an alternative understanding-based account on which an episode in science is progressive precisely when scientists grasp how to correctly explain or predict more aspects of the world at the end of the episode than at the beginning. This account is shown to be superior to the epistemic account by examining cases in which knowledge and understanding come apart. In these cases, it is argued that scientific progress matches increases in scientific understanding rather than accumulations of knowledge. In addition, considerations having to do with minimalist idealizations, pragmatic virtues, and epistemic value all favor this understanding-based account over its epistemic counterpart.

1. Introduction

Although it is nearly uncontroversial that science makes progress of some sort or other, it is far from uncontroversial what scientific progress consists in. Historically, scientific progress has often been associated with advances in scientific knowledge, e.g. by Francis Bacon (1620/1900), George Sarton (1927), and William Bragg (1936). More recently, Alexander Bird (2007, 2008, 2015) has defended an influential version of this view, *the epistemic account*, according to which an episode in science constitutes progress precisely when there is more scientific knowledge at the end of the episode than at the beginning.[1] Using Bird's epistemic account as a foil, this paper develops an understanding-based account of scientific progress and argues that it is superior to the epistemic account. On this view, an episode in science is progressive precisely when scientists grasp how to correctly explain or predict more aspects of the world at the end of the episode than at the beginning. I will refer to this as the *noetic account* of scientific progress.[2,3]

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[1] Other contemporary proponents of the epistemic account include Barnes (1991) and Cohen (1980).

[2] 'Noetic' as in the Greek 'nous', which is often translated into English as 'understanding'.

[3] Those that come closest to defending something like the noetic account of scientific progress in the contemporary literature are Sorin Bangu (2015) and Angela Potochnik (2015). Bangu argues that Bird's epistemic account should be supplemented with the suggestion that progress can be made by unifying scientific theories, where such unification constitutes increased understanding on his view. Relatedly, Potochnik suggests that one aim of science consists in giving idealized explanations that contribute to understanding of the explained phenomena. Although Potochnik is concerned with the aim of science as opposed to scientific progress, we shall see (in Section 2) that there is a straightforward way in which views about the aim of science translate into views about scientific progress.I lack the space here to discuss Bangu's and Potochnik's views in detail. Suffice it to say that both views differ in key respects from the account defended in this paper: First of all, both of these views employ conceptions of understanding that differ substantially from the one I will use in this paper (see Section 1). Bangu's and Potochnik's views are also considerably less ambitious, in effect claiming only that increasing understanding is one way for science to make progress. Indeed, Bangu and Potochnik do not argue that the kind of understanding they are interested in does not reduce to scientific knowledge, in which case their views would be entirely compatible with the epistemic view. Finally, the motivations for these views are very different from the arguments given in this paper.

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My arguments for preferring the noetic account over the epistemic account are primarily concerned with two classes of cases in which the accounts give conflicting verdicts about whether scientific progress has been made. On the one hand, I locate a class of cases in which there is an increase in scientific understanding even though no new theories or phenomena become known in the process. On the other hand, I also locate a class of cases in which knowledge is accumulated but there is no increase in scientific understanding. In both cases, I argue that scientific progress matches increases in scientific understanding rather than accumulations of knowledge. In addition, considerations having to do with minimalist idealizations, pragmatic virtues, and epistemic value all favor the noetic account over its epistemic counterpart.

The plan of the paper is as follows. Section 1 clarifies the issue at hand and briefly surveys accounts of scientific progress in the contemporary literature. Section 2 spells out the noetic account by specifying what kind of understanding the noetic account is concerned with and shows how understanding, so conceived, differs from knowledge. Sections 3 and 4 argue that the noetic account is superior to the epistemic account by examining two classes of cases in which the epistemic account and the noetic account offer conflicting verdicts about whether scientific progress has been made. Section 5 responds to concerns that achieving increased understanding is either too easy, or too hard, for it to constitute scientific progress. Section 6 briefly considers some further advantages of the noetic account of scientific progress over the epistemic account. Section 7 is the conclusion.

2. Scientific progress

In general, an episode can be said to be *progressive* when the state of affairs at the end of the episode is an improvement on the state of affairs at the beginning. However, accounts of scientific progress are not meant to capture all kinds of progress, not even all kinds of progress that concern changes in the scientific enterprise.[4] Rather, accounts of scientific progress concern the kind of *cognitive* progress that roughly consists in improving the ways in which science represents the world. For example, cognitive progress was made when Einstein's theories of special and general relativity replaced Newtonian mechanics, and also when the latter replaced the mechanical principles developed by Galileo and Descartes. Similarly, cognitive progress was made when Eddington's plum-pudding model of the atom was superseded by Rutherford's planetary-orbit model, which in turn was superseded by Bohr's quantum-mechanical model. Since the sort of progress that I will be discussing in this paper falls quite clearly under cognitive progress, I will not in this paper give a precise definition of 'cognitive progress' or distinguish it from other non-cognitive kinds of progress (in science or elsewhere). Indeed, in what follows I will use the term 'progress' as shorthand for 'cognitive progress'.

It is worth noting that the question of what constitutes scientific progress is closely related to the long-standing debate between scientific realists and anti-realists about the aim of science. Roughly following Bird (2007) and Niiniluoto (2015), this relationship can be described as follows:

(A) X is the aim of science just in case science makes progress when X increases or accumulates.[5]

So, on the epistemic account, science aims to give us knowledge of the world, whereas on the noetic account science aims to enable us to understand the world.[6] We could supplement (A) by adding that science *promotes progress* precisely when it promotes the increase or accumulation of X, where X is the aim of science.[7] Clearly, promoting scientific progress is itself very valuable, almost as valuable as progress itself. Nevertheless, since nearly anything can promote progress, we must be careful not to confuse scientific progress itself with the promotion of such progress. For example, technological advances, increased funding for scientific research, and hunches about how a problem might be solved, all promote progress in typical cases although they presumably do not themselves constitute (cognitive) scientific progress. So promotion of progress is not necessarily itself progress. We will return to this point in Section 5, where I will argue that collecting raw data is sometimes best characterized as promoting (as opposed to constituting) scientific progress.

This paper focuses on two accounts of scientific progress (thus understood), Bird's (2007, 2008, 2015) knowledge-based *epistemic account* and my own understanding-based *noetic account*. I won't be concerned here, except in a derivative way, with other accounts of scientific progress in the current literature. Of alternative accounts, two are most prominent: *the verisimilitudinarian account* and *the problem-solving account*. According to the verisimilitudinarian account, science makes progress when its theories come closer to the truth, i.e. when their 'verisimilitude' increases (Niiniluoto, 1980, 2014; Popper 1963, 1979). The *problem-solving account*, by contrast, holds that science makes progress by increasing its capacity for solving empirical and conceptual problems in a way that is recognizable by the scientific practitioners themselves (Kuhn, 1970; Laudan, 1977, 1984). Both of these accounts raise important and mostly distinct issues that cannot be adequately dealt with in this paper. Thus a systematic comparison of these accounts with the noetic account will have to await another occasion.

[4] On this point, see Niiniluoto (2015: §2.1).

[5] Those who think science has more than one (cognitive) aim may replace 'the' with 'an' in (A).

[6] Thus, in so far as Van Fraassen (1980) is correct to define scientific realism and anti-realism in terms of whether science aims at its theories being true or merely empirically adequate, these accounts amount to two distinct realist views of the aim of science. To see this, consider the epistemic account first: Since knowledge is factive, the epistemic account entails that science aims for truth as well as for other components of knowledge (e.g. epistemic justification). Hence the epistemic account amounts to a strongly realist view on van Fraassen's conception of scientific realism. Whether the noetic view also counts as realist will depend on whether understanding, like knowledge, is factive. In Section 2, I will suggest that understanding is *quasi-factive—roughly* in the sense that the explanatorily/predictively essential elements of a theory must be true in order for the theory to provide grounds for understanding. Thus conceived, the noetic account amounts to a moderately realist view of the aim of science. Specifically, the noetic account entails that the aim of science may be satisfied by theories that distort some aspects of reality, e.g. idealizations such as the ideal gas law, provided that the distortions introduced by such theories facilitate explanations and/or predictions (we will return to this issue in Section 6). So, while the noetic account holds that science does not merely aim for empirically adequate theories, it also recognizes that the aim of science may be satisfied by theories that are not completely accurate descriptions of reality.

[7] Bird (2007: 83-84) also characterizes the connection between scientific progress and the aim of science in terms of promotion, but in a different way than I do here. More on this in Section 5.