THEORETICAL VIRTUES IN SCIENCE

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Theoretical Virtues in Science: Uncovering Reality through Theory
Samuel Schindler
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Is philosophy of science best carried out at a fine-grained level, focusing on the theories and methods of individual sciences? Or is there still room for a general philosophy of science, for the study of philosophical questions about science as such? For Samuel Schindler, the answer to the last question is a resounding 'yes!', and his book *Theoretical Virtues in Science* is an unapologetic attempt to grapple with what he regards as three key questions for philosophy of science-in-general: What are the features—the virtues—that characterize good scientific theories? What role do these virtues play in scientific inquiry? And what do they allow us, as philosophers, to conclude about reality?

With regards to the latter two questions, Schindler defends what might be called the received realist view. Theoretical virtues can and do play an epistemic role in scientific theory choice. That is, scientists often use the theoretical virtues of a theory as a reason to accept it, rather than (say) merely reason to pursue it further, and these virtues often do provide epistemically rational reasons for acceptance. Moreover, the epistemic rationality of these virtues grounds arguments for scientific realism, defined by Schindler as a belief in what our best scientific theories tells us about unobservable entities (p. 20).

It is in its answer to the first question, what the virtues are, that the book diverges from current realist orthodoxy: whereas contemporary realists tend to regard novel predictive success as the key theoretical virtue, Schindler instead bases his realist position on more traditional theoretical virtues such as simplicity, unification, coherence, non-ad-hocness, and fertility. He defends this view partly on theoretical grounds—criticising existing accounts of novel predictive success and developing epistemic accounts of some of his preferred virtues (simplicity and coherence/non-ad-hocness)—and partly on empirical grounds, arguing that scientists at least sometimes accept theories based on these theoretical virtues.

This plurality of theoretical virtues also allows Schindler to propose a novel argument for scientific realism. The most prominent argument for realism today is a version of the 'no-miracles argument' (NMA), roughly, that the novel predictive success of our best scientific theories would be highly unlikely (a 'miracle') unless they were true. Following Magnus and Callender ([2004]), Schindler takes this argument to suffer from a base-rate fallacy: on a Bayesian reconstruction, the argument is only valid if the prior probability (the 'base rate') of the theory being true is sufficiently high. This is presumably not an assumption the anti-realist would grant. Instead, Schindler defends what he calls the 'no-virtue-coincidence argument' (NVC). According to this, when scientists who emphasize or interpret the theoretical virtues differently nonetheless converge on deeming a given theory true, this provides a particularly strong argument for the truth of that theory—so strong, Schindler argues, that it swamps any reasonable prior probability the anti-realist might adopt.

While these ideas form a unifying thread, the book is not structured as a single cumulative argument. Rather, it consists of seven largely self-contained chapters (plus an epilogue) that contain several contributions in addition to the main line of argument, including an analysis of theoretical fertility as the ability of a theory to accommodate anomalies in a non-ad-hoc fashion, a coherentist account of non-ad-hocness, an account of the role of historical case studies in philosophy of science, and a discussion of the demarcation problem.

In this review, I will focus on the book's arguments concerning scientific realism and the role of theoretical virtues in science. Schindler presents four 'virtuous arguments for realism'. Two of these—the 'argument from simplicity' and the 'argument from coherence'—focus on providing rationales for specific virtues and are rather short (approximately three pages each). Here I want to focus on the two arguments Schindler develops in more depth, namely, the 'argument from choice' and the NVC (which he also calls the 'central virtuous argument for realism'). These two arguments can be summarized as aiming to establish the following claims:

1. There are several virtues that characterize good scientific theories, including empirical accuracy, simplicity, unification, coherence/non-ad-hocness, and fertility.
2. Scientists often use these virtues as reasons for accepting theories.
3. For each virtue, a theory's possessing this virtue often provides epistemically good reasons for the truth of the theory.
4. Scientists relying on different virtues sometimes converge in deeming a theory true. In these cases, we have strong reasons to accept scientific realism.

The NVC here corresponds to (4), while the argument from choice mainly aims to establish (1)–(3). Now, as mentioned, Schindler also labels the argument from choice an 'argument for realism'. However, although some anti-realists deny (3)—for example, van Fraassen, who is often the main dialectical opponent in Schindler's arguments—it does not in itself establish realism. As the base-rate fallacy highlights, even if the virtues provide some reason for the truth of a scientific theory, an anti-realist could still insist that this only moderately raises its probability, insufficient to justify accepting it as true. The argument from choice is thus best seen as supporting (3), which in turn forms an important premise in the NVC, rather than as an independent argument for realism.

Realism aside, (1)–(3) still constitute interesting and potentially controversial claims. For instance, it might be that rather than providing reason for acceptance, the virtues merely provide reasons for pursuing theories, that is,

reasons for investigating whether they are true. Does the argument from choice succeed in establishing (1)–(3)?

The argument seeks, first, to establish the descriptive claim, (2), through a series of case studies covering a broad range of sciences, including general relativity, the Watson–Crick model of DNA, Mendeleev's periodic table, the VMM hypothesis on sea-floor magnetization, and the GWS model of weak neutral currents. This descriptive claim is then used to support the normative claims, (1) and (3).

This second step of the argument is underwritten by Schindler's broader methodological stance, which he calls the 'Kuhnian mode of HPS' (defended in Chapter 7), namely, that we should seek to formulate normative accounts of science that allow us to make rational sense of as many of the decisions scientists make as possible. This is motivated by the idea that science is our best example of rational inquiry, while allowing that not all decisions are going to be perfectly rational. Rather than going into a general discussion of this methodology, I want to discuss two problems for it in the context of Schindler's argument from choice.

The first is how to interpret the choices scientists make—for example, how do we know whether the scientists in a case study actually chose to accept the theory and not merely to pursue it further? Schindler confronts this objection head on. In each of the cases, he highlights that scientists faced conflicting evidence, some for and some against a theory. Nonetheless, they chose to adopt the theory because of its non-empirical virtues and dismissed the negative evidence despite having little independent evidence of its unreliability. Thus, he argues, these are cases where the theoretical virtues of a theory outweighed the negative evidence against it; otherwise, if they had chosen to pursue the theory, the scientists could have merely suspended judgement on the reliability of the evidence.

The second, more serious problem is whether Schindler is cherry-picking the scientists who support his argument. In many of his cases, there were sceptics who took the negative evidence seriously and did not accept the theory. For instance, as Schindler notes (p. 167), Rosalind Franklin took some of her experimental evidence to provide clear evidence against DNA having a helical structure. Although Crick and Watson's decision to ignore the evidence in retrospect seems the right one, Schindler's methodology asks us to focus on making rational sense of scientific decisions as they occurred at the time. He does not comment on whether we should conclude that Franklin and her colleagues were being irrational in accepting their evidence against the helical structure. At the very least, Schindler needs to explain why Crick and Watson's judgements should be given more weight in deciding which normative, philosophical account of science to adopt. As Potochnik ([2018]) points out, cases of scientific disagreement illustrate why philosophers of science cannot simply accept the views and decisions of scientists as definite, but have to critically evaluate their arguments.

Despite these reservations, the argument from choice provides a serious *prima facie* case for the epistemic rationality of theoretical virtues. It identifies several cases where scientists plausibly cited the virtues of a theory as reasons to discount negative evidence. A would-be sceptic would need to engage seriously with these cases to rebut Schindler's argument.

If we return to the question of realism, Schindler's case here rests on the NVC. This argument starts from Kuhn's ([1977]) view that there are many different theoretical virtues and that scientists differ in how they interpret and weigh each of these when assessing theories. To this, Schindler adds the observation that scientists who prioritize or interpret the virtues differently may nonetheless converge on deeming the same theory true. In these cases, he argues, we can give an argument for realism analogous to familiar convergence arguments—for example, Hacking's ([1983]) argument that several different measurement instruments based on different physical principles are unlikely to converge on the same result unless the results are correct. Similarly, Schindler argues that scientists who rely on different virtues are highly unlikely to converge on the same theory unless it is true.

Schindler explicates this argument in probabilistic terms. Suppose n scientists deem theory T true, each based on their preferred weighting and interpretation—V_1, V_2, ..., V_n—of its theoretical virtues. Denote this fact V^n. Let p(T) be the prior probability of T being true and $p(V_i|T)$ and $p(V_i|\neg T)$ be the probabilities that scientist i would deem T true based on V_i, given that T is true or false, respectively. What, then, is the probability, $p(T|V^n)$, that T is true given that n scientists converge in deeming T true? Schindler points out that if we furthermore assume that the scientists' judgements are: (i) probabilistically independent and (ii) relatively reliable, in the sense that $p(V_i|T) > p(V_i|\neg T)$, then $p(T|V^n) \rightarrow 1$ as $n \rightarrow \infty$, regardless of the prior probability of T.

This result is the crux of Schindler's argument. He interprets it as showing that when the opinion of sufficiently many scientists converge, this can swamp any reasonable prior probability the anti-realist might adopt.[1] This is how the NVC is supposed to overcome the base-rate problem. As noted, the argument depends on assumptions (i) and (ii). Schindler takes (ii) to be supported by the book's other arguments for the epistemic rationality of the virtues. What about (i)?

Schindler states that (i) is 'consistent with Kuhn's view that scientists' theory-choice preferences are subjective and diverse' (p. 58). This seems too quick. On Schindler's own account, to some extent the scientists are still relying on the same kinds of features of theories, namely, the standard virtues. Assuming that there are some similarities in the kinds of features scientists can reasonably regard as virtues—which seems a fundamental commitment of the book—this is going to limit the range of possible diversity. But it is crucial for the argument that the scientists' methods for evaluating theories are independent, not merely that they apply these methods independently of each other. Having someone double-check your barometer might slightly raise your confidence in its weather prediction, but doing so a hundred times is unlikely to add much. Similarly, even if we have thousands of people predict the weather using slightly different types of barometers, this not going produce near-certain weather predictions if barometric pressure is only a moderately reliable predictor of the weather.

More could be said on this, but the key point is that Schindler fails to sufficiently motivate a key premise in his formal, probabilistic argument. Without it, it does not follow that $p(T|V^n)$ will tend to one as the number of scientists deeming T true increases. Thus, the NVC also faces the same objections that Schindler lodges against the NMA: it cannot establish scientific realism unless it makes more substantial assumptions about either prior probabilities or the reliability of the virtues themselves.

This is not to say that the general ideas contained in the NVC are implausible. It may well be the case that the Kuhnian plurality of virtues means we should have particularly high confidence in theories around which widespread scientific consensus exists. The NVC might still make a valuable addition to the realist's arsenal, and perhaps one that realists should be paying more attention to. But it does not provide a knock-down argument for realism in the way that Schindler claims.

All told, I found Schindler's discussions of the nature and role of theoretical virtues in science more convincing and better developed than his arguments for realism. Yet it still makes valuable contributions to the literature. The book contains a wealth of interesting ideas and arguments, often supported by detailed case studies, which will be relevant to anyone interested in questions concerning theoretical virtues.

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References

Hacking, I. [1983]: *Representing and Intervening*, Cambridge: Cambridge University Press.

Kuhn, T. [1977]: *The Essential Tension*, Chicago: University of Chicago Press.

Magnus, P. and Callender, C. [2004]: 'Realist Ennui and the Base Rate Fallacy', *Philosophy of Science*, **71**, pp. 320–38.

Potochnik, A. [2018]: 'How Philosophy of Science Relates to Scientific Practices', *Auxiliary Hypotheses*.

van Fraassen, B. [1998]: 'The Agnostic Subtly Probabilified', *Analysis*, **58**, pp. 212–20.

Notes

[1] Schindler does not discuss the complications introduced if anti-realism is spelled in terms of probability-intervals rather than sharp probabilities, as for example van Fraassen ([1998]) does.