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## Book review

**Scientific Understanding: Philosophical Perspectives**, Henk W. de Regt, Sabina Leonelli, Kai Eigner (Eds.), University of Pittsburgh Press, Pittsburgh (2009). 352 pp., Hardback, \$65.00, ISBN 978-0-8229-4378-5

When Hume wrote his *Enquiry Concerning Human Understanding*, he took it—like almost everybody else in his time—that understanding is a faculty of human Reason by virtue of which the human mind acquires knowledge of the world. His *Enquiry*—like Locke's own before his—was meant to offer a *theory* “of the nature of human understanding” focused on unveiling the principles by means of which it works—the principles, more specifically, that rule the powers and capacities of understanding. Along the way, he raised his by-now famous sceptical doubts about the operation of understanding (notably related to causal reasoning) and offered his equally famous ‘sceptical solution of these doubts,’ giving a prominent role to custom or habit (as opposed to Reason) in belief and action.

Should we philosophers of science search for a *theory* of scientific understanding? Can (or should) there be an *Enquiry Concerning Scientific Understanding*? On an austere reading of this collection, the answer is negative. Judging from the contents of the book, there *cannot* be such a theory because there is no *proper* object for this theory to be a theory of. Hence we land in a paradoxical situation. We have a book that aims to offer philosophical perspectives on scientific understanding, but there is no single object on which perspectives are offered! On a more lenient reading, there are a plurality of objects—*scientific understandings*—to which the philosophical perspectives refer, but still no clear account of what binds these objects together other than that they are related to the ways in which *scientists* acquire explanatory information and put it to use.

But let us not tread too quickly. The standard story (the received view, if you wish) has been that there is such a thing as *scientific understanding* (and hence the object of a philosophical theory), but not as a distinct entity or faculty: scientific understanding is constitutively tied to explanation; hence, it is covered by theories of scientific explanation. Bluntly put, the question is this: what kind of information should science offer (and how should it offer it) in order for it to provide understanding of the world? And the standard answer is: it should provide explanatory information. There have been well-known debates about the nature and structure of scientific explanation (unification, mechanistic, deductive-nomological, causal stories, etc.), but the often-tacit assumption was that once this matter was settled (or perhaps once there was agreement that scientific explanation could be many things and not one), the philosophical issue of scientific understanding would be settled too. Part of the standard story was the thought that any other sense of understanding would be psychological and perhaps subjective; hence, beyond the ken of a proper philosophical theory, though not unworthy of pursuit. The standard story did not (and need not) deny that understanding could be something of which there can be more or

less. For there can be a distinction between the act of explaining (which is context-dependent) and the explanation itself, meaning: what does the explaining (which is objective, though varied depending on the theory of explanation). Hence, if explanation amounted to causation, the explaining (of the explanandum) would be done by (its) causes and the act of explanation must proceed by citing causes; and yet, the *portion* of the causal story to be told (or what skills and aptitudes are required to acquire/assimilate/communicate the explanatory information) would vary from context to context.

The thrust of the collection under review is—at least according to several of the contributors—that the standard story is wrong; at best, incomplete. A key and pervasive claim is that scientific understanding is distinct from scientific explanation and in ways that go far beyond distinguishing between the act of explaining and what-does-the-explaining. Here are a few things that are said of scientific understanding in the informative *Introduction*, which aims to pave a navigable path in the non-uniform terrain explored by the individual papers.

Understanding is relational in that it always involves a cognising subject.

It is a state (apparently, an internal *mental* state) of the cognising subject.

It belongs to the domain of pragmatics (which we take it to mean that an account of it requires a story as to what you do with understanding; what you can do when you possess it; etc.).

It is context-dependent (which we take to mean that the cognising subject who comes to possess understanding may possess more or less of it, according to what else it is assumed that s/he knows).

It constitutes a cognitive achievement.

It is a matter of ability (having, at least partly but not uniformly, to do with extracting understanding from explanation).

It requires the exercise of epistemic skills and of personal judgement (as to what is relevant and what not).

It may (or may not) be accompanied by a certain feeling (expressed by the exclamation mark in ‘Now I understand it!’). But it should not be equated with this feeling because understanding is a cognitive state whereas the feeling is not.

All these may well be right. Yet, they do not seem to constitute an alternative object for a proper philosophical account. For one, many if not all of the traits noted above are fully compatible with the standard story about scientific understanding. They could be taken to highlight that the possession and communication of information regarding what does the explaining is a process involving a rather complex net of abilities, skills, aptitudes, context-related assumptions, etc. But at the end of the day, it is fully consistent with the above-noted traits that understanding

and explanation go together. For another, the traits noted above could be taken to highlight the need for a psychological theory of scientific understanding. The *ability* to extract understanding (which seems to be a central underlying theme of the collection) is not quite the ability of an orange-crusher to extract juice from an orange. If anything, it is intimately related to the psychological and cognitive mechanisms that should be in place so that the cognising subject learns how to go about acquiring, assessing, learning and using certain information.

The editors insist that the volume “provides a radically different approach” (7) to understanding vis-à-vis the standard story which presents scientific understanding as a by-product of scientific explanations. This needs substantiation, even defence from ‘internal’ disagreements, since at least two of the contributors (Dieks explicitly and Morrison rather implicitly) maintain the standard view that scientific understanding results—in some way or other—from scientific explanations. Besides, the idea (advanced by de Regt, Leonelli and Boon) that a certain understanding should be related to skills if we focus on the practice of developing, extracting, constructing models or interpretative structures that apply to phenomena, does not seem ‘radically different’ either. Even among contributors who state explicitly that understanding is not a by-product of explanation, the assertion that their approach is ‘radically different’ has yet to be substantiated.

With his typical clarity and astuteness, the late Peter Lipton summarised the standard view of (scientific) understanding: “to understand is simply to have the right kind of knowledge” (60–61). The qualification ‘right kind of’ alludes to contextual factors, but the contextual factors qualify *knowledge*; sometimes tacit knowledge. Lipton however also examined the possible divergence between understanding and explanation claiming that there are ways to achieve understanding, which are not tied to offering explanations (e.g., by manipulating the causes of a certain phenomenon, or by performing a thought experiment). This may well be right, but it seems that even when explicit or full explanations are not possessed or are not on offer, the achievement of understanding has to lock into explanatory connections, some of which might become more explicit or more fully articulated as more information is acquired.

Hasok Chang too takes it that “understanding is simply knowledge taken in the active sense” (76), that is, the sense of performing or doing things with it. “Understanding” he also stresses, “is knowing how to perform an epistemic activity” (75), but what we are not quite told is what an ‘epistemic activity’ is. If we take the qualification ‘epistemic’ seriously it should be an activity by means of which knowledge (or reliable information and the like) is acquired. But then Chang’s requirement of intelligibility as “the performability of an epistemic activity” leads us into a circle. We generally do not know in advance whether or not—and to what extent—an epistemic activity is performable. But we have to understand *that* it is performable, if it is. So understanding requires intelligibility and intelligibility requires understanding. Chang brings into play what he calls ‘ontological principles’, which (roughly put) relate to how the objects of the epistemic activity should be like in order for the activity to be possible (performable). So the issue is transferred to intelligibility and, more generally, the status of the ontological principles.

The requirement of ‘intelligibility,’ which is related to skills and usability, plays a key role too in de Regt’s pragmatic account of understanding. Distinguishing between understanding a phenomenon and understanding a theory (which thus understood can be used in understanding a phenomenon), de Regt claims that an adequate conception of understanding a theory has a pragmatic element in it, captured by the ability of those who understand the

theory to use it. He then concludes that theoretical understanding and understanding of phenomena are “necessarily non-objective” (26). His key idea is that scientific understanding proper involves an extrinsic property: intelligibility, which roughly put is a function of the theoretical virtues that the theory offering the proposed explanatory hypothesis has. It is certainly true that the degree of intelligibility of a theory or theoretical hypothesis—thus understood—is not amenable to algorithmic evaluations. But to call it ‘pragmatic’ is perhaps overstated, since in certain conceptions (at least of the role of explanation in inference), intelligibility (*qua* a function of the theoretical virtues) has epistemic force. As such, it is not necessarily at odds with an objectivist approach to explanation, as de Regt (37) asserts.

Overall, though intelligibility is said to be a central feature of understanding, there is considerable divergence as to what exactly it amounts to. For, next to de Regt’s intelligibility-as-an-epistemic-value-attributed-to-theories approach, there is Eigner’s view that intelligibility is a virtue that characterises models, and Koster’s view that it is the insight into intrinsic rather than causal connections between historical actions that makes history intelligible (320–1).

Perhaps the ‘radically different’ conception of understanding proposed in the various essays of the collection is that there are various types of scientific understanding. Thus, we have one type of understanding (associated with intelligibility) that is said to be necessary for the construction of models (Leonelli, de Regt). This same kind of understanding, it is argued, is necessary prior to the construction of both interpretative systems (Boon), and of historical narratives (Koster). Arguably, Boon’s interpretative systems may bear similarities to Koster’s historical narratives in the sense that both provide structure to, and interpretation of, the available data—physical and historical respectively. But in what sense and in which ways are the types of understanding required by Boon and Koster similar to (or of the same kind as) de Regt’s, which presupposes the existence of a theory to begin with? And in what sense is either of the two types of understanding similar to (or of the same kind as) Leonelli’s, which involves embodied knowledge and presupposes interventions? Then again, why are these types of understanding different from, yet relevant to, the type of understanding that flows from the theoretical explanations that Dieks and Morrison are talking about?

This plurality of approaches, as opposed to an approach we might characterize as pluralist, is particularly evident in the essays that examine the relation of understanding to models and theories. Naturally, understanding is related to models and theories (it is *scientific* understanding after all). But throughout the collection, there is considerable divergence as to how theories and models are involved in understanding. Thus, whereas de Regt requires intelligible theories whose use can confer understanding, for Knuuttila and Merz all that is required for understanding is the development and use of models. de Regt’s conception of understanding involves models too, but his emphasis is on the necessity of usable theories, whereas the emphasis in Knuuttila and Merz is on usable models. What is more, the success of models in producing scientific understanding of phenomena is, according to Knuuttila and Merz, due to their workable and tool-like character rather than to their success in representing some target phenomenon more or less accurately (150). Following Knuuttila and Merz, and to a lesser extent de Regt, Lenhard defines understanding implicitly, as an ability the relevant models generate, only his models include simulations also. And like Knuuttila and Merz, he stresses that the kind of understanding simulations provide has very little to do with how well the models represent the target systems—in fact, simulations function partly as black boxes—but mostly with how usable such models prove to be.

As noted above, Morrison believes that understanding accompanies the existence of a theoretical account explaining why the phenomena in question behave the way they do. Although she

thinks it is not possible to offer a canonical account of understanding or even of explanation, on several occasions, she notes, understanding is enabled by abstraction (from a theory) and is produced by the abstract mathematical structure of the models that result. These abstract models function as autonomous mediators between theories and physical systems, and the key to comprehending scientific understanding is in unravelling the relation between this abstract structure and the concrete physical systems that this structure purportedly represents (125). Thus, echoing Knuuttila and Merz, and Lenhard, Morrison too is trying to offer an account of how models that definitely misrepresent the target-systems (like models involving the thermodynamic limit in physics and the Hardy–Weinberg model in biology) explain their behaviour nonetheless and thus confer understanding. On this, she parts ways with Knuuttila and Merz, and Lenhard, and rather than appealing to the usability of such models she asserts that it is the abstractions that actually do the job because they become a fundamental part of how the system is modelled or represented and consequently prove crucial to our understanding of how it behaves (129).

Evidence of a similar plurality of approaches is present in the accounts of Dieks and Boon, where theories feature prominently. As noted already, Dieks is sympathetic to the standard story since he takes understanding to result from explanations. His main aim is to show that the differences between theoretical or top-down explanations and constitutive or bottom-up explanations in the context of one theory (Einstein’s special relativity is his case study) is merely pragmatic. Thus, either of the two kinds of explanation a theory might offer confers understanding. Boon, on the contrary, proposes dropping the idea of explanation and even of theory in favour of what she calls Interpretative Structures (IS). IS allow for the understanding of phenomena, in the sense that scientists understand a phenomenon P if they have structured and interpreted P in terms of an IS, whereas they understand an explanation if they can draw inferences from it and, more generally speaking, if they can use IS in structuring and interpreting other phenomena (such as complex phenomena).

None of the essays in this collection tell us exactly which of these different types of understanding is, or should be taken to be, scientific understanding: all of them or some of them? Assuming that the understanding we are after is understanding of phenomena, if the answer is ‘all of them’, phenomena can be understood either through models that do not actually represent those phenomena but

are nonetheless usable, or through simulations, or through abstractions. Or, (inclusively) phenomena are understood through theories that are intelligible, or through theories that allow for both top-down *and* bottom-up derivations of the phenomena, or through interpretative structures that allow for structuring and interpreting the phenomena. It seems the motto should be: let a thousand flowers bloom! Characteristically, unification is said to both enhance *and* limit understanding; it is achieved by mathematical abstraction as well as by empathy; and although it requires a cognising subject it is “intrinsically social” (15). But then, what is it that unites all these different understandings? What is it that makes them eligible for being called ‘understanding’ in the first place? Similarly, if the answer is ‘some of them’, then the unifier connecting those that qualify is still missing, even if the delineator may be sought in the jungle of pragmatics.

The collection aims to map uncharted territories, but we have the feeling that, in the end, there is no single and useable map; rather the collection offers a variety of patchy and incomplete sketches of an assumed landscape. The subject is hot and a lot of very able philosophers of science concentrate their work on it. The collection provides useful material for a more systematic and careful study—perhaps in the form of a monograph—of scientific understanding. Those interested in scientific understanding will certainly benefit from this collection—though not equally well by all of its papers. In any case, we are still in need of a treatise of scientific understanding of the form Locke (Essay, Introduction 1.1) had in mind when he said: “The understanding, like the eye, whilst it makes us see and perceive all other things, takes no notice of itself; and it requires art and pains to set it at a distance and make it its own object”.

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