

MARY LENG. *Mathematics and Reality*. Oxford University Press, Oxford, 2010, x + 278 pp.

This is an interesting contribution to the debate on the allegedly *empirical* nature of mathematical knowledge. As a naturalist philosopher Leng appeals to scientific practice in attacking the famous *Indispensability Argument*. This argument, mostly due to W.V.O. Quine, contends that many mathematical statements are *empirically confirmed* through science. Leng's attack draws on various aspects of scientific practice, ranging from the role of models and idealizations in science, to the nature of scientific confirmation. This makes the book of interest to general philosophy of science, where 'confirmational holism'—Leng's central point of contention in the indispensability argument—has been long debated. The crossing of the boundary between philosophy of science and philosophy of mathematics is commendable, and Leng's study interestingly also draws inspiration from the philosophy of art, as she defends a *fictionalist* position, according to which one is rationally compelled to believe only whatever science says about the concrete world.

Those familiar with the debate on the indispensability argument will find the first half of the book covering mostly familiar ground. Here Leng sets the scene by a critical discussion of Field's nominalization programme (ch. 2), and of philosophical naturalism both in general terms (ch. 2) and in relation to mathematical and scientific practice (chs. 4 and 5). The more novel second half leads to a new fictionalist position that emerges out of Leng's analysis of some central issues in the general philosophy of science. Leng characterizes her position as an alternative to scientific realism and 'constructive empiricism', a form of anti-realism. Here, in brief, is how she arrives at it.

First, Leng draws on the currently popular 'modelling view of science', according to which scientific theories are best construed in terms of *models* that are often *idealized*: models selectively misrepresent the world that is often too messy and complex to be modelled faithfully. In the modelling view the fit between theorizing and the world is not thought of in terms of theories or models being true or false. Rather, there are more accurate and less accurate *representations* of the world. The prevalence of idealizations in science, and especially their occasional *indispensability*, begs for an explanation of how the idealized posits (e.g. continuous fluids in fluid mechanics) can be indispensable for the predictive and explanatory success of science. They are, after all, seemingly non-existent (e.g. no fluid is actually continuous). Leng's account of the indispensability of idealizations appropriates Kendal Walton's famous account of literary fiction: she likens idealizations to fiction analysed as *a game of make-believe*. This account of idealized models as fiction is then extended to mathematics: the indispensability of mathematics, like that of some idealized concrete posits, derives from its power to represent hypotheses regarding the concrete world. Finally, Leng defends her fictionalism by arguing that it can explain the success of science sufficiently well. This tallies with her overarching ontological guiding principle: the face value ontological commitments of science are to be taken seriously only to the extent required to explain the success of science.

This book-length argument for fictionalism involves much subtle thought and many novel moves. But it is open to criticism on several fronts, with respect to both the detail and the bigger picture. I'll now move on to make some quick observations to this end.

Ontology or epistemology? Leng begins: 'The central problem of this book is the problem of ontology, that is, the question of what there is.' Here, and elsewhere, there is ambiguity as to whether Leng sees herself as doing ontology or epistemology. She's (mostly) doing the latter; Leng's is (by and large) a treatise on the epistemology of science—on what one is *rationally justified* believing in. Besides equivocal use of

language, the real worry is that Leng’s position doesn’t relate to the Carnap–Quine debate—the backdrop of Leng’s project—in the intended way: ‘our ontological project can be seen as an attempt to navigate a third way between [Carnap and Quine]’ (p. 134). The debate between Carnap and Quine was ontological, turning on what it *means* for a theory to be true, and what the truth of a theory entails regarding existence. Leng, by contrast, is concerned with an epistemological issue that hinges on the possibility of explaining the success of science *without assuming* that our best theories are true. (Similar worries of misconstruction arise in connection with the discussion of Yablo on ontological commitment in ch. 6.)

Scientific confirmation. Leng aims to show that the standards of confirmation internal to science speak against the kind of confirmational holism required by the indispensability argument. This line of attack is prominent in the literature, which Leng critically reviews before mounting her own offensive. There is some tension in the big picture that gets painted here (chs. 5 and 6). Leng first discusses an idea due to both Sober and Musgrave, according to which something cannot be empirically confirmable unless it is also (potentially) empirically disconfirmable (should the world fail to cooperate). Intuitively, this is clearly something that might demarcate ‘ $2+2=4$ ’ (say) from bona fide empirical hypotheses: if we can’t conceive of gathering empirical evidence conflicting with ‘ $2+2=4$ ’, why think that it earns confirmation through the role it plays in science? Leng faults this intuition, echoing Colyvan, in a way that just seems to boil down to reasserting Quinean all-out confirmational holism. It isn’t transparent which side indulges in heavier question-begging here. Never mind; this is a strange response to Sober and Musgrave regardless, as Leng herself *opposes* confirmational holism, and advocates a *very local* notion of confirmation.

Following Maddy, Leng asserts that in actual scientific practice ‘mere indispensability’ of a theoretical posit often isn’t enough, and more ‘direct evidence’ is demanded in form of experiments or manipulations of the posits in question. Although there are well-known precedents of this gambit in the scientific realism debate, the emphasis on direct evidence is badly motivated in the present context, due to the causal undertones of manipulation and experiment talk. (Leng’s insists that her notion of direct evidence isn’t defined in causal terms, and that it doesn’t rule out non-causal evidence by fiat, but it is difficult to buy into this in light of her exemplars.) By setting such strict, local criteria for one’s realist commitments the debate gets automatically stacked against the Quinean. It is no wonder that under such conception empirical confirmation doesn’t extend to mathematical abstracta, given that it doesn’t even seem to extend to black holes or quarks! With such a local notion of confirmation Leng in effect opts out of the debate with Quine, rather than engages in it.

Regardless of such criticism, the book is very much worth reading by everyone in the broad audience it addresses.

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