Review: Bas van Fraassen's *Scientific Representation: Paradoxes of Perspective*

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Philosophers of science began publishing articles with the phrase 'scientific representation' in their titles about twelve years ago, but the questions they have pursued under this heading grew out of inquiries into theory structure and the nature of models which have been central for much longer. Given this, it is hardly surprising that Bas van Fraassen should have something to say on the topic: van Fraassen was one of the progenitors of the semantic view of theory structure, and the rise of the semantic view has been one source of the interest in models. But in this book, which develops and synthesises ideas he has been presenting in article form in recent years, and contains much new material, too, van Fraassen has lots to say about lots of things. What follows must needs be highly selective.

The book comes in four parts, and Part I is devoted to laying out a general picture of representation. Here are some doubts about three components of that picture.

First, the formula which lies at its centre: that all representation involves the use of an object by an agent to represent [23]. Don't propositions and thoughts provide counterexamples, despite van Fraassen's comments about mental representation and 'representation in nature' [2, 24]? One might attempt to dismiss such worries as irrelevant to the understanding of *scientific* representation, but that will not work if something like theoretical hypotheses in Giere's sense [1988: 80] are part of the story, as van Fraassen seems to allow [309–10], and are propositions; nor if, as I would maintain, some models are collections of propositions.

Second, the closely related claim that the main kind of object scientists use in representation is the mathematical object (or structure). For that to be true, it seems reasonable to say, there must actually be mathematical objects; yet such a commitment would seem to be in tension with the guiding empiricism of van Fraassen's thought (cf. [Rosen 1994: 164–9]). Of course, one might hope for a successful nominalist account of mathematics which legitimates talk of mathematical objects; but if such an account paraphrases mathematical entities away in the process, then although we might be able to say something true by uttering the sentence 'Scientists typically use mathematical objects to represent', we will not gain genuine philosophical understanding that way.

Third, the thesis that the use of a representation has an inevitably indexical element [see esp. 78–80] (a thesis which, as we will see, plays an important role in later parts of the book). The simplest examples involve maps: if I am to use a map of the museum to find my way around, I have to be able to point at a part of the map and say 'A-hah! So I'm here.' In this respect, van Fraassen insists, scientific theories and models are exactly like maps [80]. To use a theory—to engage with it in any or most of the ways scientists do [82]—I have to be able to point at a part of it, so to speak, and say to myself 'A-hah! Here's the situation I'm in now' or 'This is the sort of system I have in front of me.' Acts of self-location are thus the link connecting the use of representations to indexicality.

But van Fraassen sees acts of self-location as strikingly ubiquitous, and we thus have some reason to be nervous about how we should understand his talk of indexicality. In particular, van Fraassen argues that understanding an inscription requires self-location, because it requires me to relate the inscription to my own language, 'either through taking it to be an expression in [my] own language or through a translation procedure' [84]. Presumably, though, I can understand an inscription without *having the thought that* it is a text in my own language, or another—consider a monolingual child who is learning to read, but who has not yet acquired the concept of a language. If the claim is, nonetheless, that understanding an inscription involves taking a certain self-locating attitude towards it, the 'A-hah! This is something I know to handle' attitude, and that indexicality is present for that reason, it becomes hard to see what sort of activity would *not* introduce indexicality—'A-hah! This [coffee machine] is the sort of object I know to operate', 'Oh dear! This sort of thing is entirely new to me', etc. There is thus room to worry that the notion of indexicality in play here is quite thin.

In Part II, van Fraassen moves on to consider instrumentation, measurement, and experiment in the sciences. He argues in fascinating detail that instruments often seen as providing 'windows on an invisible world' can equally well be seen as 'engines of creation', creating new phenomena for theory to accommodate; in the case of the optical microscope these new phenomena are images, entities belonging to the same ontological category as rainbows and reflections in water. He also argues that measurement *is* representation, that the use of a measurement is accordingly indexical, and that measurement outcomes are, at a certain stage, strongly analogous to perspectival pictures.

Along the way, van Fraassen introduces Reichenbach's 'problem of coordination', the problem of understanding how bits of mathematics can come to be connected to the world in such a way that they manage to denote physical quantities. This sets the stage for Part III, the part of the book likely to attract the most immediate attention. Here van Fraassen sets out a compelling history of structuralism about science, framing it as an attempt on the part of philosophers to assimilate the enormous intensification in the mathematisation of the sciences in the late nineteenth and twentieth centuries. The key to resolving structuralism's central difficulties, van Fraassen claims, is to heed the indexicality of representation [239]. The issues are subtle and complex; I will merely sketch them in simplified form and raise a few questions.

As I mentioned above, on van Fraassen's view much scientific representation centres on the use of mathematical structures as vehicles of representation. It is a crucial additional claim that there is nothing to such a structure that cannot be captured by relations of isomorphism [238]. Thus if we ask 'What makes it the case that mathematical structure *S* represents concrete entity *X*?' [cf. 244–5], it might at first seem that the answer should appeal purely to relations of isomorphism between *S* and some structure constructed from the parts of *X*.[1] Provided that a given concrete entity has enough parts, however, we can always find relations amongst them yielding a structure isomorphic to *S* (as Newman pointed out to Russell). Such an answer would thus lead us to say that *S* stands in the representation relation to many, many more concrete entities than it in fact does. And that is clearly a problem for a structuralist account of scientific representation.

Here is van Fraassen's dissolution of the problem as it arises in 'a concrete practical setting':[2] First, say that mathematical structure *S* represents concrete entity *X* by embedding a data model (or surface model) of *X*—a mathematical structure constructed from the outcomes of measurements and observations on *X*. This inevitably provokes a follow-up question: 'But what makes it the case that the data model, *D*, represents *X*?'. The reply to this new question is that nothing internal to *D* itself makes that the case, and nor does any combination of two-place rela-

1. . . . on some partitioning of *X*; or to a relation of embedding between *S* and some structure constructed from the parts of *X* on some partitioning; or to some other relation between *S* and *X* resting on a close cousin of isomorphism.

2. I am not sure I understand van Fraassen's response at [247–50] to the problem as it arises in relation to phenomena 'not encountered in our practice' [246].

tions holding between *D* and *X*; instead, it is the fact that *D* was 'constructed on the basis of results gathered in a certain way, selected by specific criteria of relevance, on certain occasions, in a practical experimental or observational setting, designed for that purpose' [253]. That is, *D* represents *X* in virtue of the holding of certain three-place relations between *D*, *X*, and the agent(s) involved.

Indexicality, note, has yet to make an appearance; but there is a final step. Van Fraassen imagines someone—a 'metaphysician'—pestering the scientist with a further question: 'I see that *S* matches *D*, and that *D* is your representation of *X*, but does *S* fit *X* itself?' To this the scientist can reply 'But as *D* is my representation of *X*, it would be pragmatically incoherent of me to say "*S* fits *D*, but does not fit *X*." So all I can do in response to your question is repeat that *S* fits *D*; *for me* there is no difference between fitting *D* and fitting *X*' (cf. [254–6]).[3] Now we have indexicality in the picture, as part of a 'self-locating' by the scientist, through her use of *D*, in a logical space of the ways *X* could be [257].

On this retelling, however, something has gone awry: there has been a change of subject by the time indexicality arrives on the scene. Instead of grappling with the question of how a relation of representation comes to obtain between *S* and *X*, we are suddenly (in the last paragraph) asking whether *S* 'fits' *X*; we have moved from representation *simpliciter* to accurate representation. Indexicality shows up only after that shift in topic. It is thus unclear that indexicality plays any role in answering the question with which we began.

I have just given a reconstruction of the crucial discussion of chapter 11 on which the central question is about representation *simpliciter*. And yet I am not sure whether we are to read it that way. It may be that we are supposed to be concerned with accurate representation from the outset, or even accurate representation of the observable—that is, empirical adequacy.[4] If the issue is either of the latter two, my doubts about the role of indexicality in answering the question van Fraassen is asking may fall aside. But then we will have new questions to answer: What is the structuralist account of inaccurate representation, and the account of representation

3. It is important here that the metaphysician's question is not intended as a question about the epistemic credentials of *D* [255].

4. Some sample citations: for representation *simpliciter*, see the indented question on [240], the italicised question on [243], and the paragraph spanning [244–5]; for accurate representation, see the talk of 'adequate representation' on [243] and of a model's being 'adequate' (and a theory's being true) on [245]; and for empirical adequacy, see the italicised question on [245], and perhaps the talk of adequacy just cited if 'adequate' is intended as short for 'empirically adequate' in those places.

simpliciter? If the concern has been purely empirical adequacy, how does the structuralist account of representation of the unobservable go? (After all, even *qua* constructive empiricist van Fraassen agrees that our theories represent the world as containing unobservable things and events, and so there is nothing inappropriately realist in insisting that our account of scientific representation extend that far.) And does the indexicality of representation in use play a role in helping us to answer these further questions?

There is room, then, for further elucidation of van Fraassen's views here. Until we engage in such further elucidation, I think it must remain an open question whether van Fraassen has shown us the way to a successful structuralist account of scientific representation; but I do want to urge further exploration of the intriguing ideas he is presenting.

In Part IV van Fraassen turns to the task of clarifying the sense in which scientific knowledge is objective, in part as counterpoint to his repeated emphasis on indexicality and on the perspectival nature of various aspects of science. His approach is to discuss a series of completeness criteria to which philosophers have historically attempted to hold the sciences. The one which van Fraassen quite plausibly claims still holds sway over the philosophical imagination is that science '*must explain how [the] appearances are produced in reality*' [281]. The terms 'explain' and 'produced' have to be uttered in sonorous tones to capture the intent of the Appearance from Reality criterion, however. It will not be enough, according to this completeness criterion, merely to deduce or predict the appearances (that is, the 'contents of observation or measurement outcomes' [8]) from the account of reality postulated by our scientific representations; what is intended, rather, is 'a connection of the order of explanation through necessity and/or causal mechanisms . . . ' [283]. Van Fraassen's main aim in this last part of the book is to persuade us that contemporary physics violates this constraint, and that it should be rejected; the result will be a clearer vision of contemporary science and of the 'abstract structural forms' it employs in representing the world [267].

This is a full and complex work, and it is sure to provide fertile ground for ongoing research. The treatment is subtle, nuanced, and interesting throughout, and though I have made no attempt to convey it, van Fraassen draws on a remarkable breadth of material from the histories of the physical sciences, mathematics, philosophy, and art. He handles a dense tangle of issues with deftness and originality, and although the resulting book is not an easy one, it makes exciting and indispensable reading for anyone with an interest in the philosophy of science.

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