From Models to Reality: Van Fraassen's Critique of Structural Realism

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Abstract

In this paper I examine van Fraassen's critique of structural realism from the underdetermination of representation. I show that the critique targets a much broader class of positions than structural realism and argue that structural realists should adopt van Fraassen's own response to the problem, which is to give a pragmatic account of representation.

1 Introduction

Van Fraassen has presented a sustained critique of structural realism (2006*b*, 2006*a*, 2007, 2008), driven largely by underdetermination problems for representation. The aims of this article are to bring van Fraassen's critique into focus and assess its force. One question I want to answer is how well structural realism holds up to van Fraassen's objections, and whether it can, or should, be amended in light of them. I will focus on van Fraassen's objection concerning representation since it is the most fully elaborated of his objections, and has not been widely discussed in the literature.[1]. Van Fraassen has articulated his own antirealist, empirical structuralism, presented as a "recast[ing of] constructive empiricism"(2006*a*, p. 536). However, I will show that structural realism can incorporate van Fraassen's solution to the representational problem he discusses, without sacrificing the core thesis of structural realism, and, in particular, without collapsing into the antirealist empirical structuralism that van Fraassen himself defends.

2 Underdetermination of Structures

As I reconstruct it, van Fraassen's objection from representation has two steps. The first is to show that there is no unique way to pick out a domain's structure. Instead, the notion of structure, or equivalently, of structure-preserving mapping, is context-dependent (2006*b*, p. 302; 2007, p. 48). The premise is maintained on the basis that there are many different ways of "dividing up" a domain. For example, in algebra, we can consider a ring as an abelian group by disregarding the structure imposed by its multiplication operation and considering only addition (2006*a*, p. 292). Each way of seeing the obects in question carves them up into distinct structures. In the same way, we may divide a domain into extensionally distinct, but isomorphic ways. For example, take a finite set with a linear order, $<$: the structure of the set under $<$ is isomorphic to its structure arranged in the

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[1]Van Fraassen has raised a separate, "severe critical challenge" (2006*b*, p. 275) to ontic structural realism that I will not discuss here. He has objected that the slogan that *structure is all there is* collapses the distinction between structure and non-structure in a way that is "paradoxical" (*Ibid*) and precludes the possibility of structural realism. For,

> [It] must imply: *what has looked like the structure* of something with unknown qualitative features *is actually all there is to nature*. But with this, the contrast between structure and what is not structure has disappeared. Thus, from the point of view of one who adopts this position, any difference between it and 'ordinary' scientific realism also disappears. It seems then that, once *once adopted*, it should not be called structuralism at all! For if there is no non-structure, there is no structure either. (2006*b*, pp. 291–292)

For responses to this problem, see Ladyman (2007, pp. 39–40) and French (2014, pp. 200–201).

converse of the linear order, >, although by picking out different relations, these structures divide the set in distinct ways. Thus, van Fraassen denies that structure is inherent in objects, but instead depends on the context in which the objects are taken:

> [A] symmetry is a transformation that leaves the object the same in all relevant respects. What are the relevant respects—what are the inessential aspects, the irrelevant parameters that symmetries can vary—is equivalent to the question of which transformations are the symmetries. But relevance is contextual. A parameter may be relevant in the solution of one problem and not in another. [. . .] Symmetry, isomorphism, relevant sameness are all context-dependent notions. (2006*b*, p. 292)

The examples above show that something's structure varies according to which properties we hold salient. But it is not obvious that the structural realist would accept the point that in the examples the very same domain—composed of *the very same objects*—has two different structures. This is because according to the ontological dependence thesis of structural realism, objects owe their identity to the structure in which they exist (Ladyman & Ross 2007, § 3.4; see also French 2010). Structuralists about mathematics, in particular, would deny that the examples concern different structures on the same objects, since they deny that there are facts of the matter to identity relations between objects from different structures—for instance, natural numbers and reals (Resnik 1997, p. 90; Shapiro 1997, pp. 79-81). However, van Fraassen finds that the only way to maintain a single structure/non-structure distinction is with naturalist philosophy of science:

> [Structural realism] requires a context-independent, 'objective' division in nature between mere quality and the relational structure in which the qualities appear at the vertices, so to speak. This can be made good only by falling back on a (here unacknowledged) metaphysics in which such an intrinsic-extrinsic distinction makes sense. I rather doubt that today's structural realists in philosophy of science are very anxious to crawl into that thicket. . . but without that, and without a way of finnessing the point, the burden of unacknowledged metaphysics rests heavily on their position. (Van Fraassen 2006*b*, p. 297)

The premise of underdetermination of structure is a reprise of the key move used by Putnam in his model-theoretic arguments, and in Newman's 1928 objection to Russell. Moreover, as van Fraassen also shows, it features in a family of related puzzles found in Reichenbach, Weyl, Helmholtz and Carnap (2006*a*, n. 4; 2008, p. 239). As these precedents have revealed, the premise is a short step away from a classic underdetermination problem facing accounts of our referential access to the physical world – a "coordination" or "bridging" problem. The converse claim, which van Fraassen calls metaphysical realism (2010, p. 548), is that reality (at least,

to some degree) has a unique, determinate structure as its "metaphysical underpinning" (2010, p. 548). This has been defended by Lewis, in response to Putnam's model-theoretic arguments, and more recently by Sider (2011).

3 From models to reality

The initial premise of van Fraassen's argument against structural realism is perhaps unremarkable: of course we can consider a domain as one thing or another by varying the properties and relations taken to be salient. The argument has a second premise supplied by the semantic account of theories, which structural realism typically relies on to explain how theories represent the world (Ladyman 1998, p. 416). The semantic account of theories says that a scientific theory represents a physical system just so long as its models are structurally similar to it. Structural similarity is generally characterized as the existence of an isomorphism or homomorphic embedding from the model to the system, and so the structural realist representation relation involves an abstract mathematical mapping.

As it stands, the criterion for representation that the semantic view of theories provides is in need of further explanation. For mathematical maps relate mathematical objects, not physical systems; while there is well-defined sense in which an isomorphism relates two models of physical reality, we don't know what it means for an isomorphism to relate to a model of the physical process *itself* (Van Fraassen 2008, p. 240). To make sense, the criterion must be accompanied by the tacit assumption that the physical event in question has been mathematically regimented to make it an appropriate kind of object to serve as the range of a function. The obvious way to do this is using sets. Van Fraassen sketches one approach. Given a physical process, event, or object, A, we can take the set of all its parts, SA_1, and let this be the range of our mapping (*Ibid.* p. 242). In a similar way, for each n-adic relation, R, we can take the subset of A^n composed of the parts of A that are related by R. Let SA_2 denote this family of subsets of A^n, for all n. We thus arrive at a structured set $S(A) := \langle SA_1, SA_2 \rangle$, which is an appropriate object to serve as the range of an isomorphism from a mathematical data model.

Van Fraassen's objection is that this account of regimenting reality is problematic, in that it doesn't so much explain our representation of the world as push the problem back. For when we pick out the relations of A to be the range of our mathematical mapping, we are simply choosing to represent the world as being structured in a certain way.

> The respect in which [our theory] represents A may be one thing or
> another: that depends precisely on how we 'divide up' the entity A and which
> aspects of its relational structure we select—i.e. what we choose for SA_1 and
> SA_2. What indicates here the relationship between A and $S(A)$ is so far no

> more than our description or denotation of SA_1 as 'the set of parts of A', etc. The word 'the' is however not justified here, it is a misnomer, given that A can be *divided up* in various ways.
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> And just what is this *dividing up*? It is nothing more nor less than the act *of representing A as having SA_1 as its set of parts.* (2008, pp. 243–244)

In brief, any isomorphism to the world is an isomorphism to the world as mathematically regimented in some way or other; but to regiment the world like this is simply to *represent* it *as* being a certain way. And thus, the criterion for successful representation given by the semantic view of theories is circular. For, it amounts to the condition that a theory represents part of reality when its data models are isomorphic to that part of reality, mathematically regimented. But this is just to say that a theory represents reality when its data models are isomorphic to some representation of reality. It begins to look like representation only associates models with models, and at no stage latches onto reality.[2]

Van Fraassen puts the problem into a concrete setting to draw out a sceptical hypothesis regarding representation. For the example, van Fraassen supposes that he is to present a theory, T, with its model, to an audience. The theory describes the growth of a certain population of deer in Princeton, and has as a data model a graph of the population size over time. Van Fraassen imagines the following objection, raised by a metaphysician:

> Yes, T fits very well with this graph, your representation, but does T fit the actual deer population growth in Princeton? (2008, p. 255)

The metaphysician's complaint is not provoked by epistemic concerns about the way that the graph of population growth was produced, be they worries about sampling biases or more esoteric worries about deception. It is consistent with the claim that the graph was produced as a representation of the deer population following a measurement procedure that is epistemically justified to an arbitrary degree:

> I understand that in this case your claim to knowledge about the deer population in Princeton is warranted. But there is still the real deer population growth, which is something in the world, distinct from anything in

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[2]In respect of this, the conclusion of van Fraassen's bridging problem is much like that of Putnam's model-theoretic arguments, although van Fraassen makes different use of the conclusion than Putnam does. For van Fraassen, the problem is that "the theory does not confront the observable phenomena—those things, events, and processes out there—but only certain representations of them." (2006*a*, p. 544) However, Putnam's model-theoretic arguments, as I read them, give a *reductio* of a philosophical position committed to the thesis that our theories are true only if they engage with something like things-in-themselves, rather than the things as they are represented for us. In Putnam's words, his *reductio* undermines a position according to which "the truth of a theory does not consist in its fitting the world as the world presents itself to some observer or observers [. . .] but in its corresponding to the world as it is in itself." (1981, p. 71)

your graph, distinct from anything in the content of your warranted knowledge claim [...] – and that, the real population growth, is what we want theory T to match. (2008, pp. 255 – 256)

As this quotation shows, the hypothesis that the metaphysician has in mind is that the data model has been produced to high standards of epistemic justification, and yet the theory fails to represent its intended target, the actual growth of the deer population. The example seems to present a classic sceptical hypothesis that could be expressed as asking: given that there is no unique isomorphism between a model and physical reality, and that a model can be taken to represent many different things, what determines the subject-matter of a representation?

The parallels between the hypothetical worry about the deer population and the sceptical hypothesis raised by Putnam in his model-theoretic arguments are clear. Putnam's model-theoretic arguments attack a philosophical position that divorces truth from epistemic justification by holding it to be possible for a theory to be epistemically ideal, and in particular, empirically adequate, yet, contrary to all appearances, to be false of reality. Van Fraassen has stated (2006a, n. 1) that he first confronted this problem for structural realism in his (1997) discussion of Putnam's arguments, in which he argued that the arguments dissolve given a pragmatic account of representation. He draws on the resolution he gave there to address the problem just raised in the context of the semantic view of theories. I will argue that this resolution, which I take to be entirely correct, is available to the structural realist. Consequently, I find that the critique is not harmful to the structural realist.

4   The Resolution

Before turning to van Fraassen's resolution of the critique, I will show that its proper target is more general than just structural realism. Van Fraassen raised the problem of accounting for how a data model latches onto reality "itself" and not just another representation of it, in accordance with the widely held semantic views of theories. Although he addresses the objection to structural realists in particular (its first presentation appears in a paper entitled "Representation: the Problem for Structuralism") the problem presented is neither a uniquely structuralist problem, nor a uniquely realist one. If the objection is taken as a problem for the semantic view of theories,[3] we can see that it cuts across the realism-antirealism divide to

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[3] As van Fraassen suggests in the introduction (2006a), in which he asks "What does it mean to embed the phenomena in an abstract structure? Or to represent them by so doing? The semantic view of theories runs into a severe problem if these notions are construed either naively, in a metaphysical way, or too closely on the pattern of the earlier syntactic view" (pp.537). See also (Van Fraassen 2008, §5, n. 39).

affect even van Fraassen's own constructive empiricism.[4] However, it is hard to see the problem at the heart of the objection as depending essentially on the semantic view of theories. The sceptical hypothesis van Fraassen raised was that a representation of reality, in the form of a data model, could be the result of a meticulous measurement procedure, and yet fail to represent its intended object. But the same sceptical hypothesis could be raised for any representation of reality. And indeed, the resolution van Fraassen offers to the problem for data models is the same as that which he used in 1997 to resolve Putnam-style scepticism about the referential content of scientific theories (p. 35),[5] despite the fact that in this latter case the background view of reference is the so-called "syntactic view" according to which theories refer to their subject matter in accordance with a correspondence theory of truth, and not the semantic account which succeeded it. Thus, the problem van Fraassen presents seems to be far from unique to structural realism.

It seems most accurate to locate the blame for the problem with the premise that reality comes with a unique, or uniquely privileged, structure. For, if reality *were* to have a unique structure, then there would be just one way to carve it up, and hence we would avoid the regress step in van Fraassen's argument.[6] This would locate the target of van Fraassen's objection with metaphysical realism. Van Fraassen takes it to be the case that, were metaphysical realism true, then the paradoxes about representation can be rejected:

> The realist has one final gambit. [...] S/he insists that there is already an essentially unique *privileged* way of representing: 'carving nature at the joints'. There is an objective distinction 'in nature' between on the one hand arbitrary or gerrymandered and on the other hand *natural* divisions of *A* into a set of parts, and similarly between arbitrary and natural relations between those parts. So *A* is *already* a highly structured entity [...] (Van Fraassen 2008, p. 244)

In this quotation, van Fraassen suggests that positing metaphysical realism can be a response to the representational underdetermination problems discussed. But I am doubtful that metaphysical realism in this sense is the best answer to the representational paradoxes. For one thing, even if the world has a determinate structure, if that structure features a symmetry then we will again have underdetermination of the relationship between model and reality. But, more importantly, I find that van Fraassen's resolution of the representational paradoxes, which I shall briefly

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[4] As van Fraassen notes, "constructive empiricism and structural realism [...] share [the] difficulties"(2006*a*, p. 537).

[5] Referential underdetermination problems can be seen as a special case of the underdetermination of the relationship between elements of a model and the objects they represent (Hodesdon 2014).

[6] That this is what structural realists may have in mind as a response to problems of underdetermination of representation is suggested by Ladyman and Ross's remark that ontic structural realism "undercuts Putnam's paradox" (2007, p. 147, n. 3).

recount now, is a better response than blocking them with built-in metaphysical structure, since it illuminates the reason why the paradoxes were ill-formed in the first place. This is not to question the role of metaphysical realism in structural realism, but to suggest that the structural realist adopt van Fraassen's account of representation alongside her metaphysical realism. In what follows, I will show that this position is a consistent and an attractive one for the structural realist.

Van Fraassen's own structuralist position, which is not a kind of structural realism but an empiricist structuralism, is claimed to avoid the objection we have been discussing. It does so, not by jettisoning the semantic account of theories, but by reformulating it in order to present representation from a first-person perspective as the intentional action of an agent.[7] The need for this reformulation is shown by the fact that the sceptical hypothesis in question is incoherent when expressed from such a perspective, in the sense that it contradicts a pragmatic tautology.

A pragmatic tautology is a sentence whose utterances must be true, although the sentence needn't express a necessary truth. Indexical expressions – those whose truth conditions depend in part on the context of their utterance – often make pragmatic tautologies. Consider the sentences "I am here" or "someone is speaking"; if I speak English, I cannot truthfully utter the negations of these sentences. However, it is metaphysically possible that these sentences are false, since it could have been the case that I was somewhere other than the place where, in fact, I am, and similarly, could have been the case that at this time nobody was speaking. Van Fraassen shows that a related class of pragmatic tautology is given by sentences expressing disquotation instances, for instance, the sentence "'cat' denotes cats" (1997, p. 35). It is metaphysically possible that English could have evolved in such a way that the word 'cat' denoted something else, but if I utter the sentence "'cat' denotes cats", then my utterance must be true. And so, while the hypothesis that 'cat' denotes something other than cats is coherent in the sense that it is expressed by a meaningful sentence, *I* cannot entertain the hypothesis as a possibility. This is the case even if I lack a grasp of the meaning of 'cat'. The sceptical hypothesis that Putnam's model-theoretic arguments invoke is that our theories do not have their intended reference relation, and are instead made true under a different relation— perhaps one that attaches the word 'cat' to cherries. As van Fraassen points out, while well-formed empirical investigations can be posed by inquiring how words latch onto their referents, the sceptical question *how do we know that 'cat' denotes cats?* is not amongst them (1997, p. 36 ff., see also Horsten 2010). In his response to the model-theoretic arguments, van Fraasen writes,

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[7]There are, again, close similarities between this response and Putnam's to the model-theoretic arguments. As noted earlier, Putnam emphasizes that the position that he wants his arguments to refute is one for which a true theory must describe reality as it is in itself, rather than as it is for us, from our perspective. He names this position "externalist", because "its favourite perspective is a God's Eye point of view" (Putnam 1981, p. 49).

> Take the word 'green', which we use in making statements about parts of the world well beyond our ken. Now, what is the worry when we worry that this word might not have the right extension? The only answer I can come up with here is:
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>> the worry that there are lots of green things out there which aren't in the extension of 'green' and/or things that are not green yet are in that extension.
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> But what sense do I make if I say to myself:
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>> There are green things which are not in the extension of 'green'.
>> There are some things x such that x is green but 'is green' is not true of x.
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> If I say this sort of thing I do not make sense. (Van Fraassen 1997, p. 36)

Thus, van Fraassen dissolves the referential underdetermination problem by showing that when its sceptical hypothesis is posed from a first-person perspective it is simply incoherent. And, with some extra detail, the same goes for the underdetermination of representation. In the example of the deer population presented above, the sceptical hypothesis is that the data model fails to represent the actual population of the deer, despite being *produced and used as* a model of that physical phenomenon. Once we express the sceptical hypothesis from the perspective of the person who has created the model, we see that it cannot be maintained. To the creator of the graph, there is no question but that it represents what he uses it to represent. Thus, van Fraassen writes: "What I cannot do is to both present the graph as representing something and say that perhaps it doesn't represent that at all." (2008, p. 257) This is not to say that the creator of the graph cannot doubt the representational success of the graph. But, if he does doubt whether it is a successful representation, he is "bracketing, taking back, putting on hold, [his] presentation of the graph" (*Ibid.*), and no longer speaking as someone who *uses* the graph as a representation of the deer population. This resolution does not entail that representational error is impossible, but instead precludes a certain kind of sceptical attack. [8]

Granting for the sake of argument that, while structural realism is not unique in its vulnerability to such sceptical hypotheses about representational content, it *is* a concern for structural realism to block them, we can ask: is van Fraassen's argument sound? A case can be made for rejecting the argument's first premise, that the physical world has no unique (inherent, context-free) structure. Structural realists may instead recognize that while it is *possible* to carve the world up into

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[8]There is more to van Fraassen's solution that I have not discussed here. In particular, he locates his account of representation in the context of a rich and extended discussion of measurement as representation, and the thesis that representation in all its varieties is indexical.

different structures, there is one best-of-all, most eligible carving. Indeed, we might think that an outright rejection of the non-uniqueness premise simply follows from the scientific *realism* in structural realism. Were van Fraassen's critique of structural realism to include the negation of scientific realism as a premise then it would simply beg the question as a critique.

Van Fraassen has explained elsewhere that his premise that there is no unique structure in the world, or, equivalently, that there are no joints in the world, does not conflict with scientific realism on *his* construal of it (2010, p. 548). It clashes only with the thesis he calls metaphysical realism, which is essentially this premise's negation, i.e., that there is "a metaphysical underpinning, encoded in Plato's phrase in the *Phaedrus*, 'carving nature at its joints'." (*Ibid.*) However, since other characterizations of scientific realism, notably Psillos's, do include metaphysical realism, it is nevertheless possible that van Fraassen's non-uniqueness premise simply amounts to the negation of structural realism. Therefore, whether or not van Fraassen's premise begs the question against structural realism will depend on the precise form of scientific realism that the structural realist endorses. Moreover, it is likely that structural realists *will* endorse the kind of realism that includes metaphysical realism, or something very much like it. This is because they are motivated by a prior conviction in the validity of the 'no miracles' argument, and see structural realism as doing justice to its conclusion by entailing that scientific theories are true descriptions of objective structure.

It should be said that while metaphysical realism is one answer to the no miracles argument, accepting the no miracles argument by no means necessarily commits one to the thesis that nature has determinate joints or a determinate structure. For example, Hilary Putnam is one of the strongest critics of the latter view, at one stage in his career for reasons closely related to van Fraassen's described here. Yet he has always accepted the no miracles argument and scientific realism (Putnam 2012, p. 52 ff.).

Furthermore, even if van Fraassen's argument (or the reconstruction of it that I have given here) begs the question against structural realism by taking as a premise the negation of a joint-carving thesis to which structuralists are committed, the debate should not end here. For, while it is necessary to assume some common ground with the position that one is arguing against, we can always debate that ground separately. Van Fraassen's critique may beg the question against structural realism's particular brand of realism, adopted in order to meet the demands of the no miracles argument, but van Fraassen is, of course, famously unmoved by the no miracles argument, and has argued against it on independent grounds (1980, pp. 39–40).

I have touched on the question whether structural realists must accept van Fraassen's first premise, and claimed that they have good reason to reject it. But,

ultimately, I don't think that van Fraassen's argument is devastating for structural realism even if this premise is admitted. Let us suppose that structural realism is motivated to block the kind of sceptical worry that van Fraassen's argument invokes. Then it is not entirely clear what concrete changes would be required to the core postulates of structural realism. Van Fraassen recommends that we ensure that representation is understood in a pragmatic light, and that representations are taken to be artifacts used by certain agents, for certain purposes. But it seems clear that doing so does not contradict any structural realist postulate. In fact, van Fraassen doesn't present his resolution to the underdetermination as at odds with structural realism, or as compatible only with an empiricist approach, although the pragmatic account of representation coheres particularly well with empiricism in so far as both are rooted in practice. Instead, van Fraassen claims that his resolution makes the metaphysical postulate that there is structure in nature *redundant*. He consequently dismisses metaphysical realism as "moot" and a "superfluous postulate" (2008, p. 244). If metaphysical realism was to be adopted for the sole reason of rejecting underdetermination worries regarding representation, then van Fraassen's point that it is superfluous would be decisive. But, structural realists have another reason to adopt metaphysical realism – namely, because it provides a compelling response to the no miracles argument. However, in so far as structural realists are motivated to reject representational underdetermination, they can, and should, adopt van Fraassen's account of representation. Doing so will neither contradict the content of structural realism, nor will it yield the empirical structuralism of (2008), which involves further theses besides. Therefore, since it gives us the best response to underdetermination worries, structural realism should incorporate van Fraassen's lesson.

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