

A Realist Critique of Structural Empiricism

by

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Author's Declaration

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Abstract

In his latest work, *Scientific Representation: Paradoxes of Perspective*, Bas van Fraassen has argued for a position he describes as empiricist structuralism. This position embraces a structuralist view of science which contrasts with increasingly popular structural realist accounts of science. Unlike structural realists about science, who argue that we can be realist about theoretical structure preserved across successive scientific paradigms, van Fraassen claims that this preserved structure is little more than the structure of our ordinary empirical observations. Those structural aspects of scientific theory which extend beyond this empiricist core can be regarded as purely theoretical postulates about which we are not entitled to be realist.

In this way, van Fraassen maintains a common-sense realism about those observable objects and processes of everyday experience, while concurrently holding anti-realist views about those objects and processes which are unobservable. I argue, however, that on a more considered analysis, many of the most mundane objects and processes which van Fraassen wants to be realist about do not seem to meet his own criteria for observability. Once taken to its logical conclusions, empiricist structuralism leaves us in a far more anti-realist position than van Fraassen imagines and undermines many of the motivations for holding such a position at all. I offer alternative suggestions for a more plausible realist account of scientific practice.

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1 Introduction

As a broadly construed philosophical movement, empiricism is a view which places experience as the ultimate source or only reliable means to knowledge. While such a position has had many incarnations since the first modern empiricists such as Locke, Berkeley and Hume, this century's major expositions have increasingly considered the role of science in forming beliefs about the universe. As a position which appeals to experience or sensory observation as exclusive in granting justification sufficient for knowledge, one possible consequence of an empiricist outlook is an anti-realist position concerning those aspects of science for which we do not actually have direct sensory evidence, but which instead come about as the result of theoretical speculation or inference from observable evidence. While such a view may seem innocuous on the surface, the class of scientific assertions which may fall to this anti-realism is surprisingly large, extending even to some relatively mundane propositions, depending on what exactly we count as experienceable phenomena.

Empiricism's greatest contemporary champion is Bas van Fraassen, who, beginning with his *The Scientific Image*, has argued for a position he calls constructive empiricism. In his own words:

Science aims to give us theories which are empirically adequate; and acceptance of a theory involves as belief only that it is empirically adequate. This is the statement of the anti-realist position I advocate; I shall call it constructive empiricism. (1980, 10)

Since the initial advancement of this view, van Fraassen has continued to elaborate and refine his position with subsequent works, culminating in his latest book *Scientific Representation: Paradoxes of Perspective*¹. In this most recent work, which will be a major focus of this essay, van Fraassen outlines a structuralist account of empirical adequacy that finds traction by providing the basis for a structural empiricist position that contrasts with increasingly popular structural realist accounts of science. In addition to the already significant challenges constructive empiricism presents scientific realism generally, this structural empiricism presents major challenges for the structural realist specifically.

In response to pessimistic meta-induction arguments for anti-realism about science, structural realists argue that while scientific theories do change, and while we are probably correct in the expectation that they will change again, we can nevertheless be realists about scientific theories because there is a preservation of structural features across successive scientific frameworks (Worrall 1989). Since this structure is preserved, it is this structure that we can be realists about. What van Fraassen claims, however, is that this preserved structure is little more than the structure of our ordinary empirical observations – how the universe appears to us. It should not only be expected that scientific theories preserve our appearances, but we would hardly consider science accurate or much use if it did not. Indeed, this fact is the crux of van Fraassen’s stipulation that the aim of science is empirical adequacy or a ‘saving of appearances’. If structure is simply the structure of appearances, then we might well reformulate van Fraassen’s famous expression as the ‘saving of structure’, which is just what the structural realists appealed to in order to make their realist case. The crucial difference, of course, being that this structure reveals nothing

¹ Hereafter I will refer to this work simply as *Scientific Representation*

beyond our observations and experiences; That is, it is an empiricist, and anti-realist structuralism.

While this challenge to structural realism is interesting and clever in the way that it trades on many of the structural realist's own assumptions, it nevertheless remains a powerful attack on scientific realism generally. For the realist about science, van Fraassen's arguments must be successfully defused and doing so requires addressing issues ranging from the fundamental justification used by scientific realists, representation and the role it plays in the formation of scientific theories, as well as the structural character of our theoretical models and how this structure relates to phenomena. In this essay, I endeavor to address these issues from a realist perspective and to critically consider van Fraassen's arguments. I hope to show that while van Fraassen's position reveals much about how we should regard the results of the scientific enterprise, it does not successfully defeat realism. Ultimately, I will argue that an acceptance of van Fraassen's arguments will leave us in a far more radically anti-realist position than he imagines. I hope to make a case for how we might turn aside such extreme conclusions by abandoning a key assumption made by van Fraassen – namely, that there is a fundamental divide between what is and is not observable which occurs roughly between ordinary objects of experience and the more removed objects of scientific speculation. At a minimum, I hope to show that this divide does not occur where van Fraassen believes that it does. It will be difficult to come away entirely critical of van Fraassen, though I believe the lessons we can draw from his arguments are not entirely novel and simply a restatement, however illustrative, of the important role context and perspective play in our understanding of scientific practice.

I have organized this essay in four chapters, including this introduction as chapter one. Before moving on to any serious criticism or rebuttal, chapter two will be devoted to exposition of van Fraassen's views, focusing primarily on the empiricist position outlined in *Scientific Representation*. An important component of this exposition will be a consideration of the common-sense realism van Fraassen hopes to ascribe to ordinary objects. Once this position is properly outlined, I will turn to a critical examination and analysis in chapter three. This criticism will focus on van Fraassen's distinction between appearances (observations) and theory. It is here that I will attempt to demonstrate the manner in which van Fraassen's own criteria for observability are typically not met even by mundane objects that he hopes to maintain a realist stance towards. Once this difficulty is identified I will explore the negative implications of his characterization of the divide between theory and appearances and will offer alternatives. Ultimately, a rejection of this divide will prove to support scientific realism. My argument for this will constitute the major result of this essay. In chapter four, I will make a few concluding remarks, as well as offer suggestions for further study.

2 Structural Empiricism

The picture of science given by Bas van Fraassen is one which has slowly evolved over the decades that he has devoted to advancing his position, and as such, this picture can at times be difficult to understand. Nevertheless, much has remained constant about van Fraassen's views, and much of his modern work serves more to elaborate than to completely replace the work he started with *The Scientific Image*. In that book, van Fraassen outlined his anti-realist views and his constructive empiricism for the first time. Today, as then, van Fraassen maintains an anti-realist view about unobservables and considers the goal of science to be nothing more than empirical success (2008, 3). Expanding and refining this position, his most recent account in *Scientific Representation* attempts to explain more carefully the manner in which we use science in order to represent the empirical world. Regarding his empiricist inclinations, van Fraassen claims:

While this will undoubtedly shape my discussion, I have tried to write as much as possible of this book in a way that does not trade on the differences between this view of science ('constructive empiricism') and its contraries ('scientific realisms'). What scientific representation is and how it works is everyone's concern, and there we may find a large area where more general philosophical differences need make no difference. (2008, 3)

Nevertheless, the representation of empirical phenomena turns out to be philosophically problematic and an issue that van Fraassen believes will help support his empiricism. This exploration of the issue of scientific representation occupies more than half of the book and

while philosophically important in its own right, serves more as a base from which to make major arguments for anti-realism and structural empiricism. In addition to supporting empiricism generally, these arguments provide a more detailed explanation of how an empiricist science operates, and perhaps most interestingly, how an empiricist science can be understood in structuralist terms. In this chapter I will try to outline the key arguments of this view, beginning, as van Fraassen does, with the issue of representation. From there, we will be well-equipped to move on to van Fraassen's account of empiricist structuralism.

2.1 Phenomena and Appearances

It will be helpful before proceeding to quickly consider the terminology used by van Fraassen in his arguments. As we will see, the picture of science given by van Fraassen forms a rough hierarchy. At base, we have phenomena, which are the objects of observation. For constructive empiricists, any talk of ultimate reality, standing somehow behind phenomena is the domain of metaphysics, a subject van Fraassen hopes, in disparaging fashion, to "deliver us" from (1980, 69). Phenomena are the world as it presents itself to us irrespective of perspective or measurement. Our basic observations and sensations are of these phenomena, which constitute the basis for knowledge in the constructive empiricist view. In van Fraassen's earlier work, the realm of phenomena separated itself from the theoretical in the dichotomy between observation and theory. In his, *Science and Representation*, however, van Fraassen further clarifies his position by creating a new distinction at the realm of the observable. We are told:

Phenomena will be observable entities (objects, events, processes,...) of any sort,
Appearances are the contents of measurement outcomes. (2008, 283)

Whereas phenomena are the observable things such as they are and able to be perceived in some sense objectively, appearances are a matter of perspective and subjective relation to the phenomena. As we will see, the particular modes of measuring and interpreting phenomena are a crucial aspect of forming appearances.

Representation of phenomena is carried out when observers correlate two objects together in such a way that the one object - some phenomenon in the world - can be said to be similar, copied, matched, or otherwise in correspondence in some appropriate manner with another object. This second object, the representation, in having the appropriate relation with what is represented will allow us to note salient features about it in such a way that these features will correspond with that which is represented. In this manner, we can look to the representation in order to make predictions about that which is represented. This, according to van Fraassen, and the *Bildtheorie* - 'picture theory of science' - which inspires his view, is how science works. Our scientific theories function very much like pictures which we use as illustrations of the world (2008, 194). Van Fraassen is careful to point out that unlike the *Bildtheorie* of science as presented by thinkers such as Boltzmann, his own account does not consider these pictures to be mental objects (2008, 2). In van Fraassen's account, these pictures or representations of empirical phenomena are no more mental than the actual examples we see in scientific textbooks and models. As van Fraassen tells us:

Scientific Representation is ... by means of artifacts both concrete (graphs, scale models, computer monitor displays and the like) and abstract (mathematical models, needed especially when the infinite [and] infinitesimal play a role). (2008, 2)

On this view, the difficulty for the scientific realist position occurs given that we must consider how our theoretical models are representative of the phenomena they describe. As van Fraassen correctly illustrates, this is a complicated story and cannot be naively accepted as a simple matter of resemblance in many of the ways commonly assumed. The trouble for accurate representation stems from the fact that while the phenomena can be seen as a kind of 'objective' empirical reality, our appearances are a matter of perspective. Moreover, even this perspective is not a simple matter of my position in relation to the phenomena, but my more complicated relation through interpretation, measurement, and selective attention to detail (2008, 173-185).

From these appearances, we construct data models and 'smooth' the connections between data points by constructing surface models as representations of the phenomena. If, for example, data points on a graph constitute a data model, then by 'filling in' the missing data points by drawing a curve through these points, we create a surface model. We can draw graphs, maps, and illustrations of the phenomena given our perspective on the phenomena and our particular modes of measurement as well as our particular selection of relevant details for these representations. Finally, we take these surface models and form theoretical models from them. This final stage comprises the result of the

scientific enterprise, and the explanatory framework which realists claim to use in expressing truths about the underlying reality 'behind' the phenomena.

So, we see a progression like:

Phenomena → Appearances → Data Models → Surface Models → Theoretical Models

But why, on the constructive empiricist view, is the realist mistaken? Why shouldn't this final step of constructing theoretical models, constitute a true representation of reality, or nature itself beyond what we can observe? As we will see, the answer to this is surprisingly compelling but what is more surprising yet is that our data models cannot be 'true' representations of even just empirical phenomena.

2.2 Models and Representation

If our appearances form the basis of our data models, this presents a problem. Van Fraassen tells us:

the phenomenon, what it is like taken by itself, does not determine which structures are data models for it—that depends on our selective attention to the phenomenon, and our decisions in attending to certain aspects, to represent them in certain ways and to a certain extent. (2008, 254)

Moreover, these appearances, out of which surface models are constructed, are not uniquely determined by the phenomena. They are the result of measurement outcomes, selected by measurers. As van Fraassen suggests, there can be no representation without

representers, and as a result, representation is context-dependent and can occur in many, perhaps radically different ways. Furthermore, these different representations may focus on entirely different features selected by our interpretation of the phenomenon.

Is this so troublesome? Are we to consider scientific realists so naïve as to think that whatever phenomenon we describe, there would be a unique way of representing this abstractly? And given that different representations of some phenomenon might represent different aspects of this phenomenon, does this imply that neither is a true representation, but rather, that each tracks different, but nevertheless accurate features of nature? The reason why van Fraassen believes these to be misguided solutions to the problem is based on his own structuralist conception of science and how we characterize what we mean by structure in the first place. These are points which become clear when we consider how our abstract theories are capable of representing concrete phenomena.

To this end, a major question raised by van Fraassen is what he calls the question of representation. This is a problem which occurs at the level of our mathematical models and the manner in which these models can represent phenomena. As van Fraassen phrases this question:

How can an abstract entity, such as a mathematical structure, represent something that is not abstract, something in nature? (2008, 240)

This question is central to van Fraassen's argument against a realist conception of science, and more specifically, structural realism. In addition to being one of the primary means to attack realist metaphysics, finding an answer to this question also helps van Fraassen establish his own structural empiricist position. In order to do so, Van Fraassen

provides historical examples of roughly structural realist positions which have faced this problem and the means used by realists to account for how it is possible for the abstract to represent the concrete. Unsatisfied by typical realist responses, van Fraassen then attempts to show how his empiricist position can preserve a structuralist viewpoint, while circumventing the problems faced by realists. In what follows, I will briefly consider the examples provided by van Fraassen as well as his answer to the question of representation given above.

If we treat the mathematical formalizations of a scientific theory as structural descriptions of what the theory aims to represent, then at least in part, scientific theory consists of purely mathematical models. Understood this way, one problem we face in attempting to provide a satisfactory response to the question of representation becomes clear - A mathematical model is only describable up to isomorphism (2008, 238). This is a problem inspired in Van Fraassen by Weyl, and which plays a crucial role in his argument. Simply put, we cannot describe a model with any greater detail than isomorphism, or one-to-one correspondence with another model (2008, 207). The problem with this is that we can make no distinction between structurally identical models. If we are to say, for example, that a model is a representation of the world, then that model must pick out, in correspondence with its own objects and relations, objects and relations in the world. But which objects and relations are picked out by the theory does not seem to matter insofar as we describe the model as a true representation. Moreover, the objects and relations picked out constitute nothing more than another model, structurally isomorphic with the theory. What we 'pick out' when we attempt to describe the world constitutes our data model or surface model and is entirely a function of perspective and selective attention to detail.

This problem is further exacerbated by well known mathematical and logical results about the nature of models generally. The Lowenheim-Skolem-Tarski-Vaught Theorem tells us that any theory with a model of infinite cardinality also has models of every infinite cardinality (2008, 230). This means that if we consider the world as having infinite cardinality, then every model of infinite cardinality will be true of it, given that we appropriately match relations and objects between the model and the world. In a less formal example, but one which illustrates this point, van Fraassen considers a blank piece of paper with a sufficiently complex degree of barely detectable marks and striations, as all paper, carefully examined has. Now, there will be some function which we can use to relate those marks and the streets and landmarks of Paris. So, given that such a function exists, the paper can be correctly described as a map:

Sufficiently detailed... to rival even the best commercially available maps. (2008, 233)

It is true, van Fraassen admits, that we cannot typically regard the paper in this way, but that is a matter of our own use and perspective. Were our perspective such that the function mapping the marks on the page and the streets of Paris was the function we used in interpreting the 'map', then indeed it would be a useful representation.

This is a point which emerges in the historical examples van Fraassen provides and is finally illustrated through Putnam's Paradox. This paradox, essentially drawing on the points given above, shows that so long as the world has infinitely many objects or 'pieces' and there is a consistent theory T which says that there are infinitely many things, then this theory T is true of the world under some interpretation (2008, 229). Consider, for example,

some theory – call it Y theory - which has infinitely many objects, and which has one two place relation ‘is Y-er than’. Now, as long as we match the objects in the domain with objects in the world appropriately, then there will be some interpretation of Y in which Y theory is true. But of course we want to say more of our scientific theories, than that they are true as a result of some model theoretic fact about how terms and relations may be trivially mapped onto the world. It is here that van Fraassen’s examples provide the most illumination, both for the realist and the anti-realist about science, for in all of van Fraassen’s examples the solution offered is roughly the same.

First, van Fraassen considers Bertrand Russell’s slowly arrived at structuralism, and criticisms of this view by Newman taking essentially the form described above (2008, 213-223). In response, Russell was prompted, on Van Fraassen’s analysis, to concede to relations falling into two different categories – important, and unimportant. Moreover, this distinction must be one such that we are somehow directly acquainted with this importance or unimportance. This ‘repair’ of Russell’s view has a rough similarity with the second of van Fraassen’s examples – that of Rudolph Carnap and the structuralism he outlines in his *Aufbau*. Faced with similar problems surrounding his suggestion that science deals only with structural properties of objects, Carnap tries to overcome the triviality of the truth of models of sufficient size by suggesting that

We wish to call relation extensions which correspond to experienceable, “natural” relations *founded relation extensions*. (van Fraassen 2008, 228 – quoting Carnap)

Finally, we see the solution offered to Putnam's paradox, provided by David Lewis, in which we avoid the trivial truth of models by requiring that when we map a model one-to-one onto the world, we must do so in accordance with *natural* relations (2008, 231).

The parallel is clear, and constitutes what I see as the fundamental realist response. For Russell we have a distinction on relations between importance and unimportance, for Carnap, this distinction is between foundedness, and unfoundedness, and for Lewis it is between natural and unnatural. In all three cases, the world itself is structured in such a way that some relations just are 'natural'. Van Fraassen describes this move as the realist's 'final gambit' – saving a realist metaphysics by presupposing natural relations present in the world which are privileged somehow, and which our scientific theory must conform with. This is nothing more than a postulate, van Fraassen declares, and the realist is characterized as believing that:

Unless we subscribe to this sort of metaphysics and something like a substantial correspondence theory of truth and representation,... we cannot make sense of our own practice. (2008, 244)

But in this regard, van Fraassen declares, the realist is wrong! We can make sense of our practice, and the solution is an understanding of science that is structuralist, but only structuralist between the surface models we construct and the theories which are isomorphic with them. It is not that abstract objects need to represent concrete ones at all, as both our surface models and the theories which represent them are mathematical models. Structural empiricism, says van Fraassen, allows us a way to make sense of our practice so that we needn't make the realist postulate at all (2008, 238-239).

For van Fraassen, an empiricist structuralism is possible insofar as the structure preserved across successive scientific theories is a structuralism with regards to the relation between our theoretical models and our data models. While scientific theories may change, they maintain structural similarities with regards to their relationship with the data model. This is not the same as a structural realist view, as the structure preserved is not the structure of reality or even some supposed phenomena behind our appearances. It is the structure of our appearances, after passing through the filter of our measurement and interpretation. In this sense, structural similarity is defined in a purely mathematical fashion. When we speak of the preservation of structure, we are talking about the relationship between two mathematical models – the data model and the theoretical model. For as van Fraassen points out, if we want to speak of structural similarities in the strictest possible sense, we can only do so between two mathematical models. (2008, 238)

2.3 Structuralism

Returning to the realist inclination that our context-dependent appearances may represent the phenomena accurately, we are left with something very much like what van Fraassen calls the ‘offhand’ realist response:

What is called for is simply a function, a mapping, between mathematical objects and physical objects or processes – so what is so puzzling about that? (2006a, 538)

But for van Fraassen, this cannot be done, as the context dependency of our appearances shows that one side of this mapping, the physical objects, do not have a context

independent, measurement independent, or interpretation independent set of objects that out theoretical model can map onto.

So here is the problem baldly stated. If the target is not a mathematical object then we do not have a well defined range for the function. (2006a, 538)

It is for this reason that van Fraassen thinks our theoretical models do not say true things about reality. They say, as it were, true things about appearances and in the structuralist vein, preserve the structure of these appearances, even across scientific theory change, but, these appearances may not resemble reality at all.

Van Fraassen believes that the realist is trying to compare the structure of reality with the structure of a mathematical object but that structure is something which can only meaningfully apply to mathematical objects. He states:

The metaphysical realist's response depicts nature as itself a relational structure in precisely the same way that a mathematical object is a structure. Hence, if the mathematical model represents reality, it does so in the sense that it is a picture or copy – selective at best, but accurate within its selectivity – of the structure that is there. (2006a, 539)

He then goes on to point out that the same phenomenon may be represented in vastly different ways, given our measurement and perspective of that phenomenon. All that can be structurally compared are the two mathematical objects – the data model, and the theoretical model – but that these are not actually uniquely determined by the phenomenon in question. As he claims:

All might be well for the realist response (which thinks of the coordination as a simple two place relation between the two items) if there were only a single, unique way of representing A in this manner, but of course there is not. (2006a, 541)

Put another way:

...the phenomenon, what it is like, taken by itself, does not determine which structures are data models for it. (2006a, 544)

This, on van Fraassen's view, constitutes the key difference between structural realism and his own structural empiricism as well as the reason the former is not viable, while the latter is acceptable. The realist, after all, is looking to describe real features of the world, while the empiricist is just looking for empirical adequacy – a saving of the phenomenon. By speaking of structure as a relationship between merely the theoretical models and the data models, the basic element of structure just is the empirical results as described in our data models. Indeed, this is an oft-mentioned worry about structural realism, independent of van Fraassen's work (Bueno 1999, Ladyman 2009). If we simply accept that structure is merely structure of empirical observations, we can still benefit from the structuralist position as a means to explain the accumulation of knowledge in science across theoretical frameworks. Structure is preserved, and with this understanding, Van Fraassen claims:

We can plausibly think of the empirical description as the stable evolving surface structure of science on the face of a radically, rapidly altering theoretical content within. (2006b, 304)

When we have a representation, we make a data model, which is really a mathematical structure based upon our selective attention to the phenomena, as realized by our experiences. It is this which is structurally embeddable into theoretical models, and this structure of appearances which is preserved in scientific theory

So, Van Fraassen agrees with the structuralist that 'structure is all we know' but is clear to formulate it in the following sense:

- I. Science represents the empirical phenomena as embeddable in certain abstract structures (theoretical models).
- II. Those structures are describable only up to structural isomorphism. (2006a, 536)

There is an obvious objection here, which van Fraassen anticipates in what he formulates as a challenge to his view. This challenge he calls the 'loss of reality' objection. If the only matching is between data models and theoretical models, our theoretical models do not match the phenomena themselves, but only some non-determined representation of them. "Empirical adequacy is not adequate to the phenomena pure and simple, but to the phenomena as described!" (Van Fraassen, 2006a, 544)

It is here that Van Fraassen resorts to what he calls a 'pragmatic tautology' where he states:

The empiricist reply must be... For us the claim (A) that the theory is adequate to the phenomena and the claim (B) that it is adequate to the phenomena as represented, that is, as represented by us, are indeed the same! (2006a, 545)

This is not to say that 'the theory is adequate to the phenomena' is the same as the claim "the theory is adequate to the phenomena as represented by someone (nor as represented by everyone, or anyone)" (2006a, 545).

In a sense, we see van Fraassen here attempting to establish the relationship between appearances and phenomena as one of identity, rather than simply representation. To establish this point he considers a hypothetical example of a researcher studying the deer population in Princeton (2008, 254-257). The researcher, we are told, accepts some theory which offers a model that is in accordance with a graph of the deer population growth as measured. A metaphysician considers the situation and asks a question - Is the theoretical model simply a match with the data presented (the graph), or is it a match with the actual deer population growth in Princeton? (2008, 255)

While van Fraassen admits of a logical distinction between a theoretical model matching a data model and a theoretical model matching the phenomena itself, he claims that in the context of making a claim like 'theory T fits with the deer population growth of Princeton, as represented' there can be no such practical distinction. To hold otherwise, we are told, would effectively be to make a claim like:

The deer population growth in Princeton is thus or so, but the sentence "The deer population growth in Princeton is thus or so" is not true, for all I know or believe.
(2008, 256)

The representation is, after all, just what we mean when we speak about the deer population growth in Princeton.

Finally, van Fraassen says:

Now we can see why the offhand realist response sounds plausible at first, because it does get something right – namely that in the end there is no problem, precisely because we can (a) correctly describe relevant parts of nature and mathematical objects and (b) say how they are related to each other. But this plausibility hides the mistake of replacing “we can” with a relation independent of the user (the “we”) and ignores the selectivity exercised by the user for the user’s specific purpose. (2006a, 546)

Van Fraassen describes this state of affairs as a pragmatic tautology, given the sense in which it is logically possible for one to deny that a theory fits some phenomenon given that it fits their representation, but it is impossible in practice. For that person, having a theory fit their representation and having that theory fit the phenomenon is the same thing. As we shall see, the loss of reality objection and van Fraassen’s solution as illustrated by the Princeton example is very important in justifying his views against my own criticisms. As such I will return to this issue later.

2.4 Common-sense Realism

One important facet of van Fraassen’s overall project, especially in his earlier work, is his adherence to what he has previously called ‘commonsense realism’. What this means is that in the case of observables which define the structure of appearances, we are entitled

to be realists. In fact, it could well be said that a procession from commonsense realism is precisely what motivates constructive empiricism. Van Fraassen states:

Constructive empiricism is set squarely within a common sense realism that was foreign to much of the empiricist tradition. ... The common basis I assume is language in which reference is unproblematic to trees and mountains, people and books... (2003, 479)

This is closely related to van Fraassen's rejection of phenomena as mere sense-data and his insistence that representations are not mental. Important to the argument that I will make in this essay, Van Fraassen seems to be reliant on some form of direct perception of the world around us. When we look, for example, at a chair, presumably van Fraassen would not suggest that our appearances are of mental patches of color in two dimensions, but that our appearances somehow really are of the chair. As he tells us:

We can, and do see the truth about many things: ourselves, others, trees and animals, clouds and rivers – in the immediacy of experience. (1989, 178)

The assumption of this 'immediacy of experience' sufficient for the direct apprehension of the observable world (phenomena) is one which allows van Fraassen's empiricism to overcome many of the skeptical difficulties of the past. Hume's empiricism, for example, suggests that we do not directly apprehend the world, and hence, we do not actually perceive chairs, tables and the like, but instead merely sense data about these objects. Sense data talk is a hallmark of traditionally indirect thinking about perception. Locke, and Hume, for example, did not believe that we directly apprehend the world, but rather that the world impresses upon our senses. Our appearances then are mental images produced

by the world. The starting point of an empiricist epistemology is experience, but for past empiricists this experience is of mental images. For van Fraassen, ordinary objects serve as the starting point of his philosophy. He states:

Common-sense realism, and a rejection of the demands posed by traditional metaphysics and 'defensive' epistemology, are not themselves part of a special philosophical position, but just a refusal to submit to contrived, unrealistic demands. Common-sense realism is enough, no metaphysics is needed, to reject sceptical problems. (2007, 371)

There is a sense in which van Fraassen includes inference from observables to other observable in this common-sense realism. In *The Scientific Image*, where inference to the best explanation is discussed and in many cases discounted (as when we postulate unobservable entities) it is nevertheless at times treated as an acceptable method of discovering or otherwise drawing conclusions about phenomena. The example provided there illustrates van Fraassen's position:

I hear a scratching in the wall, the patter of little feet at midnight, my cheese disappears and I infer that a mouse has come to live with me. Not merely that these apparent signs of mousely presence will continue, not merely that all the observable phenomena will be as if there is a mouse: but that there really is a mouse. (1980, 19-20)

What seems to be the crucial element of such inferential practice is that the inferred objects – in the above case, a mouse – are themselves observable objects. That is, they are objects for which we can have an immediacy of experience, were we to actually be in perceptual

range of these objects. This is not unlike van Fraassen's criterion of observability in principle as when he has previously stated:

X is observable if there are circumstances which are such that, if *X* is present to us under those circumstances, then we observe it ... This is not meant as a definition, but only as a rough guide to the avoidance of fallacies (1980, 16)

Of course, inferences to the existence of unobservable entities are not allowed, as are many cases of inference to the best explanation in which notions of best explanation include postulates about unobservables. In these cases, van Fraassen tells us we are no longer licensed to believe in such entities, as postulation of their existence would take the function of science beyond empirical adequacy. In ordinary cases, these inferences are allowed in order to make a science truly empirically adequate – without them we would not be able to make empirical predictions about (say) finding mice in walls. But as we will never, even in principle, find many of the putative objects of science, belief in these objects is not required for science to be empirically adequate.

At least in his early work, common sense realism was not simply a consequence of constructive empiricism but a motivating assumption of the entire project. In *Scientific Representation*, van Fraassen seems to deviate somewhat from these earlier views, though never explicitly. We can see clues, however, that a more extreme anti-realism is emerging with structural empiricism, as no longer does van Fraassen always appear to consider phenomena something which we directly experience. Appearances which are the product of selective attention to detail and specific measurement outcomes no longer seem to preserve the spirit of a direct or common-sense realism. No longer is the issue of

observability and theory one of empirical access to the world, as even our observables on van Fraassen's refined position fall into the categories of phenomena and appearances. Certainly, if we do not see past our appearances and appearances merely represent, rather than grant the direct truth of objects by immediacy of experience, then it is difficult to see how a fully-fledged common sense realism can be maintained. Indeed, it is on this point – van Fraassen's slight departure from direct realism about ordinary objects - that I believe we may question the remaining motivations for accepting the position at all.

3 From Appearances to Reality

In comparisons to the empiricist tradition that has preceded him, van Fraassen sets himself apart in many ways. This is unsurprising in the sense that a fully committed empiricism as, for example, described by Hume, leaves one in notoriously skeptical territory. By adopting common-sense realism about phenomena (observables), and eschewing sense-data explanations of our perceptual contact with the world, van Fraassen avoids skeptical concerns altogether. Recall, this avoidance of these concerns is part of what drives the project at its inception. Constructive empiricism was the product of accepting the world as we found it, so to speak, but remaining agnostic about those postulated explanations that we never could find. What made that view so appealing was that despite being anti-realist about much that science told us, it was in so many ways less extreme than the prevailing scientific views about nature which were describing reality in increasingly bizarre ways. Ordinary objects were being reduced to illusion, mostly empty space, geometrically strange, or otherwise in paradoxical contrast with what we thought the world was like. If *Scientific Representation* is truly a departure from this view, that is, if it is an abandonment of even a little of the common-sense realism we could ascribe to constructive realism, then we must have other grounds on which to accept the view.

In conjunction with this point, in this chapter I wish to explore a long running theme of van Fraassen's views and one which I feel undermines his account of structural empiricism. The theme to which I refer is Van Fraassen's longstanding conviction that there is a meaningful (even if not clearly defined) divide between what is observable and

what is unobservable. This divide is first emphasized in van Fraassen's early writings, including most importantly, *The Scientific Image*. In that book, the part that the observable/unobservable divide plays in establishing constructive empiricism is central to those arguments presented. As a constructive empiricist, with a view of science which is rooted in 'saving the phenomena', it becomes essential that one understand what the phenomena *are* such that an empiricist about science can correctly pinpoint empirical features of nature and can differentiate these features from other features which we might regard as non-empirical. It is in precisely this sense that constructive empiricism is an anti-realist philosophy of science – for while it is committed to observable facts about the world (common-sense realism), it is not committed to those claims which appeal to features of the world we cannot observe. These claims may assert the existence of quarks, or forces, or centers of mass, but as these things are unobservable (theoretical) in nature, we have no epistemic warrant for believing in their literal truth. But as we have seen, this argument hinges on there being a reason for maintaining a realist understanding of observable phenomena but not unobservable postulates and this reason is the immediacy of experience van Fraassen describes. If, according to the analysis in *Scientific Representation*, this immediacy is removed, as with the separation between 'all we have' – appearances – and the phenomena they represent, it is questionable why we do not descend into a far more extreme anti-realism.

3.1 Observation

As explained in chapter 2, Van Fraassen's *Scientific Representation* expands on the distinction between observation and theory by further separating the category of what is observable into the new categories of phenomena and appearances. As ever, phenomena comprise the objects of our observations but where formerly Van Fraassen spoke simply about observations of phenomena, we are now presented with something of a divide between the bare phenomena and the observations themselves. Van Fraassen states:

The phrase "to save the phenomena" is often rendered colloquially as "to save the appearances" and "appearances" is often used synonymously with "phenomena". As emphasized from the outset, I use these terms so as to mark a crucial distinction.

Phenomena are observable entities (objects, events, processes,...) of any sort, *appearances* are the contents of measurement outcomes. (2008, 283)

While Van Fraassen does take appearances to be intersubjective, and in some sense objective once some measurement processes and theoretical conceptual framework is agreed upon, he nevertheless considers there to be a "greater objectivity of the phenomenon" (2008, 284). Where formerly the observable was contrasted with the theoretical, a more complicated picture emerges from the new appearance/phenomenon distinction. Now, Van Fraassen tells us, we have three different domains dealt with by science – observable phenomena, appearances, and theoretically postulated reality (2008, 289)

In that former distinction, a common and I believe correct realist reply to the constructive empiricist was to question the distinction between observable and the theoretical claims (Hacking 1985). Given this new threefold distinction, similar criticisms can be made. Instead of denying a break between what is observable and unobservable, however, we must instead question the break between van Fraassen's appearances and the resultant theoretically postulated reality. Indeed, as I hope to show, this is not only possible but actually easier given van Fraassen's revised view and his own examples. Moreover, the question of representation (how can an abstract object represent a concrete one) discussed earlier proves to have some severe consequences for even an extremely ordinary and modest realism about van Fraassen's observables if we insist on such a distinction.

As van Fraassen has already suggested, appearances are not objective in the sense that phenomena are. In van Fraassen's own words:

The appearance is determined jointly by the measurement set-up..., the experimental practice, and the theoretical conceptual framework in which the target and measurement procedure are classified, characterized and understood. (2008, 284)

There is an obvious circle of ideas involved with a claim such as this. Appearances, we are told, are used to construct models – data models, surface models and theoretical models – and it seems reasonable to suppose that whatever our theoretical conceptual framework is, this must be based, at least partially, on surface models that we derive from appearances. Those appearances which inform our theoretical conceptual framework would have been reliant on and similarly shaped by other theoretical conceptual frameworks, and so on.

Each appearance partially determined by a theoretical framework itself shaped by observations – appearances! – leading, I can only suppose, back to some initial state where early observers pointed at the world and grunted, perhaps accidentally.

Presumably, the theoretically conceptual frameworks van Fraassen is speaking of involve only ascriptions of terms to concrete objects and other mundane conceptualizing of this sort. After all, it is not as though constructive empiricism advocates a complete anti-realism about the entities described by science, but rather, only those entities which are theoretical postulates not corresponding to observable phenomena. For example, when speaking about Mt. Everest, Van Fraassen states that:

That mountain is undoubtedly an observable object – only weird philosophical jargon could decide differently – though of course we infer its shape from what its appearances are in telemetry data and photographs from various positions. (2008, 285)

So when we measure the mountain, looking from various directions, given various understandings, what we have are *appearances*, all of which are determined in part by the phenomenon that is the mountain itself. But in fact, it seems that the appearances are all that we have (a point made by van Fraassen himself) when we conclude that there really is a mountain. Of course van Fraassen identifies these appearances in some sense with observation of the mountain itself with his common-sense realism and some form of direct perception, but it is difficult to see how this could be the case once we have separated appearances from phenomena. When we look from various directions and see different things, but tie these together given our understanding of geometric continuity and

perspective we are taking our appearances and postulating a single phenomenon behind these appearances. Instead of concluding that there are many different mountains there, we say there is just one, and our understanding of why there is just one depends on this theoretical conceptual framework of continuity and perspective. In order for van Fraassen's commonsense realism to take hold in saying that there 'just is' one mountain, his theoretical conceptual framework must already be hard at work in allowing him (or us) to decide that there is a single mountain.

The single mountain is itself a theoretical postulate arrived at in a manner not altogether dissimilar from how we arrive at so-called 'unobservable' postulates. For after all, given van Fraassen's criteria, the single mountain *is* unobservable! It is admitted, in fact, that much of what we think we know about the mountain – that there is a single mountain, its size, shape, etc – is inferred from "what its appearances are" in the various observation data (2008, 285). While van Fraassen does allow for inferences similar to this, as in his discussion of mice and evidence of mice (1980, 19-20), it is unclear why these inferences are allowed when the complete, 'gods-eye view' of the whole mountain is something unobservable even in principle.

Given such an amazing claim, that Mt. Everest is unobservable, it follows from van Fraassen's insistent qualification that I must be deciding so on the basis of weird philosophical jargon. In fact, this weird jargon is just the very tired philosophical point that given only appearances and no allowance for making an inference from appearance to reality, then we find ourselves skeptical of a great deal. Hume, of course, is the best

champion of this conclusion, though in his own empiricism he actually accepted such an extreme position. Hume states:

The table, which we see, seems to diminish, as we remove farther from it: but the real table, which exists independent of us, suffers no alteration: It was, therefore, nothing but its image, which was present to the mind. These are the obvious dictates of reason; and no man, who reflects, ever doubted that the existences which we consider, when we say *this house* and *that tree*, are nothing but perceptions in the mind, and fleeting copies or representations of other existences, which remain uniform and independent... The mind has never anything present to it but the perceptions, and cannot possibly reach any experience of their connexion with objects. The supposition of such a connexion is, therefore, without any foundation in reasoning. (Hume 1758, section XII Part I)

Van Fraassen, on the other hand, seeks to maintain common-sense realism about mountains and other ordinary objects, and so allows for inferences to be made from various data to the singular phenomena. But these same inferences seem disallowed if the inferred object is not, in van Fraassen's view, an observable object. But if inferences need to be made in order to establish the existence of the mountain, how is the mountain different from other theoretical postulates of science? Doesn't the very fact that inferences are necessary in order to conclude an object exists mean that it is not strictly observable?

By allowing inferences to be made from observable data to realist conclusions about phenomena which are strictly unobservable, we 'save the phenomena' in a much more important way than van Fraassen describes in *Scientific Representation*, and more in

accordance with his initial sympathies for common-sense realism. Ironically, it may be that the only way to 'save the phenomena' is accept the appearance from reality criterion which structural empiricism advises us to reject.

3.2 Abstract and Concrete

The constructive empiricist may not be convinced. I am, after all, assuming a certain role for theoretical frameworks in the shaping of our appearances and this is obviously part of what is at issue in maintaining the divide between appearances and theory. Consider then another example similar to the one just described. Suppose we accept van Fraassen's views – Let us strongly maintain the appearance/theory divide and let us allow that theoretical conceptual frameworks are such that mountains and geometric continuity are not abstract or model theoretic ideas. Whatever we need to concede, we can accept that Mt Everest is indeed observable. But what happens when we look sideways, see another mountain, and are asked the question 'How many mountains are there'?

Now, accepting mountains as concrete objects is one thing, but accepting numbers is quite another. Presumably Van Fraassen is just as committed to the observability of *two* mountains as he is the observability of one mountain, but this presents a real problem for him. Any conceptual framework sufficient to give us numbers and numerical description (or more problematic still, arithmetic) cannot be described as somehow concrete. It is unnecessary to even argue this point, as Van Fraassen does such a good job himself when he disputes the connection between the abstract and the concrete through the question of

representation already discussed. As van Fraassen has already stated in his 'baldly stated problem':

The target is not a mathematical object... so how can we speak of an embedding or isomorphism or homomorphism or whatever between that target and some mathematical object? (2008, 241)

Whenever we engage in numerical description of the world, we have, in some sense, moved to the realm of abstract conceptualization. We are, at this stage, speaking about appearances, and more importantly, appearances as distinct from phenomena. Concrete objects are not abstract or mathematical while their appearances or at least our data models based on these appearances are mathematical and describe the substructure required to be homomorphically embeddable in our theoretical models such that the phenomena is saved. So how is this accomplished? And how can we say of a data model that it represents when we cannot say of a theoretical model that it represents? Indeed, this is a problem which Van Fraassen is keenly aware of when he poses the following question as a danger to empiricist structuralism:

How, or in what sense can such an abstract entity as a model "save" or fail to "save" this concrete phenomenon? (2008, 245)

Despite raising this question himself, a satisfactory explanation is less than forthcoming. As ever, answering this question relies on a distinction between those things we can observe in practice as opposed to those we cannot and the closeness of phenomena to our experience.

Two cases are initially presented to illustrate how we go about solving this. In the first, Van Fraassen considers a scientist offering a model for frog populations in the Netherlands sometime in our recent past. In the second, a scientist offers similar population models but for dinosaur populations in a larger area in a far more distant past. He states:

...the cases are different, for the first scientist can draw on actual measurement results of the relevant population density, and the second cannot. So for the first we face the question of what the adequacy of the model ... amounts to in a concrete practical setting. For the second scientist we have to understand how a phenomenon somewhere and somewhen, which is not encountered in human experience, or targeted in actual measurements or observations, can be said to “fit” a theoretical model. (2008, 246)

I imagine paleontologists would object to the suggestion that their models are based on phenomena not encountered in human experience or targeted by actual measurements or observations. While I have not seen a dinosaur, I have seen concrete evidence of dinosaurs and I suppose that large frequencies of dinosaur fossils found in various locations with correlated dating procedures might go a long way to the justification of such ancient population models. More importantly, however, it seems that Van Fraassen’s notion of observability ‘in principle’ is satisfied by dinosaurs, despite the fact that they no longer exist. It is suggested that the orbits of planets are observable and this is, in part, due to the fact that were we to move close enough to said planets, observation would be immediate (1980, 16). In fact, given this ‘in principle’ criteria for observability, even something like

the Loch Ness monster can be considered observable – it is just that no one has yet observed it, and we have no evidence for believing it exists. It is unclear why spatial distance does not affect observability ‘in principle’, while temporal distance (in the dinosaur case) seems to do so. Perhaps what matters is simply that some measure of ‘closeness’ can be recognized such that while some models can be considered to represent, others cannot.

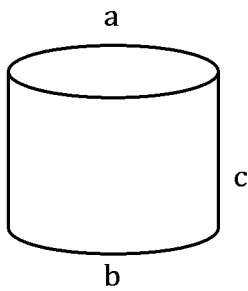
This is unsatisfactory, for the difference between those observations which are far removed from ordinary observations experiences and those which are close seem not to be a difference in kind, but a difference of degrees. This is an already much discussed point owing to examples given by Ian Hacking (1985) regarding observations through microscopes. Still, van Fraassen may not require precise demarcation so much as the acceptance that while at some stage things are clearly observable, at others they are clearly not. Of course even this is extremely contentious given that there always seems to be the possibility that highly abstract and ‘unobservable’ entities, events, or processes may actually be observable under some set of circumstances we have not yet conceived.

More to the point, it seems that any observation does involve a kind of inference from the appearance to the phenomena given all those factors which go into shaping the appearance. When, for example, we say that we observe something mundane like a mountain, we are making an inference from certain shapes and perspectives that come to us in ordinary sensation. When we conclude that electrons exist, a surprisingly similar inference takes place. The electron (which van Fraassen will almost certainly categorize as unobservable) is not just a mathematical consequence of some theory, independent of

observations. We do see vapour trails in a cloud chamber and we simply call whatever made those trails 'electrons' in a manner similar to the way a mountain disturbs its own environment. Of course the mountain is much bigger and presents us with a familiar and completely recognizable image such that we think it mundane. What is important, however, is that we recognize that all observations are mediated by the environment and eventually our own cognitive processes. And all observations require an inference to the objects of those observations. So while we might admit of difference of closeness or distance between models and experience, there is no point at which an observation is ever a pure observation, completely removed from some theoretical postulation.

3.3 Modeling Appearances

Consider the process of modeling, or treating our appearances as abstract objects (data models and surface models) sufficient for an isomorphism or embedding to be possible with a theoretical model. Suppose we encounter a fairly ordinary closed cylindrical object like a can of soup or a coin. Following van Fraassen, we should think that our appearances of this object are perspectival and not uniquely determined by the phenomena. All that we can do is take these appearances and from them, form data models and surface models. Let us consider our appearances of the cylinder and imagine what such a model might look like.



(Figure 1 - Closed Cylinder)

Whenever we observe the cylinder, one of the two end faces faces (a or b) remains hidden, and yet we typically count both as observable. Why? Are they observable in principle? Certainly each by itself is not only observable in principle, but is fairly easy to observe just by rotating the cylinder around and looking at each in turn. But the two faces are not observable even in principle when we consider any observation that would tell us about each of them and their relation to each other at the same time and from the same perspective. That this is true is a fairly trivial fact about cylinders generally. For when we have sight of one closing face (a, for example), we cannot have sight of the other (b).

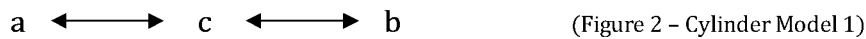
So, suppose we model this object by compiling data and constructing one of a number of representations that might be sufficient for our purposes. As an example, let us suppose we are interested in the three surface faces (a, b, c) and a relation between them, say, connectedness. Let us call connectedness between faces the relation E and let us stipulate that this relation is transitive, ie - if a is connected to b and b is connected to c, then a is connected to c. Further, suppose we start making observations in order to construct a data model about this cylinder. We can say, of one observation:

E(ac) (face a is connected to face c)

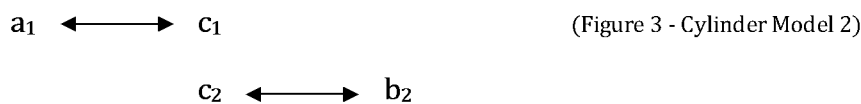
And, rotating the cylinder, we can say of another observation that:

$E(cb)$ (face c is connected to face b)

And, suppose we represent this in a simple first-order model as follows:

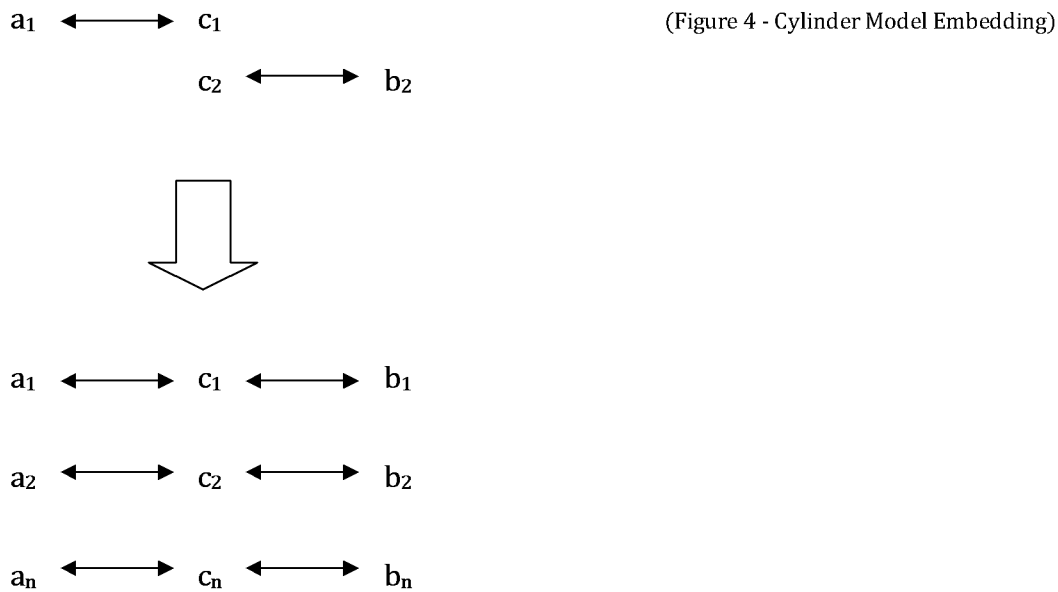


What is interesting about this model is that it is not strictly correct in light of our observations. We have actually gone beyond what the empirical data can tell us and I would argue that we have moved straight to a theoretical model. The reason for this is that we have connected these two observations in a way we are not entitled. Properly modeled, our data model will include two sets of observational data, indicated here by subscripts.



As it turns out, we can never confirm that side a is connected with side b with a pure data model. Whenever, and no matter how often we observe side a is connected to side c, and whenever and no matter how often we observe side b is connected to side c, we will never observe that both are happening at the same time. Strange as it seems, without some kind of inference to an unobservable state of affairs, we cannot say that side a is connected to side b.

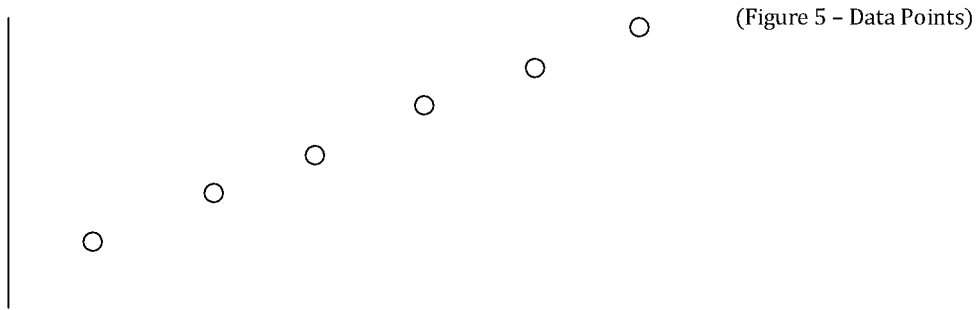
To come to this conclusion, we need to homomorphically map our cylinder data model into a larger theoretical model:



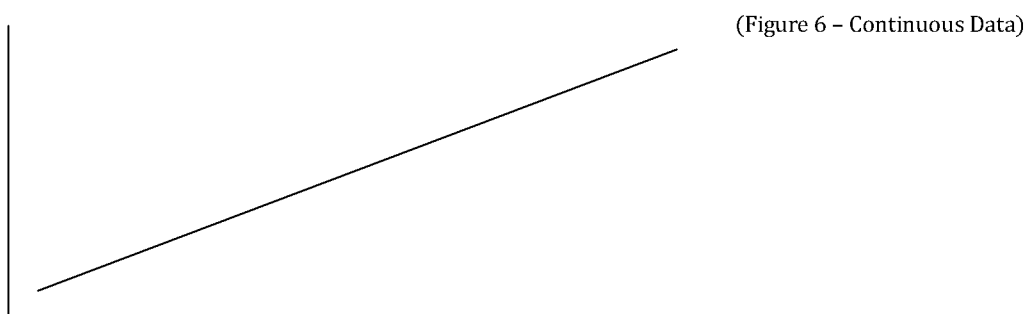
But, following Van Fraassen, we cannot be realist about the theoretical model, only the data model. In other words, we cannot be realist about the connectedness of the three faces of the cylinder. This is a strange conclusion to be sure, especially considering that we might have thought that the cylinder as we typically understand it (with three connected faces) was the phenomenon to be saved. But as it turns out, the appearance, once divided from this phenomenon by perspective does not make accessible, by “immediacy of experience” any truths at all about those larger, more complete features of the whole cylinder. As with the earlier Mt. Everest example, the problem seems to be that almost all of our ordinary

observations involve inferences, and not just the concrete inferences to observables that van Fraassen allows, as in the case of the mouse in the wall.

One possible objection to the cylinder model argument that I have just made might be that the larger, complete cylinder model is not a theoretical model, but is just a filling in of data, and is actually a surface model. Given some data model in the form of a graph plotting, for example, temperature against time,



van Fraassen allows us to extrapolate a surface model from these appearances which smoothes or completes the data points and makes the data continuous:



Perhaps our 'smoothing' or extrapolation to the connectedness of the cylinder faces constitutes a surface model, and not a theoretical model.

In order to see why this suggestion fails, we must consider why a surface model is different from a theoretical model. Each of the points that are filled in to 'smooth' or otherwise complete a surface model must be points that are themselves observable in principle. This is why when we do so, we have not yet moved to the realm of theoretical postulation. When we construct surface models, we merely take the data we have and 'complete' it by adding other data that we would expect to find if we continued making observations. As van Fraassen states:

The graph or other summary of the data found will be abstracted into a mathematically idealized form before it reaches the theoreticians desk. Let's call that processed artifact a surface model... the surface model 'smoothes' – in fact 'idealizes' this summary [the data model] still further so as to replace the relative frequency counts by measures with a continuous range of values. (2008, 167)

The key, however, is that we could only add data, or otherwise 'smooth' a data model into a surface model if the added data could be collected if we wanted to. It must be observable in principle.

We could not describe the 'complete cylinder' model as a surface model because it contains idealizations that are not observable even in principle; namely, that one closing face is connected to the other in the same observational instance. When we make seemingly mundane claims like 'the three sides of the cylinder are connected' or 'my various mountain observations are of a single mountain' I am making claims which go

beyond what is strictly observable. At that stage, I am, to use van Fraassen's parlance, already at the theoretician's desk. Moreover, any empiricist structuralism which preserved only the structure of appearances would not need to preserve any of this theoretical structure, no matter how mundane.

3.4 The Abandonment of Common Sense

As I have shown, an acceptance of van Fraassen's most recent claims takes him far from the original intent of his early work. There is, evident in his latest work, a clear shift away from common-sense realism. Between such amazing notions as "public hallucinations" (Van Fraassen, 2008, 103) and the general idea that our appearances are no longer an immediate, or otherwise direct perception of phenomena, we are left with an anti-realism that is more far reaching than the constructive empiricism of his past work. By his own standard of 'saving the phenomena', such an extreme position may well fail, particularly if we think that the list of phenomena includes objects like Mt Everest and connected cylinders. If, as I argue, van Fraassen has sufficiently disconnected appearances from phenomena, the resultant 'saving of appearances' that results from his latest work pales in comparison to a truly common-sense realism.

Accepting van Fraassen's latest views requires either a staunch commitment to empiricism, not unlike those empiricist positions he originally sought to distance himself from, or some independently justified manner of acceptance that scientific realism must ultimately fail. Long ago, Hume took empiricism to its logical ends, complete with all the

skeptical baggage of the self being little more than a 'bundle of perceptions' along with the complete dissolution of causation (1739, I, IV, VI). Pushed to this point, which is where I believe van Fraassen's latest work must ultimately lead, it is not clear what is altogether novel about it. If we reject scientific realism, given the many arguments made against that position, it is still unclear why we ought to embrace so extreme an anti-realism as we may be led into by the views advocated in *Scientific Representation*. With a more naïve form of constructive empiricism, and the belief that our observations are directly of phenomena and not the variously-determined content of measurement outcomes and perspective, van Fraassen offered a far more appealing account of scientific practice. Of course such a view would be missing the most valuable message that van Fraassen provides in *Scientific Representation*; namely, that our appearances of the world are perspectival and that representation is not so simple a matter. So, despite its extreme conclusions, and the loss of the commonsense realism originally in Van Fraassen's favor, is there any other reason to accept an anti-realism so far reaching?

Assuming for a moment that our appearances and theory do represent phenomena in a significant and meaningful way, the resistance to adopt the realist position about science stems first and foremost from a fundamentally empiricist understanding of the relationship between reality and the objects of our sensations. As van Fraassen repeatedly notes, these are views which we can trace at least as far back to the first modern empiricists, Locke and Berkeley. Van Fraassen states:

If appearances are what appear to us, then, by definition, we never do see beyond the appearances ...! This insight, clear enough in Locke and Berkeley in the next century, could be the slogan for our entire discussion. (2008, 99)

This positive argument for an anti-realist empiricism is just to claim that we simply cannot go beyond our sensations in order to conclude anything at all about whatever real objects and processes might be the reason for these sensations. As mentioned, this is a point brought home in its fullest expression by Hume, and later by the logical positivists. This is interesting, insofar as van Fraassen seeks to separate constructive empiricism from the positivists and their 'syntactic' conception of the language of science. By invoking Locke instead, one cannot help but notice a difficulty in comparison. Locke was a realist despite his empiricism, and while he did not believe we can 'see beyond appearances', he did believe that we could infer things about reality from these appearances (which *is* perhaps the realist slogan for the discussion). Locke states:

But besides the assurance we have from our senses themselves, that they do not err in the information they give us in the existence of things without us, when they are affected by them, we are further confirmed in this assurance by other concurrent reasons... those perceptions are produced in us by exterior causes affecting our senses. (1690, Book IV, Ch 11, 3-4)

A more modern rejection of realism comes from a negative analysis of the 'no-miracles' argument for the success of science. Faced with the suggestion that science must be able to explain its success and that this success must be a result of tracking real features of nature, van Fraassen offers an alternative explanation. For van Fraassen, if science is not

a true description of reality, its success needn't be a miracle at all. In fact, even if untrue, the success of science should be entirely unsurprising and can easily be explained. He states:

I would like to point out that science is a biological phenomenon, an activity by one kind of organism which facilitates its interaction with the environment. And this makes me think that a very different kind of scientific explanation is required... For any scientific theory is born into life of fierce competition, a jungle red in tooth and claw. Only the successful scientific theories survive (1980, 39-40)

But it seems van Fraassen is conflating two separate kinds of explanation here. On the one hand we might be interested in explaining how it came to pass that we happened upon scientific theories which were successful, irrespective of whether they describe reality truthfully. On the other hand, we might want an explanation for why science is successful *at all*. Scientific realists, in demanding 'no-miracles,' are addressing this second question while van Fraassen seems interested in the first. To suggest that we can avoid the cosmic coincidence of the anti-realist position by giving this sort of evolutionary account would be much like explaining the functioning of an automobile by noting that if they did not successfully perform the way that they do, there would be no automobiles. Yes, in a way, an industry evolution story about automobiles in a competitive environment of "fierce competition, a jungle red in tooth and claw" does explain their successful operation, but this is only one kind of answer. Another kind of answer would address *how* the automobile operates successfully, with an explanation of pistons, combustion, and the inner mechanics of the thing. Or, more analogously to the scientific realist position, it would at least imply that there are inner mechanisms such that real features of the world can account for why

the automobile is able to do the amazing things it does. But van Fraassen knows this, even when he makes such blatantly misdirected responses as:

The success of science is not a miracle, because in any theoretical change both the past empirical success retained and new empirical successes were needed as credentials for acceptance. (2006b, 299)

Yes, but why is it successful *at all*? In a footnote to the above remark, van Fraassen notes the “subtly different” answer to the no-miracles demand than the one the realist wants. As justification for this move, we are only told for realists:

They understand this question in such a way as to demand an ontology, thus addressing, to my mind, a question which does not arise at all. (2006b, 299)

But this is simply a refusal to deal with the problem on its own terms. All this said, van Fraassen can hardly be held at fault for his most forceful arguments against the realist occur at an entirely different level.

When van Fraassen correctly illustrates the non-uniquely determined nature of our models, the realist does have work to do in accounting for how we can be realist about our theories when any model of sufficient size will be, under some interpretation, true. It is a logical fact that given an appropriate mapping function in use, any model of sufficient size could represent the world (2008, 230). But this alone does not seem to undermine representation of the concrete by the abstract. How could this be? Simple, the realist might respond – What is important is not the model, but rather, the mapping function. If a realist were to claim, for example, that a model M accurately represents the world, or some

fragment of the world, they needn't mean that this model does so somehow independently of our language or our terms and how they meet with the world. It is an obvious point that what we mean by 'water' determines what we can truthfully say about 'water'. No realist should be surprised by this. So the realist has no grounds for worry when van Fraassen says, for example, that

A theory says nothing to us unless we can locate ourselves, in our own language, with respect to its content. (2008, 235)

What matters for the realist is just that once we have located ourselves, that is, once we have decided which terms refer to which features in nature, we be able to say of a theory that it is true or not, and of course this is something we can easily do.

But, the point remains that the structure of any model we take to be an accurate description of reality – independently of locating ourselves with respect to our language and its content – cannot be considered, by itself, isomorphic or even more loosely 'structurally similar' to the structure already present in nature. In this sense, van Fraassen has succeeded in presenting a major obstacle to structural realists about science. But this is an obstacle we might deal with in a few different ways.

The issue of what structure is, in the structural realist account might be understood in less abstract terms. The question of what, precisely, we mean by structure on such a view is not a simple thing to answer, after all, and it is not clear that one need adhere to a model theoretic account. Van Fraassen, in his criticisms, has assumed (perhaps reasonably) that structure just is the usual formal logical definition of mathematical structure. On this account of structure, we have abstract objects in some domain, and relations between

these. It is just such a view that falls prey to van Fraassen's criticisms. But we can be more sophisticated about what we mean by structure by building in the idea that structure is relativized to our particular assignment of model theoretic relations and those relations that they apply to in the world. If we specify some structure of sufficient cardinality then yes, it is true that there is some interpretation such that this structure will match the structure of the world, but our structural realism hinges then on more than just the structure – it will now crucially depend on the interpretation. That is, it crucially depends on our “locating ourselves, in our own language, with respect to its content” (Van Fraassen 2008, 235).

3.5 Empiricist Rejoinder

The empiricist response to criticisms such as those outlined above will be to reiterate the point already made by van Fraassen's Princeton example and the pragmatic tautology that van Fraassen feels we are faced with. When we criticize structural empiricism on the grounds that it can no longer 'save the phenomena' but only 'save the appearances' van Fraassen will rest on his arguments that adequacy to phenomena *represented by us* (appearances) and adequacy to phenomena are pragmatically the same (2008, 259). Indeed, many of the criticisms given above do question the conclusions provided by van Fraassen on that point. Admittedly, much of this discussion could be said to rest on the success of van Fraassen's pragmatic tautology, and the sense we can make out of his identification of appearances with phenomena, given some context.

Almost poignantly, the failure of the pragmatic tautology is perhaps best illustrated by van Fraassen's own Princeton example, and the character he provides there of the metaphysician who questions the connection between representations and phenomena. Recall, the researcher studying the deer population in Princeton holds that some model of a theory T accurately matches compiled data about the deer population in Princeton and this metaphysician challenges the researcher.

CHALLENGE: Yes, T fits well with this graph, your representation S, but does T fit the actual deer population in Princeton. (2008, 254)

This challenge is not unlike the challenges I have earlier raised about Mt. Everest and cylinders in the sense that it questions the degree to which a data model (in this case, a graph) and the phenomenon in question are connected. For Mt. Everest, I suggested that the data model might only include various disconnected mountain images and that the singular entity, Mt Everest, was a theoretical notion which we inferred from this various data. In the case of the cylinder, I suggested that the data model included only basic observations about those parts which were observable and that, like Mt. Everest, to make sense of the singular phenomenon as a whole or complete object, we needed a theoretical model.

In making this challenge, the metaphysician might be expressing doubt about the degree to which the representation captures the truth about the phenomenon, even just in relation to the population growth feature in question. Van Fraassen does a very good job of prompting these worries when the character of the metaphysician clarifies his position:

I understand that in this case your claim to knowledge about the deer population growth in Princeton is warranted. But there is still the real deer population growth, which is something in the world, distinct from anything in your graph, distinct from anything in the content of your warranted knowledge claim, distinct from the object of knowledge that you have constituted in your practice (put it how you will) – and that, the real deer population growth, is what we want theory T to match! (2008, 255-256)

What is so striking about this passage is that the metaphysician is privy to all the same data that the researcher is. The metaphysician can see the way in which the researcher's claims are warranted and, to be sure, those same claims may be warranted for the metaphysician as well. The manner in which the metaphysician raises the challenge implies, for them, a crucial distinction between two subtly different notions:

- i) The deer population, as a representation
- ii) The REAL deer population

Van Fraassen tries to separate the context state of the researcher from the metaphysician and even admits that the metaphysician:

...would not be (and is not) inconsistent or incoherent. He may be doubting that my data model is a good one, that it correctly and accurately represents the deer population growth. (2008, 256)

Notice, however, that separating the two is not necessary at all for this challenge to be raised, and so long as we maintain the subtle distinction between the deer population, as

represented (as an appearance), and the real deer population, we might even imagine that the researcher and the metaphysician are one and the same person.

Van Fraassen imagines being in such a state, and claims that we would in effect be offering a statement like:

The deer population growth in Princeton is thus or so, but the sentence “The deer population growth in Princeton is thus or so” is not true, for all I know or believe.

(2008, 256)

But this fails to recognize the crucial distinction that the metaphysician makes. In fact, they offer a different statement, which is not significantly different than the challenges described by Van Fraassen in the example. The metaphysician would be claiming: the deer population growth in Princeton, as represented, is thus and so, but the sentence “The real deer population growth in Princeton is thus or so” is not true, for all I know or believe.

If this statement has a familiar ring, it may be because it sounds like so many anti-realist claims about science. We can imagine, for example, van Fraassen making very similar statements about bacterial growth, as observed under a microscope. Still, Van Fraassen claims:

What I cannot do is to both present the graph as representing something and say that perhaps it doesn't represent that at all. This example brings out the crucial point: in the chain [theory]-[data model]-[reality] the last link is the one that is expressed in indexical judgments. (2008, 257)

What is, ultimately, at issue here, is whether or not the metaphysician is licensed in making the subtle distinction I have described. Van Fraassen seems to be suggesting that the metaphysician is not licensed and the reason for this must be his insistence that our appearances do provide us with:

...truth about many things: ourselves, others, trees and animals, clouds and rivers – in the immediacy of experience. (1989, 178)

He is, again, reliant on a direct theory of perception, which is unsurprising, given his past association with such a view. But is such an account of perception tenable once van Fraassen appropriately spells out the complex issue of representation? As I have argued, I believe it is not, and this is supported by the apparent meaningfulness that might be present in the metaphysician's challenge.

Again, however, we must be clear about what the metaphysician in this example is saying. They are not presenting the graph as representing while simultaneously suggesting that it does not represent. What they are doing is presenting a graph as having certain representational content, while suggesting that those representations do not imply the existence of some phenomenon, nor do they imply anything about that phenomenon. As van Fraassen makes clear, it is one thing for a statement to have representational content, but quite another for it to have a referent (2008, 245). Moreover, even if the representation does have a referent, it may not be the case that the representation, however accurate, can properly inform us about the true features of the phenomenon.

This is a very strange claim, and to be clear, I do not advocate such a position. Quite the contrary, I feel that these sorts of claims are in the domain of anti-realism about

science, though uncomfortably applied here to things we take to be in the realm of common-sense objects. What is important is simply that we recognize van Fraassen's pragmatic tautology to be insufficient for removing the "loss of reality objection". As with the metaphysician, all that we need do in order to topple van Fraassen's pragmatic tautology is to disallow the equivocations on phrases like 'the deer population growth in Princeton' to which van Fraassen helps himself in making his argument.

Given that the pragmatic tautology fails, van Fraassen's defense from the loss of reality objection disappears. As he has stated:

That [the theory is adequate to the phenomena] and [that it is adequate to the phenomena as represented by us] are the same is a pragmatic tautology.

Appreciating that the equivalence for us is a pragmatic tautology removes the basis for the loss of reality objection. (2008, 259)

And so, empirical adequacy on such a view will amount not to a saving of the phenomena at all, but only a saving of appearances – that is, to the phenomena as described. Fortunately, this is a conclusion which we can avoid by simply allowing for the kinds of inferences van Fraassen earlier suggests (as in the mouse example), but realizing that in all cases, the observability of objects is not direct, as van Fraassen thinks it is. Rather, there always seems to be an indirect and representational element, and this is just as true in the case of mice and mountains as it is in the case of electrons.

3.6 Summary

In this essay, I have said much about the past and most recent work of Bas van Fraassen, and have argued against an acceptance of his particular brand of empiricism. I have proceeded from an initial consideration of the major points van Fraassen espouses and from these same points have tried to draw out the possible consequences of holding these views. It may be helpful, however, to consider the key points of the argument I have made, and perhaps to tie these ideas together in a small space before moving on to a more general conclusion.

First, van Fraassen tells us that appearances of phenomena are perspectival. From these appearances, specific to each of us given our unique perspective and our particular interests, we construct data models. These data models are representations and themselves mathematical models, though not strictly representative of the phenomena independent of our perspective on the phenomena. Moreover, these data models are largely a function of the use we have in mind in constructing these models. (2008, 176)

Next, van Fraassen indicates that it is from these data models that we derive theoretical models. These theoretical models are also mathematical models and importantly contain homomorphic embeddings of the data models. It is this embedding in which structure is preserved across scientific change, but this is just the structure of appearances. Our data models were, after all, merely models of our particular appearances and any preservation of structure which includes only the structure of these data models, will amount to no more than a saving of appearances (2008, 238).

Important to this view is not only an account of how van Fraassen regards the actual practice of the scientific enterprise, but an account which also accords with our ordinary common-sense realism about observable phenomena. Put simply, we should have no trouble being realists about trees, tables, chairs and the like, even if we are anti-realist about the theoretical postulates of our scientific theories (2007, 371). This is possible, believes van Fraassen, since the structure of appearances about such objects will, for us, be identical to the structure of the phenomena themselves (2008, 259).

I argue, however, that this commonsense realism cannot be maintained without some acceptance of non-empiricist principles. To do this, I have considered some ordinary observations of phenomenon that van Fraassen takes to be non-theoretical; that is, ordinary, observable things like Mt Everest, or a cylinder. Presumably data models of these phenomena will (or could) contain the conceptual relationships between the various parts and the empirical facts about the object in question. But, as van Fraassen indicates, much of this will be the result of an inference from varied observations (2008, 285). By making this inference we speak about the phenomenon in ways that must properly be thought of as theoretical.

As I hope I have demonstrated, by tying these varied observations together, we move beyond a strictly empiricist account to one in which we are entitled to make certain realist inferences from what is strictly observable to features of the phenomena which are unobservable. Furthermore, many of these 'unobservable' features turn out to be quite ordinary and these inferences seem requisite for thinking about even the most mundane of objects as anything more than disjoint appearances. So, we find ourselves faced with a

choice. By accepting van Fraassen's structural empiricism we can either allow for the sorts of inferences which will allow basic conceptual unity required for common-sense realism, or we reject these inferences as unwarranted and merely a part of the greater theoretical framework which is not a part of the actual structure of our appearances.

In the first case, suppose we allow for these realist inferences. This is what (at times) Van Fraassen seems to suggest that we are entitled to do, as he indicates in the case of forming a single unified idea from varied telemetry data, photographs, and other observations about Mt. Everest. Similarly, these seem to be the sorts of inferences he allows when he speaks about unobserved mice which present evidence for their existence (1980, 19).

If we allow for these inferences, as I think we should, then we have a wide variety of objects which qualify as phenomena, including mountains, tables, chairs, and all the many things van Fraassen suggests we ought to be realist about. But these inferences will introduce structure to our scientific models in addition to what can be acquired strictly from appearances. This structure will qualify, therefore, as theoretical and we will be accepting these theoretical postulates as real descriptions of the phenomena. By allowing for non-empirical realist inferences, we will be including in our realist inventory things viewed through microscopes, electron microscopes, radio telescopes, and bubble chambers. After all, when we see a vapor trail, we infer the existence of the electron, and it seems we are licensed to do this. Ultimately, this may turn into a fairly robust realism

Clearly, this is not what van Fraassen has in mind so we need to consider the second option – that we do not allow any realist inferences and we do not help ourselves to realism

about anything but what is strictly observable. Such a position is classically empiricist to the logical extreme and is what (at other times) van Fraassen seems to endorse. By accepting this position, we do not allow ourselves an epistemic stance of realism about electrons, paramecium, and the many other theoretical postulates which van Fraassen takes to be unobservable. The result is just the kind of anti-realism that van Fraassen wants, except insofar as it disallows more than he realizes. Most, if not all, of our understanding of even the most mundane objects requires a theoretical component in order to conceptually unify our appearances. This conceptual unification is the means by which we move beyond disjoint and unconnected appearances and must, therefore, qualify as theoretical postulation. So, our choice turns out to be one between either a complete scientific realism or an extreme anti-realism which rules out even realism about common-sense objects, events, and processes. Intuitively speaking, the realist option is obviously more appealing, as even van Fraassen has sought to preserve realism in what he counts as observable domains.

4 Conclusion

In assessing the arguments of Bas van Fraassen's *Scientific Representation*, it is hard to come away entirely critical. There can be no doubt that his exploration of representation and structuralism is extremely ambitious, ingenious and philosophically interesting. In his discussions of representation and the perspectival nature of measurement in our discussion of phenomena, *Scientific Representation* is a masterwork of philosophical argument. Van Fraassen is correct in his early assessment of the work in that there is a significant area of interest where "general philosophical differences need make no difference" (2008, 3). Nevertheless, I believe that the more far reaching conclusions which advocate an empiricist structuralism fail.

Without some form of direct perception of the world, which is undermined by van Fraassen's own account of representation, those things which ultimately fall under the heading of observable turn out to be few in number. For many empiricists, this is a conclusion that is acceptable and even amounts to a kind of intellectual honesty. While it is easy to appreciate this sort of skeptical humility, this is not the kind of position sought by van Fraassen or the advocates of his structural empiricism. They believe that we can be moderately realist, at least about those things they consider observable, and in which they include all ordinarily visible, audible, tactile objects. Tables, chairs, wolves, planets, and stars all fall into the category of observable, they tell us, and why should this be something we doubt? After all, they experience these things in everyday contexts and we do often feel as though we have a privileged manner of interaction with them, once compared with those theoretical entities of science which seem further removed from ordinary experience. But

as we have seen, the story is not so simple. While the so-called unobservables of science do differ from our ordinary experiences, this is not so much a matter of wholly different observational status, but rather, the familiarity and regularity with which we make these observations. The more exotic claims of science, involving such alien entities as microscopic creatures, atoms and forces turn out to be very much like our ordinary claims in that they too are the result of inferences from the most basic of observational data, and insofar as we allow ourselves to be realist about the most mundane of things, we must also be realist about those things which are more removed from ordinary experience – For as we have seen, both are the result of similar inferential practices.

As van Fraassen's *Scientific Representation* is a new and important work in the philosophical literature, there is great potential for further exploration of these issues. Structural realists must take seriously the model-theoretic challenges raised by van Fraassen, irrespective of the problems present in van Fraassen's account. Moreover, a more detailed explanation may be needed to account for structuralism as containing more than simply empirical features of scientific theorizing. Finally, there may be significant motivation left for empiricists to attempt more detailed justifications for the direct realism suggested by van Fraassen's "immediacy of experience" about those objects he takes to be observable.

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