

## Van Fraassen: Arguments Concerning Scientific Realism

### 1. Scientific Realism and Constructive Empiricism

What is scientific realism? According to van Fraassen, “*Science aims to give us, in its theories, a literally true story of what the world is like; and acceptance of a scientific theory involves the belief that it is true.*” This is the correct statement of scientific realism.” His formulation has two important features:

- (1) It is pragmatic (and sufficiently circumscribed so that it applies to the actual history of science). Science only aims to provide a literally true story of the world; we shouldn’t claim that science actually does provide a true story because, for the most part, it hasn’t.
- (2) It is epistemic. Acceptance of a theory is identified with belief in its truth. This epistemic feature is itself fairly circumscribed; it says nothing about reasons for believing, and it allows for degrees of acceptance and tentative acceptance, corresponding to degrees of belief and tentative belief.

“Anti-realism is a position according to which the aim of science can well be served without giving such a literally true story, and acceptance of a theory may properly involve something less (or other) than belief that it is true.”

(N.b. We are not discussing metaphysical realism. Van Fraassen and everyone else in this debate agree that there is a real world out there which theories may or may not refer to, and which makes theories true or false, and which is independent of what anyone believes.)

What does “literally true” mean? That the language in a literally true account should be literally construed, and that the account should be true when it is so construed. So what does “literally construed” mean? This is a question to be settled by philosophers of language; for now we can say that literal means literal, and non-literal means metaphorical or allegorical or analogical.

(Concerning scientific theories, the point is that if a theory says something like “electrons are negatively charged”, then it says there are electrons, and that they are negatively charged.)

This bears upon our understanding of *what* a theory says, which is independent of whether we *believe* what a theory says. I.e., the literal construal of a theory doesn’t imply the belief that it is true.

The notion of literal construal divides anti-realists into two kinds: the kind who say that science aims to be true when construed non-literally; and kind van Fraassen belongs to, who say that while theories should be literally construed, they don’t have to be true. The first kind of anti-realist might claim e.g. that the theory of phlogiston and the modern theory of combustion say the same thing, whereas the second kind of anti-realist would claim that those two theories say totally different things.

If van Fraassen’s kind of anti-realist construes theories literally but doesn’t believe in their truth, then what’s the appropriate stance? Van Fraassen says, “*Science aims to give us theories which are empirically adequate; and acceptance of a theory involves a belief only that it is empirically adequate.*” This is the statement of the anti-realist position I advocate; I shall call it *constructive empiricism*.”

A theory is ‘empirically adequate’ if it ‘saves the phenomena’—if everything it says about observable phenomena is true. “A little more precisely: such a theory has at least one model that all the actual phenomena fit inside. I must emphasize that this refers to *all* the phenomena; these are not exhausted by those actually observed, nor even by those observed at some time, whether past, present, or future.” It’s important to keep in mind that empirical adequacy must save *all* phenomena, not merely the ones that we actually have observed or actually will observe. Empirical adequacy is modal: if we *were* to observe something, then an empirically adequate theory would say only true things about it.

Acceptance of a theory actually involves more than belief, whether in truth or empirical adequacy. It involves all sorts of commitments—to research programs, to conceptual frameworks, to linguistic terms and relations, etc. This reveals a pragmatic aspect of theory acceptance.

## 2. The Theory/Observation Dichotomy: van Fraassen vs. Maxwell

According to Grover Maxwell, the theory/observation distinction, in both its terminological and ontological forms, is untenable because:

- (1) All of our language is theory-infected. There is no way to get around this.
- (2) No non-arbitrary line can be drawn between what is observable and what is theoretical; there is a continuum between observation and inference.
- (3) Nothing in principle is unobservable; e.g., it's logically possible for us to develop sense organs that would allow us to perceive electrons.
- (4) Even if there is a real theory/observation distinction, it has no bearing on whether or not the entities posited by a theory actually exist. Such a distinction therefore has no ontological significance.

Van Fraassen's replies:

- (1) So what? Just because language is shaped by some theory doesn't mean we believe in it. E.g., we talk about sunrises, but we know the sun doesn't really rise.
- (2) So what? First, while there may be a continuum from acts of observation to acts of inference, there isn't a continuum from observable objects to unobservable objects. "X is observable if there are circumstances such that, if X is present to us under those circumstances, then we observe it." Second, while "observable" may be a vague concept, that doesn't mean it isn't perfectly serviceable in clear-cut cases.
- (3) So what? In principle it's possible for a giant to pick up the Empire State Building and carry it around, but we still don't say that it's portable. "Observable" refers to the perceptual capabilities of humans, which can in principle be described precisely. We set the standard by which these concepts are defined.
- (4) So what? We're talking about epistemology, not ontology. The issue is what to believe, and the claim is that we believe that theories are empirically adequate—i.e., that what they say about observable phenomena is true.

(Notice that (3) and (4) imply that an anti-realist's beliefs about empirical adequacy are relative to the state of the human race: "If the epistemic community changes in fashion Y, then my beliefs about the world will change in manner Z." This isn't a problem for van Fraassen.)

The point here is that van Fraassen wishes to preserve the theory/observation distinction because of his commitment to empirical adequacy as the truth of a certain part of a given theory—i.e., to believe that a theory is empirically adequate is to believe that what it says about observables is true, but to remain agnostic about its theoretical components. In other words, van Fraassen is a realist about observables; if everything in the universe were observable, then he'd be a realist. Looking at it another way, since van Fraassen wants to talk about truth with respect to part of a theory, he needs to demarcate between the true stuff and the other stuff. The theory/observation distinction is one way to draw that line.

But the theory/observation distinction isn't really necessary. We can instead rely on a distinction between truth and predictive success; truth entails predictive success, but not vice versa. An anti-realist could then drop truth and speak in terms of predictive accuracy.

### 3. Inference to the Best Explanation

At this point it will be useful to deviate from van Fraassen's text and abstract the structure of the arguments:

First, distinguish between low-level IBE and high-level IBE:

Token physical phenomena:	missing cheese, abused cat trails in cloud chamber	$\rightarrow_{IBE}$ $\rightarrow_{IBE}$	mouse in the house electrons
Success of science:	theories fit evidence	$\rightarrow_{IBE}$	truth (?)

Notice that the 'best explanations' of physical phenomena tend to be causal. Electrons cause trails to appear in a cloud chamber. But what does it mean to say that truth 'causes' the fit between theories and evidence (i.e., success)? (In analogy, what does it mean to say that antibodies 'cause' immunity?) The relation instead seems to be one of entailment. Now, to apply IBE is to select from a range of alternatives. How about van Fraassen's alternative of empirical adequacy? It also stands in the same relation to success as does truth. So we have these alternatives:

Success of science:	theories fit evidence	$\rightarrow_{IBE?}$ $\rightarrow_{IBE?}$	truth OR empirical adequacy
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These three things may be so arranged: truth  $\rightarrow$  empirical adequacy  $\rightarrow$  success. Truth presumably entails empirical adequacy, and empirical adequacy entails success. Also, empirical adequacy is weaker than truth. This leads us to the following (in)equalities:

$$\begin{aligned} \Pr(\text{success} \mid \text{empirical adequacy}) &= \Pr(\text{success} \mid \text{truth}) \\ \Pr(\text{success} \mid \text{empirical adequacy}) &= \Pr(\text{success} \mid \text{empirical adequacy and truth}) \\ \Pr(\text{empirical adequacy} \mid \text{success}) &\geq \Pr(\text{truth} \mid \text{success}) \\ \Pr(\text{empirical adequacy}) &\geq \Pr(\text{truth}) \end{aligned}$$

These seem to indicate that empirical adequacy is actually a better explanation than truth!

According to proponents of IBE, because IBE is the rule of inference used in science, we should apply it to the question of realism and conclude that the truth of theories is the best explanation for why we accept them.

Granted, it may be the case that we use IBE for all sorts of mundane cases involving observable phenomena, but does it lead us to belief in unobservables, or the truth of theories?

First objection: Do we actually use IBE? Not necessarily. What does it even mean to say that we follow a rule of inference? Certainly not that we follow it explicitly and consciously. But we also can't say that a rule is followed implicitly just when our conclusions happen to be permitted by that rule, because a rule of inference underdetermines the conclusion that may be drawn, and because a sufficiently relaxed rule permits any conclusion.

Therefore, the claim that we follow a particular rule of inference is an empirical hypothesis. Specifically, IBE is just a hypothesis, and empirical adequacy is a rival hypothesis that works just as well. Evidence for IBE is not evidence against empirical adequacy.

Second objection: even if we grant IBE, how do we know it leads to truth as the best explanation of the success of science? (See above.) Historically, we've inferred nothing but literally false theories. Can the realist avert this problem by appealing to 'approximate truth'? This only causes more problems. What does approximate truth mean with respect to reference? [Insert rant by Branden.] Furthermore, given a range of alternative theories, the realist must believe that it contains a true one. How does he know that the range contains a true theory? Only because he assumes it as an 'extra premise', and this is exactly the premise that an anti-realist denies.

#### 4. Explaining Regularities: van Fraassen vs. Smart

(Van Fraassen now turns to specific explanationist defenses of realism.)

J. J. C. Smart claims that the property of “instrumental usefulness”, on which anti-realist positions are based, can only be explained by appealing to truth. I.e., by comparing a merely useful theory to a true and useful one, or by believing that a useful theory is useful because it is true.

Granted, if no theory is assumed to be true, then no theory can have its usefulness explained in terms of truth. But why can't we explain the usefulness of one theory by comparing it to another useful theory? Smart would probably reply that this only begs the question; what explains the usefulness of the other theory? Empirical adequacy? (Well, yes: empirical adequacy. See below.)

According to van Fraassen, it doesn't have to. The usefulness of a theory is just a brute fact. No explanation is required. We can get along just fine without it.

Smart argues against this, claiming that we must postulate ‘unobservable micro-structures’ to account for observed regularities in macroscopic phenomena—otherwise we must believe in ‘lucky accidents’ and ‘cosmic coincidences’.

Two points against Smart's argument: first, what explains the regularities in the unobservable micro-structures? Can we draw a non-arbitrary line between those regularities that ought to be explained, and those that we can assume as basic and inexplicable? Theories that posit unobservable micro-structures are not automatically any better than theories that make do with macro-phenomena.

Second, coincidence and accident are in general not to be equated with inexplicability. Two events which coincide may each be explained independently, and the coincidence consists simply in the fact that there was no singular common cause. Science can't be required to eliminate coincidences in general, because it's a fact that they do occur. Van Fraassen provides an example from quantum mechanics where correlations really have no common cause in the traditional sense.

Regarding the preceding discussion of IBE, a broader objection to Smart is that (1) he's conflating and moving between the high and low levels, and (2) he's swapping the explanandum around within the high-level inference. More specifically:

- (1) At best, Smart's appeal to cosmic coincidences and low-level IBE can be viewed as an analogy. But even then it fails, because there really are micro-level cosmic coincidences that defy attempts to find an underlying causal explanation.
- (2) The original explanandum was the actual success of science. Empirical adequacy provides an explanation, and it's not tautological because empirical adequacy covers *all* phenomena, including the ones we could hypothetically observe. Explaining empirical adequacy is another question altogether. (Does truth explain empirical adequacy? Truth as opposed to what? If truth is the *only* explanation, then we can't use IBE to infer it; it would just be vacuous.)

#### 5. ‘Explaining’ Irregularities: van Fraassen vs. Sellars

Empirical generalizations of observable phenomena are not completely general; they are subject to provisions, exceptions, irregularities, etc.

Wilfrid Sellars argues that irregularities which have no observable cause must be explained by unobservable micro-structures. He provides a thought experiment: two observably identical samples of gold dissolve in aqua regia at different rates. This can be explained by postulating that ‘pure gold’ can have one of two distinct micro-structures which dissolve at different fixed rates, and any ‘ordinary’ sample of gold will be a mixture of those two different varieties of pure gold.

Sellars claims that we must make this kind of appeal to the unobservable in order to provide an explanation of observable irregularities, and such an explanation will have no observable consequences—i.e., it will leave the irregularity just as mysterious as before.

Does that even make sense? If we postulate regular micro-structures (and they must be regular, or what's the point?) that don't actually explicate the irregularities, then what kind of explanation is this? Isn't the point of explaining an irregularity essentially to make it go away? Van Fraassen seems to think so: "... a theory which says that the micro-structure of things is subject to some exact, universal regularities, must imply the same for those things themselves. This, at least, is my reaction to the points so far." I.e., Sellars has it backwards.

Regarding Sellar's thought experiment, van Fraassen has three objections:

- (1) The postulation of unobservable micro-structures does in fact have observable consequences. If the theory says that pure samples of each micro-structure will dissolve at rates  $x$  and  $x + y$  respectively, then we know that any mixture will dissolve at a rate between  $x$  and  $x + y$ , and these rates can be observed.
- (2) Such postulations are essentially the search for hidden common causes, of which there may be none (quantum mechanics).
- (3) Explanation isn't the only reason to posit these unobservable micro-structures. There are pragmatic motivations; e.g., postulates could lead to new models and new hypotheses, but this accounts for their value in terms of predictive accuracy and hence empirical adequacy.

Finally, Sellar's argument moves between high- and low-level IBE, like Smart's.

## **6. No Miracles: van Fraassen vs. Putnam**

Hilary Putnam advances THE ULTIMATE ARGUMENT (for scientific realism):

the positive argument for realism is that it is the only philosophy that doesn't make the success of science a miracle. That terms in mature scientific theories typically refer, that the theories accepted in a mature science are typically approximately true, that the same term can refer to the same thing even when it occurs in different theories—these statements are viewed by the scientific realist not as necessary truths but as part of the only scientific explanation of the success of science, and hence as part of any adequate scientific description of science and its relations to its objects.

[Van Fraassen then makes some sarcastic remarks which I'm not sure how to summarize. He concludes with an appeal to natural selection:]

Van Fraassen's reply is that even though the success of science is no miracle, it need not be attributed to the notion that somehow our theories are 'adequate' to the world and have been specifically designed to capture truth. Rather, our theories are "born into a life of fierce competition, a jungle red in tooth and claw. Only the successful theories survive—the ones which in fact latched on to actual regularities in nature."

The history of science seems to confirm the claim that we select our theories on the basis of empirical adequacy. Theories that didn't fit the data either evolved or went extinct. (If inadequate theories were preserved, it was for pragmatic reasons. And if we have a number of empirically equivalent alternatives to choose from, the choice will be based on pragmatic considerations, which themselves are independent of truth.)

There is a counter-argument which states that while we may select theories based on empirical adequacy, we still haven't explained why a theory is empirically adequate. This just swaps the explanandum around, as pointed out above.