Formulational vs. Epistemological Debates Concerning Scientific Realism

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ABSTRACT: A formulational debate is a debate over whether certain definitions of scientific realism and antirealism are useful or useless. By contrast, an epistemological debate is a debate over whether we have sufficient evidence for scientific realism and antirealism defined in a certain manner. I argue that Hilary Putnam's definitions of scientific realism and antirealism are more useful than Bas van Fraassen's definitions of scientific realism and constructive empiricism because Putnam's definitions can generate both formulational and epistemological debates, whereas van Fraassen's can generate only formulational debates.

Keywords: acceptance, aim, belief, epistemological, formulational, Putnam, van Fraassen

1. Introduction
There are diverse definitions of scientific realism and antirealism in the literature. This paper argues that Hilary Putnam's (1975: 73) definitions of scientific realism and antirealism are more useful than Bas van Fraassen's (1980: 8–12) definitions of scientific realism and constructive empiricism. Why is it important to adjudicate between Putnam's and van Fraassen's definitions? Realists and antirealists would engage in different debates, depending on which definitions they choose as the framework for their debates. Moreover, the adjudication would yield useful information about how to define scientific realism and antirealism in order to generate voluminous debates about science.

In Section 2, I specify the distinction between formulational and epistemological debates, and then show that Putnam's definitions can generate both formulational and epistemological debates. In Section 3, I argue that van Fraassen's definitions can generate formulational, but not any epistemological debate. In Section 4, I point out that the definition of 'our best theories' can be found in Putnam's definitions, but not in van Fraassen's. Thus, indispensablists in the philosophy of mathematics can utilize Putnam's definitions, but not van Fraassen's. In Section 5, I reply to reviewers' objections and other objections. This paper is intended to be useful to those who wonder what kinds of debates there are in the literature with respect to realism, and how we should formulate realism and antirealism.

2. Formulational and Epistemological Debates
This section distinguishes between formulational and epistemological debates, and shows that the no-miracles argument (Putnam, 1975: 73) has generated both types of debates.

A formulational debate is a debate over whether certain definitions of realism and antirealism are useful or useless, or whether certain definitions of realism and antirealism are more useful than others. The participants in a formulational debate construct arguments to show that certain definitions are useful, or that they are more useful than others. Presenting such arguments does not require any commitment either to realism or antirealism. The

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participants can argue for their definitions without taking an epistemic attitude toward any scientific theory, such as the Big Bang theory.

An epistemological debate is a debate over whether we have sufficient *evidence* for realism and antirealism defined in a certain manner. The participants in an epistemological debate construct arguments, such as the no-miracles argument and the pessimistic induction (Stanford, 2006: 20; Wray, 2007, 2010: 371, 2013: 4327; Khalifa, 2010; Nickles, 2017: 153), to show that we have enough evidence to believe or disbelieve that certain theories are true, empirically adequate, etc. The participants in this debate commit either to realism or to antirealism.

The no-miracles argument (Putnam, 1975: 73) says that it is reasonable to suggest that some theories are successful because they are true,[1] whereas it is unreasonable to suggest that they are successful because a miracle has occurred. A theory is successful, "so long as it has worked well, i.e., so long as it has functioned in a variety of explanatory contexts, has led to confirmed predictions and has been of broad explanatory scope" (Laudan, 1981: 23). According to the no-miracles argument, therefore, realism is the position that affirms, whereas antirealism is the position that denies, that we are warranted in believing that successful theories are true (Park, 2019a: 280).

Under Putnam's definitions, realists and antirealists have engaged in epistemological debates over whether or not we are warranted in believing that successful theories are true. Realists run the no-miracles argument to establish that we are warranted in believing that successful theories are true. In response, antirealists run the pessimistic induction, which holds that we can infer the downfall of successful present theories from that of successful past theories. The pessimistic induction implies that we are not warranted in believing that successful theories are true. It follows that Putnam's definitions have promoted epistemological debates.

Under Putnam's definitions, realists and antirealists have also engaged in formulational debates. For example, Alan Musgrave (1985: 211) and Jarrett Leplin (1997) have advanced an enhanced variant of realism to get around the pessimistic induction. This variant asserts that scientific theories making novel predictions are true. Timothy Lyons (2003: 898–899, 2017: 3204) and Peter Vickers (2017: 3227) retort that some past theories, such as Bohr's theory of the atom and Fresnel's wave theory of light, made true novel predictions. It follows that Putnam's definitions have also promoted formulational debates.

Van Fraassen attempts to undercut Putnam's explanation of the success of science by proposing an evolutionary alternative, which holds that the success of science can be explained in terms of the survival of successful scientific theories:

> … I claim that the success of current scientific theories is no miracle. It is not even surprising to the scientific (Darwinist) mind. For any scientific theory is 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. (van Fraassen 1980: 40)

This evolutionary explanation is an alternative to Putnam's in that it invokes the survival of successful scientific theories instead of their truth. The alternative creates the burden for

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[1] I drop the qualifiers, 'typically' and 'approximately,' for the sake of convenience.

Putnam to prove that his is better than van Fraassen's. It must be noted, however, that when van Fraassen advances the alternative, he operates under Putnam's definitions, and not his own, to which I turn now.

3. Van Fraassen's Definitions

Van Fraassen's definition of realism consists of the aim part and the acceptance part. The aim part holds that *"Science aims to give us, in its theories, a literally true story of what the world is like"* (1980: 8). The acceptance part holds that "*acceptance of a scientific theory involves the belief that it is true*" (1980: 8). His definition of empiricism also consists of the aim part and the acceptance part. The aim part holds that "*Science aims to give us theories which are empirically adequate*" (1980: 12). The acceptance part holds that "*acceptance of a theory involves as belief only that it is empirically adequate*" (1980: 12). In the following subsections, I argue that both the aim and acceptance parts of his definitions can generate formulational debates, but not any epistemological debate.

3.1. The Aim Parts

The aim parts of van Fraassen's definitions cannot generate any epistemological debate. Neither says anything about whether we are warranted in believing that, say, the Big Bang theory or string theory is true and empirically adequate. It is one thing to say that science aims to produce true and empirically adequate theories; it is entirely another to say that we are warranted in believing that particular theories are true and empirically adequate. In other words, even if science aims to produce true and empirically adequate theories, we might not be warranted in believing that particular theories are true and empirically adequate.

The aim parts, however, can generate formulational debates. After all, van Fraassen's opponents can object that it is problematic to define realism and empiricism in terms of aims of science, while offering the following arguments.

The idea that science has aims clashes with Thomas Kuhn's (1962/1970: 172) view of science. Kuhn argues that science develops through alternations of normal science and revolutionary science. Even if these cycles continue, science does not converge on truths. Science does not develop toward a goal any more than organisms evolve toward a given end. Organisms are "products of a process that moved steadily *from* primitive beginnings but *toward* no goal" (Kuhn, 1962/1970: 172). The analogy between organisms and scientific theories is "very nearly perfect" (Kuhn, 1962/1970: 172). Therefore, it is wrong to say, Kuhn would conclude, that science aims to give us true and empirically adequate theories.

Ironically, van Fraassen also appeals to evolutionary theory to give an account of science. Recall that he advances an evolutionary explanation to refute the no-miracles argument. The evolutionary explanation, however, does not fit well with his definitions of realism and empiricism. On the one hand, the evolutionary explanation embodies the Darwinian idea that successful scientific theories exist because they defeated others in a battle to survive. On the other hand, van Fraassen's definitions embody the Lamarckian idea that science has aims. It is not clear how van Fraassen can reconcile his Darwinian explanation with his definitions.

Moreover, van Fraassen says that empiricism is better than realism because "it makes better sense of science, and of scientific activity, than realism does and does so without inflationary metaphysics" (1980: 73). His idea is that both realism and empiricism explain science, but empiricism takes less epistemic risk. This difference amounts to "a positive

argument for constructive empiricism" (van Fraassen, 1980: 73).

Something is wrong, however, with this positive argument for empiricism. Realism and empiricism assert that science has aims, thus the explanations that they generate are not mechanical but rather teleological. In a mechanical explanation, an event is explained in terms of its efficient cause. In a teleological explanation, by contrast, an event is explained in terms of its final cause, viz., its goal or aim. For example, the mechanical explanation of a rock falling is that the Earth exerts a gravitational force on it, while the teleological explanation of it is that it has the goal of returning to its natural place. Ancient science regarded both mechanical and teleological explanations as legitimate, whereas modern science only regards mechanical explanations as legitimate. To explain science in terms of realism and empiricism is to give teleological explanations of science, which would be agreeable to ancient scientists, such as Aristotle and Ptolemy, but disagreeable to modern scientists, such as Copernicus, Kepler, Galileo, Newton, and Darwin. Modern scientists banished aims and goals not only from physics but also from biology (Park, 2019b: Section 6).

Should van Fraassen follow modern scientists on this count? Many philosophers, including van Fraassen, embrace naturalism, which holds that philosophy does not fundamentally differ from science. Van Fraassen contends, for example, that inference to the best explanation is used "in science and philosophy no less than in ordinary life and in literature" (1989: 131). As Park (2019c: Subsection 3.1) points out, van Fraassen (1980) uses inference to the best explanation to argue for his contextual theory of explanation. To apply scientific methodologies to the study of science means prohibiting the explanations of science in terms of realism and empiricism, as they are defined by van Fraassen.

There is a further issue concerning van Fraassen's contention that empiricism is better than realism. Like realism, empiricism invokes an aim of science. It is not clear which is more epistemically remote from us, the aim of science or theoretical entities, such as electrons. Van Fraassen might argue that the empiricist thesis that science aims for empirically adequate theories best explains scientific practices, thus we should believe that science aims for empirically adequate theories. Scientific theories, however, also best explain natural phenomena. It is not clear why we should believe the empiricist explanation of science, but not believe the scientific explanations of the world.

3.2. The Acceptance Parts

The acceptance part of realism holds that "*acceptance of a scientific theory involves the belief that it is true*" (van Fraassen, 1980: 8), and that the acceptance part of empiricism holds that "*acceptance of a theory involves as belief only that it is empirically adequate*" (van Fraassen, 1980: 12). To accept a theory is to commit to "confront any future phenomena by means of the conceptual resources of this theory" (van Fraassen, 1980: 12). One exhibits acceptance of a theory by the "assumption of the role of explainer" (van Fraassen, 1980: 12). In short, to accept a theory is to commit to use it for scientific purposes, e.g., explaining and predicting some phenomena.

The acceptance parts of realism and empiricism are not normative theses. The acceptance part of realism does not say that scientists ought to believe, are justified in believing, or can rationally believe that a theory they accept is true. Nor does the acceptance part of empiricism say that scientists ought to believe, are justified in believing, or can rationally believe that a theory they accept is empirically adequate.

Both parts are descriptive theses. They describe, among other things, what scientists

believe when they accept a theory. The acceptance part of realism says that scientists believe that a theory they accept is true, whereas the acceptance part of empiricism says that scientists believe that a theory they accept is empirically adequate. As noted earlier, to accept a theory is to commit to use it for scientific purposes. Thus, the acceptance part of realism implies that scientists believe that a theory they use for scientific purposes is true, whereas the acceptance part of empiricism implies that scientists believe that a theory they use for scientific purposes is empirically adequate. As van Fraassen puts it, acceptance of a theory "is a phenomenon of scientific activity" (1980: 12). Thus, the acceptance parts of realism and empiricism are different descriptions of science.

How can we adjudicate between the acceptance parts of realism and empiricism? The answer to this question is obvious. Given that they are different descriptions of science, they would be true if science is as they say it is. Specifically, if scientists believe that a theory they accept is true, then the acceptance part of realism would be true and the acceptance part of empiricism would be false. By contrast, if scientists believe that a theory they accept is merely empirically adequate, then the acceptance part of realism would be false while the acceptance part of empiricism would be true. Thus, the dispute between realists and empiricists could be resolved by conducting a thorough psychological survey about what scientists believe with respect to the theories that they use for scientific purposes.

So what? It would be pointless to construct philosophical arguments, such as the no-miracles argument or the pessimistic induction, to resolve the dispute between realists and empiricists. After all, the philosophical arguments say nothing about what scientists actually believe. The no-miracles argument does not assert that scientists believe that successful theories are true. Nor does the pessimistic induction say that scientists do not believe that successful scientific theories are true. Suppose that van Fraassen has refuted the no-miracles argument with his evolutionary explanation. The demolition of the no-miracles argument, however, would not mean that scientists do not believe that a theory they accept is true. Even if the no-miracles argument was refuted, acceptance of a theory might involve the belief that it is true. Scientists' doxastic states are independent of the status of the no-miracles argument.

Of course, van Fraassen attempts to undermine the no-miracles argument by advancing the evolutionary explanation. Recall, however, that in doing so, he operates not under his own definitions, but rather under Putnam's definitions. Under van Fraassen's definitions, empiricists have no reason to refute the no-miracles argument. After all, refuting it would not make it more likely that scientists believe that a theory they accept is empirically adequate. Refuting the acceptance part of realism requires not refuting the no-miracles argument but rather conducting a psychological survey on scientists that would show that scientists do not believe that a theory they accept is true.

Many rival participants in the scientific realism debate, however, do not believe that their disputes can be resolved by a psychological study about what scientists believe. They rather believe that the resolution will be made through the construction of philosophical arguments, such as the no-miracles argument and the pessimistic induction. They also believe that their disagreement concerns not what scientists believe, but rather what epistemic attitudes we *ought to* take toward theories that scientists accept. It follows that the acceptance parts of realism and empiricism fail to capture the disagreements among the rivaling participants in the scientific realism debate.

If scientists believe that a theory they accept is true or empirically adequate, that may be an interesting fact for philosophers of science to take into account. But neither the fact

that scientists believe that it is true, nor the fact that they believe that it is empirically adequate, would resolve the dispute among rival philosophers of science. The debate between them is not about what scientists believe, but rather about what we are warranted in believing. In general, a normative statement cannot be derived from descriptive statements (Hume, 1888/1978: 469).

In this context, it is useful to consider a standard objection to cultural relativism in ethics. Cultural relativism asserts that cultural approval makes an action right, and cultural disapproval makes an action wrong. Critics object that if cultural relativism were true, we could resolve the dispute over the morality of the death penalty simply by conducting an opinion poll. If the majority supports the death penalty, it is moral; if the majority opposes it, it is immoral. The majority opinion, however, cannot resolve this moral dispute. Neither retentionists nor abolitionists would give up their positions in the face of the majority opinion. They would only take the majority opinion into account when determining their attitude towards the death penalty. Therefore, cultural relativism is problematic (Davis, 2014: 78).

A similar objection can be raised against van Fraassen's definitions. Under his definitions, the dispute between realists and empiricists could be resolved by conducting an opinion poll among scientists. If the majority of scientists say that they believe a theory they accept is true, then the acceptance part of realism might be true and the acceptance part of empiricism might be false. By contrast, if the majority says that they believe that it is empirically adequate, then the acceptance part of empiricism might be true and the acceptance part of realism might be false. A majority opinion, however, cannot resolve the epistemological dispute over whether we are warranted in believing that a theory that scientists accept is true or empirically adequate. No philosopher in the scientific realism debate would give up a position in the face of the correct descriptions of what scientists believe.

Empiricists might object that van Fraassen's definitions do not have the absurd consequence that the majority opinion would settle the dispute between realists and empiricists. Even if the majority of scientists testified that they believe that a theory they accept is true, the dispute between realists and empiricists could persist. Empiricists could argue that they do not believe what scientists say about what they believe. They could disregard scientists' testimony and stick to their position that scientists believe that a theory they accept is empirically adequate.

It would, however, be arrogant to contend that philosophers know better about what scientists believe than the scientists themselves. It is well-known in philosophy of mind that we have better epistemic access to our own mental states than others do. For example, if pain occurs in my mind, that mental state is better known to me than to anyone else. Of course, I might be wrong about my own mental state. It is still true, however, that I have better epistemic access to my mental state than anyone else (Goldman, 1993). Therefore, we should put more trust in what scientists say about what they believe than in what empiricists say concerning what scientists believe.

In sum, the acceptance parts of realism and empiricism cannot trigger any epistemological debate between realists and empiricists. They can, however, stimulate formulational debates among rival philosophers over how useful they are. They can also trigger a psychological debate among rival psychologists concerning whether scientists believe that a theory they accept is true or empirically adequate.

Many years have passed since van Fraassen (1980) defined realism and empiricism in

terms of acceptance. No philosopher, however, has attempted to adjudicate between the acceptance parts of realism and empiricism, i.e., to determine whether "*acceptance of a scientific theory involves the belief that it is true*" (van Fraassen, 1980: 8) or "*acceptance of a theory involves as belief only that it is empirically adequate*" (van Fraassen, 1980: 12). That is not surprising, given that philosophers do not conduct opinion polls to resolve psychological disputes.

The no-miracles argument and the pessimistic induction have dominated the scientific realism debate since the 1970s (Magnus and Callender, 2004; Sankey, 2017). Why is it that Putnam's definitions, as opposed to van Fraassen's definitions, have dominated the scientific realism debate for the past several decades? My partial answer to this question is that Putnam's definitions can generate both formulational and epistemological debates, while van Fraassen's definitions can generate only formulational debates.

4. Our Best Theories

How can we adjudicate between Putnam's and van Fraassen's definitions? The more debates certain definitions generate about science, the more insights they will generate, and hence the more useful they will be. In Sections 2 and 3, I argued that Putnam's definitions can generate both formulational and epistemological debates, whereas van Fraassen's definitions can generate only formulational debates. In this section, I present another reason to think that Putnam's definitions are more useful than van Fraassen's.

There are many theories in current science, e.g., the Big Bang theory, evolutionary theory, string theory, and so forth. Which of them are our best theories? On what basis can we pick our best theories? Is the Big Bang theory one of our best theories? If so, why? What about string theory? If not, why not? In short, how can we define 'our best theories'?

An answer to this question can be found in Putnam's definitions, which suggest that our best theories are those that are successful. We can pick our best theories by investigating whether a particular theory "has functioned in a variety of explanatory contexts, has led to confirmed predictions and has been of broad explanatory scope" (Laudan, 1981: 23). The Big Bang theory fits this definition of success, while string theory does not.[2] Consequently, realists would believe that the former is true, but they would not believe that the latter is true.

By contrast, the answer to the question above cannot be inferred from van Fraassen's definitions. His definitions say that science aims to give us true and empirically adequate theories, and that acceptance of a theory involves the beliefs that it is true and empirically adequate. Important questions arise. Did science achieve its aim by giving us the Big Bang theory or string theory? Are scientists justified in accepting them? Van Fraassen's definitions do not suggest any answers to these questions. That is not surprising, given that his definitions do not concern the question of which theories are true or empirically adequate, but rather the questions of whether science aims to produce true or empirically adequate theories, and whether scientists believe that a theory they use for scientific purposes is true or empirically adequate.

For this reason, van Fraassen's definitions cannot help indispensabilists in the philosophy of mathematics. Indispensablists advocate the Quine-Putnam indispensability argument "that mathematics is indispensable to our best scientific theories, observations confirm mathematical components as well as concrete components of our best scientific theories, and

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[2] See Park (2017: 382) for how scientists plan to confirm string theory.

hence we ought to believe that mathematical entities are real, just as we ought to believe that theoretical entities, such as electrons and black holes, are real" (Park, 2016: 116). This argument is advocated by Willard Quine (1948, 1980, 1992), Putnam (1971), Michael Resnik (1997), and Mark Colyvan (2001). None of these indispensabilists has defined 'our best theories.' Without this definition, however, it is not clear which mathematical statements are worthy of our beliefs, and which mathematical entities are worthy of our ontological commitment. For example, are we justified in believing that the mathematical components of the Big Bang theory are true? If so, why? Are we justified in believing that the mathematical constituents of string theory are true? If not, why not? Indispensablists cannot find any answers to these questions in van Fraassen's definitions.

Indispensabilists, however, can find answers to the questions in Putnam's definitions. We are justified in believing that the mathematical components of the Big Bang theory are true, but not in believing that those of string theory are true, because the Big Bang theory is successful whereas string theory is not. Of course, mathematical antirealists might object that we are not warranted in believing that mathematical components of successful present theories, including the Big Bang theory, are true, conjuring up the pessimistic induction that since successful past theories were discredited, successful present theories, including the Big Bang theory, will also be discredited. The mathematical antirealists' appeal to the pessimistic induction, however, would demonstrate that Putnam's definitions could even trigger epistemological debates between mathematical realists and antirealists. Stimulating such debates is further proof that Putnam's definitions are more productive than van Fraassen's.

5. Objections and Replies

Critics might argue that both the no-miracles argument and the pessimistic induction are relevant to van Fraassen's definitions. The no-miracles argument indicates that true and empirically adequate theories are achievable aims of science, and that it is rational to accept a theory. By contrast, the pessimistic induction indicates that true and empirically adequate theories are unachievable aims of science, and that it is irrational to accept a theory.[3]

This critical comment is agreeable. It is, however, compatible with everything I said in the previous sections. In Subsection 3.2, for example, I state that the no-miracles argument does not assert that scientists believe that a theory they accept is true, so the refutation of the no-miracles argument does not mean the refutation of realism. In other words, it is one thing that the no-miracles argument is refuted, and it is another that scientists do not believe that a theory they accept is true. My claim does not conflict with the reviewer's reasonable comment above.

My opponents might raise the following objection. This paper claims that Putnam's definitions are better than van Fraassen's definitions. It does not follow, however, that the former are correct, and that the latter are incorrect.[4]

Strictly speaking, this paper claims that Putnam's definitions are more useful than van Fraassen's. It does not claim that the former are correct and the latter are incorrect, or that the former are true and the latter are false. Why not? A definition is a proposal about how to use a certain term. A proposal can be useful or useless, but it can never be true or false. To say that Putnam's definitions are true and van Fraassen's definitions are false is as absurd as

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[3] I thank a reviewer for this critical comment.

[4] I thank a reviewer for this objection.

to say that my marriage proposal is true and your marriage proposal is false.

Let me elucidate an implication of the definitional nature of scientific realism. Anjan Chakravartty observes that "scientific realism is characterized differently by every author who discusses it, and this presents a challenge to anyone hoping to learn what it is" (2017). Chakravartty's assertion that different authors *characterize* scientific realism differently should be interpreted not as the claim that different authors *describe* scientific realism differently but rather as the claim that different authors put forward different definitions of 'scientific realism.' Relatedly, it is wrong to ask, 'What is scientific realism?' but right to ask, 'What definitions of "scientific realism" are there in the literature?' Which are useful? Which are influential?

Let me turn to another possible objection. On the one hand, this paper criticizes van Fraassen's definitions and defends Putnam's definitions, thus it clearly engages in a formulational debate. On the other hand, it criticizes van Fraassen's definitions for generating only formulational debates. That might appear strange, but it is certainly not self-defeating. My position would be self-defeating if it asserted that van Fraassen's definitions cannot generate any formulational debate. My position, however, does assert that they can generate formulational debates. Thus, the foregoing criticism is compatible with my position. Let me pick up another possible objection, namely that it is wrong to say that van Fraassen's definitions cannot generate epistemological debates. An epistemological debate under van Fraassen's definitions could be over whether or not acceptance of a scientific theory requires the *belief* that it is true, empirically adequate, useful, and so on. In other words, there can be a debate over whether those who accept a scientific theory believe that it is true, empirically adequate, or useful. Realists, empiricists, and instrumentalists might argue, respectively, that accepters believe that it is true, empirically adequate, and useful.

In light of this objection, I distinguish between epistemological and doxastic debates. An epistemological debate concerns whether or not we have sufficient evidence for a doxastic state, whereas a doxastic debate concerns whether or not we are in a certain doxastic state. Van Fraassen's definitions can be a starting point for a doxastic debate, but not for an epistemological debate. To reiterate, realists and empiricists under van Fraassen's framework are not engaged in a dispute over whether or not we have sufficient evidence for a scientific theory.

Let me now turn to a more general issue. Moti Mizrahi observes that "Whenever the work of an influential philosopher is criticized, a common move made by those who seek to defend the influential philosopher's work is to claim that his or her ideas have been misconstrued" (Mizrahi, 2018: 19). I have criticized van Fraassen's definitions in the previous sections. So I anticipate that the prospective defenders of van Fraassen's definitions will accuse me of having committed the straw man fallacy. I turn to this objection next.

The defenders of van Fraassen's definitions might argue that on close analysis, a normative statement can be derived from the aim parts of realism and empiricism. Van Fraassen states that an aim "determines what counts as success" (1980: 8). For realists, what promotes truths is good, whereas for empiricists, what promotes empirical adequacy is good. Hence, realists and empiricists would say, respectively, that scientists *ought to* perform activities that promote truths and empirical adequacy. For example, they ought to make novel predictions. Thus, a normative judgement can be derived from the aim parts of realism and empiricism, and I misread van Fraassen's definitions.

It is one thing, however, to say that science aims for true and empirically adequate

theories; it is another to say that scientists ought to pursue them. The inference from the former to the latter requires an additional premise, such as the thesis that scientists have a motive to achieve the aims of science. Van Fraassen, however, drives a wedge between the aims of science and individual scientists' motives, saying that the aims of science are different from individual scientists' motives, just as the "aim of the game of chess is to checkmate your opponent; but the motive for playing may be fame, gold, and glory" (1980: 8). Thus, van Fraassen would not say that a normative thesis can be derived from the aim parts of realism and empiricism.

Moreover, I already pre-empted this possible objection in the first paragraph of Subsection 3.1 where I argued that it is one thing that science aims to produce true and empirically adequate theories; it is another that we are warranted in believing that particular theories are true and empirically adequate. Suppose that science has historically aimed for empirically adequate theories. Does it follow that scientists were justified in believing that their theories, such as Aristotelian mechanics, the caloric theory, and the phlogiston theory, were empirically adequate? My answer is no. We now know that past theories could not handle empirical anomalies, i.e., that they were empirically inadequate (Park, 2018: 5). Thus, past scientists would not have been justified in believing that their theories were empirically adequate. It is fallacious to infer that since science aims for empirically adequate theories, scientists are warranted in believing that their theories are empirically adequate. Thus, claiming that normativity can be derived from the aim parts of realism and empiricism is to attribute this fallacious inference to van Fraassen.

In addition, this possible objection clashes with van Fraassen's contention that empiricism "makes better sense of science, and of scientific activity, than realism does and does so without inflationary metaphysics" (1980: 73). Empiricism cannot explain science at all, if it consists of the acceptance part and the epistemic thesis that scientists are warranted in believing that successful scientific theories are empirically adequate. It is conceptually problematic to say, for example, that the Big Bang theory is successful because scientists are warranted in believing that it is empirically adequate. In general, it is bizarre to explain phenomena in terms of a normative thesis. Thus, to claim that normativity can be derived from the aim parts of realism and empiricism is to attribute bizarre explanations to van Fraassen.

Consider also that van Fraassen invokes the English view of rationality when he argues that the realist belief that a successful scientific theory is true is "reasonable enough, but supererogatory" (2017: 102). The English view of rationality asserts that "what it is rational to believe includes anything that one is not rationally compelled to disbelieve" (van Fraassen, 1989: 171–172). Note that van Fraassen makes a *normative* claim about the realist belief by appealing to the English view of rationality. If normativity already inheres in the aim part of realism, as the forgoing possible objection suggests, it is not clear why van Fraassen would invoke the English view of rationality to make a normative claim about the realist belief.

Some readers might still think that I have committed the straw man fallacy against van Fraassen. I challenge them to present textual evidence to support their interpretations, instead of merely interpreting realism and empiricism according to their own wish, or merely expressing their opinions about how realism and empiricism should be interpreted. Also, they would have to defuse the textual evidence that I presented in Subsection 3.2, and the arguments that I presented in this section for my interpretation of van Fraassen's definitions.

Recall that as Mizrahi observes, philosophers commonly defend an influential

philosopher's position by saying that critics misunderstand the influential philosopher's ideas. Mizrahi makes an apt criticism against those philosophers, viz., the continued iterations of such a defence make it doubtful that "the influential philosopher's ideas are worthy of attention and/or acceptance" (Mizrahi, 2018: 19). Mizrahi's criticism is insightful and admirable. Continued invocations of the straw man fallacy against the critics of van Fraassen's definitions run the risk of transforming his clear definitions into elusive ones, and hence decreasing rather than increasing their philosophical value.

We can learn nothing from an elusive idea, but we can learn something from a problematic one. There is no difference between an elusive idea and an empty one, or at least we should treat an elusive idea as if it were empty. As mentioned earlier in Subsection 3.2, the no-miracles argument and the pessimistic induction have dominated the scientific realism debate since the 1970s. Another partial explanation of why they have been so influential is that they are clear, simple, and elegant. Not surprisingly, they have been roundly criticized in the literature. As a result, we have learned a lot about science.

6. Conclusion

Putnam's definitions can generate both formulational and epistemological debates, whereas van Fraassen's definitions can only generate formulational debates. This difference partially explains why Putnam's definitions have dominated the scientific realism debate since the 1970s. One philosophical moral is that if you aim to define realism and antirealism in a way that can trigger copious debates, you should do so not in terms of the aims of science and/or acceptance of a theory, but rather in terms of a common property of our best theories. The resulting debates would yield rich insights about science.

Finally, I anticipate that many readers will accuse me of having committed the straw man fallacy against van Fraassen. Let me remind them that I presented arguments to support my interpretation of van Fraassen's definitions, and that to play the card of the straw man fallacy without refuting my arguments and without presenting alternative arguments runs the risk of transforming van Fraassen's clear definitions into elusive ones. Prospective objectors are reminded of these two caveats: No elusive idea is instructive, and obscurity is an anathema to analytic philosophers.

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