Formulational vs. Epistemological Debates Concerning Scientific Realism

Abstract
A formulational debate is a debate over the usefulness of ~~whether~~ certain definitions of scientific realism and antirealism. ~~are useful or not.~~ By contrast, an epistemological debate is a debate over whether certain scientific theories deserve realist or antirealist commitments. I argue that Putnam's definitions of realism and antirealism are more useful than van Fraassen's definitions of realism and empiricism, because the former can generate both formulational and epistemological debates, whereas the latter can generate only formulational debates.

Keywords
Acceptance, Aim, Belief, Empiricism, Putnam, Realism, van Fraassen

1. Introduction

There are diverse formulations of scientific realism and antirealism. ~~in the literature.~~ This paper attempts to adjudicate between Hilary Putnam's ~~formulations~~ and van Fraassen's formulations. According to Putnam (1975: 73), scientific realism and antirealism are the views that we are justified and not justified, respectively, in believing that successful theories are true. According to van Fraassen, scientific realism asserts that "*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*" (1980: 8). In contrast, constructive empiricism asserts that "*Science aims to give us theories which are empirically adequate; and acceptance of a theory involves as belief only that it is empirically adequate*" (1980: 12).

The main thesis of this paper is that Putnam's formulations are more useful than van Fraassen's. ~~formulations.~~ This paper is structured as follows. In Section 2, I specify the distinction between formulational and epistemological debates, and then argues that Putnam's definitions can generate both formulational and epistemological debates. In Section 3, I argue that van Fraassen's formulations cannot generate an~~y~~ epistemological debate, although they can generate formulational debates. In Section 4, I argue that the definition of 'our best theories' can be found in Putnam's, ~~formulations,~~ but not in van Fraassen's, formulations, so indispensablists can use Putnam's formulations, but not van Franssen's, ~~can be utilized by indispensablists~~ in the philosophy of mathematics. ~~, whereas van Fraassen's formulations cannot.~~

It is important to adjudicate between Putnam's and van Fraassen's formulations because participants in the scientific realism debate would engage in different sorts of debates, depending on which formulations they choose as the framework for their debates.

2. Formulational and Epistemological Debates, and the No-Miracles Argument

This section aims to distinguish between formulational and epistemological debates, and ~~then~~ to show that the no-miracles argument has generated both formulational and epistemological debates.

A formulational debate is a debate over the usefulness of~~whether~~ ~~certain~~ definition~~s~~ of realism and ~~and~~ antirealism. ~~are useful or not.~~ Participants in this debate construct arguments ~~to the effect~~ that certain formulations are useful, or that they are more useful than others. Presenting these~~such~~ arguments does not require ~~that they~~any commitment either to realism or antirealism. Participants ~~They~~ can argue for their definitions without taking an~~y~~ epistemic attitude towards any particular scientific theory, say, the special theory of relativity, as the present paper will illustrate.

A~~By contrast, a~~n epistemological debate is a debate over whether certain theories

deserve realist or antirealist commitments. Participants ~~in this debate~~ construct arguments, such as the no-miracles argument and the pessimistic induction, to show that certain theories are true, empirically adequate, approximately true, approximately empirically adequate, useful, or what have you. They are committed either to realism or to antirealism.

According to the no-miracles argument (Putnam, 1975: 73; Psillos, 1999), the success of science would be a miracle if successful theories were~~are~~ false, so we are justified in believing that successful theories are true. The no-miracles argument indicates that realism and antirealism are the views that we are justified and not justified, respectively, in believing that successful theories are true. Let me call these formulations ~~of realism and antirealism~~ *Putnam's formulations.*

Under Putnam's formulations, realists and antirealists have ~~been~~ engaged in epistemological debates over whether successful theories, such as evolutionary theory and the general theory of relativity, are warranted. ~~or not.~~ Antirealists run the pessimistic induction (Laudan, 1977: 126) to demolish the no-miracles argument. It holds that we can infer the demise of successful present theories ~~can be inferred~~ from the demise~~that~~ of successful past theories, so we are not justified in believing that successful theories are true. Thus, Putnam's definitions of realism and antirealism have served as ~~the~~ stepping stones for epistemological debates.

~~Under~~ Putnam's formulations ~~, realists and antirealists also~~ have also engendered~~been in~~ formulational debates over whether certain formulations can overcome the pessimistic induction. ~~or not.~~ For example, Alan Musgrave (1985: 211), Jarrett Leplin (1997), and Juha Saatsi (2009: 358) propose an enhanced version of realism, according to which theories making novel predictions are true. Timothy Lyons (2003: 898–899, 2016: 2) and Peter Vicker (2016: 6) retort that some past theories, such as Fresnel's wave theory of light and Bohr's theory of the atom, made novel predictions. Seungbae Park (2011: 23–35) also puts forward an enhanced version of realism, according to which successful theories that cohere with each other are true. Thus, Putnam's definitions of realism and antirealism have served as ~~the~~ stepping stones for formulational debates.

Van Fraassen (1980: 39–40) operates under Putnam's formulations, when he advances ~~puts forward~~ the evolutionary explanation of the success of science. It holds that the success of science can be explained in terms of the survival of successful 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 (1980: 40).

This evolutionary explanation presents~~is~~ an alternative to Putnam's, ~~explanation~~ in that it invokes the survival of successful theories while Putnam's invokes their truth. ~~of successful theories.~~ Presenting the alternative creates the burden for Putnam to prove that his is better than van Fraassen's. It must be noted, however, that when van Fraassen advances such a criticism, ~~against Putnam's,~~ he operates under Putnam's formulation of realism, and not ~~under~~ his own, ~~formulation of realism,~~ to which we turn now.

3. Van Fraassen's Formulations

3.1. The Aim Parts

Can van Fraassen's (1980) definitions of realism and empiricism generate formulational and epistemological debates? This section focuses on the aim parts of realism and empiricism. The aim part of realism holds that "*Science aims to give us, in its theories, a literally true story of*

Commented [1]: Is there a reason that false is not on the list?

Commented [2]: Minor premise, which you always leave unstated, is that there are no miracles.

what the world is like" (1980: 8). The aim part of empiricism holds, in contrast, that "*Science aims to give us theories which are empirically adequate*" (1980: 12).

The aim parts of realism and empiricism cannot generate any epistemological debate. After all, neither ~~none~~ of them says anything about whether we are justified in believing that, say, the special theory of relativity or ~~and~~ string theory are true and empirically adequate. It is one thing that science aims to produce true and empirically adequate theories; it is another that we are justified in believing that ~~–~~ particular theories~~ies in current science~~ are true and empirically adequate. In other words, even if science aims to produce true and empirically adequate theories, it might be that we are not justified in believing that the special theory of relativity or~~and~~ string theory are true and empirically adequate.

The aim parts of realism and empiricism, however~~though~~, can generate formulational debates. Van Fraassen (1980) obviously thinks that it is legitimate to formulate realism and empiricism in terms of the aims of science. Let me, however, present some reasons for thinking that it is illegitimate to do so.

The aim parts of realism and empiricism clash with Thomas Kuhn's (1962/1970: 172) view of science. Kuhn argues that the development of science consists of alternations of periods of normal science and revolutionary science. As ~~Even if~~ the cycles of normal science and revolutionary science continue, science does not converge on truths. He contends that ~~As far as he is concerned,~~ the development of science is a goal-free process, just as the natural selection of organisms is a goal-free process. Organisms are "products of a process that moved steadily *from* primitive beginnings but *toward* no goal" (Kuhn, 1962/1970: 172). So, too, are scientific theories. They do not evolve toward a goal any more than organisms do. This~~e~~ analogy between organisms and scientific theories is "very nearly perfect" (Kuhn, 1962/1970: 172). If Kuhn is right that science is a goal-free enterprise, it is wrong to say that science *aims* to give us true and empirically adequate theories.

N~~It is n~~ot only Kuhn, but also ironically van Fraassen ~~who~~ appeals to evolutionary theory to explain the development science. Recall that van Fraassen advances the evolutionary explanation of the success of science ~~with the view~~ to refut~~e~~ing the no-miracles argument. The evolutionary explanation does not go well with his definitions of realism and empiricism, because it ~~. The evolutionary explanation~~ implies that successful theories exist in current science not because past science *aimed* to produce successful theories, but because successful theories have gone ~~went~~ through the process of natural selection. The definitions of realism and empiricism, however, imply that past science *aimed* to produce true and empirically adequate theories, respectively. There is no reason for thinking that science does not aim to produce successful theories, but does aim~~s~~ to produce true and empirically adequate theories.

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

There is, however, something wrong with that~~e~~ positive argument. Realism and empiricism presuppose that science has aims, so the explanations ~~that~~ they yield are not simply mechanical, but teleological. How do mechanical and teleological explanations differ from each other? A ~~In a~~ mechanical explanation explains~~n,~~ an event ~~is explained~~ in terms of its cause and a law of nature. A ~~In a~~ teleological explanation ~~, an event is~~ explains an event ~~ed~~ in terms of its goal or aim. For example, it is a mechanical explanation that a stone thrown upwards falls down because the Earth exerts a gravitational force on it. It is a teleological explanation that the~~a~~ stone ~~thrown upwards falls down because it~~ has the goal to return to its natural place.

Ancient science regarded ~~T~~teleological explanations ~~were regarded~~ as legitimate , whereas modern science ~~in ancient science, but~~ only regards mechanical explanations ~~are regarded~~ as legitimate. ~~in modern science.~~ To explain science in terms of realism and empiricism is to give teleological explanations, which ~~of science. Such explanations~~ would be agreeable to ancient scientists, such as Aristotle and Ptolemy, but not to modern scientists, such as Copernicus, Kepler, Galileo, and Newton.

Should van Fraassen follow modern scientists on this account? Many philosophers, including van Fraassen, embrace naturalism, ~~according to~~ which holds that there is no fundamental difference between philosophy and science. Van Fraassen observes, 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). Van Fraassen (1980: Chapter 5) uses inference to the best explanation to show that his contextual theory of explanation is true. He is a thorough-going naturalist. Naturalists, in my view, would have to ~~cannot but~~ choose mechanical over teleological explanations.

3.1. The Acceptance Parts

Let me now move onto the acceptance parts of realism and empiricism. The acceptance part of realism holds that "*acceptance of a scientific theory involves the belief that it is true*" (1980: 8). The acceptance part of empiricism holds, by contrast, that "*acceptance of a theory involves as belief only that it is empirically adequate*" (1980: 12). To accept a theory is to commit to "confront any future phenomena by means of the conceptual resources of this theory" (1980: 12). Acceptance of a theory is exhibited by~~in~~ a person's "assumption of the role of explainer" (1980: 12). In short, to accept a theory is to commit to use it for scientific purposes, such as explaining and predicting.

The acceptance parts of realism and empiricism are different *descriptions* of the ~~what~~ beliefs ~~are~~ involved in accepting a theory. Specifically, they hold that scientists believe that a theory which they accept is true and empirically adequate, respectively. As noted earlier, to accept a theory is to commit to use it for scientific purposes. Thus, according to the acceptance parts of realism and empiricism, scientists believe that a theory which they use for scientific purposes is true and empirically adequate, respectively. In other words, the acceptance parts of realism and empiricism are different *descriptions* of what scientists believe with respect to a theory that they use for scientific purposes.

Commented [3]: This makes it sound like it is an empirical question. If we simply studied scientists and found what they actually believed when they accepted a theory, we would resolve the difference between realists and empiricists.

The acceptance parts of realism and empiricism are not normative. ~~theses.~~[1] The acceptance part of realism does not say that scientists ought to believe (or are justified in believing) that a theory which they accept is true. Nor does the acceptance part of empiricism say that scientists ought to believe (or are justified in believing) that a theory which they accept is empirically adequate. As van Fraassen puts it, acceptance of a theory "is a phenomenon of scientific activity" (1980: 12).

S~~The s~~cientific activity is not the activity of philosophers of science but the activity of scientists. Thus, ~~So~~ whether the acceptance parts of realism and empiricism are true ~~or false, not~~ depends not~~ding~~ on whether philosophers of science believe that a theory which scientists accept is true or empirically adequate, but ~~depending~~ on whether scientists believe that a theory which they accept is true or empirically adequate.

How can we adjudicate between the acceptance parts of realism and empiricism? The

[1] Van Fraassen (2017: 102) combines his definitions of realism and empiricism with the English view of rationality to argue that it is *reasonable* to believe that a theory which scientists accept is true but also reasonable to believe that it is merely empirically adequate.

answer ~~to this question~~ is obvious. Given that they are different descriptions of science, they are true only if ~~or false, depending on whether~~ science is as they say it is, which depends on ~~. Specifically, they are true or false, depending on~~ what scientists actually believe. If scientists believe that a theory which they accept is true, then the acceptance part of realism is true and the acceptance part of empiricism is false. In contrast, if scientists believe that it is empirically adequate, then the acceptance part of realism is false and the acceptance part of empiricism is true. Thus, the dispute between realists and empiricists could~~an~~ be resolved by a thorough psychological study on what scientists believe with respect to a theory that they use for scientific purposes.

It follows that i~~I~~t is pointless to construct philosophical arguments, such as the no-miracles argument and the pessimistic induction, to resolve the dispute between realists and empiricists, as defined by van Fraassen. After all, the philosophical arguments say nothing about what scientists actually believe. The no-miracles argument does not claim~~say~~ that scientists believe that successful theories are true, and the pessimistic induction does not claim ~~say~~ that scientists do not believe that successful theories are true. Suppose ~~that~~ van Fraassen has refuted the no-miracles argument with his evolutionary explanation of the success of science. This~~e~~ demolition of the no-miracles argument, however, would~~does~~ not mean that acceptance of a theory does not involve the belief that it is true. That is, even if the no-miracles argument is incorrect, scientists might still believe that a theory which they accept is true. Refuting the acceptance part of realism would require~~s not refuting the no-miracles argument but~~ conducting a psychological survey to ~~on what scientists believe and~~ establish~~ing~~ that scientists do not believe that a theory which they accept is true, and the status of the no miracles argument is irrelevant to that. Accordingly, empiricists have no reason to refute the no-miracles argument.

Many rival~~sing participants~~ in the scientific realism debate, however, do not believe that their disputes could ~~between them can~~ be resolved by a psychological study on what scientists believe. They rather believe that the resolution will arise from the ~~from~~ construction of~~ng such~~ philosophical arguments like~~as~~ the no-miracles argument and the pessimistic induction. They also believe that their disagreement ~~between them~~ concerns not what scientists believe, but the~~what~~ epistemic attitudes we *ought to* take towards theories which scientists use for scientific purposes. It follows that the acceptance parts of realism and empiricism fail to capture the disagreements ~~between the rivaling participants~~ in the scientific realism debate.

If scientists believe that a theory which they accept is true or empirically adequate, that may be an interesting fact that rival~~sing participants~~ in the scientific realism debate can 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 their dispute ~~between the rivaling participants~~, for ~~the dispute~~ it is not about what scientists actually believe but about what we are warranted in believing. As David Hume (1978) famously pointed out, there is a wide gap between descriptive and normative statements.

In this context, it will be~~is~~ useful to consider a standard objection to cultural relativism in ethics. Cultural relativism asserts that cultural approval ~~is what~~ makes an action right, and cultural disapproval ~~is what~~ makes an action wrong. Critics object that, if cultural relativism were true, we could resolve the dispute ~~between retentionists and abolitionists~~ over the morality of the death penalty by conducting an opinion poll. ~~on the general public.~~ 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~~e~~ 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 attitudes towards the death penalty. Therefore, cultural relativism is problematic (Davis, 2014: 78).

A similar objection can be raised against van Fraassen's formulations. Under his formulations, the dispute between realists and empiricists could~~an~~ be resolved by conducting an opinion poll among scientists. If the majority of scientists say that they believe that a theory which they accept is true, then the acceptance part of realism is true and the acceptance part of empiricism is false. In contrast, if the majority of scientists say that they believe that it is empirically adequate, then acceptance part of empiricism is true and the acceptance part of realism is false. A~~The~~ majority opinion, however, cannot resolve the epistemic dispute over whether we are justified in believing that some theories are true or ~~and~~ empirically adequate. No ~~participant~~rivals~~s~~ in the scientific realism debate would give up their positions in the face of the correct descriptions of science.

Empiricists might object that van Fraassen's formulations do not have the absurd consequence that the majority opinion could~~an~~ settle the dispute between realists and empiricists. Even if the majority of scientists were to testify that they believe that a theory which they accept is true, the dispute between realists and empiricists could~~an~~ persist. After all, empiricists could~~an~~ argue that they do not believe what scientists say about what they believe, interpreting what scientists say in their own manner. ~~what scientists say about what they believe.~~ As a result, empiricists could~~an~~ disregard scientists' testimony and stick to their position that scientists believe that a theory which they accept for scientific purposes is empirically adequate.

It would~~is~~, however, be a manifestation of philosophical arrogance to contend that philosophers know better ~~about~~ what scientists believe than the scientists themselves. It is common knowledge in the philosophy of mind that we have a 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. It is not the case that you know more about my mental state than I do. Of course, I may be wrong about my own mental state. But it is still true that I have ~~a~~ better epistemic access to my mental state than anyone else (Goldman, 1993). Therefore, we should put more trust in~~on~~ what scientists say about what they believe than on what empiricists say about what scientists believe.

The acceptance parts of realism and empiricism cannot trigger any epistemological debate between realists and empiricists, since~~for~~ they are not epistemological, ~~theses~~ but psychological theses. They pertain to a debate between rivaling psychologists over whether scientists believe that a theory which they accept is true or empirically adequate. It is therefore not surprising that no participant in the scientific realism debate has attempted to adjudicate between the acceptance parts of realism and empiricism ~~ever~~ since van Fraassen (1980) formulated them. His definitions, however~~though~~, can stimulate formulational debates between rival~~ing~~ philosophers over how useful they are, as the present paper illustrates.

The no-miracles argument and the pessimistic induction have dominated the scientific realism debate since the 1970s (Worrall, 1989: 101, 2011; Psillos, 1996; Magnus and Callender, 2004: 322; Sankey, 2017: 201). Why have ~~did~~ Putnam's formulations, as opposed to van Fraassen's, ~~formulations, have~~ dominated the scientific realism debate for the past several decades? My partial answer to this question is that Putnam's formulations can generate both formulational and epistemological debates, while van Fraassen's formulations can generate only formulational debates.

4. Our Best Theories

How can we adjudicate between rival~~ing~~ formulations of realism and antirealism? The more certain formulations generate debates, the more useful they are. In Sections 2 and 3, I argued that Putnam's formulations can generate both formulational and epistemological debates, whereas van Fraassen's formulations can generate only formulational debates. In this section,

Commented [4]: This move would still accept that the actual content of scientists beliefs was determinative, which means that they have already lost this argument. If the survey didn't capture what scientists believe, then get a better method for finding out the facts.

Commented [5]: I spent a year on this, and I believe the only reason that you think this is common knowledge is because it is not your field.

Commented [6]: If you honestly say that you are in pain, do you think it is possible that you are wrong? Maybe if you didn't know the meaning of the word, but how else would you be wrong about it?

Commented [7]: Here also, is belief simply a mental state?

Commented [8]: So a formulation which got universal assent would be useless? This strikes me as counterintuitive.

I present another reason to~~for~~ think~~ing~~ that Putnam's formulations~~the former~~ are more useful than van Fraassen's~~the latter~~.

Consider that there are many theories in current science, e.g., the special theory of relativity, evolutionary theory, string theory, and so forth. Which of them are our best theories? How can we go about picking them out? ~~our best theories from current science?~~ If the special theory of relativity is one of our best theories, realists would believe that it is true, and empiricists would believe that it is empirically adequate. But is the special theory of relativity one of our best theories? If so, why? Is string theory one of our best theories? If not, why not? In short, ~~what is the definition of~~how do we define 'our best theories'?

The answers ~~to these questions~~ can be found in Putnam's formulation of realism, which~~. It~~ indicates that our best theories are the ones that are successful. We can pick out our best theories ~~from current science~~ by investigating whether a given theory has the property of being successful~~. or not.~~ Given that the special theory of relativity has the property, realists believe that it is true. Given that string theory does not have the property, they do not believe that it is true.

By contrast, van Fraassen's formulation of realism does not contain a ~~the~~ definition of 'our best theories.' By this formulation, r~~R~~ealism claims that science aims to give us true theories, and that acceptance of a theory involves the belief that it is true. Important questions arise. Did science achieve an aim of science by giving us the special theory of relativity and string theory? D~~In other words, d~~o we have sufficient evidence for believing that they are true? Are scientists justified in accepting them, i.e., in believing that they are true? Realism does not have answers to these questions. That is not surprising, given that realism is not about which theories are worthy of our belief, but about whether science aims to produce true theories, ~~or not,~~ and about what scientists believe with respect to a theory that they accept.

So what? Van Fraassen's formulations cannot be utilized by indispensablists in the philosophy of mathematics. Indispensablists ~~are those who~~ 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 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 was constructed by Willard V. O. Quine (1948, 1980, 1992), Putnam (1971), Michael Resnik (1997), and Mark Colyvan (2001). These philosophers do not have the definition of 'our best scientific theories.' Without the definition, however, it is not clear ~~exactly~~ which mathematical statements are worthy of our beliefs, and which mathematical entities can be claimed to be real. For example, are we justified in believing that the mathematical components of the special theory of relativity are true? If so, why? Are we justified in believing that the mathematical constituents of string theory are true? If not, why not? Indispensabilists cannot find the answers to these questions in van Fraassen's definition of realism.

In contrast, indispensabilists can find the answers ~~to those questions~~ in Putnam's definition of realism. We are justified in believing that the mathematical components of the special theory of relativity are true, but not in believing that the mathematical components of string theory are true, because the special theory of relativity is successful whereas string theory is not. Of course, mathematical antirealists might object that we are not justified in believing that mathematical components of successful present theories, including the special theory of relativity, are true, conjuring up the pessimistic induction to show that successful present theories are false, on the ground that since successful past theories were discarded, successful present theories, including the special theory of relativity, will also be discarded. Mathematical antirealists' appeal to the pessimistic induction, however, would demonstrate~~proves~~ that Putnam's formulations can stimulate even epistemological debates between mathematical

Commented [9]:
You said just above that Putnam does have the definition of our best theories, but now, as an indispensibalist he does not?

Maybe you should say something like Van Franssen does not supply these indispensiblists with the definition.

realists and antirealists. Stimulating such debates is a further proof that Putnam's formulations are more useful than van Fraassen's formulations.

5. Conclusion

Putnam's formulations of realism and antirealism can generate both formulational and epistemological debates, whereas van Fraassen's formulations can only generate formulational debates. That distinction partially explains why the former have dominated the scientific realism debate since the 1970s. If you aim to formulate realism and antirealism in a way that can trigger voluminous debates, you are advised to define realism and antirealism not in terms of the aims of science and/or the acceptance of a theory, but in terms of what you think is a common property of our best theories.