The Routledge Handbook of Scientific Realism

Juha Saatsi

Success of Science as a Motivation for Realism

Publication details
K. Brad Wray
Published online on: 01 Dec 2017

How to cite :- K. Brad Wray. 01 Dec 2017, Success of Science as a Motivation for Realism from: The Routledge Handbook of Scientific Realism Routledge
Accessed on: 10 Dec 2021

PLEASE SCROLL DOWN FOR DOCUMENT

Full terms and conditions of use: https://www.routledgehandbooks.com/legal-notices/terms

This Document PDF may be used for research, teaching and private study purposes. Any substantial or systematic reproductions, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The publisher shall not be liable for an loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.
PART II

Classic debate

Core issues and positions
Science is undeniably very successful. All those involved in the debate, realists and anti-realists, are struck by this fact. Science is successful in a number of ways. Our scientific theories enable us to make very accurate predictions of observable phenomena. For example, from Isaac Newton’s theory, Edmond Halley predicted the return of a comet decades in advance. The precision with which scientists have been able to predict some phenomena is quite startling. Urbain Le Verrier predicted the location of the hitherto unseen planet Neptune within 55’ of arc on the basis of Newtonian mechanics and observed anomalies in the orbit of Uranus (see Grosser 1979 [1962]: 118).

Realists marvel at the success of science and see it as providing compelling grounds for believing that the claims our theories make about unobservable entities are likely approximately true and that the unobservable entities posited by our best theories likely exist and likely have the properties that our theories attribute to them. Anti-realists, though, are skeptical about theoretical knowledge. They question whether the success of our current best theories offers adequate support for scientific realism.

All arguments in support of realism involve, in one way or another, some aspect of the success that we attribute to science. The key issues I will discuss here include:

1 What sense of success can the realist appeal to?
2 How are the various kinds of successes meant to support realism?
3 How convincing are the realists’ arguments?
4 What are the anti-realist responses to these arguments?

2 The No Miracles Argument

The No Miracles Argument (NMA), one of the key realist arguments, is motivated by the desire to explain the success of science. The No Miracles Argument notes that if the success of our current scientific theories is not due to the fact that they are true or at least approximately true with respect to what they say about unobservables, then the success of these theories is a miracle (see Putnam 1978). No one is claiming that the success of science is a miracle. So the realist urges us to accept that the success of science is best explained by the hypothesis that our current best theories are probably true or approximately true.
This explanation for the success of science is presented as an argument for scientific realism. It seems that because the realist offers the best explanation for the success of science, we have reason to believe that our theories are in fact approximately true. This pattern of reasoning is non-deductive. It is often referred to as “abductive reasoning” or alternatively as an “inference to the best explanation,” or IBE for short (see J. Saatsi, “Realism and the limits of explanatory reasoning,” ch. 16 of this volume). The best explanation for the success of science, the fact that our theories enable us to make very accurate predictions, is that they are approximately true. Alternative explanations, for example the miracle explanation, are far less plausible. Though it is not logically impossible that our theories misrepresent the world and their success is just a happy accident, realists claim that it is quite unlikely that this is the case.

### 2.1 Refining the No Miracles Argument

More recently, Alan Musgrave has suggested that a revised version of the No Miracles Argument would strengthen the case for realism (Musgrave 1988: 239–240). Musgrave believes that what needs to be explained are not just any successes of a theory but rather a specific class of successes, the successful predictions of novel phenomena. “A predicted fact is a novel fact for a theory if it was not used to construct the theory” (Musgrave 1988: 232). Musgrave refines the No Miracles Argument further. He suggests that it is not enough to merely show that the best explanation for the success of a particular scientific theory is that it is approximately true. Rather, the explanation that appeals to the truth must pass some sort of threshold of plausibility. The exact details of when an explanation does pass the threshold are not specified, and Musgrave recognizes that this issue needs to be addressed (see Musgrave 1988: 239). But if a theory does in fact predict some otherwise unpredictable phenomena that it was not designed to account for, then it seems there is some reason to believe the theory is likely approximately true.

Though Musgrave suggests that this is a strong argument in support of scientific realism, he does raise a concern for the Ultimate Argument, as he calls it. Contemporary realists and anti-realists are divided on the goals of science. Realists believe that scientists seek to explain the phenomena (see Musgrave 1988: 246). Some contemporary anti-realists, on the other hand, suggest the goal of science is merely to “save the phenomena,” that is, account for the observables. As a result, anti-realists are not likely to be persuaded by an explanationist defense of realism, the sort of defense offered by the No Miracles Argument (see Musgrave 1988: 249; see also Lipton 2004: 186). Anti-realists, after all, do not think explanation is a goal of science.

Larry Laudan raises a more serious concern for the No Miracles Argument. He argues that inferring the truth of a theory from its success is an instance of the fallacy of affirming the consequent (see Laudan 1981: 45). And Greg Frost-Arnold (2010) argues that the scientific realism that appears in the No Miracles Argument makes no new predictions and thus fails as a scientific theory about the success of science (see also Doppelt 2005: 1080).

Eric Barnes (2002), though, argues that a version of the No Miracles Argument can be defended provided it can be shown that “the rate at which empirically successful theories emerge is significantly higher than one can attribute to chance” (Barnes 2002: 117).

### 2.2 Novel predictions

As mentioned, one thing that makes the scientific realists’ No Miracles Argument seem compelling is the fact that our best theories often enable scientists to predict novel phenomena, phenomena that our theories were not initially designed to explain or predict.
Jarrett Leplin (1997) believes that novel predictions provide the best defense of scientific realism. It is certainly impressive when a scientist is able to derive some hitherto-unnoticed observable consequence from a theory and then discovers that the world is as she predicts. Galileo, for example, predicted that Venus would exhibit the full range of phases like the moon if the Copernican theory were correct. The Ptolemaic model for Venus’s orbit, on the other hand, was incompatible with this prediction. Importantly, the phases of Venus can only be seen with the aid of a telescope, and over the course of many months. In order to secure his priority in making the discovery, Galileo sent the prediction encoded in an anagram in a letter to Johannes Kepler. When Galileo’s observations confirmed that Venus does exhibit the range of phases, Copernicus’ theory did attract the attention of more astronomers. One can see why the realist is tempted to say that such successes are inexplicable if they are not a consequence of the fact that the theory from which the predictions were derived is in fact approximately true.

But throughout the history of science there are numerous cases in which vindicated predictions of novel phenomena were derived from false theories. Peter Vickers (2013) and Timothy Lyons (2002) have identified a number of cases in which various novel phenomena were successfully predicted on the basis of theories that were subsequently discovered to be false (see also Saatsi and Vickers 2011). Lyons provides a long list of novel successes from 13 different theories that we now regard as false, including predictions derived from the caloric theory, Newtonian mechanics, Fresnel’s wave theory of light, and Dalton’s atomic theory (see Lyons 2002: 70–72). Some of these theories supported a number of successful predictions of novel phenomena. Even the phlogiston theory enabled scientists to generate vindicated predictions of novel phenomena. For example, “Priestley predicted and confirmed that heating a calx with ‘inflammable air’ (hydrogen) would turn it into a metal” (see Vickers 2013: 191).

These examples of vindicated predictions of novel phenomena derived from false theories suggest that the realists’ appeal to novel predictions does not settle the issue in favor of the realists’ explanation for the success of science.

### 3 Rethinking the evidence of success

Realists who appeal to the No Miracles Argument assume that success is a reliable indicator of the truth of a theory. A number of philosophers, though, have suggested that the realists’ No Miracles Argument commits the base-rate fallacy. In the No Miracles Argument the relevant base-rate is the rate of approximately true theories in the population of successful theories. If there are many successful but false theories and few approximately true successful theories, then it is fallacious to infer that a successful theory is likely true (see Howson 2000: 54; Magnus and Callender 2004: §§2–4; Lipton 2004: 197–198; Worrall 2012: §4.3). Colin Howson (2013) expresses the point in the following way. The “fallacy . . . consists in ignoring the dependence of the posterior probability on the prior [probability]” (2013: 206). The prior probability of a successful theory being true is quite low if in fact there are many successful but false theories. For success to be a reliable indicator, it would have to be the case that most successful theories are true (see Wray 2013).

Laudan has developed a sustained attack against the realists’ claim that success and truth are connected in a way that would make success a reliable indicator of the truth of our theories. Laudan (1981) argues that the realist is mistaken (i) in regarding success as a reliable indicator of the truth of a theory, and (ii) in regarding success as a reliable indicator that the theoretical terms in a theory genuinely refer, that is, that the theoretical entities posited by our successful theories really exist. Laudan argues that there are a number of successful theories in the history of science that, by the lights of today’s best theories, we regard as false. Hence, not all successful
theories are even approximately true. Similarly, Laudan argues that many successful theories of the past have turned out not to have genuinely referring theoretical terms. For example, the phlogiston theory had a number of successes, but contemporary scientists believe there is no such substance as phlogiston. Hence, not all successful theories have genuinely referring theoretical terms.

Laudan’s general point is that theoretical truth in science is not systematically tied to empirical success, as realists assume. But realists generally assume that success is a reliable indicator of truth. Laudan has extended this attack by suggesting that other theoretical virtues, like scope and simplicity, are not tied to the truth in any reliable or systematic way. The fact that one theory purports to explain more things than a competitor theory does not give us adequate reason to believe the theory with the larger scope is true or even more likely true than the competitor (see Laudan 2004).

Eric Winsberg (2006) also argues that success and truth are not linked in the strong way that realists assume in the No Miracles Argument. Winsberg is specifically concerned with simulation models that scientists design and use that incorporate “contra-factual principles” that make the models more accurate than they would otherwise be (Winsberg 2006: 1). Such models pose a serious challenge to any form of realism that takes success to be a reliable indicator of the truth of scientific theories and models. It is only with the aid of the contra-factual principles that the models are able to generate the successes they do.

Peter Lewis (2001) has understood the connection between success and truth differently from Laudan. Lewis does not think that the realist needs to show that most successful theories are true in order to claim that success is a reliable indicator of the truth. Rather, Lewis believes that success is a reliable indicator of truth provided a higher proportion of successful theories are true than are unsuccessful theories. Thus, even if most successful theories are false, success can be a reliable indicator. K. Brad Wray (2013) has challenged Lewis on this claim. Wray argues that in order to support the realists’ claim about the approximate truth of our current best theories, the realist needs to argue that most successful theories are approximately true. Otherwise, the fact that a theory is successful provides little reason for believing it is approximately true.

4 Abductive inference

The No Miracles Argument has given rise to a number of related debates, including a debate about the power and scope of abductive reasoning.

Richard Boyd (1984) argues that abductive reasoning figures in the strongest defense for realism. Boyd believes that a key challenge facing realists and anti-realists is to explain the instrumental reliability of the methods of science. Realists and anti-realists believe that the methods of science are instrumentally reliable; they enable scientists to develop theories that generate and continue to generate true predictions. Boyd argues that the best explanation for the reliability of our current best methods is that they are conducive to leading scientists to develop theories that are approximately true. These methods, Boyd argues, were developed with the aid of background theories that are themselves approximately true. The anti-realist, he suggests, provides no explanation for the instrumental reliability of our current best methods.

Boyd claims that the reliability of scientific methods explains why the history of science is marked by ever-increasingly more accurate theories (see Boyd 1984: 59, 64). Further, Boyd believes that the anti-realist’s “rejection of abduction . . . would place quite remarkable strictures on intellectual inquiry” (Boyd 1984: 67). Without abduction as a resource, our scientific knowledge would be extremely limited. It would amount to a form of skepticism far beyond the sort of skepticism of theoretical knowledge that contemporary anti-realists aim to defend.
Eric Barnes, though, argues that Boyd’s explanation for the success of science just pushes the need for an explanation of the success of science further back. According to Barnes, Boyd needs to explain why it is that scientists were able to develop approximately true background theories (see Barnes 2002: 100–101).

Peter Lipton (2004) provides an extensive analysis and defense of abductive reasoning in science and everyday life, including its relevance to the realism/anti-realism debate. He is less sanguine about the power of abductive reasoning. People and scientists in particular use abductive reasoning on a regular basis. For example, a person may “infer that the fuse is blown . . . because none of the lights or electrical appliances in the kitchen are working” (Lipton 2004: 202). This is a typical example of abductive reasoning. Positing a hitherto-unseen blown fuse explains the phenomena and does so better than alternative explanations. Scientists also use abductive reasoning. An archaeologist may find the skeletal remains of two humans at an excavation, where one is buried 30 centimeters below the other. She then concludes that the best explanation for the relative proximity of the two sets of human remains is that the one found deeper in the ground died at an earlier time. Clearly, the archaeologist could be mistaken, but, other things being equal, this is a reasonable inference.

But Lipton thinks that the No Miracles Argument involves an illegitimate application of abductive reasoning. Lipton believes that unlike the Inferences to the Best Explanation that scientists make, the inference in the No Miracles Argument is not a causal Inference to the Best Explanation. Consequently, it does not provide warrant for the conclusion (see Lipton 2004: 196). Further, Lipton claims that the underdetermination of theory choice by data poses a serious threat to the No Miracles Argument. This makes an Inference to the Best Explanation unwarranted in this context. Theory choice is underdetermined when there are two or more theories that can account for the available data equally well. Often the competing theories cited are merely logically possible alternative theories. But sometimes in the history of science scientists have encountered transient underdetermination, a choice between two real theories that are equally well supported given the available data. The existence of competing theories that are as successful as the currently accepted theory undermines the inference from the success of a theory to its truth (Lipton 2004: 196).

Bas van Fraassen (1989) has developed a more wide-ranging attack on abduction than Lipton’s, one that has significant implications for the realists’ appeal to abductive inference. Van Fraassen argues that there is no principle of abductive reasoning that is binding on all rational agents. There is no rule of reasoning that says it is irrational not to believe “the best explanation.” Van Fraassen notes that unless we have good reason to believe that we are choosing between a set of alternative explanations that includes the truth in it, then reasoning abductively can be detrimental. When the set of alternative explanations or theories we are choosing between does not include the true explanation or theory, then we will be led to believe the best of a bad lot (see van Fraassen 1989: §4).

Van Fraassen’s position is frequently misunderstood, so it is worth emphasizing that he is not saying that it is irrational to reason abductively. His claim is weaker than this. He claims that the canons of rationality do not demand that one believe an explanation that is merely supported by an inference to the best explanation. In fact, the canons of rationality do not demand or prescribe belief in any scientific theory. It is enough for scientists to accept the best supported theory, where acceptance involves a commitment to work with a theory, which is something less than belief in the truth of a theory.

Van Fraassen also argues that the Ultimate Argument for Scientific Realism considers a rather narrow set of explanations, specifically (i) our theories are likely true, or (ii) the success of our theories is due to a miracle. These options hardly exhaust the possibilities. Van Fraassen argues
that there is bound to be an alternative explanation for the success of science, and quite likely a more plausible one (van Fraassen 1980: 38–39; see also Wray 2007). Van Fraassen’s preferred alternative is discussed in detail in what follows.

5 Selective realism: isolating the cause of success

Insofar as realists are driven by the need to explain the success of science, they only need to be realists about those parts of theories that are responsible for the successes of our theories (see P. Vickers’s “Historical challenges to realism,” ch. 4 of this volume). Some realists have attempted to defend realism by isolating those parts of theories that are responsible for their success. These realists recognize that no theory is likely completely true. But they also insist that it is quite probable that those theories that have been successful are either approximately true or have truth-like qualities. This form of realism is called “selective realism” in recognition of the fact that the realist can be selective about which of the claims implied by her theory she is committed to. Alternatively, this position is called “deployment realism” or “preservative realism.”

Both Philip Kitcher (1993) and Stathis Psillos (1999) have defended a form of selective realism. Kitcher distinguishes between the working posits of a theory, those elements that are causally responsible for a theory’s successes, and the presuppositional posits of a theory. The latter are the sorts of things that are abandoned over time, as scientists refine their theories. The former, on the other hand, are retained through theory change. With this distinction, Kitcher believes he can reconcile realism with revolutionary changes of theory, which seem to be an undeniable part of science.

Similarly, Psillos recognizes that scientists are apt to (i) develop better theories in the future and (ii) discover that their predecessors held false beliefs. But he argues that through a change of theory some elements of the theory that is being replaced are retained and that these are the parts of the theory that were causally responsible for the successes of the theory. Consequently, Psillos argues that theory change need not threaten the growth of theoretical knowledge.

Selective realism has some prima facie plausibility. It is a modest form of realism and acknowledges that in the future scientists are apt to develop even better theories, even in those fields in which scientists are able to make extremely precise predictions. But some critics have suggested that it is only retroactively that the selective realist can identify which elements in a theory are the working posits. Selective realists are in no position to indicate which posits in a currently accepted theory are the genuine working posits that will be retained in the future and which are merely presuppositional and thus apt to be abandoned in the future. Its explanatory power is post hoc (see Stanford 2003: 569; Chakravartty 2007: 46). In this respect, selective realism is of limited value. Gerald Doppelt raises a different concern for selective realists. He believes that selective realists, Psillos in particular, fail to realize that “realists are committed to accounting for the explanatory success of theories, not their mere empirical adequacy or instrumental reliability” (Doppelt 2005: 1076). That is, “what the . . . realist needs to but cannot explain is the explanatory success of theories; why theories succeed in producing simple, consilient, intuitively plausible, unifying, and complete accounts of observed phenomena” (2005: 1084).

Despite these criticisms, selective realism is still regarded as a viable position. David Harker (2010), for example, argues that a stronger selective realism can be defended that focuses on the comparative achievements of successor theories. If a new theory is more accurate than its predecessor, we have reason to believe that the new theory is relatively closer to the truth and that the greater accuracy is due to the elements of the new theory that are different from those of its predecessor. Harker, though, rightly resists the temptation to speculate how close our current theories are to the truth.
6 The varieties of success in science

In recent decades there has been a proliferation of types of scientific realism. These various positions are developed in response to some of the concerns discussed already. Common to all of them is a recognition that realists may need to be more modest than they have been in the past. The ways in which our theories latch onto reality are more circumscribed than previously assumed. Some realists have conceded that changes of theory have been ubiquitous in the history of science and are likely to continue into the future. But some insist that through radical theory change progress is still possible. This line of defense has taken a variety of forms.

Some claim that scientists often retain the theoretical equations used in earlier theories. The fact that a theoretical equation is retained through a change of theory suggests that the equation is getting at the underlying structure of reality. This position is called structural realism and is defended by John Worrall (1989) and James Ladyman (1998), among others. Structural realists claim that the theoretical equations describe the formal structure of the world, and this is where scientific knowledge is growing. James Clerk Maxwell, for example, was able to retain Augustin-Jean Fresnel’s theoretical equations despite the fact that Maxwell made radically different assumptions about the nature of light. Whereas Fresnel regarded light as a wave moving through the ether, Maxwell regarded light as a periodic disturbance “in the ‘disembodied’ electromagnetic field” (see Worrall 1989: 116). As far as Worrall is concerned, the mistake of many is to think that we are deepening our understanding of the theoretical entities posited by our theories. Despite the fact that Fresnel’s and Maxwell’s beliefs about the nature of light were mistaken, the persistence of the theoretical equations through radical changes of theory suggests that scientists really have latched onto an understanding of the underlying structure of phenomena related to light.

Alternatively, both Ian Hacking and Anjan Chakravartty emphasize the fact that scientists are able to manipulate the world in very precise and subtle ways. This is a different type of success than prediction, the focus of the arguments discussed earlier.

Hacking (1983) defends a view called “entity realism,” which he developed as he worked on scientific experimentation while he studied the scientists at the Stanford Linear Accelerator Center (SLAC; see Hacking 1983: ch. 16). Hacking notes that when scientists can use a particular theoretical entity in their investigations of other purported entities, they have strong evidence that the entity they use as an instrument exists, even if they may be mistaken about some of the properties of that type of entity. For example, Hacking notes that scientists studying photons use electron guns as tools in their investigations. Hacking claims that the predictable way in which scientists manipulate electrons as instruments provides strong evidence that electrons exist. Importantly, Hacking notes that the various scientists involved in such experiments may have very different views about the properties of electrons (Hacking 1983: 264).

Axel Gelfert (2003) argues that Hacking’s suggested criterion of manipulative success is not a sufficient condition for determining the existence of entities. So-called quasi-particles satisfy the criterion despite the fact that they are not entities.

Hacking’s entity realism suggests that there is no plausible global defense of realism. Rather, we are required to consider the case for each type of theoretical entity independently. Similarly, Magnus and Callender argue that the only defensible arguments in support of realism are local arguments pertaining to specific entities and scientific specialties. Thus, in order to make any progress in the realism/anti-realism debate, the battle needs to be fought on a case-by-case basis (Magnus and Callender 2004; see also Achinstein 2002).

More recently, Chakravartty (2008) has argued that scientists are accumulating knowledge of the properties they study rather than the theoretical entities they posit. In fact, Chakravartty believes that the structure that is captured in the equations that persist through theory change
K. Brad Wray captures the relations between properties. Chakravartty’s view can be regarded as a form of Structural Realism. Importantly, his view provides an answer to a criticism that is frequently raised against Structural Realism: what exactly is structure?

Kitcher (2001) develops what he calls a “Galilean strategy” in defense of realism, an argument aimed at showing that anti-realists are overly skeptical about the claims that scientists make about unobservable entities. As the name suggests, Kitcher draws inspiration from Galileo. In *Starry Messenger*, Galileo reported his first telescopic discoveries: the uneven surface of the moon, the fact that there are many more stars in the sky than can be seen with the naked eye, and the hitherto unseen moons of Jupiter. When challenged about the reliability of the telescope as an instrument for astronomical discoveries, Galileo argued that because we can confirm the reliability of the telescope on earth, and there is no reason to believe that the telescope is unreliable when looking at celestial objects, there is no reason to believe that the various things he reported seeing through the telescope are not in fact as they appear through the telescope. Galileo thus shifted the burden of proof to his skeptical opponents. Similarly, Kitcher argues that unless there is some independent argument against extending the reliability of a scientific instrument from what we can observe directly to what we can only detect indirectly, there is no reason not to be realists about the sorts of entities that figure in our successful theories. The anti-realist, Kitcher claims, owes us an argument for why we should not trust our instruments and theories that have proved successful with respect to directly observable entities.

Unlike Kitcher, P. D. Magnus thinks that the onus for proof is on the realist to supply some independent grounds for thinking that the reliability of instruments can be extended into realms beyond our direct perception (see Magnus 2003). Magnus grants that in the case of Galileo’s telescopic observations, there was reason to believe that optical laws did not change from one locale to another. But Magnus doubts that realists are in a similar position with respect to many of the other sorts of unobservable entities postulated by scientific theories.

On the one hand, the proliferation of varieties of realism shows the ingenuity of realists in meeting the challenges posed by anti-realists. On the other hand, the lack of consensus amongst realists seems to suggest that they are, in some respects, on the defensive. Realism may be more threatened than is commonly thought.

7 Anti-realist alternatives

Realists often claim that anti-realists are unable to explain the success of science. If we reflect on the nature of the No Miracles Argument we realize that the realist is claiming that there really is no alternative to the realists’ explanation for the success of science. To attribute the success to a miracle really amounts to no explanation at all. No one seriously believes that the success of our current theories is a result of a miracle.

This has put anti-realists on the defensive. If anti-realism is to be at all plausible, then anti-realists will need to give some indication of how it is that our best theories are able to deliver successes on a regular basis, and often with great precision.

Van Fraassen (1980) suggests that the anti-realist can explain the success of science by appealing to a selection mechanism, a mechanism comparable to natural selection in the biological world. Van Fraassen argues that the success of our current best theories is a consequence of the fact that theories that fail to generate accurate predictions are abandoned. Importantly, van Fraassen’s selectionist explanation does not assume that successful theories are likely approximately true with respect to what they say about unobservables. Van Fraassen (1980) compares the selection of successful theories to the fact that all the mice we encounter run from cats. Those mice that do not run from cats are less apt to survive long enough to breed and leave offspring. Other
things being equal, those mice that do run from cats are more likely to survive and produce offspring. As van Fraassen notes, we need not assume the mice that run from cats perceive cats to be their natural enemies. All the mice need to do is run from cats. Successful theories are similar. All a theory needs to do in order to survive is to be successful, to generate true predictions of observable phenomena. Strictly speaking, even less is required. All a theory needs to do is be more successful than existing competing theories (see Wray 2010).

Realists are critical of this anti-realist explanation for the success of science, noting that it is unlikely that a false theory would continue to remain successful over time. Despite the commonsense plausibility of this criticism, as a matter of fact we know from the history of science that false theories have enjoyed successes, and often for long periods of time.

Wray (2007, 2010) has defended van Fraassen’s selectionist explanation for the success of science against a series of criticism. Wray notes that scientific success is a relative term. Standards of success, including standards of accuracy, have changed over time. And a successful theory is just one that is better than the available alternatives. Wray also argues that provided a theory is applied to problems and phenomena similar to the problems and phenomena it was initially designed to address, it should not surprise us that a successful theory continues to be successful.

This is not the only anti-realist response to the realists’ challenge for an explanation for the success of science. Kyle Stanford (2000) argues that the most we can reasonably infer from the predictive successes of a theory is that either (i) it is approximately true or (ii) it is predictively similar to the truth. Psillos objects to Stanford’s argument, claiming that his appeal to predictive similarity is parasitic on the truth (see Psillos 2001: 352). Psillos argues that insofar as predictive success is distinct from the truth, the predictive success of one theory in a specific scientific specialty cannot explain the predictive successes of successor theories in that specialty.

8 Concluding remarks

Those who appeal to the success of science as support for scientific realism face some serious challenges:

1. They need to clarify the notion of success relevant to their arguments. Though science is successful in many ways, maybe only some successes provide evidence that our theories are latching onto reality. And the traditional appeal to explanatory success seems threatened by evidence from the history of science.
2. They need to be more precise about the correlation between the success of a theory and the nature of their realist commitments. And it seems clear that the base-rate fallacy poses a threat to probabilistic versions of the No Miracles Argument.
3. They may also want to explore ways in which local arguments for realism can be developed. A global argument like the traditional No Miracles Argument seems doomed.

Further reading

Stathis Psillos’s Scientific Realism: How Science Tracks Truth is the most useful introduction to scientific realism in general. Chapter 4 provides an analysis of the No Miracles Argument, and Chapter 5 provides a clear and accessible introduction to his selective realism. Alan Musgrave’s “The Ultimate Argument for Scientific Realism” (in R. Nola, ed., Relativism and Realism in Science) also provides an accessible and useful introduction to the No Miracles Argument. Peter Lipton’s Inference to the Best Explanation (2nd edition) is a useful guide to Inferences to the Best Explanation and includes an analysis of the Miracles Argument, as he calls it, in Chapter 11. John Worrall’s “Structural Realism:
The Best of Both Worlds?” (in *Dialectica*) remains one of the best introductions to Structural Realism, which, though an elusive position, is still a very influential view in the contemporary debates. Larry Laudan’s “A Confutation of Convergent Realism” (in *Philosophy of Science*) provides a sustained attack on the alleged connection between empirical success and theoretical truth.

**Acknowledgement**

I benefited enormously from critical feedback from Juha Saatsi and Lori Nash. Part of the research for this article was completed while I was a Visiting Scholar in the Department of Linguistics and Philosophy at the Massachusetts Institute of Technology. I gratefully acknowledge the support of MIT. I also thank the State University of New York, Oswego, for my sabbatical leave in the 2015–2016 academic year, providing me with the time to work on this project.

**Notes**

1. Psillos argues that it is a mistake to treat scientific realism as a scientific hypothesis. Psillos explains that “scientific realism is not a theory; it’s a framework which makes possible certain ways of viewing the world” (Psillos 2011: 33).

2. In order to account for the fact that Venus never appears more than 45° from the sun, in devising a model for Venus Ptolemy stipulated that the center of Venus’s epicycle must always lie on a line running from the center of the earth to the sun. Given this restriction, Venus would not exhibit the full range of phases as the moon does.

3. The phases of Venus were compatible with Tycho Brahe’s theory. Consequently, Galileo’s vindicated prediction did not persuade all astronomers to accept the Copernican theory.

4. Lewis’s notion of a reliable test or indicator is adopted from reliable medical tests. A test for cancer, for example, is regarded as reliable if it has a low rate of false positives and a low rate of false negatives. False positives are test results that indicate cancer when in fact the subject does not have cancer. False negatives are test results that indicate no cancer when in fact the subject has cancer (see Lewis 2001: 374–375).

5. Worrall suggests that the position can be traced back to Henri Poincaré (see Poincaré 2001 [1903]).

6. Matthias Egg distinguishes between causal warrant and theoretical warrant and argues that there is causal warrant for realism about particle physics (see Egg 2012). Physicists, Egg claims, are sometimes warranted in making an inference to the most likely cause of the effects they study in the lab, as they did with the discovery of neutrinos.

7. Kitcher and Magnus misrepresent the historical details in this case. Well into the early 1600s, it was commonly believed in scientific circles that the terrestrial realm and the celestial realm were made of radically different substances. The terrestrial realm was made of four basic elements: earth, air, water, and fire. The celestial realm, on the other hand, was made of quintessence or ether, an indestructible element. On the basis of this distinction, it seems reasonable to doubt the veracity of the telescope with respect to observations of celestial objects. So the burden of proof may have been on Galileo.

**References**


Success of science as a motivation