

Scientific realism and the inevitability of science

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Abstract: This paper examines the question of whether scientific realism is committed to the inevitability of science or is consistent with claims of the contingency of science. In order to address this question, a general characterization of the position of scientific realism is presented. It is then argued that scientific realism has no evident implications with regard to the inevitability of science. A historical case study is presented in which contingency plays a significant role, and the appropriate realist response to this case study is indicated. Finally, it is argued that, when conjoined with a reliabilist theory of method, realism does have implications for the inevitability of science.

Keywords: Inevitability, contingency, scientific realism, reliabilism, Hacking

1. Inevitabilism

In *The social construction of what?* (1999), Ian Hacking describes a position which he refers to as *inevitabilism*. According to Hacking, inevitabilists

... do not think that the progress of physics was inevitable (we could have stayed with Zen). They do think that *if* successful physics took place, *then* it would have inevitably happened in something like our way. (1999, p. 79)

The inevitabilist position is opposed to a position which emphasizes the contingency of science:

... there could have been a research program as successful (“progressive”) as that of high-energy physics in the 1970s, but with different theories, phenomenology, schematic descriptions of apparatus, and apparatus, and a different, and progressive, series of robust fits between these ingredients. Moreover ... the “different” physics would not have been equivalent to present physics. Not logically incompatible with, just different. (1999, p. 72)

Though Hacking restricts the discussion to physics, the contrast he has in mind may be characterized more generally as follows. On the one hand, the inevitabilist holds that science, properly conducted, will tend to converge on a single unified theory of the world. This theory will closely resemble current science, though it will be refined in various ways. On the other hand, the opposing position – we might call it *contingentism* – holds that science, properly conducted, might well have led to a completely different theory of the

world from that of contemporary science. There is nothing inevitable about the way science views the world.¹

The contingentist claim is not a claim about the way the world is, independently of humans. It is a claim about the way in which our epistemic practices engage with the world. It is a claim about the extent to which contingencies pervade scientific practice. Scientists might collect different evidence from the evidence they in fact do collect. They might have developed different instruments and techniques from the ones which have been developed and put to use. They might be influenced by different historical circumstances or pursue different interests. As a result, there are countless ways in which the empirical basis of science might be different from what it is, and might provide empirical support for a range of alternative possible scientific views of the world. In addition, scientists who accept different theories, or who work in different scientific research traditions, may bring different theoretical commitments to bear on the scientific problems they address. Even the methodology of science is contingent. Scientists might employ different methods and procedures from those which they now employ.

The contingency of scientific theory, method and practice is a separate matter from the issue of whether the world itself has a determinate character. It is a point about the nature of scientific inquiry into the world. It is only a point about the world to the extent that it is claimed that the world allows such potential flexibility of scientific practice.

Hacking claims that the thesis of the contingency of science is consistent with scientific realism (1999, pp. 79-80). But the idea that scientists could just as well endorse a quite different set of scientific theories from the ones that they in fact endorse does not sit easily with the realist's view that the well-established theories of contemporary science are approximately true. If our current theories are approximately true, but quite different theories might just as well have been arrived at by scientists, then why should we be confident about the theories of contemporary science? If science could just as well have come up with radically alternative empirically supported theories, then why should we think that our current theories are approximately true?

In this paper, I will consider the question of whether the scientific realist should endorse a thesis of the inevitability of science or rest content with a contingency thesis. After some preliminary clarification, I will provide a general characterization of the position of scientific realism. I will then argue that scientific realism has no evident implications with regard to the inevitability of science. After that, I will present a historical case study in which contingency plays a significant role, briefly noting the appropriate realist response to this episode in the history of science. Finally, I will argue that, if combined with a reliabilist theory of method, realism does have implications for the inevitability of science.

2. Necessity and fallibilism

Talk of contingency and inevitability raises questions about necessity and certainty in science. To clarify what is at issue in relation to the inevitability of science, I will offer some preliminary clarification of these matters before turning to the question of scientific realism and the inevitability of science.

2.1 Contingency and necessity

Logicians distinguish between statements whose truth is contingent and statements whose truth is necessary. The statement '2+3=5' is a necessary truth, whereas the statement 'There

are five coins in my pocket' is not. It is contingent that I have five coins in my pocket, since I might have lost the coins through a hole worn by my keys on the way to work this morning.

One might ask the question whether the truths of science are necessary or contingent. It might be argued that the observation reports of science are factual statements that report facts which might have been otherwise, and so are contingent. Opinion might then divide over the question of whether laws of nature have the status of contingent or necessary truths.

But the question whether the truths of science are necessary or contingent is a different question from the question of the inevitability of science. The question of the inevitability of science is the question of whether the methods and practices of science might have led to a different set of scientific claims about the world from the ones that we currently take to be true. Even if it is true that science is contingent in the sense that scientific inquiry might have led to a different set of claims about the world, nothing follows from this with respect to whether the claims that science asserts about the world are themselves contingent or necessary claims about the world. The question of the inevitability of science is not a question about the logical status of the claims that form the content of science. It is a question about the outcomes of the processes of science.

2.2. Fallibilism and revisability

Philosophers of science have been impressed by science as an ongoing process of revision at both the factual and the theoretical levels. As a result, contemporary philosophers of science typically endorse a position of fallibilism. According to the fallibilist, scientific knowledge is uncertain knowledge. Our best-established theories, even the seemingly most incontrovertible of facts, may some day be shown to be false by future scientific developments. While science aims at and may even advance on truth, it does not progress toward truth by a series of infallible steps.

Here we might distinguish between a naive version of inevitabilism and a refined version. The naive inevitabilist assumes that science advances on truth by a series of unflinching, secure steps. Such a naive stance conflicts with fallibilism. For the fallibilist points to the existence of scientific theory-change, to previously rejected theories which have returned to prominence and to factual statements which have been rejected as false, as evidence that the advance of science is not an unflinching progress toward certain truth. By contrast, the refined form of inevitabilism recognizes the self-corrective nature of science and allows that progress is fallible, while nevertheless asserting that, in the long run, the processes of science will tend to converge on truth. Such refined inevitabilism is consistent with fallibilism.

More precisely, the refined version of inevitabilism is consistent with fallibilism in the short to medium term. It may not be consistent with fallibilism in the long run, as the end of science approaches. For if science inevitably converges on truth in the long run, then the scope for revision and self-correction would appear to be reduced as science approaches the inevitable end-point. The closer science gets to the truth, the less likely it is for revision to occur. Inevitabilism therefore seems to entail infallibilism in the long run. Conversely, a radical form of fallibilism according to which science is destined to remain forever open to revision seems akin to contingentism.²

But the fact remains that if the position of inevitabilism is to be taken seriously within the context of contemporary philosophy of science, it must be understood as a refined inevitabilism which assumes a fallibilist stance toward science, even if it falls short of fallibilism in the long run. Given the widespread acceptance of fallibilism, the naive version

of inevitabilism would be rejected as committed to an implausible conception of science. Thus, in what follows, I shall assume that the inevitabilist position at issue is a refined, fallibilist version of inevitabilism, at least with respect to the short to medium term.

3. Scientific realism

Before turning to the question of the realist view of the inevitability of science, I will briefly sketch the position of scientific realism. This sketch of scientific realism is based on a characterization of the position that I have formulated elsewhere (Sankey, 2001).

It is characteristic of scientific realism that the aim of science is taken to be truth. This has the consequence that progress in science is understood as progress toward the truth. Hence, the first principle I propose of scientific realism is a principle about the aim of science:

1. *Aim realism*: the aim of science is to discover the truth about the world, and scientific progress consists in advance toward that aim.

It is not enough, however, to stipulate that truth is the aim of science. For the aim is not merely to obtain the truth about the world, but to acquire knowledge. Though it is possible to combine epistemic scepticism with various elements of realism, the main thrust of scientific realism is to provide an epistemological defense of science. I therefore propose the following epistemological principle of realism:

2. *Epistemic realism*: scientific inquiry leads to knowledge of the world.³

While some philosophers of science (e.g., instrumentalists) propose an anti-realist construal of discourse about theoretical entities, it is a defining feature of scientific realism to employ a realist treatment of such discourse. In particular, the realist adopts a literal interpretation of theoretical discourse as discourse that purports to refer to real things:

3. *Theoretical discourse realism*: scientific discourse about theoretical entities is to be interpreted in literal fashion as discourse that is genuinely committed to the existence of real unobservable entities.

But the realist does not merely assert that talk about theoretical entities is to be construed literally. By contrast with various forms of idealism, the scientific realist is a realist not just about such entities but about the ‘external world’:

4. *Metaphysical realism*: the world investigated by science is an objective reality that exists independently of human thought.

Though there is an important school of realists (‘entity realists’) who downplay the role of truth, in its standard form scientific realism places considerable weight on truth as the aim of science and a component of knowledge. Realists usually understand truth as a relation of correspondence between assertion and reality:

5. *Correspondence theory of truth*: truth consists in correspondence between a claim about the world and the way the world is.

Because the correspondence theory of truth is consistent with a variety of alternative metaphysical views, it is important to note that what makes assertions true in the correspondence sense is the way things stand in the objective world:

6. *Objectivity of truth:* theories or claims about the world are made true (or false) by the way things are in the mind-independent, objective reality investigated by science.

Scientific realism thus emerges as an anti-sceptical, metaphysical realist doctrine, according to which science aims at truth about observable and unobservable dimensions of the world, where truth is understood as correspondence to an objective reality.

4. Realism and inevitabilism

No explicit statement about the inevitability of science occurs among the principles of scientific realism that have just been presented. So, in a strict sense, scientific realism says nothing about the issue. But the question remains of whether the principles of realism may have implications with respect to the inevitability of science. I will now consider a number of connections which might be drawn between various principles of realism and the issue of the inevitability of science.

To begin with, it might be thought that the principle of aim realism has implications with respect to the inevitability of science. According to aim realism, truth is the aim of science and scientific progress consists in advance toward this aim. Provided that science does progress toward truth, this may suggest that science will converge on a single true picture of the world. Such convergence might, indeed, appear to be an inevitable outcome of scientific progress toward truth.⁴

But there need be no commitment on the part of aim realism to convergence on a single true theory of the world. Nor need there be any commitment to the inevitability of convergence on such a unique theory. Realism has sometimes been characterized in terms of the view that there is one true and complete description of the world which it is the purpose of science to discover (e.g. Putnam, 1978, p. 49). But the idea of a single true and complete description of the world plays no part in scientific realism as characterized here. Nor need the aim realist claim that scientific progress consists in advance on truth be construed in terms of convergence on a single complete theory of the world. If there is such a theory, then scientific progress will consist in convergence on this theory. But, equally, scientific progress might provide an increase in truths known about the world without those truths adding up to a single, coherent theory of the world. It might simply be an increase of truth.

As for epistemic realism, it is not clear that the view that science leads to knowledge of the world implies anything at all about the inevitability of any particular scientific conception of the world. However, there is a possible inevitabilist interpretation of epistemic realism which turns on an appeal to metaphysical realism and the objective nature of correspondence truth. In light of metaphysical realism, one might argue that there is only one world and only one way that the world is. There is only one true theory which corresponds to such a world. In order to arrive at genuine knowledge, science must arrive at this one true theory. Given the epistemic realist view that science yields knowledge, it might therefore appear that epistemic realism is committed to the view that science will inevitably arrive at this one theory.

But epistemic realism says only that science leads to knowledge of the world. It does not say that science leads to knowledge of the whole truth about the world. While it might be the case that, in the ideal limit, scientists would know all that there is to know about the world, there is nothing inevitable about this. Scientific inquiry might fall well short of knowledge of the whole truth. And yet scientists might still acquire genuine knowledge about the world. For to acquire knowledge of the world does not require knowledge of the whole truth about the world.

Similar remarks apply with respect to the principle of metaphysical realism. The fact that there is an objective mind-independent reality entails nothing about whether the truth about such a reality consists of a single, complete theory. Nor does it require that such a theory exist. Metaphysical realism does not entail that any particular view of the nature of the world is an inevitable outcome of scientific inquiry. Moreover, nothing follows from the existence of a mind-independent world about whether scientists will arrive at knowledge of the nature of the mind-independent world. Given metaphysical realism, it is not inevitable that science will form any particular view about the nature of reality.

It might be thought that additional appeal to the correspondence theory of truth will import an element of inevitabilism. For, if science advances on truth, and there is only one world to which theory may correspond, then scientific advance must bring science closer to this one true theory about the world.

But, again, there need be no commitment on the part of the realist to some single theory which is true of the world. The correspondence theory of truth entails nothing about the unity or otherwise of true theories about the world. It requires only that claims true of the world be true in the sense of corresponding to the world. It might be the case that there is only one true theory of the world. But this is something about which the realist should remain open. It is an empirical question. It is for the advance of science to reveal whether theories in the various branches of science may be conjoined to form a single, coherent picture of the world. Surely, the realist need not be committed to a position on the likelihood of such an outcome.

Finally, it is important to consider the question of whether theoretical discourse realism implies anything of relevance to the inevitability of science. This aspect of realism relates to the realistic interpretation of theoretical discourse. Theoretical terms are to be interpreted as putatively referring expressions rather than interpreted in an instrumentalist manner. It is difficult to see how a realist interpretation of discourse about theoretical entities might have any implications about the inevitability of science. The fact that a vocabulary is employed to speak about a given range of entities entails nothing about the inevitability of arriving at a given theory about the nature of those entities.

In sum, scientific realism has little or nothing to do with the question of the inevitability of science. Hacking, therefore, appears to be right to assert that the contingency thesis is consistent with realism. I will provide further reason to accept this conclusion in the next section. However, I will then argue in the following section for a reliabilist version of realism that comes close to inevitabilism.

5. The ocean floor

I will now consider a case study which illustrates the role played by contingency in the formation of the empirical basis of science. I will then suggest the appropriate scientific realist attitude toward such contingency.

While continental drift is now a widely accepted phenomenon, this was not always the case. The idea that the continents move across the surface of the Earth was proposed by Alfred Wegener early in the 20th century. But, until the 1960's, most earth scientists continued to adhere to a stabilist viewpoint which denies the lateral displacement of continents. By the late 1960's, however, the tide had begun to turn. At that stage, Earth scientists increasingly rejected earlier geological theories in favour of the plate tectonics version of continental drift.

A variety of evidence in favour of continental drift was presented by Wegener and later drifters, but the evidence which finally prompted this change of opinion emerged from investigation of the ocean floor, mostly undertaken in the 1950's and 60's. The ocean floors were found to consist of relatively young crustal material, youngest at the mid-oceanic ridges and oldest near trenches, which was significantly thinner than continental crust. Increased heat-flow was detected along the crest of the ridges, which are also associated with shallow focus earthquakes. It was discovered that alternating strips of opposed magnetic polarization run along both sides of the ridges. Such evidence suggested that new ocean floor is created as mantle material wells up from within the Earth and spreads out on either side of the ridges. The magnetic orientation of the Earth, which is subject to periodic reversal, is imprinted into the material as it emerges at the ridges, which accounts for the patterns of reversed polarity on opposing sides of the ridges. (For further details, see Giere, 1988, chapter 8, and Legrand, 1989, pp. 176-180.)

The evidence from the ocean floors was hard to reconcile with a stabilist view of the Earth, according to which the oceans and continents are fixed and unmoving features of the Earth's surface. But it was readily explained on the basis of the theory of continental drift. For the movement of the ocean floors supports the hypothesis that the continents have moved from earlier positions and that the oceans have opened up in the process of such continental movement. It remained only to suggest that the continents themselves move as a result of the movement of the ocean floors.

For present purposes, the significant point is that the pivotal evidence from the ocean floors was lacking before explorations of the ocean floors began in earnest after the second world war, and gained momentum throughout the 1950's. Prior to this time period, the bulk of the evidence relating to theories of the Earth derived from land-based geology. Evidence from continental land-masses tended to support stabilist models of the Earth. By contrast, the evidence from the ocean floors was difficult to reconcile with stabilist models, but readily explained in terms of continental drift.

This appears to be a clear case in which contingent factors play a role in the development of science. Prior to the 1950's, scientists had only limited capacity to study the ocean floors. The necessary instrumentation had not been developed. In some cases, the relevant scientific knowledge did not yet exist. In addition, there was a major injection of research funding in the 1950's, as the U.S. Department of Naval Research supported research of relevance to submarine warfare. As a result of such factors, important evidence in favour of drift only became available in the 1950's and 60's.

It is contingent that evidence capable of supporting drift did not become available until so late a stage in the history of geology. Until that time, scientists were warranted in accepting stabilist models. The epistemic situation is therefore dependent on contingent factors such as the availability of evidence and relevant knowledge, the development of instrumentation and the provision of research funding.

There is no need for the scientific realist to deny the role that contingency plays in the formation of the empirical basis of science. The appropriate realist response to a case such as

that of the exploration of the ocean floors is simply to note that what is rational to believe depends on the evidence that is available. Provided that the evidence available prior to the 1950's was sufficiently strong in favour of stabilist models, the rational attitude was to espouse stabilism. By the late 1960's the tide had turned, and the evidence then available made it rational to adopt drift. Apart from the remark that the best explanation of the evidence available prior to 1950 might be different from the best explanation of the evidence available by the late 1960's, there is little for the realist to do other than to grant the significant role played by contingent factors in the development of the sciences.

6. Realism, reliabilism and inevitability

So far in this paper, I have sought to show that there is no clear connection between scientific realism and the question of inevitability. In the preceding section, I presented an example in which historical contingency plays a role in determining the empirical basis of science. In this section, I will explore an extension of scientific realism which leads to consequences that are inevitabilist in character. But I must stress that the form of inevitabilism at issue in this section is not the same as the one that has been at issue in previous sections of this paper. What is inevitable is not that science will converge on a single unified theory similar to current science, but that the quantity of truth known about the world will increase if reliable methods continue to be employed.

I have elsewhere argued that scientific realism faces an epistemological challenge which I call *the problem of method and truth* (Sankey, 2002; 2006). The problem arises because of the non-epistemic nature of truth in the correspondence sense favoured by the realist. The problem is that there is no intrinsic connection between method and truth. While satisfaction by a theory of the rules of method warrants acceptance of the theory, nothing about the warrant entails that the theory be accepted as true. If truth is non-epistemic, then it remains to be explained why use of the methods of science conduces to truth in a non-epistemic sense.

One way to resolve the problem of method and truth is to define truth in terms of method. But this avenue is not open to the realist, given the realist commitment to the non-epistemic character of truth. Instead, I argue that the realist should employ an inference to the best explanation of the success of the methods of science. In particular, the best explanation of the fact that employment of the methods of science has led to successful theories is that the methods of science are a reliable means for the acquisition of truth (Sankey, 2000; 2002). In effect, this approach is a form of reliabilist epistemology applied at the level of the methods of science, rather than at the level of cognitive processes.

When combined with a realist view of the nature of reality and truth, such a reliabilist theory of method appears to have inevitabilist consequences. For if the methods of science are a reliable means of truth-acquisition, and if the methods of science continue to be employed, then it seems inevitable that the continued employment of such methods will lead to the truth. Of course, it is contingent that the methods of science continue to be employed. But, on the assumption that they continue to be employed, then it is inevitable that science will arrive at the truth about the world.

But while realism combined with a reliabilist theory of method seems to entail an inevitabilist view of science, there is a problem with this line of argument. None of the methods of science which have so far been developed are completely reliable. None guarantee truth. Unless one is prepared to assume that the methods of science are completely

reliable, there is no reason to suppose that the inevitable outcome of continuing to apply the methods of science will be the truth.

It is, however, reasonable to assume that the methods of science will continue to be improved. Science is a self-corrective enterprise. The self-corrective character of science applies not only at the level of observation and theory, but at the level of the method and practice of science. Given this, it is fair to assume that the methods of science are likely to continue to become increasingly reliable. This, in turn, may be taken to suggest that the continued application of the methods of science will ensure that science continues to move closer to the truth about the world.

Does this mean it is inevitable that science will reach the truth? The answer I propose to this question is a qualified affirmative. Science is a fallible human enterprise. It is not inevitable that science will continue to be pursued by humans. Nor is it inevitable that the methods of science will continue to be improved. But, assuming that science continues to be pursued, and that the methods of science become increasingly reliable, then science will continue to acquire knowledge of the world. In so doing, it will increase the quantity of truths known about the world.

But will science lead to the whole, absolute truth about the world? It is unclear what this might involve. It is unclear what all the truth about anything might be, much less all the truth about everything (cf. Hacking, 1983, pp. 93-5). For this reason, I prefer not to say that it is inevitable that science will lead to the whole truth about the world. Instead, I prefer to say that, if science continues to be pursued, and its methods continue to be improved, then it is inevitable that science will continue to increase the quantity of truth known about the world.

Thus, as indicated in the discussion of aim realism in section 4, it is not inevitable that science will converge on one true theory about the world. But, if science continues to employ increasingly reliable methods, it is inevitable that it will continue to increase the truth known about the world.

7. Conclusion

Before concluding, it is important to briefly mention one final variation on the theme of contingency and inevitability in science. As I understand the claim of the inevitabilist, it is a claim about the inevitability that science will converge on a single true theory of the world that is in large part similar to current science. This, I have said, is a thesis about the nature of our epistemic practices, rather than a thesis about the nature of the world as such. Nor, I should add, is it a thesis about the nature of consensus-formation in science. It is not a thesis about the inevitability of consensus, as such, but a thesis about the theory on which science will ultimately converge. Consensus is the by-product, rather than the immediate outcome, of the continued application of the methods of science.

But, while the inevitabilist claim is not a claim about the nature of consensus-formation in science, it should be said that there is a close connection between the issue of realism and that of consensus-formation. For it is difficult to see how consensus might ever be formed in science if there were not a mind-independent reality which might serve as the basis for such consensus. The best, if not the only, explanation of consensus-formation is the existence of an external reality that is independent of representations of such a reality. Thus, while the realist need not be an inevitabilist, if inevitabilism is taken to be a theory about consensus-formation, then the inevitabilist must be a realist.

In this paper, I have explored the question of whether the scientific realist is committed to an inevitabilist view of science. I have argued that scientific realism does not clearly entail any inevitabilist consequences. However, the impression may remain that scientific realism is in some respect an inevitabilist doctrine. I have sought to show that this impression derives, not from scientific realism itself, but from certain assumptions about the nature of the method and practice of science which are entirely consonant with realism. In particular, if one is prepared to make certain assumptions about the reliability of the methods of science, and to combine these assumptions with a realist perspective, then the outcome of science begins to look increasingly inevitable.

Acknowledgements

Work on this paper was in part undertaken while I was a visitor at the Poincaré Archives – Laboratory of the Philosophy and History of Science, University of Nancy 2 (France), supported by an Arts Faculty Special Studies Program travel grant from the University of Melbourne. Talks based on earlier versions of this paper were presented at the Poincaré Archives, as well as the Steno Institute, University of Aarhus (Denmark), and the Department of History and Philosophy of Science, University of Melbourne. I am grateful to the audiences on all three occasions for their comments and discussion. I would like to specifically thank Hanne Andersen, Allan Franklin, R.N. Giere, Tim Lyons and Lena Soler for their comments on earlier drafts of this paper, which have led to the improvement of the final product.

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Notes

1. The contrast between restricted and general statements of the position reflects a distinction between local and global versions of inevitabilism. In the local version, some particular science (e.g. physics) will converge on a single theory of its specific domain. In the global version, science as a whole will converge on a single unified theory of the world. The distinction is genuine, but of no immediate relevance to the present topic, which concerns the relation between inevitabilism and scientific realism. The distinction *is* relevant to the question of the relations between the sciences.

2. I owe the point about fallibilism in the long run to R.N. Giere.

3. Given the context in which this principle is stated, it should be evident that the notion of knowledge here is one that requires truth. As it happens, I hold that the standard justified true belief analysis of knowledge may be employed in the context of scientific realism (cf. Sankey, 2000, p. 219 ff).

4. It is worth emphasizing that aim realism is a thesis about the aim of science and the nature of scientific progress. While scientific realists typically hold that science has made considerable progress, aim realism is not a thesis about the degree to which progress has occurred in science. Nor does it say anything about the mechanism of progress. However, in section 6, I will propose a mechanism which suggests an account of progress that resembles an inevitabilist account of science.