Scientific realism and antirealism

Traditionally, scientific realism asserts that the objects of scientific knowledge exist independently of the minds or acts of scientists and that scientific theories are true of that objective (mind-independent) world. The reference to knowledge points to the dual character of scientific realism. On the one hand it is a metaphysical (specifically, an ontological) doctrine, claiming the independent existence of certain entities. On the other hand it is an epistemological doctrine asserting that we can know what individuals exist and that we can find out the truth of the theories or laws that govern them.

Opposed to scientific realism (hereafter just 'realism') are a variety of antirealisms, including phenomenalism and empiricism. Recently two others, instrumentalism and constructivism, have posed special challenges to realism. Instrumentalism regards the objects of knowledge pragmatically, as tools for various human purposes, and so takes reliability (or empirical adequacy) rather than truth as scientifically central. A version of this, fictionalism, contests the existence of many of the objects favoured by the realist and regards them as merely expedient means to useful ends. Constructivism maintains that scientific knowledge is socially constituted, that 'facts' are made by us. Thus it challenges the objectivity of knowledge, as the realist understands objectivity, and the independent existence that realism is after. Conventionalism, holding that the truths of science ultimately rest on man-made conventions, is allied to constructivism.

Realism and antirealism propose competing interpretations of science as a whole. They even differ over what requires explanation, with realism demanding that more be explained and antirealism less.

1 Arguing for realism

Late nineteenth- and early twentieth-century debates over the reality of molecules and atoms polarized the scientific community on the realism question. Antirealists like Mach, Duhem and Poincaré - representing (roughly) phenomenalist, instrumentalist and conventionalist positions - at first carried the day with a sceptical attitude towards the truth of scientific theories and the reality of the 'theoretical entities' employed by those theories (see Phenomenalism; Conventionalism). Led by the successes of statistical mechanics (see Thermodynamics) and relativity (see Relativity theory, philosophical significance of), however, Planck and Einstein helped turn the tide towards realism. That movement was checked by two developments. In physics the quantum theory of 1925-6 quickly ran into difficulties over the possibility of a realist interpretation (see Quantum mechanics, interpretation of) and the community settled on the instrumentalist programme promoted by Bohr and Heisenberg. This was a formative lesson for logical empiricism whose respect for developments in physics and whose positivistic orientation led it to brand the realism question as metaphysical, a pseudo-question (see Logical positivism, philosophy of). Thus for a while empiricist and instrumentalist trends in science and philosophy eclipsed scientific realism.

The situation changed again in the 1960s, by which time science and its technological applications had become a ubiquitous and dominant feature of Western culture. In this setting philosophers like Smart (1963) and Putnam (1975) proposed what came to be known as the 'miracles' argument for scientific realism (see Smart, J.J.C. §3; Putnam, H. §2). They argued that unless the theoretical entities employed by scientific theories actually existed and the theories themselves were at least approximately true of the world at large, the evident success of science (in terms of its applications and predictions) would surely be a miracle. It is easy to see, at least with hindsight, that the most one could conclude from scientific success, however impressive, is that science is on the right track. That could mean, as the argument concludes, on the track to truth or it could just mean on the track to empirical success, perhaps with deeply flawed representations of reality. The 'miracles' argument is inconclusive. Nevertheless, during the next two decades it was compelling for many philosophers. Indeed, during this period realism became so identified with science that questioning realism was quickly put down as anti-science.

Realist orthodoxy found support in Popper's attack on instrumentalism, which he criticized as unable to

account for his own falsificationist methodology (Popper 1956) (see Popper, K.R. §2). Broadening this line, Boyd developed an explanationist version of the 'miracles' argument that focused on the methods of science and tried as well to give proper due to the human-centred (constructivist and conventionalist) aspects of science emphasized by Kuhn and Feyerabend. Boyd asks why methods crafted by us and reflecting our interests and limitations lead to instrumentally successful science. Contrasting realism with empiricism and constructivism, he finds that realism offers the best (indeed, the only) explanation. That is because, he argues, if we begin with truths or near-truths the methods we have crafted for science produce even more of the same. Since it is only realism that demands the truth of our scientific theories, then realism wins as giving the best explanation for the instrumental success of science. Hence, like a scientific hypothesis, realism is most likely to be true and we should believe in it.

The explanationist argument is carefully framed so that we ask only about the instrumental success of science; that is, success at the observational level. To take science as successful (for example, truth-producing) at the theoretical level would beg the question against empiricism and instrumentalism. Once this is recognized, however, we can see a significant gap in the reasoning. The argument is driven by a picture of science as generating new truths from old truths, but the explanatory issue raised is only about truths at the level of observation, not about truths in general. Antirealists might well reject this as an illegitimate request for explanation. If they accept it, there is an obvious empiricist or instrumentalist response: namely, that our scientific methods are made by us to winnow out instrumentally reliable information. If we begin with fairly reliable statements, the methods we have crafted for science will produce even more. Thus the explanation for scientific success at the instrumental level need not involve the literal truth of our scientific principles or theories, just their instrumental reliability. This move nicely converts the argument for realism as the best explanation of scientific success into an argument for instrumentalism.

There is a second problem with the explanationist tactic, perhaps even more serious. The conclusion in support of realism depends on an inference to the best explanation (see Inference to the best explanation). That principle, to regard as true that which explains best, is a principle that antirealisms (especially instrumentalism and empiricism) deny. Van Fraassen, for example, regards being the best explanation as a virtue, but one separate from truth. (He reminds us that the best may well be the best of a bad lot.) Although not required, there could perhaps be an instrumentalist principle of inference to the best explanation. It would not infer to the truth of the explanation but to its instrumental reliability (or empirical adequacy) - precisely the strategy pursued above where we infer instrumentalism from the instrumental success of science. Thus the explanationist argument uses a specifically realist principle of inference to the best explanation and, in so doing, begs the question of truth versus reliability, one of the central questions at issue between realism and antirealism.

2 Piecemeal realisms

Inference to the best explanation promised the most cogent version of the 'miracles' argument. Its inadequacy hastened a retreat from realism's original undertaking as a global interpretation of science. Retreat was fostered by two other antirealist developments. One was the pessimistic meta-induction to the instability of current science, a conclusion based on the repeated overthrow of scientific theories historically and the consequent dramatic alterations in ontology. The other was a sharpening of the underdetermination thesis associated with Poincaré and Duhem, suggesting that there may be empirically equivalent theories between which no evidence can decide (see Underdetermination). Both developments tended to undermine claims for the reality of the objects of scientific investigation and the truth of scientific theories.

Pursuing a salvage operation, several philosophers suggested that realism could confine itself to being a doctrine about the independent existence of theoretical entities ('entity realism') without commitment to the truth of the theories employing them. Hacking (1983) proposed an 'experimental argument' for this entity realism; roughly, that if you can deploy entities experimentally to discover new features of nature (for example, use an electron gun to learn about quarks), then the entities must be real whether or not the covering theories are true (see Experiment §3). Cartwright (1983) suggested that the strategy of inference to the best

explanation be confined to an inference to the causes of phenomena, since causes are unquestionably real. To the antirealist, however, these related strategies seem far from compelling. For one thing, it is not clear that one can so neatly disengage theoretical entities from their covering theories. Moreover, in both cases, we can see that the basis on which one is asked to draw a realist conclusion need support no more than a conclusion about utility or reliability. In Hacking's case one need conclude only that electrons are a useful theoretical construct (perhaps a useful fiction?) and in Cartwright's that certain causal hypotheses are reliable in certain domains.

Faced with these difficulties realism has fragmented even further. Sometimes it takes an historicist turn, countering the pessimistic meta-induction by endorsing as real only those fruitful entities that survive scientific revolutions. Sometimes realism becomes highly selective in other ways; for example, looking only at what seems essential in specific cases of explanatory or predictive success, or at entities that stand out as supported by only the very best scientific evidence. Although each of these principles locates matters of scientific significance, it is not clear that such criteria overcome the general strategies that have undone global realist arguments. In particular they do not seem to discriminate effectively between what is real and what is merely useful (and so between realism and instrumentalism).

3 Alternatives to realism

Several alternatives to realism have developed in the course of these debates. Principal among them are Putnam's 'internal realism' (1981) (see Putnam, H. §8), van Fraassen's 'constructive empiricism' (van Fraassen 1980) and what Fine (1986) calls 'the natural ontological attitude', or NOA. In a chameleon-like move, Putnam switched from being realism's champion to its critic. Rejecting what he called 'metaphysical realism' (associated with a 'God's eye view'), Putnam proposed a perspectival position in which truth is relative to language (or conceptual scheme). He could then allow scientific claims to be true in their proper domain but deny that they tell the whole story, or even that there is a whole story to tell. His picture was that there could be other truths - different stories about the world - each of which it may be proper to believe. Van Fraassen's constructive empiricism eschews belief in favour of what he calls commitment. He takes the distinguishing features of realism as twofold: realism seeks truth as a goal, and when a realist accepts a theory it is accepted as true. Constructive empiricism, by contrast, takes empirical adequacy (not truth) as the goal of science, and when it accepts a theory it accepts it as empirically adequate. This involves commitment to working within the framework of the theory but not to believing in its literal truth. Unlike these others, Fine's NOA is not a general interpretive scheme but simply an attitude that one can take to science. The attitude is minimal, deflationary and expressly local. It is critically positive, looking carefully at particular scientific claims and procedures, and cautions us not to attach any general interpretive agenda to science. Thus NOA rejects positing goals for science as a whole, as realists and constructive empiricists do. NOA accepts 'truth' as a semantic primitive, but rejects any general theories or interpretations of scientific truth, including the perspectivalism built into internal realism and the external-world correspondence built into realism itself. NOA is perhaps better classified as a nonrealism than as an antirealism.

It is interesting to contrast how these positions respond to good science. Realism accepts good science as true of an observer-independent world; internal realism accepts it as true relative to our scheme of things; constructive empiricism accepts it only as empirically adequate. NOA simply accepts it. This brings out two significant features of the recent debates. One is that they are more about the reach of evidence (what kind of acceptance is warranted) than about the metaphysical character of the objects of belief. The contrast also shows that major contenders, whether realist or not, share a basically positive attitude towards science. This has not always been acknowledged and a contrary suspicion still attaches to constructivism, which is frequently regarded as anti-science.

4 The constructivist challenge

Contemporary developments in the history and sociology of science have revived constructivist approaches (see Constructivism). Sharing with instrumentalism and other forms of pragmatism an emphasis on science as

an activity, constructivism borrows the Marxist vocabulary of the 'production' of ideas (see Marxist philosophy of science) to place science among the manufacturing institutions. Specifically, what science makes is knowledge, which includes concepts and theories, along with things and even facts. Constructivism also emphasizes that science is open-ended. It highlights the role of unforced judgment in scientific practice, challenging the picture of a strict scientific method and of decision-making forced by rationality at every turn. The upshot is to see science as a form of human engagement like others; just people doing their own thing as best they can. Many regard this placement of science as a displacement, demoting science from its privileged position as the paradigm of rational and objective inquiry.

The emphasis on human constructions may challenge the mind-independence that is the hallmark of realist metaphysics. The respective roles of the social order and of nature in shaping these constructions, however, differ among constructivists, making for strong idealism at one pole (see Idealism) and pragmatic realism at the other. Despite these differences, constructivism challenges the unique position that realism marks out for itself with respect to ongoing science. If we look beyond the relatively sophisticated arguments for realism rehearsed above, perhaps realism's major hold on our attention is its claim to offer the only viable setting for understanding scientific practice. We are told that unless we take scientists to be engaged in finding out about a world not of their own making we cannot begin to understand how science works. The major constructivist challenge is right here. The heart of constructivism consists in richly detailed studies of science in action. These studies set out to understand how science actually proceeds while bracketing the truth-claims of the area of science under investigation. Instead, constructivists typically employ little more than everyday psychology and an everyday pragmatism with respect to the common objects of experience. To the extent to which these studies succeed they paint a picture of science quite different from realism's, a constructivist picture that may undermine not only the arguments but also the intuitions on which scientific realism rests.

See also: Dewey, J.; Empiricism; Fictionalism; Pragmatism; Realism and antirealism; Theories, scientific

ARTHUR FINE

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