Instrumentalism vs. Realism and Social Construction

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Abstract

An important debate in the philosophy of science, whether an instrumentalist or realist view of science correctly characterizes science, is examined in this paper through the lens of a related debate, namely whether science is a social construct or not. The latter debate arose in response to Kuhn's work *The Structure of Scientific Revolutions*, in which he argued that while there exists a process through which scientific understanding evolves from primitive to increasingly refined ideas, it does not describe progress 'toward' anything. Kuhn's work was then used to argue that there is no such thing as a knowable objective reality, a view much in agreement with that of the instrumentalist.

This paper argues that a generalized version of the correspondence principle applied to a theory's domain of validity is an exclusive feature of science which distinguishes it from socially constructed phenomena and thereby supports the realist position. According to this argument, progress in science can be characterized as the replacement of old paradigms by new ones with greater domains of validity which obey the correspondence principle where the two paradigms overlap. This characterization, however, is susceptible to the instrumentalist objection that it does not fit the transition from Aristotelian to Newtonian physics. In response, it is required that this argument depend on the intactness of certain core concepts in the face of experimental challenge within some regions of the theory's original domain of validity. While this requirement saves the argument and even offers an answer to the question of what it would take for our most established theories in physics, relativity and quantum theory, to suffer the same fate as Aristotelian physics, it also defers a conclusive resolution to the debate between instrumentalists and realists until it can be determined whether an ultimate theory of nature can be found.

Keywords: Philosophy of Science, Instrumentalism, Operationalism, Social Construction, Kuhn, Correspondence Principle, Domain of Validity, EPR paradox

1 Introduction

An important debate in the philosophy of science concerns itself with the question of whether the aim of science should be taken as nothing more than to formulate a set of rules, explanations, laws etc. which (in the case of 'good' scientific theories) give excellent predictions as to what an observer can directly observe when he carries out a particular experiment but say nothing about what the world *really* is like, or whether this set should also be regarded as a true description of an underlying reality. The former view is usually labeled an *operationalist* or *instrumentalist* view and the latter a *realist* view of science (DeWitt, 2004).

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This paper will examine this question through the lens of a related debate, namely, whether science is a social construct or not. A *social construct* can be defined as "a phenomenon invented or constructed by participants in a particular culture or society, existing because people agree to behave as if it exists; an example of a social construct is social status(*Social Construction*)". The determination of whether science is a social construct or not has direct bearing on the debate between realists and instrumentalists, for if it is true that science is a social construct, then this lends significant support to the instrumentalist, who could legitimately claim the social construction as supporting evidence. If science is determined to not be a social construct, then it must be an endeavor anchored in some underlying reality, much in agreement with the realist's position.
Using this related debate, an argument will be given for a principle that distinguishes science from other fields more easily recognizable as social constructs, which in turn will be used to support the realist position. However, this argument is susceptible to an important objection by the instrumentalist side, necessitating the introduction of one additional idea.

2 Kuhn's Work and the Social Construction Debate

A good starting point for such considerations is the well-known work *The Structure of Scientific Revolutions* by the philosopher of science (and physicist by training) Thomas Kuhn (Kuhn, 1962). To give a condensed account, Kuhn argues that the prevailing contemporary view of science as progressing in a strictly cumulative fashion does not correspond to the historical record. Rather, he proposes, science progresses through periods of 'normal science' which are cumulative, interspersed by 'scientific revolutions' which are not. He defines 'normal science' as "research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges as supplying the foundation for its further practice". He calls these achievements 'paradigms' and describes in some detail a process by which normal science, the goal of which is to verify, develop and extend the implications of an established paradigm eventually leads to the discovery of anomalies, i.e. phenomena which do not fit that paradigm. If repeated and varied efforts to address and resolve the anomalies within the framework of normal science fail, a crisis ensues. According to Kuhn, there are only three ways by which a crisis is eventually resolved: Either normal science is ultimately able to solve the crisis-provoking problem, or the problem is shelved for future generations, or a new paradigm emerges out of a proliferation of speculative theories and replaces the old one. This is what he calls a *scientific revolution.* He deems the paradigm change non-cumulative because the fundamental assumptions of the new paradigm are philosophically incompatible with those of the old one and because it permits predictions that are different, something which should not occur if the two paradigms were logically compatible. For example, while among physicists the view is common that Newton's theory of gravity can be derived as a limiting case of Einstein's theory of General Relativity which replaced it, Kuhn argues that this derivation is only possible if fundamental terms and concepts are redefined: the terms 'space' and 'time', central to both, refer to very different concepts in the two theories. Kuhn takes this to be an indication that the two theories are actually incompatible with one another. If one agrees with the general position that scientific revolutions are characterized through the replacement of old paradigms by new ones with which they are incompatible, then this puts to question the notion that successive changes in paradigm carry scientists closer and closer to "the truth", that is, an objective, true account of nature. So while the process outlined by Kuhn describes the evolution from a primitive to an increasingly detailed and refined understanding of nature, it does not describe progress 'toward' anything. Kuhn's work was used, especially by post-modern philosophers, as the basis of an argument that there is no such thing as a knowable objective reality, which in turn would seem to imply that the subject of science is really no different from that of other activities which have no objective existence of their own, but depend on their participants agreeing to behave as though they did, which is to say, an argument that science is a social construct. Perhaps not surprisingly, this argument came under

heavy criticism, especially by practitioners of science, who charged that Kuhn's characterization of science and especially that of his followers misrepresent the essence of science. For instance, the eminent physicist Steven Weinberg wrote: "Kuhn made the shift from one paradigm to another seem more like a religious conversion than an exercise of reason." (Weinberg, 1998).
To make some headway in this debate, it seems a promising exercise to try to pin down what feature might make science different from socially constructed phenomena.

3 The Correspondence Principle and Domains of Validity

While people with a scientific background may feel that science is not a social construct, it is more challenging than it seems at first to find a distinction that is truly exclusive to science to show that it is more than a social construct. Referring to Weinberg's quote, for instance, even endeavors within fields that are commonly taken to be socially constructed can and often do require "an exercise of reason". There should be little doubt that, say, Bach did exactly that in order to fit his musical ideas to the then-prevailing rules of composition, even though these rules did not have any reality apart from what their practitioners agreed to give them.
I propose as a candidate for such a distinction the *correspondence principle*. This principle was first introduced by the Danish physicist Niels Bohr within the context of quantum mechanics (Tipler Llewellyn, 2003), but here I am using this term in a broader sense: By the "correspondence principle" I mean that in science, every new paradigm must subsume the predictions of experimental outcomes of the paradigm it is meant to replace, in addition to yielding new ones. The statement of this principle can be made more precise by considering it together with the concept of a paradigm's *domain of validity*, by which I mean that subset of all possible physical phenomena to which it is considered applicable.
The correspondence principle requires then that every new paradigm that is meant to replace an older paradigm must yield the same predictions where the domains of validity of the two paradigms overlap. So, one way one could characterize much of the history of science is that earlier paradigms with narrower domains of validity were subsequently replaced by paradigms with increasingly broader domains of validity that at least partially overlapped with those of the earlier ones. One could then take this to be what gives meaning to progress in science *toward something*, namely a theory (or set of theories) with the broadest possible domain of validity, that is, a theory that is applicable to the set of all possible physical phenomena. The reproducibility of the outcomes of the same experiments in eras with different prevailing paradigms (performed by impartial observers) is one measure by which we can ascertain that this sense of progress is really imposed upon us by our experience of how the world actually works and not simply because scientists agreed to behave as though this is how it works.
One tends not to see something like the correspondence principle in other fields which could be much more easily considered to be social constructs, such as the arts, music or literature. To be sure, it is perhaps not uncommon that even in those fields, insights and achievements of one era are subsumed in those of subsequent eras, but there is no discernible requirement that it *must* be so. In fact, some of the most interesting developments in those fields derive their intrinsic interest precisely because they represent a complete break with what had been done before. Well-known examples are the introduction of twelve-tone music and abstract art in the early part of the 20th century. This stands in stark contrast to science, where it would seem hard to imagine that any new theory which gives radically different predictions from an established theory within the latter's domain of validity would be taken seriously, let alone received with interest, by practitioners of the field.
Returning to the debate between realists and instrumentalists, the proposition of the correspondence principle as one feature exclusive to science that reveals it to be more than a social construct could be seen as strong support for the realist point of view, since progress toward a theory with the broadest possible domain of validity could be interpreted as progress toward a theory that describes

the world 'as it really is'.

4 The Instrumentalist Objection and a Response

The characterization of progress in science given above seems to fit well with the history of physics since Newton's theory was first introduced. The predictions of Newtonian theory have now been subsumed by more modern theories which can be said to have broader domains of validity because they reproduce the empirically verified predictions from before while also giving correct predictions in certain limits, such as high velocities and small size, in which Newtonian theory gives incorrect predictions.

An instrumentalist might legitimately object that the characterization of progress given above does not fit the transition from Aristotelian to Newtonian physics. Newton's theory did not subsume that of Aristotle, but rather caused it to be thrown out wholesale. Essential concepts of Aristotle's framework, such as the idea that things naturally come to rest, met their demise with the introduction of Newton's framework. In light of this objection, how can we consider the type of progress as described above to be a truly distinct feature of science which supports the realist's view?

To respond to this objection, I think, one needs to supplement the above characterization with one additional idea, namely that *this characterization of scientific progress depends on the intactness of certain core concepts in the face of experimental challenge within some regions of the theory's original domain of validity.* By a 'core concept', I mean a central idea in a framework to which it is indispensable. DeWitt likens a scientific theory to a jigsaw puzzle in which core pieces cannot be replaced without changing the puzzle itself, and this metaphor seems rather apt. If the outcome of an experiment reproducibly demonstrates a core concept of a theory to be false, then that theory cannot be a true account of reality. But this does not necessarily mean that the entire theory must be immediately discarded. If there are some regions within the theory's original domain of validity in which the core concept still agrees with experiment to a reasonable approximation, then the new domain of the theory can be considered to have shrunk to those regions, even though the theory is no longer taken to be a true account of nature. For instance, where the core concepts of Newton's theory such as absolute space and time are invalidated, they usually involve regimes to which that theory is already inapplicable because of a failure to give correct predictions for a large number of other kinds of experiments. In other words, the core concepts of Newtonian theory tend to succumb to experimental challenge most readily outside its domain of validity, whereas within its domain of validity, such as the scale of our everyday experience where its predictions of many other experiments tend to be essentially correct, they tend to agree with experiment within tolerable limits. The theoretical justification that Newton's theory maintains a domain of validity even after some of its core concepts are regarded as incorrect is that in certain regimes they can be considered to be reasonable approximations of core concepts of theories with broader domains of validity. This is why Newtonian theory is still one the first subjects taught in introductory physics courses. In contrast, where core concepts in Aristotelian theory were successfully challenged, they involved the entire domain of validity of the theory. Its domain of validity effectively shrank to zero because in no regions within its original domain of validity could its core concepts be maintained even as reasonable approximations to those of a theory with a broader domain of validity. This is why Aristotelian physics is no longer considered a scientific subject.

What it would take for our currently most established theories in physics, quantum theory and relativity, to suffer the same fate as Aristotle's physics, then, would be a successful experimental challenge that repudiates one or more core concepts in either framework within their entire respective domains of validity.

Perhaps the closest that anyone has come to formulating such a challenge for the case of quantum theory is Albert Einstein, who in 1935 in a famous argument now called the EPR (Einstein-Podolsky-Rosen) paradox sought to show that one core concept of quantum theory, called non-locality, could

not be right. At the time Einstein published his paper, the challenge was not yet experimentally feasible, but almost fifty years later it became so, and it was non-locality that was empirically confirmed, not Einstein's argument (Griffiths, 2005).
What makes Einstein's challenge noteworthy, among other things, is that in order to construct it he was able to think of a question that presumably no one had thought to ask before to make explicit and then challenge a core concept of quantum mechanics. His effort ultimately failed, but had his challenge been successful, it would probably have eventually led to an overthrow of quantum mechanics, because non-locality is a pervasive feature of the theory i.e. it is a feature found within its entire domain of validity. This suggests at least the possibility that someone else might in the future be able to construct a successful challenge by asking another question that so far has not occurred to anyone. In this light, the difference between the realist and the instrumentalist amounts to a difference in a prediction about the future: If a realist takes a successful scientific theory to be true a description of reality, then he must deny the possibility that anyone could in the future think of a question to successfully overthrow a core concept of that theory, because no such questions actually exist. An instrumentalist, however, would by his conviction be forced to admit that such questions do in fact exist and that therefore the success of that theory is simply due to the fact that so far no one has been imaginative enough to ask them.
Given that the difference between these two positions has now become a matter of a prediction about the future, it seems improbable that this debate can be conclusively settled one way or another, unless it is known with certainty at some point in the future that the then-established scientific framework has in fact the broadest possible domain of validity (e.g. in the form of a theorem). In that case, it would then also be known that no questions that could successfully challenge the theory's core concepts actually exist, for if they did, they would shrink its domain of validity, thereby opening up the possibility for the existence of a theory with a yet broader domain of validity. So in this rather unique situation, any distinction between "the" theory with the broadest domain of validity and a true account of nature will be contrived, because there is no longer any good reason to deny that its core concepts do describe reality. The debate between realists and instrumentalists will therefore have been settled in favor of the realists. But then, science itself, as an activity to understand aspects of our world not yet understood, will also have come to an end.

5 Conclusion

This paper attempted to frame some aspects of the debate between instrumentalists and realists within the context of the question of whether science is a social construct and presented an argument in favor of the realist position that is however not entirely invulnerable to an instrumentalist objection.
As a final thought, though, I would like to give an aesthetic argument in favor of the realist position: Many practitioners of science chose their vocations because of an intrinsic curiosity about how the world works. Adopting an instrumentalist attitude seems to undercut this sense of curiosity because any explanation one might discover cannot be considered to be one of how the world 'really' works. To the extent that an instrumentalist attitude might diminish this sense of curiosity, it robs science of one of its most attractive features.

References

[1] R DeWitt *Worldviews* Blackwell Publishing, Malden 2004

[2] D Griffiths *Introduction to Quantum Mechanics* Pearson Prentice Hall,Upper Saddle River 2005

[3] T Kuhn *The Structure of Scientific Revolutions* University of Chicago Press, Chicago 1962

[4] n.a. *Social Construction* http : //en.wikipedia.org/wiki/Social$_c$onstruction Retrieved 04 08, 2008

[5] P Tipler, R Llewellyn *Modern Physics* W.H Freeman and Company, New York 2003

[6] S Weinberg *New York Review of Books*
1998