On Realism and the Pessimistic Meta-Induction

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Abstract

In this paper I will discuss the Pessimistic Meta-Induction put forth by Larry Laudan in his paper *A Confutation of Convergent Realism* and discuss how it overcomes the No Miracles argument for scientific realism. I will then reconcile these two positions through the theory that scientific terms posit and refer to models of reality that are relevantly similar to how the world is.

This paper will begin with a discussion of the No Miracles argument and Pessimistic Meta-Induction, resulting in doubt that scientific terms genuinely refer to objects in the world. In order to overcome the anti-realist position that the Pessimistic Meta-Induction has resulted in, I will then put forth a form of realism that does not rely on the genuine reference of terms. This being that scientific terms refer to models and structures that are relevantly similar to objects in reality. This will be done with a brief discussion in the history of science, particularly with a discussion of the caloric fluid theory of heat and the evolution of the theory of light, first as a wave in either, then as a wave in space, and finally as a 'wavicle'. This will result in the aforementioned position that retains a form of realism, but is still able to overcome the Pessimistic Meta-Induction.

Introduction

The realist positon often maintains that the terms used in scientific study and the scientific theories that the study produces genuinely refer to entities and structures that exist within reality. They maintain that this is the best explanation for the incredible success of science and the special epistemic weight given to science. In this paper we will explore an objection to this view, the pessimistic meta-induction and how this objection relates to the no miracles argument for realism. We will then explore an alternative explanation to genuine reference for the success of science. This alternative being that scientific terms posit and refer to models of reality that are relevantly similar to how the world is. We will then look at a couple of possible explications of the idea of relevant-simularity.

The No Miracles Argument and the Pessimistic Meta-Induction

The realist position often takes the form that the entities and structures posited by scientific theories do actually exist in reality. More so, these “observational and theoretical terms within the theories of a mature science genuinely refer” (Laudan 1109), meaning that when a scientist uses terms such as ‘atom’ or ‘electron’ she is referring to entities that exist in the world. When she says “electrons have a negative charge” she is referring to the entity in the world and describing the property of that entity that the entity actually has.

One of the main arguments for the truth of this position is the no miracles argument. This argument states that our current scientific theories are incredibly successful in terms of explaining observable phenomena and making prediction that are empirically testable and that turn out to be empirically verified. As more experimentation occurs the theories are then more and more empirically verified, confidence in them increases accordingly. The realist then asserts that the best explanation for the theories’ success is that it accurately explains reality and that the entities that are posited in the theory genuinely do exist, and thus when the terms are used they are genuinely referring to the entities in reality. If this were not the case, says the realist, it would be incredibly unlikely that our scientific theories would work so well. If terms did not genuinely refer, the success of modern science would be a miracle. Thus the main reason for the realist position is that success is a reliable indicator of the truth of a theory.

A problem with this line of argumentation is that “false theories, as well as true ones, [can] have true consequences” (Laudan 1123). For example, the geocentric view of the solar system had been making accurate predictions for over one thousand years at the time of Copernicus, for “even Copernicus’s more elaborate proposal was neither simpler nor more accurate than Ptolemy’s system” (Kuhn 76). The realist could reply to this example in two ways. First, that over time the heliocentric model of the solar system was better verified than the geocentric model, and with further verification can be said to accurately describe the solar system. The second way to respond would be to say that the entities in question were real in this case, and thus the terms were genuinely referring, but that the problem was one of conceptualization and organization. It got the structures and entities right, but the relationships between them wrong.

To the latter argument the critic could say that those relationships are in fact part of the structure of reality that the realist believes theories are genuinely referring to. To the former objection he can say that while the heliocentric model of the solar system is the best verified theory we have so far[1], but why could there not, in the future be a new theory that is then even better verified than the current theory? Would the current theory still be thought to genuinely refer?

The critic can then offer up more examples of theories that were very well confirmed in their times but would eventually be replaced. In their times, realists would have maintained that the entities and structures posited by the theories did exist in reality for the same reasons that current realists maintain that the entities and structures posited by our current theories genuinely refer to entities and structures in the world. Some examples that Laudan provided are the effluvial theory of static electricity, the phlogiston theory of chemistry, the caloric and vibration theories of heat, the optical and electromagnetic ether theories, and the theory of circular inertia (1120).

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1 We are here just using it to talk about the planetary revolution within the solar system and granting that it is not a pure heliocentrism.

A common move for the realist is to then say that realism only applies to mature sciences, and all of the counterexamples are of immature sciences. The problem with this is that the distinction between mature and immature sciences is not clear. It seems to be arbitrarily created to make current science distinct from historical science. Any line drawn to exclude Laudan's examples would also exclude areas of science that the realist would like to preserve. More so, there seems to be no reason for the critic to grant this distinction exists. Even if the critic grants the distinction between mature and immature sciences, it still does not save the realist's position, because even "if the realist restricts himself to explaining only how the 'mature' sciences work…then he will have completely failed in his ambition to explain why science in general is successful" (1121). In maintaining this distinction, the realist is giving up the no miracles argument when it comes to immature sciences. If the realist doesn't grant that immature sciences are genuinely referring, then there is no explanation for their success outside of luck, or a miracle. Thus, the realist has given up that "the success (of a scientific theory) is a reliable indicator of truth" (Curd, Cover, Pincock, 1258), and without this premise, the no miracles argument has fallen apart.

Once the anti-realist effectively reduced the structural differences between past, unsuccessful theories and our current theories to irrelevance then the failure of past theories to genuinely refer, it is reasonable to believe that our current theories also fail to genuinely refer, and will be replaced by other theories in time.

An Alternative

Laudan showed, with a fair amount of success, that there is no clear correlation between the success of a theory on empirical grounds and whether that theory genuinely refers to entities or structures that exist in reality. Once the success of a theory has been removed as a reliable indicator for the truth of a theory and the structures and entities it posits, it seems that we have little reason to believe our current theories are true, or that the entities that they posit exist. If science does not refer to entities and structures that exist, or if we have no way of knowing if they do, how can we explain the extraordinary success of the sciences?

A way to resolve this 'no miracles' argument for realism and the pessimistic meta-induction could be, rather than embrace the truth of reference that realism endorses or the skepticism of the anti-realist, to formulate a middle ground, a pessimistic realism, as it were.

In order to do this we will consider two cases of theories that were highly successful in their time, but have been shown to be false, and whose central tenets refer to entities that do not exist. The first example is the caloric fluid theory of heat. This theory posited that heat was a form of fluid that would flow from a warmer object to a cooler one until an equilibrium was reached, much like how water will flow from higher pressure to lower pressure systems until an equilibrium is reached. This theory was extremely successful, both in the theoretical and practical realms. Thermodynamics flourished and many of the engines and power generation cycles that were developed under the caloric fluid model were developed and optimized to the point where they are still used today.

Unfortunately caloric fluid does not exist. The theory did not genuinely refer to entities within the world. This serves as an effective counter-example to the 'no miracles' argument. Here we have a case of a theory that had a strong record of empirical success, but genuinely did not refer. The realist could then respond that while not genuinely referring, the caloric fluid was approximately true. This move is dubious, the entities posited by caloric fluid theory and the entities posited by the replacing theory, the mean kinetic energy of constituent molecules (MKE), in no way resemble each other. If we were to grant that caloric fluid theory is "approximately true" we would be saying that caloric fluid theory is approximately MKE. Most people would not be willing to grant this. For similar reasons, we see that the caloric fluid theory is not a 'special case' of MKE, because there is no special case of MKE that caloric fluid exists, and thus no special case where the term 'caloric fluid' genuinely refers.

This leaves us with a problem, if the caloric fluid theory of heat is false, and the term 'caloric fluid' does not genuinely refer, why did the theory work for as long as it did? Why was a non-referential theory able to make so many accurate predictions? Why are we able to use the models presented by the theory to model and optimize many engines and power generation cycles?

We now know that heat isn't some form of caloric fluid, but the mean kinetic energy of atoms and molecules. We have also observed that MKE posits entities and structures of reality that in no way resemble the entities and structures that the caloric fluid theory posits. In many ways, though, heat in the MKE theory behaves in a manner that one would expect a fluid to behave. The models and relationships (particularly the relationship between temperature and entropy) derived from the caloric fluid model have stood the test of time far better than caloric fluid theory itself. This seems to be because, while 'caloric fluid' could not have accurately referred to actual caloric fluid, it did genuinely refer to some underlying structure. More so, this structure, while in most respects completely different from caloric fluid, is relevantly similar to caloric fluid when it comes to certain behaviors of heat and relations of heat.

Now consider the wave theory of light. Initially this theory stated that light was a transverse wave travelling through ether. This, too, was a very successful theory in its time. Despite its success, the theory was shown to be incorrect. Initially the theory was reduced to a transverse wave in ether to an electromagnetic transverse wave that no longer required ether to move through. The theory was then replaced by the current theory where light has both the properties of a wave and a particle, leading to a 'wavicle' theory of light. Let's consider the evolution of the theory in three stages:

1. Light is a transverse wave traveling through ether
2. Light is an electromagnetic transverse wave traveling through space
3. Light is a wavicle

Stage one replaced a particle theory of light due to a number of successful predictions that effectively showed the transverse wave theory to be more empirically adequate than its predecessor. This theory was then genuinely referred to light as waves and to some sort of ether that the light travelled through. When the theory moved into stage two the properties of electromagnetic waves no longer required ether to move through. Ether was summarily dropped from the theory of light. Ether was no longer believed to be genuinely referring to any entity that existed in the world. Over time anomalies arose from the electromagnetic wave theory and theories of light entered stage three. Simple electromagnetic waves were no longer thought to be genuinely referring.

Progressing from stage two to stage three of the theory of light is much like the previous example of caloric fluid. A theory posited entities and structures that didn't exist in reality, but described the world that was relevantly similar to reality in how it relates to empirical evidence and for it's the contemporary mathematical modeling of the time.

The case of progressing from stage one to stage two is a different. Rather than moving from one system of beliefs and models, the theory seemed to remain the same in most manners, but the presence of ether simply fell out of the theory without having being replaced. This seems to be confusing a singular hypothesis (the existence of ether) and an entire theory (light is a transverse wave through ether). Hypotheses do not exist in a vacuum though. The ether hypothesis can only be posited with a transverse (pre-electromagnetic) wave, and the existence of light as a transverse (pre-electromagnetic) wave only can be posited with an ether. When the theory was proposed, it was believed that waves could not move without a medium to travel through, so it would have been irrational to suggest that light did not have this medium. Since the hypothesis came together as a set, not individually, we can see that this is actually not a case of a term merely falling away, not genuinely referring to anything, but an entire system being replaced by a newer, more empirically adequate system. The replaced system was at the time of its adoption, the most empirically and super-empirically acceptable, and over its life as the predominant theory of light posited many new predictions that were empirically adequate. This was not a miracle or coincidence, but because it described reality in a way that is relevantly similar to how the newer, better theories that we now use, and more importantly, it describes the world in a way that is relevantly similar to the world.

In both of these examples there were theories that were thought to genuinely refer to entities and structures in reality, but these entities and structures do not in fact exist. These theories did describe the world though, but not in a way that genuinely referred. They provided models that were relevantly similar to reality. These models were then replaced with other, superior models that, due to their greater empirical support, seem to have more similarity to reality. These models will then be replaced by superior models that are more similar still.

This, obviously, applies to our contemporary theories. Take our theories in quantum physics about quarks. The theory is not actually positing the existence of quarks as we know them, and thus not genuinely referring to quarks. What the theory is positing is that there exists something in nature that behaves similarly to the quarks we have posited in ways that are relevant to the model.

Looking at science as the development and testing of models that are relevantly similar to reality would allow for the ‘no miracles’ argument for scientific realism without having to accept or believe that the current body of scientific knowledge genuinely refers to entities in reality, nor would it have to commit to our current body of knowledge being “right”.

This differs from anti-realism in that the anti-realist position is that observation does not give us any knowledge about the underlying structures and entities, just that those entities are only posited as predictive aids, not as entities that exist in the world. Anti-realists are not claiming to refer to the unobserved world in any way. The difference is that the relevantly similar model is that the model is referring to an entity that, while not identical to the entity posited by the theory, is similar to the posited entities in a relevant manner.

On Relevant-Similarity

This, of course, brings about the question “What does it mean to be relevantly similar, exactly?” Outdated theories have been shown to have some level of similarity with the replacing theories, but what is the nature of this similarity?

The most intuitive answer to this question is that the old theories are mathematically similar to the way the world is, or in other words that, while the terms used in the theory are incorrect and the relationships posited in the theory are described wrong, they get the math right, or close enough. The numbers work out. By using a fluid model of heat, Carnot was able to come up with a set of equations that predict how heat would behave. It could then be said that the term ‘caloric fluid’ was just the trappings for the isothermal process equations. Similarly the ether and waves of light were just the backdrop for the mathematics of light. One of the main reasons this seems promising is that the carryover from the old theory to the new theory is often in the equations. Heat isn’t thought of as a fluid when a Carnot cycle is developed and the concept of light doesn’t regress when refraction is calculated, the equations are just used. Another reason the idea of mathematical relevance is appealing is because the mathematical rigor of the sciences is often what seems to set the sciences apart from other forms of study, so it seems fitting for mathematics to be central to a theory of relevance about the sciences.

While initially promising, it seems to run into three main problems. The first is that these mathematical equations don’t exist in a vacuum. They refer to entities and the relationships between entities. When velocity is treated as the derivative of position with respect to time, it isn’t the equation $v=dx/dt$ on its own, it is the motion of an object measured as the rate of change of position of that object. If then the theory that the equations were developed off of (or that was developed out of the equations) drops away, then the equations are lost as well. One could respond to this criticism by saying that it is more of a feature than a bug. Once the old theory falls away, the equations aren't lost, as shown by the fact that they are still used. When the new theory comes along they are ported over to it, referring to new entities or newly understood versions of the old entities. How these equations stay and evolve would then just go to show that they are in fact the relevant part of the theory. While the rest falls away, they remain.

The question, then, is "why do they remain?" or "in the development of our theories, why do we stick with the equations?" The answer to this seems to be that we stick to them because they work. The math *does* work out. By the math works out it is meant that the equations make accurate predictions. They then are modified to make more accurate predictions and are said to refer to different entities that they then make predictions about. This leads us to the next problem with this view, that is, if the equations are central and the theories around them are secondary, and the centrality of the equations is due to their predictive accuracy, then hasn't this theory just fallen back into full-blown anti-realism? By focusing on the equations of the theories and their predictive power, hasn't the scientific theory become merely a predictive aid rather than a description of the actual world? It seems that as the theory as a whole loses its primacy to the mathematical component of the theory, any form of realism becomes harder and harder to maintain.

A third objection to this view would be that it requires all sciences to be mathematizable. Moreover, it would not just require the sciences to be on a path towards being mathematized, but to be currently mathematized in order to be a science. This would seem to write off many of the life sciences as well the infancies of the harder sciences. This would make the sciences a much more exclusive group of studies than most people would be willing to grant.

Upon viewing the shortcomings of a mathematically relevant similarity, one could then go in the opposite direction. Relevant similarity could be framed as a historical or contextual phenomenon. This would be saying that the similarity between theories would be defined by their own historical context and in each case of theory transition could be explicated based on the previous and replacing theories. Furthermore, due to the diversity of scientific practice any attempt to systematize relevance would be doomed to fail. This too, has its problems. First off, it seems to simply avoid the question it is trying to answer. When asked how "relevant similarity" works, it shrugs and says that it has to look at things on an isolated, case by case basis. That is not a fulfilling answer to the question. The idea can be defended though by saying that, while yes it is unfulfilling that our theory of relevance isn't universal to the sciences and to scientific theory, neither are our sciences. The methods of experimentation and how theories are developed isn't unified across scientific disciplines and paradigms, so why would our theory of relevance need to be? Relevance within biology can be different than relevance in quantum physics which in turn can be different than relevance in thermodynamics, just as the methods of biological experimentation, thermodynamic experimentation, and the experimentation in quantum physics are all different.

Another hang up with the historical approach is that it has reduced itself to being merely descriptive, in that it can only speak of past cases of relevance. It requires the replacing theory to be available to speak about how the old theory was relevantly similar to the new theory, and presumably reality. Since we don't know what scientific theories will replace our current scientific theories, this theory of relevance cannot speak to our current scientific theories.

Conclusion

Instances of the general realist position that scientific terms genuinely refer have been shown to be false throughout the history of science. It seems unfounded and arrogant to believe that current scientific terms genuinely refer in spite of this history, to believe that “we have gotten it right this time”. Both sides, then, are still left with the problem of how science could be successful if it does not genuinely refer to the entities and structures in the world. More so, they are left with the problem of how past theories that have been shown to be non-genuinely referential were empirically adequate, and are in many cases still pragmatically adequate.

An answer to this conundrum is that the scientific terms and theories, rather than genuinely referring to entities and structures are models referring to a world that is similar to the models that they are presenting in a relevant manner. This idea can both explain why current theories make accurate predictions and why old theories worked as well as they did for as long as they did before being replaced by models that were more similar. In this we have a form of realism that does not rely on the genuine reference of terms but grants an account of science that doesn’t rely on a miracle.

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