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On the No Miracle Argument

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The dispute between scientific realism and anti-realism is one of the most exciting topics in the current general philosophy of science. In the debate, the anti-realists attack their opponents with two main arguments, the pessimistic induction and the underdetermination of theories by all possible data. The realists, on the other hand, defend their position through the famous no miracle argument, which seems to be their most important standpoint.

Scientific realism[1] has been the subject of various characterizations throughout this struggle (see, for example, van Fraassen 8, Kukla 3–4, Carman 43–6, Diéguez Lucena 252–253). We could summarize this position in the following four theses:

1. There is a world independent of the human mind, which is spatial and temporal.
2. This world is cognizable.

[1] I am referring to traditional scientific realism. I will not discuss the structural variants of realism in this paper.

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3. The best scientific theories are such that their theoretical terms refer.
4. These theories are true or approximately true.

In this paper, I will expose two reconstructions of the no miracle argument and will make a criticism of it, so that the realistic approach will be seriously questioned.

§1 - Posing the problem

First of all, I would like to clarify that I adhere to an anti-realist position. I think, as I tried to show elsewhere (Thiry), that there are no good reasons to ensure that our best theories satisfy theses 3 and 4.[2] But then a series of questions arise, namely, How do we explain the success of science? How is it that with false theories it is possible to account for the phenomena observed or produced and from them create advanced technology? We could pose the following dilemma: Is it by miracle that we can formulate successful (yet false) theories or is there no choice but to embrace scientific realism and consider that our best theories are true or that they approach the truth? I will try to show that it is not necessary to opt for either of the two horns of this dilemma, i.e., I will try to show how it is possible that certain theories, although false, can be successful and also, that their success is not miraculous.

This approach leads us to consider one of the best arguments of the realists, specifically, the already mentioned no miracle argument. One of its formulations was given by Putnam (1975). For this philosopher, realism "is the only philosophy that does not make the success of science a miracle" (Putnam 73). Thus, a way to reconstruct the argument would be the following:

(P1) If the best theories are not true or approximately true then their success is due to a miracle.
(P2) Miracles do not exist.
(C) The best theories are true or approximately true.

It is clear that this is valid reasoning since it is a case of Modus Tollens. To avoid the conclusion, my goal will be to show in paragraph three that P1 is false, i.e., I will show an example of a theory that is neither

[2] To be honest, I also have serious doubts about 1 and 2. However, I will not analyze these points in this work.

true nor approximately true and yet it is not due to a miracle that it has been successful, but its success is due to other reasons that I will develop later. That way, I will reject the two horns of the previously formulated dilemma by proposing a third way. Before I do, I will present my point of view using a thought experiment.

§2 - A thought experiment[3]

Let us suppose that some magnitude y depends on another magnitude x according to the equation $y = e^x$ (where 'e' is Euler's number, which is irrational and is approximately equal to 2.71828182). Let us also admit that scientists *do not know* that y depends on x in this way. Let us also suppose that in a certain period the two magnitudes (x, y) have been measured with their respective measurement errors and that the following data has been obtained:

$x_1 = 0 \pm 0.1;$ $\quad y_1 = 1 \pm 0.3$
$x_2 = 0.25 \pm 0.1;$ $\quad y_2 = 1.28 \pm 0.4$
$x_3 = 0.5 \pm 0.1;$ $\quad y_3 = 1.64 \pm 0.6$

At that time, researchers proposed some theory, with their respective principles, unobservable entities, etc., deducting from this theory that the formula that gives the dependency of y respect to x is:

(I) $\quad y = 1 + x + x^2 / 2$

This formula is in accordance with the experimental data, taking into account measurement errors, since if we replace x by 0 in the formula (I), we obtain $y = 1$, in accordance with the measured data; if $x = 0.25$, we get from (I) $y = 1.28125$, also according to the measurement, and finally, if $x = 0.5$, we obtain $y = 1.625$, also in the line with the empirical data.

Let us now consider that the scientists who work on this theory decide to make some novel predictions:

(II) If $x = 1$, then $y = 2.5$
(III) If $x = 1.5$, then $y = 3.625$

Imagine that one hundred years pass before it is possible to experimentally reach the corresponding values of x. After that period, the pertinent measurements are made and the following data is obtained:

[3] The article by Paul Hoyningen-Huene (2011) contains a highly technical exposition with some ideas similar to the ones developed here.

(IV) $x_4 = 1 \pm 0.3$; $y_4 = 2.71 \pm 0.4$
(V) $x_5 = 1.5 \pm 0.2$; $y_5 = 4.48 \pm 0.9$

It is clear the predictions (II) and (III) agree with the measurements (IV) and (V). Suppose now that researchers continue obtaining novel and successful predictions for another hundred years. What would a scientific realist say after this? That our theory has made novel predictions and that, as these have been confirmed experimentally, we must conclude that our theory is approximately true and that its theoretical terms refer. It would be very strange, a realist would think, that for two hundred years we have been able to make successful predictions with our theory and that it was completely false and that we have found it by pure miracle.

But note that for higher values of x, the differences between the value given by e^x and formula (I) are increasing. So for example, if $x = 10$, e^{10} is approximately equal to 22026, but equation (I) gives: $y = 61$; if $x = 20$, we obtain as an approximate value of e^{20} the number 485,165,195, but (I) gives the value 221; and so on for larger values of x. Thus, when those values of x can be reached experimentally, the measurements of the variables (x, y) will differ from the predictions made by the formula (I), and the theory in question will no longer successfully pass the empirical tests.

What is the moral of all this? We can formulate theories that fit the experimental data obtained previously, that make novel predictions, that these predictions are confirmed . . . and yet the theory can be false. But how is it possible that a theory makes successful novel predictions and that it is false? The point is that the first predictions of the theory of the example were within the range in which the numerical values of the formula (I) were similar to the numerical values of the supposed true equation $y = e^x$, and for this reason the predictions were fulfilled. It is possible that this situation is maintained for a long time but, after a number of years, scientists may be able to reach higher values of the variables x and y for which predictions no longer hold. Furthermore, the difference between two theories could lie not only in the accuracy of their predictions, but it could be the case that the ontologies proposed by each of them are completely different.

In this way, we have that it was not by miracle that the predictions were fulfilled, but neither was it because the theory corresponding to the formula (I) is true or approximately true. The same can be held for our best theories and hypotheses, at least those that are expressed by mathematical equations.

§3 - A real case

According to Newtonian mechanics, the inertial mass of a material object ("quantity that measures how much acceleration the unit-mass-body has when it is interacting with the given object") (Roederer 71), does not depend on the speed of the object. But, according to the theory of relativity, the mass of a body depends on the speed of the body in relation to a system of reference S, and it satisfies the formula [Feynman-Leighton-Sands 15–1]:

$$m = m_r / [\sqrt{(1 - v^2 / c^2)}]$$

where m_r is the mass of the body at rest in relation to a system of reference S, v is the speed of the body in relation to S, c is the speed of light in vacuum (approximately equal to 300,000 km/s). From that equation we obtain that m is approximately equal to m_r, remaining almost constant, if v is much slower than c, for example, if v is less than 1% of c.

Then, (A) if the theory of relativity (special and general) is true, we should consider Newton's mechanics false, given that Newton states, for example, that space and time are absolute, whereas Einstein considers them to be relative. That is, if a metal bar measures 1 m in relation to a system of reference S, it could measure 10 cm in relation to another system S', moving in relation to S, according to Einstein (Bunge 14). However, in Newtonian mechanics, the bar will measure 1 m in any system of reference. Something similar happens to elapsed time in S and S'. For relativistic mechanics, the elapsed time depends on the system of reference, and for Newtonian mechanics, it does not. There are other differences between the two theories: in relativity, space-time is described by Riemannian geometry and, by contrast, in Newtonian mechanics, space and time are described by means of Euclidean geometry; in Newtonian mechanics, the force of gravity acts at a distance, but according to Einstein, gravitational phenomena are explained through slopes in space-time produced by massive bodies; etc. The two theories cannot both be true at the same time (but they can both be false). They are logically incompatible with each other.

Currently, Einstein's theory is empirically adequate, and Newton's is not. So, how do we explain how Newton's mechanics had been successful for more than two hundred years? Was it by miracle? Was it because it was approximately true? Newton's mechanics cannot be considered nearly true if Einstein's theory is true, given the remarkable differences between the two theories. Its success can be explained by the following, which in no way appeals to miracles, but is based on facts:

In Newton's time, all the mobiles traveled at much less than 1% of the speed of light (that is, at much less than 3000 km/s). At these speeds, the numerical values provided by the equations of classical mechanics approximate the numerical values provided by relativity. Thus, the empirical data of that time confirmed Newton's mechanics for many years. This was the reason for the Newtonian theory's predictive success, and not a miracle. If the speeds reached in the seventeenth century had been greater, the inadequacy of Newton's theory would have been noticed in that century. Newton's mechanics were perfectly suitable for the data of his time and even accurately predicted values for many subsequent years, and thus appeared successful. But this does not imply that its success was due to a miracle or that it was nearly true.

That is not the only example that can be cited, for this kind of situations has happened on various occasions throughout scientific history, e.g. Wien's formula for the radiation of a black body versus Planck's formula, (Pérez Izquierdo 56–59). Ancient theories yielded certain numerical values that were later confirmed by experimentation, but this does not imply in any way that such theories are approximately true. These ancient theories have been contrasted under certain experimental conditions (for example, at low speeds in the case of Newtonian mechanics) and have been confirmed. And for that reason they have been considered successful. But when the range of values of the measured variables is extended or when new phenomena are discovered, we no longer have any guarantee that these theories will pass the experimental tests or that they will be able to account for the new empirical data. The truth could be very different.

(B) Let us now consider this other possibility: what would happen if the theory of relativity were false? In this case, a theory *T* not yet formulated could be true, such that the numerical results of *T* and Newtonian mechanics are very similar at low speeds. And, from here, the previous analysis is repeated *mutatis mutandis*.

What could be affirmed is that the numerical values of our theories are increasingly closer to the real values . . . but it could happen that the ontologies proposed by our theories are completely different from the real ontology and, thus, there are no guarantees that our theories are approximately true or that their theoretical terms refer.

§4 - The argument of non-miracle and the inference to the best explanation

Another way to present the no miracle argument is by relating it to the inference to the best explanation. According to Psillos (1999) "The realist claim is that accepting that successful scientific theories describes truly (or, near truly) the unobservable world best explain why these theories are empirically successful" (69).[4] This author goes on to assert that "NMA[5] intends to conclude that the main theses associated with scientific realism, especially the thesis that successful theories are approximately true, offer the best explanation of the explanandum"(Psillos 69).

If we consider that one way of presenting the inference to the best explanation is the following,[6]

(P1) q is the best explanation of p
(P2) p
(C) q

We could give a new formulation of the argument of no miracle:

(P1) The approximate truth of the theories T_1, $T_2, \ldots, T_n$ is the best explanation that they are empirically successful
(P2) $T_1, T_2, \ldots, T_n$ are empirically successful
(C) $T_1, T_2, \ldots, T_n$ are approximately true.

Now, it is clear that the argument I presented in §§ 2 and 3 directly attacks (P1) by showing that it is false that the best explanation of the success of the theories is that they are approximately true. Indeed, in those paragraphs I have given another explanation of the empirical success of theories as good as the assumption that they approach the truth. In this way, the inference to the best explanation loses its strength by not being able to conclude that $T_1, T_2, \ldots, T_n$ are approximately true.

§5 - Final considerations

I have tried to show that although it is not by miracle that certain theories and hypotheses are successful—namely, those expressed through equations—it is also not because they approach the truth. The reason for their success is due to the fact that for a certain range of its variables, the predicted numerical values are similar to the numerical values of the true equations. And this situation can be maintained for many years and even centuries. But, after a certain period of time, experimental scientists can

[4] Redlined in the original.
[5] No miracle argument.
[6] See Frost-Arnold, Greg (2010).

expand the range of values of the equations reached and it can happen that the theories and hypotheses in question are no longer confirmed.

One could continue insisting with the approach to the truth affirming that the old theories are a limit case of the new ones. Those arguing in this manner forget that a theory is much more than the numerical value provided by its equations because it involves a whole ontology proposal and new theories, usually, not only differ in the values of the equations but also in that ontology. It is enough to think about the great ontological difference between, for example, Ptolemaic and Keplerian astronomy or between Newton's physics and Einstein's.

I think I have shown that scientific realists have lost their best argument, that of the no miracle, in their attempt to show that our best theories are approximately true and that their theoretical terms refer. It only remains to embrace a healthy skeptical position with respect to the thesis of realism.

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