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# Can meaningless statements be approximately true?

# On relaxing the semantic component of scientific realism

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First, I show that the semantic thesis of scientific realism may be relaxed significantly—to allow that some scientific discourse is not truth-valued—without making any concessions concerning the epistemic or methodological theses which lie at realism's core. Second, I illustrate how relaxing the semantic thesis allows realists the flexibility to avoid commitment to the existence of abstract entities and potentially avoid some objections to the 'no miracles' argument from positions such as cognitive instrumentalism. Third, I argue that the semantic thesis of scientific realism *should* be relaxed, because it is possible for scientific statements to be partially true, and hence approximately true, without being false.

## 1. Relaxing the Semantic Thesis

Scientific realism is often said to consist of several distinct theses, which come in somewhat different variants.[1] The semantic thesis is normally understood to involve the claim that scientific discourse is truth-valued, even when it concerns unobservable entities. For example, Psillos (1999: xix) writes:

[1] 'What is scientific realism?' requires extensive discussion to answer fully and is thus beyond the scope of this piece. See, for example, the treatments of Rowbottom (2017) and Chakravartty and Van Fraassen (2018). The characterization I give in the main body captures how several key proponents of scientific realism, such as Boyd (1983) and Psillos (1999), understand the position.

> The semantic thesis takes scientific theories at face-value, seeing them as *truth-conditioned descriptions* of their intended domain, both observable and unobservable. Hence, *they are capable of being true or false*… [my emphasis]

And Chakravartty (2017) writes, in a similar vein:

> According to [scientific] realism, claims about scientific objects, events, processes, properties, and relations … whether they be observable or unobservable, should be construed *literally as having truth values, whether true or false.* [my emphasis]

The primary purpose of the semantic thesis is to block various positions on scientific discourse that threaten—or are straightforwardly incompatible with—scientific realists' positive epistemic attitude towards scientific claims concerning unobservable entities. For instance, a contemporary scientific realist would think that electrons (or something highly similar) exist. But this could not be correct if discourse concerning electrons were merely a device to enable inductive generalisations about how phenomena interrelate, in line with positivistic proposals in response to Hempel's (1965) theoretician's dilemma.

More precisely, the semantic thesis is intended to block various linguistic routes to attacking, or denying the truth of, two other theses that lie closer to the core of scientific realism.[2] First is the

[2] They lie much closer to the core because they express the epistemic optimism of scientific realism, when an appropriately realist view of truth—such as a correspondence view—is assumed. And as Psillos (2000: 716) notes: 'the main target of the non-realist onslaught has been realism's epistemic optimism'. I will not here discuss the

epistemic thesis of scientific realism, which is normally understood to be similar to: scientific discourse is (probably) approximately true when it has played a significant role in issuing successful novel predictions.[3] Second is a methodological thesis that does not feature in most explicit formulations of scientific realism, but which Rowbottom (2017; 2021) has recently highlighted and discussed. Psillos (1999: xxi) mentions this methodological thesis in the following passage:

> It should be taken to be implicit in the realist thesis [i.e., in scientific realism] that the ampliative-abductive methods employed by scientists to arrive at their theoretical beliefs are reliable: they tend to generate approximately true beliefs and theories.

Evidently, the epistemic and the methodological theses require that scientific discourse can be approximately true even when it concerns unobservable things. Somewhat less obviously, they also require that scientific discourse is *frequently* capable of being approximately true even when it concerns unobservable things. Else many scientific theories could fail to be approximately true despite being generated by ampliative-abductive methods (in line with the methodological thesis) and despite playing significant roles in generating successful novel predictions (in line with the epistemic thesis).

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metaphysical thesis of scientific realism, as it might be true independently of the other theses. In particular, it might be true irrespective of whether the semantic thesis is.

[3] Psillos's (1999: xix) variant is as follows: 'Mature and predictively successful scientific theories are well- confirmed and approximately true of the world. So, the entities posited by them, or, at any rate, entities very similar to those posited, inhabit the world.'

Relatedly, approximate truth features in the key argument for scientific realism, namely the 'no miracles' argument, which is (roughly) that what best explains why a scientific theory is empirically successful, when it is empirically successful, is that it is approximately true. If this argument is sound, then empirically successful theories are typically, if not always, capable of being approximately true.

In summary, then, the idea behind the semantic thesis is as follows. If we can safely say that almost all scientific discourse is true or false, then this opens the way for approximately true claims concerning unobservable things to be (reliably) identified by scientists. However, the semantic thesis is bolder than is necessary in one respect, and is insufficiently bold in another respect, to 'screen off' semantic issues in considering whether the epistemic and methodological theses are true. I will deal with each aspect in reverse order.

First, the semantic thesis claims only that scientific discourse is (frequently) true or false. But this doesn't entail (or even make it highly probable) that said discourse is (frequently) capable of being approximately true, in the light of the difficulties that have faced content-based and consequence-based theories of approximate truth.[4] Second, the semantic thesis is stronger than it needs to be. That's because it's sufficient for scientific discourse to frequently be capable of being approximately true for there to be no effective semantic objections to the epistemic and methodological theses (and the 'no miracles' argument). In essence, that's to say, the scientific realist's semantic commitment need only be as follows:

> Semantic*: Scientific discourse is (typically or frequently) capable of being approximately true, even when it concerns unobservable entities.

[4] See Oddie (2014) for an overview of these problems.

It is possible that some scientific realists would object to having semantic* replace the standard semantic thesis, however, because scientific realists tend to believe something that isn't made explicit in the epistemic or methodological theses. Roughly, this is as follows: *some* theories are true and scientific methods are *sometimes* able to identify true theories.[5] Thus, it is prudent to add an extra clause to semantic*, to arrive at:

> Semantic†: Scientific discourse is (typically or frequently) capable of being approximately true, even when it concerns unobservable entities; scientific discourse is also sometimes capable of being true.

In summary, I have so far shown that a semantic thesis stronger than semantic† is an overreaction to the threat to the epistemic and methodological theses posed by logical positivism (and closely aligned positions). In the next section, I will go on to argue that adopting semantic† allows realists to avoid positing abstract entities, and to resist the semantic objections to scientific realism due to Rowbottom (2011 & 2019) provided that scientific discourse may be approximately true while failing to be false. In the final section before the conclusion, I will provide a novel argument to the effect that scientific discourse may be approximately true without being false.

Before I continue, however, note that putting semantic† in place of the standard semantic thesis is a significant improvement in the formulation of scientific realism irrespective of whether the subsequent arguments are sound. Doing so illustrates that scientific realists are free to adopt

[5] Although as even Boyd (1980: 631), a highly influential realist, admits: 'Exactly true theories, if there have been any at all, are utterly exceptional in science.'

more nuanced views on the use of language in science than those permitted by the standard semantic thesis, as may be desirable in the light of psychological studies illustrating how rich science is in analogies and metaphors.[6] Semantic† is also compatible with any individual scientific realist making stronger semantic commitments, should she so wish.

## 2. Advantages of Relaxing the Semantic Thesis

Scientists posit and discuss things that many philosophers of science take to be fictional.[7] Abstract models involving idealisations are commonplace, especially in physics, as has been highlighted by Cartwright (1983), Morgan and Morrison (1999), and many others. It would be natural, in the light of this, for a scientific realist to 'admit that in many cases, there will be *local* independent reasons to take some posited entities as fictitious' (Psillos 2011: 6). However, Psillos (2011) prefers to maintain the semantic thesis and allow that abstract entities exist:

> A literal understanding of scientific theories implies commitments to models *qua* abstract objects. Insofar as these theories (taken literally) are true, there are these abstract entities… They are abstract objects that can stand in representation relations to worldly systems. (Psillos 2011: 8)

[6] See, for example, Gentner et al. (1997) and Dunbar and Blanchette (2001).

[7] See Frigg (2010) for an overview and several quotations from earlier work. Frigg bases his own theory on Walton's and notes that 'Walton's theory is antirealist in that it renounces the postulation of fictional or abstract entities, and hence a theory of scientific modelling based on this account is also free of ontological commitments.' (Frigg 2010: 264).

In short, Psillos holds that approximately true physical claims can be derived from facts concerning real abstract entities, to the extent that said entities adequately represent physical things. This is a bold and interesting move. However, it is unnecessary to preserve the core of scientific realism and insufficient to handle many cases of scientific discourse that are (*prima facie*) figurative but do not concern models. I will argue each point in turn. In doing so, I will take it as uncontroversial that many scientific realists would prefer to avoid commitment to the existence of abstract entities, *ceteris paribus*. As Psillos (1999) himself notes, many scientific realists are naturalists; see, for example, Boyd (1980).

First, why might one think that maintaining the semantic thesis, and taking talk of abstract entities literally, is prudent? Psillos (2011: 6) worries that to think otherwise:

> …amounts to a rejection of a face-value reading of theories. Realism has to go for a non-uniform semantics of scientific theories, and a story should be told about where exactly, and why, the line between the literally understood and the non-literally understood part of a theory is drawn.

Psillos (2011) doesn't say much more on this issue. However, it is reasonable to conclude that he considers it to be extremely difficult to formulate such a non-uniform semantics. I am more optimistic. Consider, for example, how Rowbottom (2011 & 2019: ch.2) makes a concrete step towards providing a non-uniform semantics for discourse concerning unobservable things by providing a necessary condition for such discourse to be taken literally; on this condition, for example, talk of objects possessing unobservable properties is neither true nor false. Formulating a non-uniform semantics with broader scope might proceed in the same vein. For instance, one might take scientific discourse concerning an object to be non-literal if said object

is assigned properties that are incompatible according to the scientific theories or beliefs of the day (unless it is stated in the context that said theories or beliefs are being challenged). Thus, discourse concerning a solid object with volume but no mass—or with mass but no volume—would typically be construed non-literally. One might add further necessary or sufficient conditions for discourse concerning objects to be non-literal, and thereby construct a non-uniform semantics. This might never be complete or uncontroversial, but one should be careful about demanding too much. It is especially curious to demand precision concerning the semantic component of realism that is evidently lacking from other elements thereof. For instance, Psillos lacks 'a story about … where exactly, and why, the line' between falsehood and approximate truth should be drawn. But he endorses scientific realism nonetheless.

Second, some seemingly figurative discourse in science is difficult to take as literally concerning abstract entities, because it is entrenched in broad 'framework' theories or general laws rather than merely in local models involving explicit idealisations. Consider relativistic mass, which is a notion that appears in many classic university level textbooks, as a case in point.[8] How this ought to be construed, and whether it's even a useful heuristic device, is a matter of considerable controversy; see, for example, Adler (1987), Okun (1989), and Sandin (1991). Several of the issues at stake are ontological. For example, mass in classical mechanics is naturally construed as an intrinsic property of bodies, and it is unnecessary to differentiate between inertial and gravitational mass in applications thereof. In short, a single mass value may be attributed to any given body. Yet increasing the speed of a body in special relativity need not be construed as altering an intrinsic mass-like property thereof. It isn't even correct to say that the inertial mass of a body increases as its speed does—although this is a common misconception—because

[8] Adler (1987) provides several interesting quotations illustrating how textbooks introduce this.

only (something like) *inertial mass relative to forces applied in specific directions* is so affected. Lorentz introduced longitudinal and transverse mass concepts for exactly this reason.

In essence, there is rather a conceptual mess in this area, which is easily missed—or ignored—from a 'shut up and calculate' perspective. And this explains, to some extent, Feynman's remarkable declaration that: 'For those who want to learn just enough about it so they can solve problems, that is all there is to the theory of [special] relativity—it just changes Newton's laws by introducing a correction factor to the mass.' (Feynman et al. 1963: section 15-1). But the fact that so many different notions of mass are possible—inertial, rest, relativistic, longitudinal, transverse, passive gravitational, and active gravitational[9]—results in considerable conceptual confusion. Physicists' treatments are often even incoherent, when read literally. As Okun (1989: 35) puts it, rather pointedly:

> I have seen many books in which all the notions, consistent and inconsistent, are so mixed up that one is reminded of nightmare cities in which right and left-side traffic rules apply simultaneously.

And truth requires consistency, irrespective of whether abstract or concrete entities are the object of discussion. Thus, it does not seem to be possible to handle many cases in which 'relativistic mass' appears by the 'commitment to abstract objects' strategy. Moreover, Rowbottom (2019) covers other pervasive physical posits, such as spin and virtual photons, which are similar to relativistic mass in this respect.

[9] The (potential) difference between 'passive' and 'active' gravitational masses is also obscured in normal secondary school, and often even in university-level, education. See Roll et al. (1964) for an indication of its significance.

Even in several simple local cases involving consistent abstract models, furthermore, only what is *approximately true* therein is used to represent physical systems. Take the simple pendulum as a case in point. The model involves a highly idealised scenario that is logically, if not metaphysically, possible—a pendulum swinging in a uniform gravitational field in just two dimensions, with no friction forces, etc.—but an approximation is applied to this to derive an equation for the period of a pendulum at low angles of swing. In this specific case, Psillos might respond as follows: it is *true* that the motion of the simple pendulum is approximately simple harmonic under appropriate circumstances, and *this* recognition enables the equation to be derived. It is unclear, however, whether such a strategy will generally be applicable when dealing with toy models. Thus, the underlying thought here is that the semantic thesis might be too strong at the ('higher') level of discourse concerning abstract things, because discourse concerning abstract things may also be non-literal.

In summary, semantic$^{\dagger}$ gives the realist flexibility to argue that approximate truths about the physical world can be established despite the presence of figurative language, vague terminology, and even inconsistencies, in scientific discourse. Indeed, semantic$^{\dagger}$ may even be reformulated as follows—to avoid making implicit claims about discourse concerning abstract entities—without doing any explicit violence to the epistemic and methodological theses of scientific realism:

> Semantic$^{\ddagger}$: Scientific discourse directly concerning (observable and unobservable) physical entities is (typically or frequently) capable of being approximately true; scientific discourse directly concerning said entities is also sometimes capable of being true.

In fact, adopting semantic‡ in place of the standard semantic thesis also potentially allows scientific realists to accept some views advanced by their opponents, such as the *property instrumentalism* argued for by Rowbottom (2011 & 2019: ch.2), while continuing to endorse the 'no miracles' argument (for the epistemic and methodological theses). To be more specific, Rowbottom (2019: 29) outlines property instrumentalism as follows:

> [T]alk of unobservable objects should be taken literally only in so far as those objects are assigned properties, or described in terms of analogies involving other things, with which we are experientially (or otherwise) acquainted.

*Prima facie*, this is a threat to the core of realism because if talk of unobservable entities is neither true nor false, then is not approximately true. However, the idea that approximate truth *requires* falsity is exactly what I will challenge in the next section. Property instrumentalism is no threat to the core of realism provided that talk of unobservable objects is often approximately true and that what best explains the success of a scientific theory is the approximate truth thereof.

## 3. Approximate Truth without Falsity

Many of the most plausible candidates for approximately true statements—such as 'The Earth is spherical', 'The acceleration of a body is directly proportional to the resultant force acting on it, when its speed is much lower than the speed of light', and Kepler's second law of planetary motion—are false. In this section, however, I will argue that approximately true statements may lack classical truth values altogether (and be 'meaningless', in accord with the title of this piece, in this precise sense). Beforehand, I would reiterate that my findings up to this point are of considerable value even if this final argument is eventually found wanting.

The argument runs as follows. Consider a sentence *S* of the form '$p$ and $p_1$ ... and $p_n$ and $\mathcal{J}$'. Let $p$ to $p_n$ have truth values but $\mathcal{J}$ lack a truth value. (Ayer (1936) gave 'God exists' as an example of $\mathcal{J}$, and Rowbottom (2019) offers 'Electrons have spin'.) As a result, *S* lacks a truth value. *S* is incomplete.

However, an expert in the language used in *S* could easily identify the content therein. Indeed, she might readily identify how to delete 'and $\mathcal{J}$' in order to form a complete sub-sentence *S** of the form '$p$ and $p_1$ ... and $p_n$'. In fact, it is likely that most readers have encountered an utterance of the form *S*, where the speaker stopped for dramatic effect, was curtailed by an interruption, or just unwittingly failed to obey the rules of syntax in the language (perhaps due to inebriation). Nonetheless, said readers will likely have acquired true beliefs about what the speaker wanted to convey, based on *S**'s meaning (or, more plausibly, on the possible interpretations of *S** in the context of utterance).[10]

My argument rests on the claim that sentences of form *S* are sometimes approximately true. Consider the following two scenarios in support. First, let $n$ be large, $p$ to $p_n$ be true, and $\mathcal{J}$ be very small (in terms of relative written or spoken length). Then *S** is true although *S* has no truth value, and because *S** is so much longer than *S*, it is reasonable to attribute approximate truth to *S* (in the domain that *S** concerns). Second, let $n$ be large, let *S** be approximately true,

[10] In the remainder of this piece, I will put aside issues concerning context in determining the meaning of a sentence, although context is clearly important for a variety of reasons. Consider, for instance, how the meaning of indexicals is fixed.

and let $\mathcal{J}$ be very small relative to *S**. Again, it appears reasonable, at least *prima facie*, to attribute approximate truth to *S* (in the domain that *S** concerns).[11]

The presence of 'in the domain that *S** concerns' covers the fact that when approximate truth is claimed of a theory, a narrative concerning a historical event, a factual statement concerning a specific matter, and so forth, this is only relative to a proper subset of all true claims, which is the set of all true claims concerning its target. For instance, when realists say general relativity is approximately true they mean only that it has a high degree of truth relative to the truth concerning its target domain. So the fundamental idea behind the previous two examples is that *S* may be *partially true* despite some elements thereof lacking truth values, and that under specific circumstances, *S* may also be approximately true of a domain. For example, if *S** contained only the true theory of mechanics and $\mathcal{J}$ was very small in relation to *S**, then *S* would be approximately true of mechanics.

An initial concern might be about how to measure length (or 'size') of elements (in *S*) in a principled way. This arises because it is often possible to express the same hypothesis in more than one way, such that one expression is verbally longer than the other. Take 'Io is a moon of Jupiter' and 'Io is a celestial body that orbits Jupiter' as cases in point. One way out of this difficulty is to measure string length when the propositions involved are atomic and represented in predicate logic (such that they therefore involve atomic predicates). (By 'atomic', I mean 'not decomposable'; complex predicates can be expressed in terms of other predicates.) This works for the propositional components of *S*. But what about $\mathcal{J}$? Provided this involves language that superficially appears to be meaningful and has a sentential form—and in science, this is

[11] 'Note that '*p* & *q* is approximately true' does not follow from the fact that the conjuncts are each approximately true; hence, I write of *S** being approximately true.

typically the case—then $\mathcal{J}$ can be represented in a similar way. Consider one of the putative examples of $\mathcal{J}$ mentioned earlier: 'Electrons have spin'. Rowbottom (2019) doesn't deny that this can be represented in logical form. Rather, his discussion is consistent with 'Electrons have spin' being representable in predicate logic but being inconsistent or incoherent when decomposed for *semantic* rather than syntactic reason*s*. It is not possible to fully reproduce his argument concerning spin here, but it rests on a denial that 'intrinsic angular momentum' can be coherently ascribed to an object in a case where the object is explicitly held to not *really* be spinning: 'angular momentum is to momentum as torque is to force: both are moments, in the language of physics, in so far as they involve distances. But what is the distance we're supposed to be using in the case of the electron's "angular momentum"?' (Rowbottom 2019: 49).[12] In short, the moral is that there are principled measures of length that may be applied to all elements of many sentences of form *S*.

What further objections might there be to the notion that some sentences of form *S* may be approximately true? There are certainly no standard refutations of the claim. Oddie (2014) reflects the *status quo* in his article on truthlikeliness; his focus is on how 'inquiry can progress by moving from one falsehood to another falsehood'. The possibility of approximate truth without falsehood is not even mentioned. '*S* is not a well-formed formula' might be a knee jerk response. But this has been explicitly accepted. The contention is that *S* need not be well-formed to be approximately true. And this should perhaps be unsurprising, given that the very idea of a 'well-formed formula' arises in the context of bivalent logic(s).

[12] If there is only inconsistency present in the relevant predicate logic representation of 'Electrons have spin', then claims about spin will just be necessarily false. Incoherence of spin discourse would involve at least one semantically defective (such as 'empty') atomic predicate (or perhaps 'pseudo-predicate').

Nonetheless, an objector might rejoin as follows. Why not consider *S**, which does have a truth value, in isolation? The reason is that whether an incomplete sentence is approximately true depends on all its components, not just a part thereof. For instance, if $\mathcal{J}$ is extremely long relative to *S** then this matters for what we conclude about *S*. Moreover, $\mathcal{J}$ might perform significant non-representative epistemic functions, such as aiding in heuristic respects (in some contexts). For example, Rowbottom (2019: 100) notes that: 'the idea of spin (*qua* self-rotation) proved useful in making predictive progress, and especially in working out the proper (*qua* predictively successful) values for the fourth quantum number.' Thus, $\mathcal{J}$ may not be easy to dispense with. And anti-realists may add that elements like $\mathcal{J}$ are often understandably mistaken for (truth-valued) propositions partly as a result.

It remains an open question as to how much scientific discourse can reasonably be understood to be representable in the form of *S* (such that all elements of *S* can be measured in length in a principled way). In some cases, matters seem relatively clear. For example, 'Electrons have charge and mass and spin' appears to be legitimately representable in such a way, and true to a degree, even if 'Electrons have spin' is neither true nor false. However, showing that special relativity is representable in said way, with discourse concerning 'relativistic mass' being a part of $\mathcal{J}$, is a more difficult prospect. I am sanguine about the prospects of doing this, although it is not possible within the confines of this piece. I should add that an attempt to do so might disclose interesting facts about exactly how appeals to 'relativistic mass' function.

In closing this section, I should reiterate my suggestion *S* might have a degree of truth—or just be partially true in a qualitative sense—even when it is not approximately true. This possibility bears on the necessary semantic presuppositions of positions that are intentionally weaker than standard scientific realism, such as Saatsi's (2019) *minimal realism*. Minimal realism involves

significant elements of truth replacing approximate truth in an explanatory role. It likely only requires an elegant but weak semantic thesis, akin to: 'Scientific discourse directly concerning (observable and unobservable) physical entities is capable of being partially true.'

## 4. Conclusion

I have argued for three things. First, the semantic component of scientific realism may be significantly relaxed without making any concessions concerning the epistemic and methodological components thereof. Second, relaxing the semantic thesis proves advantageous in avoiding commitment to the existence of abstract entities and evading recent linguistically motivated objections to scientific realism. Third, it is possible for scientific claims to be approximately true even when they are not, strictly speaking, false (although the standard semantic thesis fails to allow for this). Overall, my conclusion is that scientific realists should relax the semantic thesis in the manner I have detailed.

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