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DISCUSSION NOTE

Dejustifying Scientific Progress

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Abstract

Stegenga (forthcoming) formulates and defends a novel account of scientific progress, according to which science makes progress just in case there is a change in scientific justification. Here, we present several problems for Stegenga's account, concerning, respectively, (i) obtaining misleading evidence, (ii) losses or destruction of evidence, (iii) oscillations in scientific justification, and (iv) the possibility of scientific regress. We conclude by sketching a substantially different justification-based account of scientific progress that avoids these problems.

1. Introduction

In a recent article in this journal, Stegenga (forthcoming) formulates and defends a justification-based account of scientific progress. In this account, science makes progress just in case there is a change in scientific justification. Stegenga notes that he was "surprised to learn" that the literature had "neglected [this] compelling contender" (forthcoming, 1). Here, we present several problems for Stegenga's account, which may go some way toward explaining this neglect. We conclude by offering up a substantially different justification-based account of scientific progress that avoids these problems.

2. Stegenga's account

There are many ways to build justification into an account of scientific progress. In Bird's (2007, 2022) epistemic account, for instance, justification is front and center because science makes progress via the accumulation of knowledge, and knowledge requires justification. Indeed, even when justification is not front and center, it has certainly not been neglected in discussions of progress. Niiniluoto (2014, 76), for

instance, when defending his truthlikeness account from Rowbottom's (2008) objections, claims that "beliefs without any justification simply do not belong to the scope of *scientific* progress." Stegenga's account is unique, however, in that justification is its *only* component, thereby eschewing notions that have been central to the most prominent accounts proposed in the last 50 years, such as *knowledge* (Bird 2007, 2022), *truthlikeness* (Niiniluoto 2014), *understanding* (Dellsén 2021), and *problem-solving* (Laudan 1977).

According to Stegenga's statement of his account, "*[s]cience makes progress if and only if there is a change in justification*" (forthcoming, 3, italics in original). Strikingly, Stegenga considers but immediately rejects a justification-based account according to which progress is made just in case there is an *increase* in the degree to which some hypothesis is justified. What matters for progress, he insists, is not increase but *change*. This aspect of the account is motivated by the observation that evidence that bolsters our justification for some hypothesis H will correspondingly decrease our justification for its contrary, ¬H, and vice versa, so any new evidence will increase our justification for *some* hypothesis. Thus, argues Stegenga, increases and changes in justification are "formally interchangeable as an account of scientific progress" (forthcoming, 10).

Stegenga considers various explications of "change in justification" but doesn't commit to any particular one for the purposes of his account. Notably, however, Stegenga says of the notion of *scientific* justification that it is "special: it is communal and inter-subjective" (forthcoming, 2), and he goes on to emphasize that scientific progress must have uptake in the broader community beyond the scientists doing the research itself. The social function of scientific progress has been given insufficient attention in the literature (although see Dellsén 2023), and thus this emphasis is, in our view, a laudable feature of Stegenga's account.

Finally, Stegenga's article does not explicitly propose a measure of the *degree* to which there is scientific progress in a given episode—that is, the *amount* of progress. This is a crucial issue for any account of progress to address because an account that merely judges that there was (some) progress in certain episodes cannot account for the fact that there was *more* progress in theoretical physics in the first few decades of the 20th century than in the first few decades of the 14th century, for instance (assuming that there was *some* progress during both periods). In light of this, we shall interpret Stegenga as being committed to a natural extension of his stated account, according to which the *degree* to which there was progress in a given episode is in some way proportional to the degree to which there was a change in justification.[1]

With Stegenga's account thus outlined, we will now show that it faces four substantial problems.

3. Progress through misleading evidence?

The first problem stems from the commonsensical observation that evidence can be *misleading*. That is, part or all of someone's evidence E may support some particular hypothesis H, despite H being false—even radically so. There seem to be two broad

[1] Stegenga (personal communication) has confirmed that this is a correct interpretation of his view.

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ways in which this could occur. First, E might itself be flawed in some way, such as in a failed experiment or botched observation.[2] Second, even if E is itself in good standing, E might nevertheless be in some way unrepresentative of the truth. As an example of the latter, consider all the evidence available to European naturalists in the 16th and 17th centuries that lent justification to the hypothesis that there are no egg-laying mammals. This hypothesis is false, as demonstrated by the existence of the platypus and other monotremes, but there was no way for Europeans to know this because all specimens of monotremes were located on the other side of the globe.

Misleading evidence is a problem for Stegenga's account because obtaining misleading evidence would imply a change in justification. After all, although misleading evidence is *misleading*, it is still *evidence*—and evidence is, paradigmatically, the sort of thing that changes whether or the extent to which a hypothesis is justified. So no matter how misleading a given piece of evidence is—for example, in that it supports a radically false hypothesis—obtaining it would still be progressive on Stegenga's view. Indeed, a consequence of Stegenga's view is that obtaining misleading evidence of this kind would be just as progressive as obtaining ordinary, nonmisleading evidence that changes our justification of some hypothesis to the same degree. As a corollary, obtaining a substantial amount of misleading evidence and no ordinary (nonmisleading) evidence would be highly progressive—more progressive than obtaining a slightly smaller amount of ordinary (nonmisleading) evidence.

This is all very hard to swallow. Surely, evidence that misleads the scientific community into accepting false or decreasingly truthlike theories should not count as equally progressive as ordinary nonmisleading evidence. Indeed, the problem is not just that these consequences of Stegenga's account are highly counterintuitive. More importantly, they show that Stegenga's account does not have the resources to explain the basic fact that we should prefer to have made more progress rather than less (all other things being equal), for if Stegenga's account is correct, then "scientific progress" might put us in a position in which we have lots of misleading evidence and no ordinary (nonmisleading) evidence at all regarding various scientific claims. In such a scenario, those of us who put our trust in the scientific evidence, with confidence buoyed by the apparent prevalence of progress in science, would be led astray, in that we would believe and act on false claims. This would be a type of "scientific progress" that we would arguably be better without.

[2] Some might object that E would not actually be evidence in such cases, on the grounds that "evidence" is factive or even coextensive with "knowledge" (Williamson 2000). However, this type of objection does not seem available to Stegenga because he motivates his account by imposing an *epistemic accessibility desideratum* according to which it should be obvious to scientists whether they are making progress (see sec. 7). This clearly conflicts with the idea that evidence should be factive because whether a given piece of apparent evidence is in fact due to a failed experiment, botched observation, or data fraud is not necessarily—or even typically—obvious to the scientists themselves (if it were, then the scientists would immediately discard it). With that said, because it might be controversial among our readers whether this first type of misleading evidence is indeed evidence at all, and there is another type of misleading evidence that will not be similarly controversial (as discussed next), we are happy to rely only on the existence of the second type of misleading evidence in what follows, thus in effect bracketing the issue of whether "evidence" is factive.

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4. Progress through lost/destroyed evidence?

A related problem stems from the fact that a change in justification may come about because evidence is *lost* or even *destroyed*. In everyday life this is commonplace; it may simply consist of forgetting something. In science, by contrast, there are various mechanisms in place that are designed to prevent evidence from being lost or destroyed. For example, academic libraries, data servers, and online repositories are all designed to preserve data and other forms of evidence, as well as other information that may contribute to justification (e.g., arguments, proofs, computer code). Even so, scientific evidence can be lost or destroyed. After all, libraries have burned down or had their books stolen, servers have been destroyed or had their files deleted, repositories have been hacked or decommissioned, and so on.

This is a problem for Stegenga's account because losing scientific evidence is one way in which scientific justification may change.[3] In particular, in losing evidence for some proposition P, our justification for P often decreases. For specificity, suppose that some data are lost and unrecoverable, and the researchers cannot recall whether and the extent to which the data supported rejecting their null hypothesis. We take it that in such a case, the scientific community might have less justification for the negation of the researchers' (null) hypothesis than they had before the data server crashed. By Stegenga's lights, such a decrease in justification counts as progress.

As before, the problem here is not just that these consequences of Stegenga's view are bizarre. The concern is that a concept of "scientific progress" according to which progress may consist of losing evidence does not seem to be well suited to explain why scientific progress is worth making. Relatedly, Stegenga's account seems to imply that scientists who are seeking to maximize scientific progress on a given issue should behave in ways that seem antithetical to the ethos of science. For example, scientific progress would be achieved by deliberately destroying extant pieces of evidence.[4] Indeed, because activities such as hacking research repositories would presumably destroy a great deal of evidence—which in turn would cause large-scale changes in justification and thus a great deal of scientific progress—such activities should be highly incentivized.

5. Excessive progress through justification oscillations?

A third problem concerns the way in which the amount of progress that occurred during a given episode is measured. Suppose that the scientific research into some phenomenon from an initial time t_0 to the current time t_n has substantially increased our degree of justification for some hypothesis H. On Stegenga's view, one would have thought that this change in justification should straightforwardly translate into a corresponding degree of progress. But note that this substantial increase in justification could either have been the result of (a) a series of incremental increases in the justification for H or (b) a series of incremental increases interspersed with even smaller decreases in the justification for H, such that the substantial increase in justification is reached via a repeated process of "two steps forward, one step back."

[3] Note that this is compatible with granting–as we are happy to do here–that losing evidence need not affect justification in every case (see, e.g., Goldman 1999).

[4] This consequence is very much at odds with the intended "account of scientific progress faithful to the spirit of the scientific attitude and to the real achievements of science" (Stegenga, forthcoming, 2).

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Because there would be more *changes* in justification between t_0 and t_n in scenario (b), on Stegenga's account, there would be more progress in that scenario, despite the two scenarios having the very same starting points and end results.

This situation creates two related problems for Stegenga's account. The first (and more straightforward) problem is that it simply does not seem plausible that there would be more progress in scenario (b) than in scenario (a), as Stegenga's account implies. The second (less straightforward) problem concerns what this implies about how—or indeed, whether—progress can be measured over any extended time interval. Given the possibility of (b)-type scenarios, in which justification oscillates back and forth, Stegenga's account implies we cannot tell how much progress was made between t_0 and t_n by simply looking at the net change over that time. After all, every tiny increase and decrease in justification must be summed together to determine how much progress occurred. It thus turns out to be surprisingly difficult to estimate the extent to which there was scientific progress over any given period of time, on Stegenga's account, because doing so requires knowing about and measuring the extent of every single minuscule change in justification that occurred over that period.

6. Conceptually impossible regress?

A final problem concerns scientific regress. As we understand the term, *regress* is not the mere absence of progress but the inverse thereof, such as when a given instance of progress is reversed or undone. Thus, if scientific progress is a type of improvement over time, scientific regress is a type of deterioration. Although the regress of science as a whole is arguably rather rare—because the scientific enterprise is designed, at least in part, so as to ensure that progress is made and regress is avoided—regress is presumably more common in particular scientific subdisciplines. An account of progress needs the resources with which to make sense of straightforward claims about the relative prevalence of regress, and indeed, such resources are provided by all of the major extant accounts of scientific progress. For each of these accounts, it is possible for there to be *decreases* in the achievement in terms of which progress is defined (e.g., a decrease in knowledge or understanding).

Stegenga's account, by contrast, seems to make scientific regress *conceptually impossible*. To see why, note first that there is not really any such thing as the inverse of change. Put differently, the "inverse" of some particular change would just be another change, namely, a change in the opposite direction. Thus, although it is possible for there to be an absence of progress according to Stegenga's account—that is, when there is no change in justification whatsoever—it is not possible for there to be scientific regress. After all, regress would, on Stegenga's account, be the inverse of a change in justification, but that, too, is a change in justification and would thus simply count as more progress on Stegenga's account. In a way, then, Stegenga's account implies a collapse of the distinction between scientific progress (understood as a type of improvement) and scientific regress (understood as a type of deterioration), in which both are equally counted as scientific progress.[5]

[5] Another way to see this point is to note that there is a tripartite distinction between *progress*, *stagnation*, and *regress*, which the major extant accounts then map onto a tripartite distinction between *more*, *same*, and *less* of some epistemic achievement, for example, knowledge or understanding. By contrast, the distinction between *change* and *no change* in scientific justification is a dichotomous one.

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One might think that this consequence of Stegenga's view is not so bad because (as we've acknowledged) instances of scientific regress are presumably quite rare as a result of how the scientific enterprise is set up. However, the fact that science is designed to minimize regress simply highlights the problem: how can Stegenga's account explain why science is set up to minimize regress if regress is conceptually impossible in the first place? Indeed, if any change in justification is progressive, then the worst thing that could ever happen to the cognitive development of a discipline is *stagnation*, that is, the mere absence of progress. By contrast, there is no risk whatsoever of regress. Thus, it seems that all the mechanisms of science that one would think are in place at least partly to minimize regress, such as protections against fabricated and falsified data, would at least in this respect be completely unnecessary (and perhaps even detrimental insofar as they may promote stagnation). If scientific regress cannot occur, there is absolutely no need to protect against it.

7. From justification changes to justification for true answers

For the reasons provided in previous sections, we find Stegenga's justification-based account of scientific progress unsatisfactory. Scientific progress is not mere change in scientific justification. In this final section, we supplement this negative conclusion with a positive, albeit tentative, proposal of a different type of justification-based account of scientific progress.

In this account, scientific progress would roughly consist of increasing scientific justification for *truths*.[6] However, roughly for reasons provided by Dellsén (2021, 11252–53), we take the most plausible elaboration of this idea to be one in which progress is always defined relative to a given question Q. Thus, the more precise version of the account holds that scientific progress with respect to a given question Q consists of increasing scientific justification for the question's true answer A_T.[7] As we shall emphasize, this account does not construe progress in terms of justification for true *beliefs*, only for true answers, regardless of whether they are believed.[8] In contrast to Stegenga's account, this modified account does not define progress in terms of mere changes in justification; rather, scientific justification *for true answers* must *increase*. As a result, increases and changes in justification are not "formally interchangeable." After all, contrary answers to a given question, such as A and ¬A, cannot both be true, so the fact that any change in justification with respect to such a pair will be an increase in the justification of one or the other does not entail that such a change must involve an increase in justification for a true answer.

Thus, any attempt to map the dichotomy between *change* and *no change* onto the tripartite distinction between *progress*, *stagnation*, and *regress* would have to merge two of the latter three concepts.

[6] Other versions of the account might appeal instead to increasing justification for sufficiently, or increasingly, truthlike theories.

[7] We assume a fairly standard account of questions as partitions of logical space, where each element of the partition is a direct answer (Belnap and Steel 1976). Thus, by definition, there can be only one fully true answer to a given question (although many answers may be "approximately true" or "truthlike"). As noted in the main text, the move to relativizing progress in roughly this way is independently motivated by Dellsén (2021, 11252–53), although Dellsén relativizes to "topics" rather than "questions."

[8] The notion of justification to which we appeal is therefore *propositional* as opposed to *doxastic* justification.

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Although this modified account arguably faces serious problems, some of which will be familiar from the extant literature on scientific progress (e.g., the problems for epistemic and truthlikeness accounts highlighted by Rowbottom [2008, 2023] and Dellsén [2022]), it does not succumb to the problems we have identified for Stegenga's justification-based account. First, misleading evidence increases our justification for false rather than true answers, so gathering it would not contribute to progress. Second, losing or destroying evidence generally does not increase justification for true answers—unless, of course, the evidence is misleading, in which case it may well be right that losing or destroying it would amount to progress. Third, net increases in justification for a true answer during some episode will always align with the degree of progress attained in that episode, regardless of whether the degree of justification oscillated or always increased. Fourth, scientific regress can simply be understood as a decrease in justification for a true answer—which would happen, for example, if we gathered misleading evidence regarding the relevant question or if we lost some (nonmisleading) evidence. As a corollary, this account effortlessly explains why there are mechanisms in place to prevent the gathering of misleading evidence and the destruction of (nonmisleading) evidence in science because both eventualities would constitute regress rather than progress.

It is also worth noting that this modified justification-based account is well placed to address one of the central issues that motivate Stegenga's account, namely, what he calls *the Ptolemaic challenge*. In brief, the challenge is that Ptolemaic astronomy developed models of the solar system that, according to Stegenga (forthcoming, 12), "were [all] false, and ... were not, over all of those centuries, getting any closer to the truth." And yet it seems that some progress was made by Ptolemaic astronomy. In Stegenga's view, progress was made by virtue of the fact that Ptolemaic astronomy *changed* our justification for various hypotheses about the movements of celestial bodies. In our alternative justification-based account, by contrast, Ptolemaic astronomy made progress with respect to various questions to the extent that it increased our justification for their true answers, for example, via numerous correct predictions of the apparent movements of celestial bodies far into the future.

However, there is a requirement for accounts of progress, spelled out by Stegenga (forthcoming), that is not satisfied by the modified justification-based account outlined here. In particular, it doesn't satisfy the Laudan-inspired (1977) *epistemic accessibility desideratum*, according to which "a scientist or a scientific community should be able to ascertain that by doing x they are making progress" (Stegenga, forthcoming, 11). Here, "ascertain" seems to be used in a very strong sense to mean that scientists should not merely be able to make rational, educated *estimations* of whether progress would occur; rather, this should be as obvious as a baker determining whether the bread is rising, to use one of Stegenga's examples.

Now, admittedly, whether or not a given episode in science increases our justification for true rather than false answers—for example, because the evidence obtained is not misleading—is not quite as obvious as determining whether bread is rising. But is this really a problem for an account of scientific progress? Why think that scientific progress should be the sort of thing about which it is nearly impossible to be wrong? In other walks of life, we generally do not think that any form of improvement must be epistemically accessible in this very strong sense. For example, the power imbalances between different genders in a given society may subtly

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improve in a way that can only be conclusively ascertained years or decades later, after extensive sociological research into how the power dynamics shifted. In the meantime, the best we can do may be to *estimate* whether, to the best of our knowledge, some particular change or intervention is *likely* to be counteracting gendered power imbalances. So whether or not a society is making progress in this respect is arguably not epistemically accessible in Stegenga's strong sense. Similarly, although scientific progress, conceived of as an increase in justification for the true answer to a given question, is not epistemically accessible in Stegenga's strong sense, it is surely something about which we can make all sorts of rational estimations, both in real time and after the fact. And that—we submit—is good enough.

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