Refutations of the Two Pessimistic Inductions

Abstract
Both the pessimistic inductions over scientific theories and over scientists are built upon what I call proportional pessimism: as theories are discarded, the inductive rationale for concluding that the next theories will be discarded grows stronger. I argue that proportional pessimism clashes with the fact that present theories are more successful than past theories, and with the implications of the assumptions that there are finitely and infinitely many unconceived alternatives. Therefore, the two pessimistic inductions collapse along with proportional pessimism.

Keywords
Pessimistic Induction, Proportional Pessimism, Unconceived Alternatives

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1. Introduction

This paper raises a new objection to the pessimistic inductions over scientific theories and over scientists. It proceeds as follows. In Section 2, I explicate the two pessimistic inductions, arguing that they are built upon what I call proportional pessimism: as theories are discarded, the inductive rationale for concluding that the next theories will be discarded grows stronger. In Section 3, I undermine proportional pessimism with the observation that present theories are more successful than past theories, and with the implications of the assumptions that there are finitely and infinitely many alternatives. In Section 4, I reply to a referee's criticisms and a possible criticism. The main thesis of this paper is that the demise of past theories does not create an inductive rationale for predicting the demise of present theories.

2. Proportional pessimism

Henri Poincaré (1905/1952: 160), Ernst Mach (1911: 17), Larry Laudan (1977: 126), and Hilary Putnam (1978: 25) formulated the pessimistic induction over scientific theories. It says, roughly, that since past theories were abandoned, present theories will also be abandoned. John Worrall (1989: 99), Philip Kitcher (1993: 136), Stathis Psillos (1999), and K. Brad Wray (2013: 4321) regard the pessimistic induction as the strongest objection to scientific realism, the view that successful theories are (approximately) true.

P. Kyle Stanford (2006) propounded the pessimistic induction over scientists: since past scientists could not conceive of present theories that drove out past theories, present scientists cannot conceive of future theories either that will drive out present theories. K. Brad Wray, an endorser of the pessimistic induction over scientists, says that "future developments in a field will reveal additional competing theories that are also able to account for the data, theories, though, that are now *unconceived* alternatives" (2010: 371). Today, the pessimistic induction over scientists enjoys so high a place in the scientific realism debate that any participant in the debate, whether defending realism or antirealism, has to take it seriously.

How does Stanford justify the premise that past scientists could not conceive of present theories? He (2006: 19-20) provides a long list of the transitions from past to present theories:

> Stanford's List
> from elemental to early corpuscularian chemistry to Stahl's phlogiston theory to Lavoisier's oxygen chemistry to Daltonian atomic and contemporary chemistry
>
> from various versions of preformationism to epigenetic theories of embryology
>
> from the caloric theory of heat to later and ultimately contemporary thermodynamic theories
>
> from effluvial theories of electricity and magnetism to theories of the electromagnetic ether and contemporary electromagnetism
>
> from humoral imbalance to miasmatic to contagion and ultimately germ theories of disease
>
> from eighteenth century corpuscular theories of light to nineteenth century wave theories to the contemporary quantum mechanical conception
>
> from Darwin's pangenesis theory of inheritance to Weismann's germ-plasm theory to Mendelian and then contemporary molecular genetics
>
> from Cuvier's theory of functionally integrated and necessarily static biological species and from Lamarck's autogenesis to Darwin's evolutionary theory (Stanford, 2006: 19-20)

After providing this list, Stanford concludes that "the history of scientific inquiry itself offers a straightforward rationale for thinking that there typically are alternatives to our best theories equally well-confirmed by the evidence, even when we are unable to conceive of them at the time" (2006: 20).

Note that Stanford's pessimistic induction, although over scientists, relies on the downfall of scientific theories. If no theory had been overthrown, Stanford's list could not exist, and nor, as a result, could the pessimistic induction over scientists. Therefore, the demise of past theories is what grounds Stanford's conclusion that present scientists cannot conceive of future theories.

The pessimistic induction over scientists is intended to improve upon the pessimistic induction over scientific theories. Regarding the latter, many realists reply that present theories are more successful than past theories. Those realists are Jarrett Leplin (1997: 141), Gerald Doppelt, (2007: 111; 2014), Juha Saatsi (2009: 358), Michael Devitt (2011: 292), Ludwig Fahrbach (2011a; 2011b: 1290), Seungbae Park (2011: 80), and Moti Mizrahi (2013). This observation on the difference between past and present theories invalidates the pessimistic induction over scientific theories.

Stanford admits that present theories are more successful than past theories, saying that the differences between them "invalidate the pessimistic induction's attempt to project from past to present cases" (2006: 43). He argues, however, that his pessimistic induction over scientists goes through because present scientists do not differ cognitively from past scientists. Past and present scientists are all "creatures whose cognitive constitutions are not well suited to the task of exhausting the kinds of spaces of serious candidate theoretical explanations from which our scientific theories are drawn" (Stanford, 2006: 45). In other words, like past scientists, present scientists cannot exhaust the spaces of unconceived alternatives.

The strength of the two pessimistic inductions is directly proportional to the number of discarded theories. The more theories were replaced by unconceived alternatives, the more

likely it is that present theories will be superseded by unconceived alternatives. The two pessimistic inductions are built upon this very assumption that I call proportional pessimism. Proportional pessimism seems intuitive. Imagine that pessimists provide a very short list of past theories, say, three past theories, and then predict that all or most present theories will be superseded by unconceived alternatives. Such a pessimistic induction is so weak that no participant in the realism debate would take it seriously. Thus, the size of the list of rejected theories is crucial for the strength of a pessimistic induction. Stanford's pessimistic induction is a serious threat to realism simply because his list is long enough.

Let me apply proportional pessimism to the transitions from the humoral theory, to the miasma theory, and to the germ theory. No theory of diseases was overthrown prior to the humoral theory, one theory of diseases was overthrown prior to the miasma theory, and two theories of diseases were overthrown prior to the germ theory. Proportional pessimism implies that the germ theory at t_3 is more likely to be false than the miasma theory was at t_2 and that the miasma theory at t_2 was more likely to be false than the humoral theory had been at t_1, where t_1, t_2, and t_3 refer to the times at which the respective theories were accepted.[1]

This implication of proportional pessimism accords with our intuition about the strengths of other inductive inferences. Suppose that Alice, Bob, and Charles observed no black crow, one black crow, and two black crows, respectively, and that they all infer that the next crow will be black. We believe that Charles's inference is stronger than Bob's and that Bob's inference is stronger than Alice's. By parity of reasoning, we should believe that the germ theory at t_3 is more likely to be false than the miasma theory was at t_2 and that the miasma theory at t_2 was more likely to be false than the humoral theory had been at t_1.

Stanford claims that the possibility space of unconceived alternatives "appears to be indeterminate and unbounded" (2006: 133). In other words, there are infinitely many unconceived alternatives. He employs this assumption to combat the realist view that as science progresses, we get closer and closer to truths and that present theories are more likely to be true than past theories. This realist view does not seem promising, if there are infinitely many unconceived alternatives. Given that scientists are finite beings, they can only eliminate a finite number of false theories from the possibility space. No matter how many theories the scientists eliminate, the possibility space will still have an infinite number of unconceived alternatives waiting to be eliminated, and hence scientists will never be able to reach true theories. Thus, the assumption that there are infinitely many unconceived alternatives plays an important role in Stanford's case against realism.

For Stanford, an unconceived alternative is an alternative that will later be articulated and accepted by scientists. For example, when the humoral theory was accepted, the miasma theory was unconceived, but it was later articulated and accepted by scientists just like the humoral theory. Thus, eliminating the kind of alternatives that Bas van Fraassen (1980: 46) generates does not count as eliminating the kind of alternatives that Stanford has in mind. Van Fraassen generates an infinite number of rival theories to Newton's theory of motion. While Newton's theory of motion claims that the absolute velocity of the universe is zero, rival theories make diverse claims about the absolute velocity of the universe. In such cases, simplicity can be invoked to eliminate infinitely many alternatives even before they are articulated. To argue that scientists have such ability, however, is not to refute Stanford's pessimistic induction.

It is controversial, however, whether there are finitely or infinitely many unconceived alternatives that Stanford has in mind. Samuel Ruhmkorff (2011) argues that the mere historical fact that past theories were ousted by unconceived alternatives does not show that

[1] I thank a referee for sharpening my point.

there are infinitely many unconceived serious alternatives. It will become clear in the next section that Ruhmkorff is on the right track.

3. Critiques

3.1. More Successful

As many realists point out, and as Stanford admits, present theories are more successful than past theories. Let me explore how this difference between past and present theories relates to proportional pessimism and to Stanford's contention that there are infinitely many alternatives.

The difference between past and present theories implies that present theories are more probable than past theories. Proportional pessimism, however, implies that present theories are less probable than past theories. After all, to say that we have a stronger inductive rationale for thinking that the germ theory will turn out to be false than we had for the miasma theory means that the germ theory is less probable than the miasma theory. Thus, either proportional pessimism is false, or pessimists owe us an account of how present theories are more likely to be overturned than past theories when present theories are more successful than past theories.

The difference between past and present theories also undermines Stanford's contention that there are infinitely many alternatives. To say that present theories are more probable than past theories implies that present theories have nonzero probabilities. But how can present have nonzero probabilities if they compete with infinitely many alternatives? The sum of probabilities of a set of rival theories of diseases cannot be above 100%. It is impossible, for example, that the probabilities of the humoral theory, the miasma theory, and the germ theory, are 90%, 91%, and 93%, respectively. If the set is infinitely large, the probability of the germ theory is 0%. Thus, either it is false that there are infinitely many alternatives, or pessimists owe us an account of how present theories have nonzero probabilities when they compete with infinitely many alternatives. It appears that Ruhmkorff is on the right track concerning the number of alternatives.

In sum, the fact that present theories are more successful than past theories is a strike against proportional pessimism, and also against the assumption that there are infinitely many alternatives.

3.2. Two Assumptions

From now on, let me set aside the fact that present theories are more successful than past theories and explore how proportional pessimism relates to the alternate assumptions that there are finitely and infinitely many alternatives.

Proportional pessimism clashes with the assumption that there are finitely many unconceived alternatives. Under this assumption, as we eliminate more and more theories from the space of alternatives, the space becomes smaller and smaller. The fewer theories an accepted theory competes with, the more likely it is that it is true. Hence, present theories are more probable than past theories. Proportional pessimism says, however, that present theories are less likely to be true than past theories. Thus, either proportional pessimism is false, or pessimists owe us an account of how present theories are less probable than past theories when present theories compete with fewer theories than past theories did.

Proportional pessimism also clashes with the assumption that there are infinitely many unconceived alternatives. When an accepted theory competes with infinitely many alternatives, its probability is 0%, as noted earlier. It follows that the probabilities of past and present theories are all 0%. Proportional pessimism asserts, however, that past theories are more probable than present theories, and this implies that past theories have nonzero

probabilities. Thus, either proportional pessimism is false, or pessimists owe us an account of how past theories could have had nonzero probabilities when they competed with infinitely many alternatives. What was so special about past theories that endowed them with nonzero probabilities, when present and future theories have zero probabilities? It appears that Stanford's contention that there are infinitely many alternatives spells doom for proportional pessimism and hence for his own pessimistic induction.

In sum, proportional pessimism is undermined by the two opposing assumptions that there are a finite and infinite number of unconceived alternatives. Accordingly, it does not matter whether the number of alternatives is finite or infinite. Proportional pessimism is problematic.

4. Objections and Replies

4.1. The Sum of Probabilities

In the previous section, I claimed that the sum of probabilities of a set of alternatives cannot go above 100%. A referee objects, however, that the sum need not have an upper bound. On the referee's account, probabilities reflect evidential states, and evidential states vary from time to time. So it is possible that when the humoral theory was accepted, its probability was, say, 90%. But when the germ theory was accepted, the probability of the humoral theory dropped below 90% and the probability of the germ theory was 90%. Note that the sum of the probabilities of the humoral theory and the germ theory is above 100%.

The referee's view, although insightful, contradicts other philosophers' view about the sum of probabilities of a set of alternatives. The following consideration will sharpen the two contradictory views. Suppose that there are infinitely many rival theories of diseases: the humoral theory, the miasma theory, the germ theory, U_1, U_2, U_3…,U_n where U is an unconceived alternative. Only one member of the set is true, and the rest of them are all false. In such circumstances, how probable is a member of the set?

It depends, the referee would say, on which theory is selected and when it is selected. If the miasma theory is selected at the time when it is accepted, its probability is, say, 90%. If the same theory were selected at a time when the germ theory is accepted, its probability would be far below 90%. So are the probabilities of all the other infinitely many theories of diseases. Thus, the probability of each alternative can be, say, 90%, if it is selected at the time when it is accepted.

Bas van Fraassen says, however, that if a theory competes with infinitely many successful rival theories, "it must seem very improbable to me that it is true" (1989: 146). So present theories, although successful, are all probably false. In the literature, his argument goes by the name 'the argument from indifference.' It is reconstructed as follows:

> The argument from indifference adds to the first that since, for every choice of a particular theory *T* as best explaining the evidence *e*, there will be (probably infinitely) many unborn hypotheses, inconsistent with *T* and with one another, which explain *e* at least as well, and since only one of these can be true, it is very improbable that the theory considered to be the best explanation is true (see *LS* p. 146). (Ladyman, Doven, Horsten, and van Fraassen, 1997: 309).

Note that the argument from indifference presupposes that the sum of probabilities of a set of alternatives cannot go above 100%. After all, if it can go above 100%, as the referee suggests, the proponents of the argument from indifference cannot say that the best of all the alternatives is probably false and unwarranted.

The main thesis of this paper that proportional pessimism is problematic does not require the resolution of the dispute between the referee and the proponents of the argument from indifference over whether the sum of probabilities of a set of alternatives can, or cannot,

go above 100%. What is important for the purpose of this paper is that the referee's view also undercuts proportional pessimism. Proportional pessimism implies that the germ theory is less probable than the miasma theory. The referee's view, however, implies that the germ theory can be more probable than the miasma theory. The probability of the germ theory can be, say, 90%, while the probability of the miasma theory can be far below 90%, at the time when the germ theory is accepted. Therefore, it does not matter whether the referee is right or the proponents of the argument of indifference are right about the sum of probabilities of alternatives. Proportional pessimism is problematic.

The referee objects that "the argument from indifference is beside the point because it refers to partitions of unconceived alternatives at the same point in time." The referee's idea seems to be that although the argument from indifference suggests that, for example, infinitely many theories of diseases exist at the same point in time, they are in fact spread over different points in time. So an accepted theory of diseases does not compete with infinitely many alternatives, and hence the probability of each accepted theory can be, say, 90%. By putting forward this objection, the referee seems to admit that the probability of an accepted theory is 0%, provided that infinitely many alternatives exist at the point in time when it is accepted.

As far as I can tell, the proponents of the argument from indifference do not address the issue of whether infinitely many unconceived alternatives are spread over different points in time or not. Van Fraassen only says that "I believe, and so do you, that there are many theories, perhaps never yet formulated but in accordance with all evidence so far, which explain at least as well as the best we have now" (1989: 146). Also, Ladyman, Doven, Horsten, and van Fraassen only say that "there will be (probably infinitely) many unborn hypotheses (1997: 309). They are silent about at what points of time the infinitely many alternatives exist.

In my view, the proponents of the argument from indifference could say that infinitely many unconceived alternatives exist at every point in time. So, for example, infinitely many unconceived theories of diseases existed when the humoral theory was accepted. They also exist when the germ theory is accepted. They will also exist when a successor of the germ theory is accepted. Thus, the probability of each accepted theory is 0%. It is wrong to think that if infinitely many alternatives are spread over different points in time, an accepted theory competes with no alternative or with finitely many alternatives, and hence the probability is each accepted theory can be, say, 90%.

The referee also objects that the argument from indifference is a new burden for me and that if I want to defend realism, I have to refute it. The referee is right on this account.

In my view, the argument from indifference is incorrect, for no proponent of it has yet provided the justification for the premise that there are infinitely many unconceived alternatives. It is in this context that Stanford's pessimistic induction comes into play. It asserts that we have an inductive rationale for thinking that present theories compete with infinitely many unconceived alternatives. In this sense, Stanford's pessimistic induction improves upon the argument from indifference.

Note that I reject the argument from indifference not on the grounds that it assigns probabilities inadequately to unconceived alternatives but on the grounds that its premise is unjustified. Also, my introduction of the argument from indifference in this section achieves the aim of exposing the difference between the referee's view and the other philosophers' view on the probabilities of unconceived alternatives without undermining realism.

4.2. Psychological Abilities

Stanford might now reply that my preceding discussion about the probabilities of past and

present theories does not refute his pessimistic induction over scientists because it is not about the probabilities of scientific theories but about scientists' psychological abilities to think up unconceived alternatives. In other words, even if the probabilities of present theories are higher than those of past theories, it is still true that present scientists are not better able to think up unconceived alternatives than past scientists. Thus, his observation of scientists' abilities stands independently of the probabilities of past and present theories.

It is not clear, however, whether the pessimistic induction over scientists is separable from the epistemic status of scientific theories or not. Recall that Stanford justifies the pessimistic induction over scientists by providing a long list of the transitions from past to present theories. His list exhibits the epistemic status of past theories, i.e., it shows that they were disclosed to be false. As I pointed out in Section 2, if no theory had turned out to be false, Stanford's list could not exist, and without the list, the pessimistic induction over scientists could never get off the ground. Therefore, it is problematic to say that my discussion about the probabilities of past and present theories has no impact on the status of the pessimistic induction over scientists.

If, however, Stanford now insists that his pessimistic induction over scientists is separable from the epistemic status of scientific theories, he can keep his pessimistic induction. But it would then cease to be relevant to the realism debate. The realism debate is not about the psychological abilities of scientists *per se* but about the epistemic status of scientific theories. Participants in the debate are interested in the abilities not because the abilities are interesting in themselves but because the abilities are presumed to be relevant to the epistemic status of scientific theories. If the abilities, however, are not relevant to the epistemic status of scientific theories, as Stanford might suggest, it is not clear why participants in the debate should take the pessimistic induction over scientists seriously. Nor is it clear whether it would continue to be regarded as the strongest argument against realism.

Furthermore, I am tempted to point out that the premise of the pessimistic induction over scientists is false. Think about the theories that were accepted in the early 20^{th} century, such as evolutionary theory, the oxygen theory, the kinetic theory, the germ theory, and the special theory of relativity. They are not only present theories but also recent past theories from the perspective of the early 21^{st} century, given that the early 20^{th} century falls in the recent past. Thus, "past scientists conceived of their future theories" (Park, forthcoming).

5. Conclusion

Proportional pessimism asserts that as theories are discarded, it becomes more likely that the next theories will also be discarded. It is undercut by the fact that present theories are more successful than past theories and by the assumptions that there are finitely and infinitely many alternatives. It follows that proportional pessimism is problematic regardless of whether the number of alternative theories is finite or infinite.

The downfall of proportional pessimism has a negative repercussion not only on Stanford's pessimistic induction over scientists but also on the pessimistic induction over scientific theories. Like the pessimistic induction over scientists, the pessimistic induction over scientific theories also relies on proportional pessimism. Consequently, the two pessimistic inductions collapse along with proportional pessimism.

The moral is that it is wrong to think that the demise of past theories constitutes an inductive rationale for predicting the demise of present theories. If you want to believe that a current theory is false or unwarranted, you should not point out that its forerunners were replaced by unconceived alternatives; rather you should point out that it has empirical anomalies, it clashes with other scientific theories from neighboring domains, it comprises a contradiction, and so on. What if it has no such problem? You are not entitled to believe that

it will be driven out by an unconceived alternative, no matter how many of its predecessors have been driven out by unconceived alternatives. The two pessimistic inductions are incorrect, since they are built upon the problematic thesis, proportional pessimism, although they are regarded these days as the most compelling arguments against realism.

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