How Explanatory Reasoning Justifies Pursuit: A Peircean View of IBE

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This article develops and defends an account of inference to the best explanation according to which it first and foremost justifies pursuing hypotheses rather than accepting them as true. This sidesteps the issue of why better explanations should be more likely to be true. I defend an account of justification for pursuit, inspired by Peirce's mature account of abduction, and develop it as a formal decision-theoretic model. This account provides a straightforward connection between explanatoriness and justification for pursuit.

1. Introduction. *Explanationism* is the view that interprets *inference to the best explanation* (IBE) as an inference where the fact that a hypothesis is (in some sense) the best available explanation of one or more phenomena justifies accepting it as (approximately) true. More generally, explanationists also tend to hold that considerations concerning how good an explanation a hypothesis is can act as a guide to its truth.[1] This is supposed to give a normative account of the role of explanatory reasoning in scientific practice.

Explanationism faces a well-known problem. For why should a hypothesis be any more likely to be true simply because it would be the best explanation? Call this the *truth-connection problem*. This article proposes and defends an alternative account of IBE, called *the Peircean view*, which sidesteps the problem altogether.

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1. The most developed version of explanationism remains Lipton (2004). See Douven (2011) for further references.

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C. S. Peirce often discussed an inference he called *abduction*. He construed this as an inference where the premise that a hypothesis *H*, if true, would make an otherwise surprising fact "a matter of course" gives some kind of support for *H* (Peirce 1932–58, 5.189). Explanationists often cite this as a forerunner of IBE. However, recent scholarship has emphasized that Peirce's mature account of abduction differs significantly from the explanationist interpretation of IBE (e.g., McKaughan 2008; Campos 2011). While Peirce construed abduction as a guide to theory choice, he understood this as choosing which hypotheses to investigate further. Peirce held that only empirical investigations can justify accepting a hypothesis, insisting that abduction gives us no reason to regard a hypothesis as true—except insofar as it leads to successful empirical testing of the hypothesis. He did regard abduction as an inference, since it involves giving reasons (whether good or bad), and not, for instance, a mere heuristic for "discovery." However, these are reasons for courses of action, namely, subjecting hypotheses to empirical testing, rather than reasons for belief or acceptance.[2]

Inspired by these Peircean insights, and drawing on the distinction between acceptance and pursuit (Laudan 1977), I propose to see explanatory reasoning as first and foremost providing justification for pursuing hypotheses, as opposed to justification for accepting them. This view sidesteps the truth-connection problem and faces no relevantly similar problems. I defend, in section 3, a general account of justification for pursuit and develop it into a formal decision-theoretic model. In section 4 I show that this provides a simple and straightforward connection between explanatoriness and justification for pursuit. I start by introducing the truth-connection problem for explanationism.

2. The Truth-Connection Problem. The slogan that one should infer "the best" explanation conceals an important distinction. For there are at least two senses in which an explanation can be better than its competitors (Lipton 2004, 59–60). First, a hypothesis may be more likely to be true than all other available explanations of some otherwise puzzling phenomena. For instance, we may be able to rule out, or show highly improbable, all plausible alternative explanations in light of the available evidence and accepted background theories. Here the remaining hypothesis would be the likeliest available explanation, and in this sense the best. But as Lipton (2004, 60–62) stresses, explanationism is only interesting to the extent that it goes beyond merely recommending inferring the likeliest explanation. If we seek an explanation of a phenomenon *p*, and the hypothesis *H* is the likeliest available explanation of *p*, it may be reasonable to infer that *H* is (approximately) true. For the purposes of this article, at least, I do not intend to challenge this

2. McKaughan (2008) defends this interpretation in detail.

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inference. What I am interested in are interpretations of IBE that assign a more substantial role to explanation.

The more interesting sense of "best explanation" brackets likeliness and asks how good the different potential explanations would be if they were true. Let us say that the *explanatoriness* of *H* is the number and quality of the explanations *H* would provide, if it were true.[3] Since the quality of explanations is usually taken to concern how much understanding they give us, the explanatoriness of *H* might also be understood as the amount of understanding *H* could potentially afford us. For explanationists, then, if *H* is the most explanatory hypothesis, relative to its available competitors, this gives us some additional reason to regard *H* as true, or at least approximately or partially true.

This claim is also what makes explanationism controversial. One question concerns what the criteria of "good explanations" are. There are different accounts of explanation (causal, unification, etc.) that variably emphasize certain explanatory virtues (simplicity, unification, coherence, elegance, etc.). But since the argument of this article does not depend on any particular view of explanation or of how they give us understanding (however we conceive of this), I will simply assume that it makes sense to distinguish between more and less explanatory hypotheses. Whichever account of these matters suffices for explanationism will be good enough for my account too.

Explanationism faces a more pressing problem. For as critics have pointed out, the fact that a hypothesis would be a good explanation of something if it were true does not seem to have any implications for whether it is true. So why should this give us any additional reason to accept it?[4] Indeed, this seems worryingly close to wishful thinking. This is the truth-connection problem. IBE may be a fallible inference, so explanationists should not be expected to guarantee its reliability. Nonetheless, they ought to give some account of why it is reasonable to infer the most explanatory hypothesis.

Explanationists have, of course, tried to solve this problem.[5] But I will not go into these arguments here. I restrict myself to showing that by adopting the Peircean view we can sidestep the truth-connection problem altogether.

3. Pursuing Hypotheses and Justifying Pursuit. In his exegetical study of Peircean abduction, Daniel McKaughan (2008) distinguishes three competing interpretations: *generative*, *justificatory*, and *pursuitworthiness*. The justificatory interpretation corresponds to explanationism, where abduction is

3. Explanatoriness is my preferred term for what Lipton calls "loveliness."

4. Lipton (2004, 142–47) calls this "Voltaire's Objection." Van Fraassen (1989, 131–50) criticizes IBE along these lines.

5. Douven (2011, sec. 3.2) provides a brief overview.

taken to provide reasons for accepting hypotheses as true or approximately true. This is often contrasted with the generative interpretation, where abduction is interpreted as an account of how novel scientific hypotheses are first formulated or generated.[6]

McKaughan argues that both interpretations overlook an important step in the process of inquiry between the initial formulation of a hypothesis and its subsequent acceptance or rejection as part of established scientific knowledge. In addition to generating new hypotheses and testing them, scientists, in order to prioritize their time, resources, and efforts, also need to make decisions regarding which of these to first investigate or develop further. In other words, scientists need to make decisions regarding which hypotheses are most worthy of further pursuit. As McKaughan shows, this was an important theme especially in Peirce's later discussions of abduction—thus the pursuitworthiness interpretation. It is this aspect of Peirce's views on which I draw in the following.

The distinction between *acceptance* and *pursuit* was first made (in those terms) by Larry Laudan (1977, 108–14) and has since been developed by several other philosophers, including Whitt (1990), Franklin (1993a, 1993b), and Šešelja, Kosolosky, and Straßer (2012). Building on their discussions, I draw the distinction as follows. Accepting a hypothesis is to regard it as a piece of established scientific knowledge, whereas pursuing a hypothesis is to investigate it further (Franklin 1993a, 253). Pursuit can include things like testing or refining a hypothesis empirically and developing it theoretically, for example, by solving conceptual problems (Laudan 1977; Whitt 1990). So while justifying acceptance concerns which hypotheses to regard as (approximately/partially) true, justifying pursuit involves practical reasoning about which courses of action to follow (McKaughan 2008, 454).[7]

One reason to draw this distinction is descriptive.[8] Laudan notices that, historically, scientists have often worked on scientific theories that had major empirical and conceptual problems relative to the dominant competing views, citing (among others) Copernicanism and quantum mechanics in their early stages. Laudan argues that it was rational for scientists to pursue these theories even though there where strong reasons to accept their competitors.

Franklin's case studies are especially suggestive for present purposes, since these concern hypotheses that were pursued exactly because of their po-

6. Campos (2011) is closer to this interpretation.

7. Since most explanationists are scientific realists, I adopt a realist construal of acceptance for the purposes of this article. But the pursuit/acceptance distinction also applies to empiricist and pragmatist notions of acceptance (e.g., empirical adequacy, problem-solving power).

8. For further case studies of pursuit, see Whitt (1990) and McKaughan (2008).

tential for explaining otherwise puzzling phenomena. For example, Franklin (1986, 7–38) describes the rejection by particle physicists of the so-called principle of parity conservation. The puzzling phenomenon physicists faced was this: for a specific set of decay patterns, the principle that each particle has a unique mass indicated that these decays stemmed from a single particle, while the principle of parity conservation ruled this out. When the physicists T. D. Lee and C. N. Yang in 1956 proposed that parity conservation may be violated in weak interactions and suggested experiments to test this hypothesis, it sparked an intense experimental interest. To the great surprise of many of the physicists involved, these experiments came out in favor of parity violation.[9] Interestingly, the same hypothesis had earlier been suggested as a logical possibility, but without being proposed as a solution to the above puzzle and without arousing much interest (Franklin 1986, 29–31).

Apart from the descriptive point that scientists often actually do make and argue for decisions about which hypotheses to pursue, there are also normative reasons why scientists ought to justify such choices. For the resources available to scientists are simply too scarce to investigate every conceivable hypothesis. In Peirce's words,

> Proposals for hypotheses inundate us in an overwhelming flood, while the process of verification to which each one must be subjected before it can count as at all an item, even of likely knowledge, is so very costly in time, energy, and money—and consequently in ideas which might have been had for that time, energy, and money, that Economy would override every other consideration even if there were any other serious considerations. In fact there are no others. For abduction commits us to nothing. It merely causes a hypothesis to be set down upon the docket of cases to be tried. (Peirce 1932–58, 5.602)[10]

Scientists need to justify which hypotheses are worth investigating in order to prioritize their resources. Justifying pursuit is, essentially, a decision-theoretic problem of how to optimize the epistemic output of science.

Although based on pragmatic concerns, justification for pursuit is not wholly detached from epistemic matters. On the contrary, it is concerned with how to most effectively achieve our epistemic goals. So the distinction between (justification for) accepting and pursuing hypotheses should not be

9. Richard Feynman apparently bet Norman Ramsey $50 to $1 that the experiments would fail to show parity violation—and ended up paying (Franklin 1986, 24).

10. As McKaughan (2008, 452–58) documents, Peirce often connects abduction to "Economy."

conflated with the much-discussed distinction between the "context of discovery" and "context of justification."[11] Choices regarding which hypotheses to accept and which to pursue can and ought to be justified.

How do we decide which hypotheses we are justified in pursuing, then? To answer this, we must first make clear what kinds of goals we are aiming toward when justifying pursuit (Šešelja et al. 2012). If we are interested in a broader set of moral, political, and epistemic goals, we need to take things such as ethical implications and technological progress into account (e.g., Kitcher 2011). But since ethical implications and potential technological applications are usually regarded as irrelevant to the explanatoriness of a hypothesis, my focus in this article is only on our *epistemic* or *cognitive* goals. I take these to include things such as learning the truth or getting more accurate representations of the world, but also getting better explanations or more understanding of the phenomena we are interested in.

Given this focus, we are justified in pursuing those courses of action that we judge will bring us the closest to achieving our epistemic goals. This can be thought of as somehow weighing and ranking the salient competing hypotheses in terms of factors we take to be relevant to estimating this (McKaughan 2008). What these factors are exactly will presumably vary from case to case, but some general suggestions can be made. Thus, Peirce highlights the "cost, the value of the thing proposed, in itself; and its effect upon other projects" (Peirce 1932–58, 7.220). Summarizing Peirce's view, McKaughan mentions "factors like our time, resources, and value of the estimated payoff in comparison to other courses of action. . . . If we estimate that testing the hypothesis will be *easy*, of potential *interest*, and *informative*, then we should give it a high priority" (2008, 457). Independently, Franklin observes from his case studies that "the decision to pursue an investigation seems to depend on a weighting of at least three factors; the interest of the hypothesis, its plausibility, and its ease of test" (1993b, 122). He also mentions factors to do with conserving resources, such as "recycling expertise" and continuity with already-ongoing research programs (Franklin 1993a).

This, of course, raises the question of how these factors should be weighed against each other. In practice, this will probably be a matter of informed judgement. But in order to clarify the underlying logic, it can be useful to think of it in terms of simplified or idealized decision-theoretic models.[12] To illustrate this, I now develop a model that is particularly useful for thinking about explanatory reasoning.

11. See also Hoyningen-Huene (1987) on some of the problematic ambiguities in the discovery/justification distinction.

12. Peirce (1932–58, 7.139–57) also developed a formal treatment of "the Economy of Research," although in a direction different from the one taken here.

This model focuses on just three types of outcomes of pursuing a hypothesis H:

1. We get strong enough evidence in favor of H to accept it.
2. We get strong enough evidence against H to reject it.
3. We get inconclusive evidence and so stay agnostic.

We can abbreviate each of these outcomes as $a(H)$, $r(H)$, and $\sim a(H)$ & $\sim r(H)$, respectively. In choosing this focus, we are ignoring how to figure in the costs of pursuing H, whether pursuing H might reveal other interesting things about the world, and any potential "effects upon other projects."

Let $EV(a(H))$, $EV(r(H))$, and $EV(\sim a(\mathrm{H})$ & $\sim r(H))$ represent the *epistemic value* associated with each of the three outcomes obtaining. We can think of this as the degree to which each of these outcomes would take us toward or away from reaching our epistemic goals. These quantities correspond (roughly) to what Peirce, McKaughan, and Franklin call the "value" or "interest" of the hypothesis. Since pursuing H has a causal influence on which outcome obtains, we should weigh each of these in terms of how probable they are to obtain given that we pursue it. Let $p(H)$ be the decision to pursue H and let $EEV(p(H))$ be the *expected epistemic value* of pursuing H. We then have[13]

$$\begin{aligned} EEV(p(H)) = {} & EV(a(H)) \cdot Pr(a(H) \mid p(H)) \\ & + EV(r(H)) \cdot Pr(r(H) \mid p(H)) \\ & + EV(\sim a(H) \,\&\, \sim r(H)) \cdot Pr(\sim a(H) \,\&\, \sim r(H) \mid p(H)). \end{aligned} \tag{1}$$

Since we are ignoring the costs and other effects of pursuing H, it is natural to stipulate, for simplicity, that the value of staying agnostic is nil, and so drop the last term.

How epistemically valuable it would be to accept H, as well as how likely we are to get evidence for or against it, presumably depends on whether H is in fact true. To make this explicit in the model, we can conditionalize on the truth and the falsity of H in each line:

$$\begin{aligned} EEV(p(H)) = {} & EV(a(H) \,\&\, H) \cdot Pr(a(H) \mid H \,\&\, p(H)) \cdot Pr(H) \\ & + EV(a(H) \,\&\, \sim H) \cdot Pr(a(H) \mid \sim H \,\&\, p(H)) \cdot Pr(\sim H) \\ & + EV(r(H) \,\&\, H) \cdot Pr(r(H) \mid H \,\&\, p(H)) \cdot Pr(H) \\ & + EV(r(H) \,\&\, \sim H) \cdot Pr(r(H) \mid \sim H \,\&\, p(H)) \cdot Pr(\sim H). \end{aligned} \tag{2}$$

13. I stay neutral on how to interpret the probabilities and related conceptual issues in causal decision theory (Joyce 1999). I assume that the correct solutions will also work for my application of the framework.

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In this model, then, we would be justified in prioritizing the pursuit of that hypothesis H that maximizes $EEV(p(H))$.[14]

One attractive feature of this model is that it explicitly represents a number of the factors mentioned above and furthermore calls attention to some factors left out. I have already mentioned that $EV(a(H)\ \&\ H)$ and $EV(r(H)\ \&\ \sim H)$ represent how valuable or interesting it would be to know whether H is true. Correspondingly, $EV(a(H)\ \&\ \sim H)$ and $EV(r(H)\ \&\ H)$ represent how problematic it would be to mistakenly accept a falsehood or reject a truth. The unconditional probabilities represent how likely or plausible H (and $\sim H$) is prior to testing, and the four conditional probabilities represent how likely we are to get reliable and misleading evidence for or against H, respectively.

This model is, of course, highly idealized and abstract. I do not suppose that it is generally possible to make anything but rough estimates or comparisons of these factors. Furthermore, the estimates of individual scientists, as well as which epistemic goals they regard as the most important in science, probably vary significantly. I do not have any comprehensive account of these matters. Finally, scientists obviously do not always conform to or even approximate this model in their deliberations about which hypotheses to pursue even when their goals are purely epistemic, nor do I claim that it would be better if they did. Nonetheless, I find that this kind of model provides a useful normative framework for expressing and clarifying issues regarding justification for pursuit. In the following I apply it to explanatory reasoning.

4. How Explanatory Reasoning Justifies Pursuit. I claim that the Peircean view avoids the truth-connection problem. In a nutshell, my argument is that explanatory reasoning justifies pursuing a hypothesis H by showing that it would be more epistemically valuable to learn that H is true than to learn that one of its salient competitors is true. Since nothing in this account requires a connection between explanatoriness and the truth of H, the truth-connection problem does not arise.

Consider this analogy. Suppose that a team of treasure hunters know of two caves, C_1 and C_2, where a large treasure could be stashed. As far as they know, the treasure is equally likely to be in either cave, but they only have the resources to send an expedition to one of them. However, they do know that C_1 could hold up to twice as much treasure as C_2. Assume that this does not give them any further information about where the treasure is or how difficult or expensive it would be to recover. Still, it would be more rational,

14. The model becomes more complicated if we take into account possible synergy effects of pursuing more than one hypothesis simultaneously.

for obvious decision-theoretic reasons, to send the expedition to explore C_1 rather than C_2.

To spell out my argument in more detail, notice first that the epistemic goals of science include more than simply knowing as many truths as possible. As Philip Kitcher puts the point, "Tacking truths together is something any hack can do. . . . The trouble is that most of the truths that can be acquired in these ways are boring. Nobody is interested in the minutiae of the shapes and colors of the objects in your vicinity, the temperature fluctuations in your microenvironment, the infinite number of disjunctions you can generate with your favorite true statement as one disjunct, or the probabilities of the events in the many chance setups you can contrive with objects in your vicinity. What we want is *significant* truth" (1993, 94). There are plenty of trivial truths out there that could be discovered, and at much lower cost than the questions actually pursued by scientists. The value of scientific knowledge involves more than simply knowing as many truths as possible.

What other epistemic goals are important in science is not something I need a general account of here. I only need to assume, following most philosophers of science and explanationists in particular, that having good explanations is among them.[15] One way a hypothesis can be more epistemically valuable than merely being true is by being a good explanation or increasing our understanding of one or more phenomena. Philosophers may disagree about why explanation and understanding are epistemically valuable—maybe they are intrinsically valuable, or maybe they are only valuable as a means to achieving other epistemic goals. There might also be disagreement about which criteria (unification, mechanism, parsimony, etc.) characterize good explanations. But all I need for the present argument is that the notion of better or worse explanations makes sense—an assumption explanationists also need—and that having better explanations is in fact more epistemically valuable, all things being equal.

Granted these premises, consider the premise of an IBE: that the hypothesis H would provide the most understanding out of a set of rival explanations, if it were true. Thus, if we were to learn that H is in fact true, this would be an epistemically valuable outcome, and indeed the optimal epistemic outcome as far as explanation is concerned. Suppose, then, that everything else is held equal between a set of rival hypotheses: the costs of pursuing them are the same, we regard it as equally likely that pursuing them would give us reliable evidence for or against them, all other expected epistemic outcomes of pursuing them are equal, and so on. In this case, given

15. For instance, Kitcher (1993, 105–12) highlights "explanatory progress" as one of the goals pursued by science beyond mere truth.

my account of justification for pursuit, scientists would be justified in pursuing the most explanatory hypothesis.

In terms of the decision-theoretic model developed earlier, we can express the assumption that explanatoriness is one important epistemic goal as the claim that if H_1 is more explanatory than H_2, then, all else being equal, $EV(a(H_1) \,\&\, H_1)) > EV(a(H_2) \,\&\, H_2))$.[16] Notice from equation (2) that if $EV(a(H_1) \,\&\, H_1)) > EV(a(H_2) \,\&\, H_2))$, then, all else being equal, $EEV(p(H_1)) > EEV(p(H_2))$. It follows that if H_1 is more explanatory than H_2, we are, all else being equal, justified in pursuing H_1 rather than H_2.

This shows that IBE can justify the pursuit of a hypothesis if all else is equal. Explanatoriness can serve as a tiebreaker to justify pursuing one hypothesis rather than others. But, more generally, it is also clear that if a hypothesis has a high degree of explanatoriness, this adds to the expected epistemic value of pursuing it and thus gives some additional reason to pursue it, although not always a decisive reason.[17]

Let me close by considering the following potential objection: justifying the pursuit of a hypothesis still involves showing it to be minimally plausible or probable. Notice that Peirce sometimes says that abductions give us "reason to suspect that [the hypothesis] is true" (Peirce 1932–58, 5.189) or reasons "regarded as lending the hypothesis some plausibility" (Peirce 1932–58, 2.511n) and that "certain premises will render an hypothesis probable, so that there is such a thing as legitimate hypothetic inference [i.e., abduction]" (Peirce 1932–58, 2.511n). However, if this is the case, the Peircean view also requires some connection between explanatoriness and likeliness (or plausibility), even if it is a weaker one than explanationists tend to require. But this is sufficient for the truth-connection problem to apply to the Peircean view as well.

The premise of this objection is mistaken. Justification for pursuit need not stem from showing that the hypothesis is any more probable or plausible. Even if a necessary condition for a hypothesis being pursuitworthy is some minimal degree of plausibility, it is not sufficient. One way of justifying pursuit might be to show that the hypothesis is more plausible than

16. This is "all else being equal" since H_2 might be more valuable in terms of other epistemic goals besides explanatoriness.

17. Notice that which hypothesis to pursue is decided after fixing our estimates of all relevant factors. If we discover that a hypothesis is more explanatory than we previously thought, or change it to become more explanatory, this can influence our estimates of the other factors. So changes, say, to the plausibility of the hypothesis may outweigh any gains in explanatoriness. Analogously, for the treasure hunters, if knowing the size of the cave provides additional clues about the location of the treasure, this needs to be taken into account as well.

previously thought, but it is not the only way. One could equally argue that a hypothesis is only worth investigating if it is not completely trivial or obvious.[18] So another way to justify pursuit might be by showing that there is more reason to doubt the hypothesis than previously thought. And, as argued above, justification for pursuit can also stem from how interesting or valuable it would be to know whether the hypothesis is true, independently of its plausibility.

Furthermore, it is not generally the case that having higher plausibility gives us more reason to pursue a hypothesis. Consider equation (2) again. From $Pr(H_1) > Pr(H_2)$ it does not follow that, all else being equal, $EEV(p(H_1)) > EEV(p(H_2))$. First, raising $Pr(H_1)$ gives more weight to both the first and third terms in equation (2). So if, say, $EV(a(H_1)\ \&\ H_1)) \cdot Pr(a(H_1) \mid H_1\ \&\ p(H_1)) < EV(r(H_1)\ \&\ H_1)) \cdot Pr(r(H_1) \mid H_1\ \&\ p(H_1))$—which by assumption is the same for H_2—this would make $EEV(p(H_1))$ lower than $EEV(p(H_2))$. Second, raising $Pr(H_1)$ at the same time lowers $Pr(\sim H_1)$, thus lowering the second and fourth terms. Again, depending on our estimates of the other factors, this could make $EEV(p(H_1))$ lower than $EEV(p(H_2))$.

In sum, although being very likely or plausible can sometimes be a good reason to pursue a hypothesis, we can equally be justified in pursuing a hypothesis exactly because we think that it is very likely false and it would be easy to show this. This was in fact something Peirce often stressed: "the best hypothesis . . . is the one which can be the most readily refuted if it is false. This far outweighs the trifling merit of being likely" (Peirce 1932–58, 1.120). This is also a plausible interpretation of why the physicists in Franklin's (1986) story chose to pursue the parity violation hypothesis, despite regarding it as almost certainly false.

5. Conclusion. The argument given in this article is quite general. It only rests on the premise that it, all else being equal, is more epistemically valuable to learn that more explanatory hypotheses are true than to learn that less explanatory ones are. In particular, I have not presupposed any specific account of explanation or of why explanations are valuable. Combined with the account of justification for pursuit developed in section 2, I have shown how the Peircean view provides a simple and straightforward connection between explanatoriness and pursuit, thus avoiding the truth-connection problem.

18. In fact, neither of these conditions is necessary. As Franklin (1993b, 122–25) points out, physicists sometimes pursue experimental work on a hypothesis after they regard it as conclusively falsified. Pursuing H can serve other epistemic goals beyond generating evidence for or against H.

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