Dispelling the Disjunction Objection to Explanatory Inference

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Abstract: Although inference to the best explanation (IBE) is ubiquitous in science and our everyday lives, there are numerous objections to the viability of IBE. Many of these objections have been thoroughly discussed; however, at least one objection has not received adequate treatment. We term this objection the "Disjunction Objection". This objection challenges IBE on the grounds that even if H is the best explanation, it could be that the disjunction of its rivals is more likely to be true. As a result, IBE appears to license accepting a hypothesis that is more likely than not to be false. Despite initial appearances, we argue that the Disjunction Objection fails to impugn IBE.

Explanatory inference is common. Why did she eat that dish when she doesn't like it? Answer: She must have been very hungry. What accounts for his absence at school? Answer: There's a bad cold going around, and he must have come down with it. These conclusions are based on inference to the best explanation.

Is inference to the best explanation (IBE) a good form of reasoning though? Many challenges to IBE have been thoroughly discussed in the literature. However, there still remain important challenges to it that have not been adequately addressed. One such challenge is what we call the "Disjunction Objection".[1] Roughly, this objection arises from the possibility that a particular hypothesis is the best explanation of a given set of evidence even though the disjunction of its rivals is more likely to be true. In light of this possibility, the Disjunction Objection purports to give us reason to doubt the general rule to infer the best explanation of a field of hypotheses. After all, it is not rational to believe that H is true when H is more likely to be false than true. So, one might think

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[1] Although this objection to IBE is often pressed informally, it is rarely seen in print. Van Fraassen (1989) and Fumerton (1995) are the only ones we know of to make the objection explicit in the literature. Cf Nozick (1993: 82) for a related objection.

that we should not infer the truth of the best explanation because that explanation may still be unlikely despite being the best among its rivals.

Fortunately, for those who employ IBE (which some would argue is pretty much everyone[2]), the Disjunction Objection fails to impugn IBE. In what follows we first describe the Disjunction Objection more fully (section 1). Then we distinguish it from van Fraassen's (1989) 'best of the bad lot' objection and the objection Lipton (2004) refers to as 'Voltaire's objection' (section 2). Finally, we dispel it (section 3). Dispelling the Disjunction Objection requires distinguishing two conceptions of IBE. One conception is that the best explanation of some set of evidence is an objective relation that holds between a hypothesis and the evidence that (i) tracks how much understanding the hypothesis provides for the evidence and (ii) does not depend at all on background evidence.[3] A different conception of IBE retains (i) but denies (ii). That is, the second conception of IBE holds that the quality of a hypothesis relative to background evidence is essential to making the inference to that hypothesis's truth permissible. In other words, it's not enough that a hypothesis is the best explanation among its rivals—in order to be inferred the best hypothesis must be a sufficiently good explanation in its own right.[4] In our view the Disjunction Objection is successful against the first conception of IBE but not the second. This should not worry advocates of IBE because the second conception is intuitively much more plausible than the first one; non-deductive inference is always inference against a background.

1. The Disjunction Objection

[2] See McCain (2016) for discussion.
[3] See Lipton (2004: 61) for discussion.
[4] See Musgrave (1988) and Lipton (2004) for defense of this conception of IBE.

What is the Disjunction Objection? Richard Fumerton gives a clear statement of this objection when arguing that IBE fails to provide the tools necessary for a convincing reply to skepticism.

> E1 might be [a] better [explanation] than E2, than E3, than E4 and so on. This fact by itself does not imply that even if we are justified in believing that one of these explanations is correct, we are justified in believing that E1 is the correct explanation…I can cheerfully admit that E1 is the most attractive explanation while admitting that the disjunction of propositions asserting alternative explanations is much more likely to be true. (1995: 209)

What is it for E1 to be the most attractive/best explanation among its rivals? Clearly it doesn't mean that we are justified in believing it is true. Rather, it means that E1 is a more lovely explanation than any of its rivals (E2, E3, E4, and so on). That is to say, E1 is the explanation that, if true, would confer the most understanding of the evidence to be explained. So, in essence Fumerton is arguing that it is not reasonable to infer the truth of the loveliest explanation of some body of evidence because that explanation might be unlikely to be true overall. Hence, he is arguing (correctly, we believe) that being the loveliest is not always good enough.

For the purpose of illustration, consider the New England Patriot's chances of winning the SuperBowl.[5] They have the best quarterback in the league, good wide-receivers, a good running-back, a superior offensive line, and a premier defense. Of the 32 teams in the league the Patriots by far have the best chance of winning the SuperBowl. Suppose one doesn't know who won the SuperBowl. The loveliest explanation of the fact that a team won is that the Patriots did. They have the best team, but sometimes the best team doesn't win. So, independently of knowing who won, should we infer by IBE that the Patriots won? No. The reason is that even though they have the best team, the rest of the 31 teams have a shot at winning and those individual chances add up to

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[5] Our example here is similar to van Fraassen's (1989: 149) horse race example.

beat the chances of the Patriots. In the lingo of betting, even though the Patriots have the single best odds at winning of any individual team, it doesn't make sense to take them versus the field.

In order to better situate our reply to the Disjunction Objection, let us consider a simple formal example. Let H1 be the hypothesis that a fair coin has been chosen, i.e., Pr(heads | H1) = 1/2; H2 is the hypothesis that a coin with a strong bias for heads is chosen, e.g., Pr(heads|H2)=3/4; and H3 is the hypothesis that a coin with a strong bias against heads is chosen, e.g., Pr(heads|H3)=1/4. There are only three coins to be chosen and each has the same probability of being chosen—Pr(H1)=Pr(H2)=Pr(H3)=1/3. The results of the flip of each coin are independent of previous flips. A coin is selected at random and flipped four times. The results are: H, T, T, H (call this our evidence, "E"). In such a case it is plausible that H1 is the best explanation of E. After all, if we knew that H1 were true before flipping the coin, we would predict results similar to E. While H2 and H3 don't rule out E, they wouldn't predict E as well as H1 would.[6] For the evidence, E, is more likely given H1 than given the other two hypothesis. Pr(E|H1)=16/256; Pr(E|H2)=Pr(E|H3)=9/256. Given that the priors are equal, this difference in the likelihoods not only means that H1 is a better predictor of E, it implies H1 is the most probable of the three hypotheses given the evidence. Bayes's theorem gives the following values for the posterior probabilities: Pr(H1|E)≈0.47 > Pr(H2|E)=Pr(H3|E)≈0.26. But Pr(H2 or H3|E)≈0.53.[7] Consequently, H1's being more probable than either of its rivals doesn't mean that it is overall likely

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[6] Our point here doesn't rely on the assumption that prediction and explanation are really the same thing (with the former being forward looking and the latter being backward looking), although such a view has been defended (see Hempel and Oppenheim (1948) and McCain (2016) for discussion). All that is required for our point is the extremely plausible claim that making successful predictions is an important explanatory virtue, and, when other things are equal, the explanation that provides better predictions is best.

[7] In this case, ~H1 is equivalent to (H2 or H3). And so, Pr(H2 or H3|E)=Pr(~H1|E).

to be true. Thus, being the best (and the most probable) among the individual rivals isn't sufficient for inferring the truth of H1.

This simple scenario provides a concrete model of the Disjunction Objection. There is some evidence to be explained and H1 is the best of the candidate explanations, but it is less probable than the disjunction of the rivals. So H1 is the best but one should not believe the best because it is more likely that H2 or H3 is true. Hence, it seems that a hypothesis's being the best explanation of a given set of evidence is insufficient for inferring its truth.[8]

In general, the Disjunction Objection requires the following two claims.

Explanatory Privilege: There exists a hypothesis H such that it explanatorily dominates all rivals H*; $Pr(H|E)>Pr(H^*|E)$.[9]

Swamping: $Pr(H^*1 \text{ or } H^*2 \text{ or } \dots \text{ or } H^*n|E) > Pr(H|E)$.

Explanatory Privilege tracks the fact that H is the loveliest explanation of the evidence. Swamping tracks the logical fact that probabilities are additive so that small probabilities can add up to a large probability.

2. Distinguishing Objections

Despite some similarities, the Disjunction Objection is distinct from two prominent objections to IBE.

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[8] It is worth noting that Smith (2016) has recently put forward an impressive case against the assumption that in order to be justified in believing a proposition that proposition must be likely to be true. If Smith is correct, then the Disjunction Objection may be harder to motivate than its proponents have thought. Given that Smith's view is controversial it behooves explanationists to attempt to tackle the Disjunction Objection head on by granting the assumption that in order to be justified in believing a proposition that proposition must be likely to be true.

[9] This assumes that loveliness tracks likeliness. In other words, the most explanatory hypothesis has the highest likelihood. Note also that we are just comparing H to individual rival hypotheses. If we take ~H as a rival then **Explanatory Privilege** is inconsistent with **Swamping.**

2.1. Best of a Bad Lot

First of all, on a cursory examination one might be inclined to think that the Disjunction Objection

is simply a version of van Fraassen's (1989) "Best of a Bad Lot" objection. This inclination should

be resisted though. According to van Fraassen when we choose the best available explanation from

a set of competing explanations "our selection may well be the best of a bad lot." That is, van

Fraassen argues that recognizing that H is the best available explanation of one's evidence is not

enough to justify belief in H. As he says:

> To believe is at least to consider more likely to be true, than not. So to believe the best
> explanation requires more than an evaluation of the given hypothesis. It requires a step
> beyond the comparative judgment that this hypothesis is better than its actual rivals…For
> me to take it that the best of set X will be more likely to be true than not, requires a prior
> belief that the truth is already more likely to be found in X, than not. (1989: 143)

Although the Best of a Bad Lot and the Disjunction Objection are similar in some ways,

they are importantly different. The Best of a Bad Lot objection arises from the concern that the true

hypothesis may not be among the set of hypotheses that one considers. As a result of this, van

Fraassen argues that H's being the best of the set of hypotheses is not a sufficiently good reason to

infer that H is true. The Disjunction Objection, however, does not depend on the possibility of the

true hypothesis not being among those considered. In fact, when putting forward the Disjunction

Objection one can grant that the true hypothesis is among those considered and still press the

objection. (Cf. the Patriots example; we know that one of the teams will win.) Not only this, it can

be granted that we *know* the true hypothesis is among those considered—even that we are *certain* that

the true hypothesis is among the hypotheses considered! After all, as we noted in our example above

the Disjunction Objection is often put forward with examples including the assumption that we are

aware of *all* of the competing hypotheses and how well they stack up relative to one another. So, one

might argue that even if we are certain that the true hypothesis is one of H1, H2, H3 and that H1 is the best explanation, it might still be that we cannot reasonably infer that H1 is true because it is more likely than not to be false. Consequently, the Disjunction Objection is distinct from the Best of a Bad Lot.[10]

2.2. Voltaire's Objection

A second objection that the Disjunction Objection might be confused with is what Peter Lipton (2004, p. 144) has called "Voltaire's Objection" (this has also been called the "Truth Demand")[11]:

> Why should the explanation that would provide the most understanding if it were true be the explanation that is most likely to be true? Why should we live in the loveliest of all possible worlds? Voltaire's objection is that, while loveliness may be as objective as you like, the coincidence of loveliness and likeliness is too good to be true. It would be a miracle if using explanatory considerations as a guide to inference were reliably to take us to the truth.

Essentially, this objection challenges IBE on the grounds that explanatory considerations may not be linked to the truth. So, for example, if simplicity is not linked to truth, then the fact that H is the simplest explanation does not make it any more likely to be true than rival hypotheses. Hence, if

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[10] On a cursory reading one might be misled into thinking that the Disjunction Objection is a version of van Fraassen's (1983a, 1983b) argument that explanatory power is not a confirmational virtue because it increases the informativeness of a theory and so decreases its probability. However, careful consideration reveals that the Disjunction Objection has nothing to do with informativeness. Rather, the Disjunction Objection is a matter of the best explanation having rivals whose disjunction seems to be more probable than the truth of the best explanation. To illustrate the difference between these objections, assume that van Fraassen is mistaken. This would mean that explanatory power is a confirmational virtue, i.e. greater explanatory power yields higher probability, all other things being equal. This assumption does not get rid of the Disjunction Objection. It is possible that an explanation has greater explanatory power—and hence, other things being equal, higher probability—than each of its rivals, and yet the disjunction of those rivals is more probable than it. Consequently, the Disjunction Objection remains even if van Fraassen's argument against explanatory power being a confirmational virtue fails. See Nelson (1996) for a helpful discussion of van Fraassen's argument concerning confirmation and informativeness.

[11] See McCain (2016) for discussion.

explanatory considerations in general are not linked to the truth, then it is not rational to infer that the hypothesis that best explains a given body of evidence is true.

Again, the Disjunction Objection is distinct from Voltaire's Objection. One can grant that explanatory considerations are linked to the truth while pressing the Disjunction Objection. The Disjunction Objection requires that **Explanatory Privilege** and **Swamping** are true. The truth of those claims is independent of the issue of whether, in Lipton's terms, loveliness tracks likeliness.

Let's spell this out a bit. Lipton reasons that IBE must be understood in terms of loveliness rather than likeliness. He argues that if explanatory considerations are to provide a ground for non-deductive inferences, then explanatory inferences must provide grounds for determining likeliness. One might think that the whole project of a theory of induction is to provide a basis for assigning probabilities to hypotheses on the basis of non-entailing evidence. So, if one has successfully argued that explanatory inferences are a guide to inductive inference, then explanatory inferences will play a role in determining the likeliness of various hypotheses, i.e. one will have responded to Voltaire's Objection. Nonetheless, even granting that Voltaire's Objection has been put to rest, the Disjunction Objection can still arise. The reason for this is that even if loveliness is a guide to likeliness, it is still possible that the loveliest explanation, which gets some significant probability, in virtue of its explanatory merits, is swamped in probability by the field of less-lovely competing hypotheses. In other words, Voltaire's Objection is solved so long as lovelier explanations are more probable than their less lovely rivals, but this still allows that the loveliest explanation is more likely than not to be false. Thus, the Disjunction Objection is importantly different from Voltaire's Objection.

2.3. Upshot

It is worth keeping in mind that the Disjunction Objection is distinct from both the Best of the Bad Lot and Voltaire's Objection for at least three reasons. First, distinguishing the Disjunction Objection from these other objections helps to better situate this objection in the literature on IBE. Second, recognition of the differences between these three objections makes it clear that responses to the Best of a Bad Lot and Voltaire's Objection may leave the Disjunction Objection unscathed. Third, since the Disjunction Objection is distinct from the Best of a Bad Lot and Voltaire's Objection, our method of dispelling the Disjunction Objection may not provide responses to these other objections. That all being said, the Disjunction Objection is an independent objection that is often, at least informally but sometimes formally, pressed against IBE, and it's now time for it to be dispelled.

3. Dispelling the Objection

It is critical to responding to the Disjunction Objection that we get clear on the general structure of IBE.

Inference to the Best Explanation

    (1) There is some body of evidence, *e*, and some background evidence, *k*.

    (2) Hypothesis H explains *e* better than any available competing hypothesis.

    (3) H is a good explanation given *k*.

    (4) Therefore, H is true.[12]

While explanatory reasoning is ubiquitous, it is easy to miss a key feature of when IBE licenses

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[12] See Lipton (2004) and Musgrave (1988) for more on the importance of restricting IBE to hypotheses that are sufficiently good.

accepting a conclusion. In particular, one might be tempted to overlook (3) of *Inference to the Best*

Explanation. However, doing so is clearly a mistake. After all, it could be that H explains e better

than the competing hypotheses, but H is obviously a horrible explanation of e. In such a case

explanationists aren't going to insist that it is reasonable to infer that H is true. It is simply not

enough that an explanation is the best; the best must also be good overall. [13]

Although neglecting (3) is a mistake, it isn't hard to see how one might make this mistake.

Explanatory reasoning is so ubiquitous in our lives that we often don't even realize that we are

engaging in such reasoning[14], and even if we do recognize it, we rarely employ IBE in an explicit

fashion. Additionally, IBE is often treated as a slogan along the lines of "the best explanation is

true", which can be convenient to use, but without qualification is false. It is common to treat this as

meaning that the explanation that would yield the most understanding if true, is true. Indeed, as

Lipton (2004: 61) writes "the explanation that would, if true, provide the deepest understanding is

the explanation that is the likeliest to be true."[15] On its own though, without (3), this can't be right

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[13] It is worth emphasizing that we are focused on inferences to the best explanation where the conclusion is that the inferred hypothesis is *true*. We grant that one might use a similar method of reasoning without (3) in situations where action must be taken regardless of whether the best explanation is likely to be true. For example, a scientist might be faced with the decision of which of a set of hypotheses she should invest time and effort into researching. In such a case, it can be reasonable for the scientist to go with the best explanation even if it fails to satisfy (3). Similarly, in medical cases where not treating is guaranteed to lead to a bad outcome it can be reasonable to infer the best explanation of the patient's symptoms and treat her accordingly, even if that best explanation is likely to be false. Nonetheless, in such cases the conclusion inferred is not that the hypothesis that provides the best explanation is *true*. Instead, in such cases it seems that what is inferred is something along the lines of the hypothesis that provides the best explanation is to be *accepted* as a working hypothesis. In other words, in such cases the inferred hypothesis is accepted and used to guide actions, but it is not *believed* (see Cohen (1992) for more on the distinction between acceptance and belief). Hence, there can be reasonable inferences that we might want to call "inferences to the best explanation" even though they do not include (3). However, such inferences do not license believing their conclusions; they only license accepting conclusions as working hypotheses. Here we are concerned only with inferences to the best explanation that purport to license believing that their conclusions are true.

[14] Douven (2017)

[15] Of course, Lipton does make it clear elsewhere that the sort of restriction encapsulated in (3) is necessary for this to be true.

because it conflicts with **Swamping**. After all, construing the likeliest explanation as the one that is loveliest without taking background evidence into consideration is precisely where the Disjunction Objection succeeds. Indeed, they are correct that it would be a surprising fact if whether an explanation was likely had no relation to background evidence. This would be such a surprising "fact" that we shouldn't accept it at all. Background evidence must play a role in IBE because at least sometimes background evidence can undermine the probability conferred by the loveliness of a hypothesis.

Once we see that acknowledging that *H* must be a good explanation given our background evidence—i.e., (3), our response to the Disjunction Objection is straightforward. In order to see this let us recall our coin example. In the coin case, H1, the hypothesis that a fair coin was selected, is the loveliest explanation of E, the evidence that four flips resulted in H, T, T, H. Thus, **Explanatory Privilege** is true. But note that, while this is true, our background evidence includes that Pr(H2 or H3) >> Pr(H1). That is, **Swamping** is true.

The truth of **Swamping** in this case complicates the inference. **Swamping** and **Explanatory Privilege** are working at cross-purposes. **Explanatory Privilege** tells us that H1 offers the best account of E, if we are just considering E in isolation of everything else we know. **Swamping** tells us that some other view is more likely to be true before we consider the effect of E. The main question for the defender for IBE is how one should put together **Swamping** and **Explanatory Privilege**. Our proposal is simple. Explanatory inference requires that the hypothesis to be inferred must be a good one; this requires that the hypothesis fit well with our background evidence. In the coin case, H1 doesn't fit well with our background evidence.

Although it's not easy to spell out exactly what's required for fitting well with background evidence, we don't have to worry about providing a full account of this here. For our purposes it is enough to recognize that in the cases used to press the Disjunction Objection the hypothesis favored by **Explanatory Privilege** is not good given our background evidence. Consider the coin case, the whole reason there is a problem is that the background evidence includes that it is two times more likely that either H2 or H3 is true than it is that H1 is true. The explanatory power of H1 does beat out H2 and H3 each individually when we are focusing solely on E, but there are other virtues for assessing goodness in explanation. The crucial one for the Disjunction Objection is *fit with background evidence*. Clearly, H1 fits poorly with the background evidence, i.e. *Inference to the Best Explanation*'s (3) isn't satisfied in this case. Although H1 better explains E, once the background evidence concerning the coins and the setup is taken into consideration it is not a good enough explanation to license inferring its truth. The importance of background evidence and the potential for **Swamping** is why many explanationists explicitly point out that the hypothesis we are justified in inferring must be part of the best explanation of one's *total evidence* not merely some proper subset of one's evidence.[16]

We've seen that the explanationist isn't committed to claiming that the truth of H1 should be inferred in the coin case. But, what about the intuitive idea that in such a case one should accept the disjunctive claim that H2 or H3 is true? One might think that in order to yield this result the explanationist will have to claim that the disjunctive hypothesis (H2 or H3) is the best explanation of the evidence. This isn't correct though. The explanationist is only committed to claiming that the

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[16] See McCain (2014), (2016) and Poston (2014).

truth of a hypothesis should be inferred when (1)-(3) have been satisfied with respect to that hypothesis. There's nothing in explanatory reasoning that says you can't reasonably believe according to known probabilities. In other words, the explanationist can readily admit that in the coin case one should believe the disjunctive claim that H2 or H3 is true because the truth of this disjunction is more probable than not. This is clearly not a problem for the explanationist who simply accepts that IBE is a legitimate form of inference.[17]

It is worth pausing to emphasize the key idea when it comes to dispelling the Disjunction Objection: background evidence is crucial for understanding IBE.[18] When making an explanatory inference the relevant options are evaluated in terms of multiple virtues. A hypothesis might be explanatorily better than another according to some virtues, but worse according to others. What matters is the overall balance of explanatory virtues. Importantly, a significant explanatory virtue concerns fit with accepted background information. Hence, a hypothesis that is the best with respect to a number of virtues may not be the best overall hypothesis if it conflicts with the relevant

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[17] One might worry that this is a problem for full-blown explanationists who want to claim that all ampliative inference is ultimately IBE. Although our sympathies lie with such an explanationist view, its defense is outside the scope of this paper. We will, however, mention that it is plausible that this sort of concern isn't a problem for the full-blown explanationist. The reason for this is that the full-blown explanationist can plausibly maintain that explanatory reasoning is required to set the relevant probabilities. After all, the explanationist might argue that the *best explanation* of our background evidence in the coin case is that it makes (H2 or H3) more probable than H1, i.e. in this case more probable than not. So, it's not that IBE is irrelevant when it comes to making the disjunction reasonable to believe, it's simply that a different IBE is doing the heavy lifting here—the earlier one that told us about the probabilities which are in our background evidence when we began considering E.

[18] One persuaded by the line of argument in Schupbach (2014) might think that such a formal requirement isn't applicable to IBE. In other words, one might agree with our claim that IBE needs to include a total evidence requirement and yet disagree with the idea that a total evidence requirement is a formal requirement. If one takes this route, then the disagreement with our position comes down to what should count as a matter of form when it comes to non-deductive inference. Importantly, such a position, if correct, wouldn't allow the Disjunction Objection to bounce back from our response. Instead, it would simply mean that the Disjunction Objection is misguided as an attack on the inference form, IBE. Adjudicating between our position and Schupbach's would take us too far afield, however, it is worth emphasizing that whichever way one goes the Disjunction Objection can be dispelled.

background information; it may fail to be a *good enough* explanation. In other words, even if a hypothesis satisfies **Explanatory Privilege**, it may be that **Swamping** makes it so that the hypothesis shouldn't be inferred. [19] On our view this is the crucial fact that is overlooked in the Disjunction Objection. It is built into the cases used to motivate this objection that the hypothesis with the greatest explanatory power is swamped by the probability of the field of rivals. As a result, our response amounts to the sober realization that IBE is a multi-track inference. Or, perhaps more simply, we must realize that IBE says to infer the truth of the best explanation only if that explanation is sufficiently good in light of the background evidence. This should be unsurprising when we recall Carnap's (1950: 211) "requirement of total evidence." When making a non-deductive inference "the total evidence available must be taken as a basis for determining the degree of confirmation." Proper appreciation of the role of background evidence in IBE dispels the Disjunction Objection.[20]

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[19] There is recent empirical research that suggests the average person is sensitive to the need for the best explanation to be *good enough*. It seems that people tend to infer the best explanation only when it is significantly better than its rivals. See Douven and Mirabile (forthcoming).

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