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Laplaceanism defended

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Abstract This work is a critical consideration of several arguments recently given by Elliott Sober that are aimed at undermining the Laplacean stance on probability in evolutionary theory (and, by extension, the special sciences more broadly). The Laplacean contends that the only objective probability an event has is the one assigned to it by a complete description of the relevant microparticles. Sober alleges a formal demonstration that the Laplacean stance on probability in evolutionary theory is inconsistent. But Sober's argument contains a crucial lacuna, one that likely cannot be repaired to yield the conclusion that Sober draws. He also argues that the Laplacean is committed to inferring semantic facts about probabilities from pragmatic facts about agents' reasons for using probabilities. But Sober's arguments against inferring semantic facts from pragmatic constraints would only undermine one basis for Laplaceanism. The Laplacean who formulates her position carefully need not leave herself vulnerable to Sober's objection to inferring semantics from pragmatics.

Keywords Objectivity · Probability · Evolutionary theory · Laplace's demon

Introduction

Recently, Sober (2010, 2011) has put forward several arguments aimed at undermining what he calls the Laplacean interpretation of probability in evolutionary theory. According to the Laplacean view, the only objective probability an event has is the one assigned to it by a complete description of the relevant microparticles (Sober 2011, 179). The probabilities assigned by evolutionary theory are not necessarily objective, says the Laplacean, because they may differ in value from those assigned on

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the basis of a complete description of the microparticles. When they do differ, such probabilities should be interpreted subjectively, often as the degrees of confidence agents have, or *should* have, in the conclusions they draw from evolutionary theory (see Hájek 2012, §3.3).

Laplaceanism is not identical to subjectivism: the Laplacean grants that there are objective probabilities, but the only objective probabilities are those dictated by a complete description of the microstates of the system. Nor, despite the name, is Laplaceanism a version of the classical interpretation of probability, with its fatal invocation of the principle of indifference (see Gillies 2000, ch. 2). Instead, the Laplacean is a pluralist, interpreting probabilities assigned on the basis of microstates and fundamental microphysical laws objectively and while interpreting other probabilities, ones that differ from the objective ones, in subjective terms. Here I seek to rebut Sober's arguments allegedly defeating the Laplacean position; the reader is referred to Schaffer (2007) for a positive defense of the view.

Sober's arguments are quite general and, if successful, would make the Laplacean position untenable as an interpretation of probability in any special science. Moreover, one of the arguments, which I dub Sober's *derivability argument*, consists in an alleged formal demonstration that the Laplacean viewpoint is internally inconsistent. Sober claims that anyone who grants the objectivity of microprobabilities, as the Laplacean does, must grant the objectivity of the macroprobabilities that appear in evolutionary theory. (Microprobabilities are unconditional probabilities of microstates, or probabilities of either macro- or microstates that conditionalize on microstates (Sober 2011, 182)) Central to Sober's derivability argument is a demonstration that macroprobabilities are derivable from microprobabilities. I will argue below, however, that Sober's demonstration fails to show that subjectivism about probability in evolutionary theory is untenable. Moreover, the macroprobabilities to whose objectivity the Laplacean is committed, the ones that appear in Sober's formal demonstration, are likely different from those that appear in evolutionary theory.

Sober also alleges that the Laplacean illicitly justifies her stance on the objectivity of probability by appeal to the pragmatic reasons that agents may have for using probabilities. Theorists who do so are vulnerable to a couple of objections, says Sober. Sober argues that the Laplacean would not espouse the non-objectivity of fundamental natural laws even if there were an agent even more powerful than Laplace's demon who could foresee the future and so had no pragmatic reason to make predictions using any law. Moreover, Sober points out that the frequentist interpretation of probability is objective but might be eschewed for predictive purposes by some agent. However, the Laplacean may simply formulate her position carefully so as to avoid the sort of illicit inferences that Sober finds objectionable and thereby resist Sober's arguments. Thus, Sober's arguments fail to show that Laplaceanism is untenable.

Sober's derivability argument

In his derivability argument, Sober is concerned to demonstrate the objectivity of conditional macroprobabilities of the sort assigned by evolutionary theory. Sober's argument invokes a distinction between macrostates and microstates. Macrostates

include states of the sort found in biology and psychology (Sober 2011, 181); these include such things as frequencies of alleles in populations, fitnesses, and population sizes. Microstates are states of microparticles, the smallest material objects in the universe (Sober 2011, 179). Macrostates supervene on microstates in accordance with principle MS:

> A complete specification of the properties that all particles have at a given time uniquely determines all the properties that all macro-objects have at that same time. (Sober 2011, 180)[1]

As Sober characterizes objectivity, probabilities are objective provided that they are conceptually mind-independent (2010, 149–50). The Laplacean does not deny the objectivity of some probabilities; instead, she claims that the objective probability an event has is the one assigned to it on the basis of its microstates.

Sober attributes to the Laplacean two further theses that he labels L_1 and L_2:

> (L_1) Suppose you want to predict whether the system will be in state Y at time t_2 and you know the system's macrostate (X) at t_1 and the value of the macroprobability $\Pr(Y \text{ at } t_2 | X \text{ at } t_1)$. You should not base your prediction about t_2 on this information about t_1 if you also know the system's microstate (A) at t_1 and the value of the microprobability $\Pr(Y \text{ at } t_2 | A \text{ at } t_1)$, and the micro- and macroprobabilities differ in value.
> (L_2) If the only justification you have (or could have) for using the macroprobability $\Pr(Y \text{ at } t_2 | X \text{ at } t_1)$ to predict whether Y will be true at t_2 is that you don't know that A is the microstate at t_1 or you don't know the value of the microprobability $\Pr(Y \text{ at } t_2 | A \text{ at } t_1)$, then the macroprobability $\Pr(Y \text{ at } t_2 | X \text{ at } t_1)$ is not objective. (Sober 2011, 182–83)

Note how these elements have to do with predictions about a single system and whether it will be in a particular state at a particular time. Together, they entail the core tenet of the Laplacean view that "the only way the macroprobability $\Pr(Y \text{ at } t_2 | X \text{ at } t_1)$ can be objective is for it to have the same value as the microprobability $\Pr(Y \text{ at } t_2 | A \text{ at } t_1)$" (Sober 2011, 183).

The core of Sober's derivability argument is a demonstration that the probability of a macroevent conditional on a temporally antecedent macroevent can be derived from what the Laplacean will grant are objective probabilities, in particular, unconditional probabilities of microstates and probabilities conditional on microstates (Sober 2011, 187–88). Sober considers a definite case of a system in which macrostate Y at t_2 is caused by microstate C_j at time t_0 in the fashion illustrated in Fig. 1 (Sober 2011, 187).

In Sober's system, macrostate X has n "possible microrealizations" (A_1, A_2, …, A_n) generating n microprobabilities of the form $\Pr(Y \text{ at } t_2 | A_i \text{ at } t_1)$. The realizations of X, along with X itself, are caused by microstate C_j. Sober writes that $\Pr(Y|X)$ can be assigned this way (Sober 2011, 187):

[1] For the sake of argument, Sober undertakes MS, though he cautions that the principle may be false (2010, 144). I will suppose MS, too.

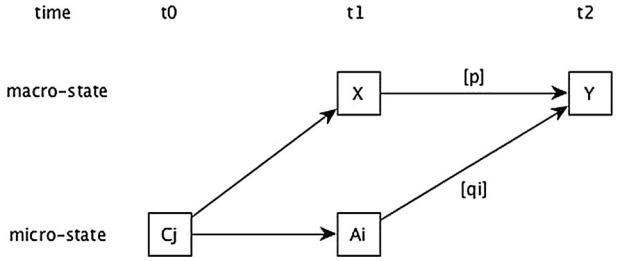

Fig. 1 Sober's system in which Y is caused by C_j (Sober 2011, 187)

$$\begin{aligned}
\Pr(Y|X) &= \sum_i \Pr(Y|A_i)\Pr(A_i|X) \\
\Pr(Y|X) &= \sum_i \Pr(Y|A_i)\frac{\Pr(A_i\&X)}{\Pr(X)} \\
\Pr(Y|X) &= \sum_i \Pr(Y|A_i)\frac{\sum_j \Pr\left(A_i\&X|C_j\right)\Pr\left(C_j\right)}{\sum_j \Pr\left(X|C_j\right)\Pr\left(C_j\right)}
\end{aligned} \tag{1}$$

All the right-hand side probabilities in (1) are conditional microprobabilities or unconditional probabilities of microstates. Allowing that the microstates are complete descriptions of the relevant microparticles, the Laplacean should grant that the right-hand side probabilities in (1) are objective (Sober 2011, 187).

Sober's derivation raises an immediate question that has to do with the many "possible microrealizations" of X. In what sense is a single system possibly realized by multiple microstates? The summations in (1) over the various values for C_j prompt a similar question: In what sense does a single system exhibit multiple microstates C_j over which to add? Here is a natural answer: An individual applying evolutionary theory may not *know* the microstate of some individual system and accordingly may profitably treat the system as possibly being in one of many different microstates and then summing, as Sober does, over these. But this response hardly serves Sober's anti-Laplacean rhetorical purposes.

Possible realizations of a macrostate must be objectively possible realizations of it as far as the Laplacean is concerned for Sober's argument to go through. Sober aims to show that the Laplacean must concede the objectivity of macroprobabilities because they are derivable from microprobabilities that the Laplacean already regards as objective. But the derived probabilities will only be counted by the Laplacean as objective if those used to derive them are equally objective, and this means that the possible microstate realizers of macrostates must be objectively possible realizers.

One way to make sense of the summation in (1) over the possible microrealizations of X is to consider a system that undergoes indeterministic evolution: each of the n microstates A_i represents a distinct metaphysical possibility given the state of the system at time t_0. That is, each possibility is objective insofar as it is a complete description of the relevant microparticles that instantiate X, and each is a distinct metaphysical possibility given the initial state of the system. This approach

will not help make sense of the summations over the values for C_j, however, since that state does not evolve indeterministically out of an earlier one in Sober's set-up. Nevertheless, it will be useful to retain those sums and to explore the consequences of treating the possible realizers of X as what the Laplacean will concede are objectively possible realizers of X.

The more serious difficulty with Sober's argument is that it contains a lacuna. By exhibiting, in (1), what the Laplacean will concede is an objective characterization of $\Pr(Y|X)$, Sober shows nothing incompatible with the Laplacean position. To demonstrate the objectivity of the probabilities assigned by evolutionary theory, Sober would have to show that the values of the probabilities assigned by evolutionary theory coincide with the values of the objective ones he derives. But absent such a demonstration, the Laplacean may maintain both a commitment to the objectivity of the probabilities Sober derives as well as a rejection of the objectivity of the probabilities assigned by evolutionary theory.

Indeed, the probabilities assigned by Eq. (1) are demonstrably the same as the probabilities assigned on the basis of a consideration of the microstates alone. To see this, it will be helpful to add to Sober's figure the microrealizers of macrostate Y, too. Figure 2 is a diagram of Sober's system with supervenience relationships filled in by directionless edges and the m microstates upon which Y supervenes, B_k, added. In a context in which relationships between microstates across times are indeterministic, both X and Y may be multiply realizable for a given system whose initial state is C_j.

The Laplacean will regard the probability of a macroevent, given antecedent microevents, as determined entirely by the probability of the microstate instantiators of the macrostates, given antecedent microstates. In particular, the Laplacean will regard the following probability as objective:

$$\Pr\left(Y|C_j\right) = \sum_j \sum_i \sum_k \Pr(B_k|A_i)\Pr\left(A_i|C_j\right) \tag{2}$$

We can state the probability $\Pr\left(Y|C_j\right)$ in an alternative fashion that will allow us to exploit the probability Sober derives in (1).

$$\Pr(Y|C) = \Pr(Y|X) \sum_j \Pr\left(X|C_j\right)$$

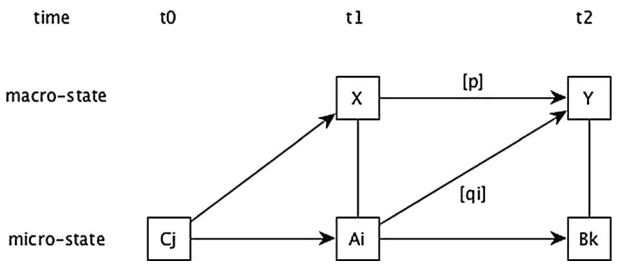

Fig. 2 Sober's system in which Y is caused by C_j with supervenience relations

Substituting in using Eq. (1),

$$\Pr(Y|C) = \sum_i \Pr(Y|A_i) \frac{\sum_j \Pr(A_i \& X|C_j) \Pr(C_j)}{\sum_j \Pr(X|C_j) \Pr(C_j)} \sum_j \Pr(X|C_j)$$

Because $\Pr(A_i \& X|C_j) = \Pr(A_i|C_j)$ by Principle MS, we can reduce to the following expression:

$$\Pr(Y|C) = \sum_j \sum_i \Pr(Y|A_i) \Pr(A_i|C_j)$$

Since $\Pr(Y|A_i) = \sum_i \sum_k \Pr(B_k|A_i) \Pr(Y|B_k)$,

$$\Pr(Y|C) = \sum_j \sum_i \sum_k \Pr(B_k|A_i) \Pr(Y|B_k) \Pr(A_i|C_j)$$

Because, finally, by MS, $\Pr(Y|B_k) = 1$,

$$\Pr(Y|C) = \sum_j \sum_k \sum_i \Pr(B_k|A_i) \Pr(A_i|C_j)$$

This last expression is identical to (2), the one the Laplacean will regard as objective. The point is that even if the Laplacean concedes the objectivity of expression for $\Pr(Y|X)$ given by the right-hand side of (1), that formula can be used to assign a probability to a system being in state Y given its initial state C that is exactly the one that the Laplacean will assign on the basis of considerations of microstates alone.

I wrote earlier that Sober's argument contains a lacuna. The objective probabilities that Sober derives must coincide with those assigned by evolutionary theory for Sober's derivation argument to go through. As we have just seen, the probability that Sober derives in Eq. (1) is the same as the one the Laplacean already regards as objective, the one assigned on the basis of the system's microstates, which the Laplacean denies must be the same as the one assigned by evolutionary theory.

The above demonstration is sufficient to show that Sober's derivability argument fails insofar as it is missing a premise. It is worthwhile to consider whether the objective probability that an evolutionary system will be in some future state is the same as the probability assigned to the same outcome by evolutionary theory. That the probabilities assigned on the basis of microstates are not in fact the same as those assigned by evolutionary theory is straightforward to demonstrate in deterministic contexts, but impossible to show conclusively in indeterministic ones. For the latter case, I briefly consider some evidence that the probabilities will not match.

For the sake of a definite example, let X represent the state of a biallelic discrete generation evolutionary system with respect to this-generation frequency of a neutral allele along with its effective population size. Let Y represent next-generation allele frequency. In that case, in evolutionary theory, $\Pr(Y|X)$ is given by

the binomial sampling equation. $\Pr(Y|X)$ is never assigned value 0 or 1 by evolutionary theory for any value of X by the binomial sampling equation, while $\Pr(B|A)$, the probability the Laplacean will regard as objective, must be 1 or 0 in deterministic contexts for any individual system.

In indeterminstic contexts, the value of $\Pr(Y|X)$ is dictated entirely by the indeterministic relationships that govern microstate dynamics. In these sorts of cases, we cannot prove that the value assigned by evolutionary theory for $\Pr(Y|X)$ is not the same as the one that the Laplacean will regard as objective. But there are good reasons to deny that they are the same, and Sober himself allows the possibility.

The position that the probabilities in evolutionary theory reflect fundamental ontological indeterminism has been defended by Brandon and Carson (1996). However, those authors have been stringently criticized elsewhere (Abrams 2007; Graves et al. 1999; Rosenberg 2001a; Weber 2001, 2005). Sober allows that hidden variables may determine which events occur even when different outcomes are assigned the same probability by biologists (Sober 2011, 137). Moreover, a variety of macrolevel phenomena, including diseases, droughts, parasites, and floods are quantified in probabilitistic terms in evolutionary theory (Frankham 1995, 100; see also Gildenhuys 2009). This would suggest, at least, that causal influences over evolutionary outcomes that are fundamentally deterministic are quantified probabilistically in evolutionary theory.

It is not necessarily true that the probabilities assigned by evolutionary theory will fail to match the ones the Laplacean will regard as objective even if deterministic causal influences are quantified probabilistically in evolutionary theory. It is possible that treating deterministic causes probabilitistically, in addition to so treating indeterminsitic ones, makes no difference to the resulting probability assignments. However, some causes quantified probabilistically have outsized influences on effective population size, and hence a correspondingly large influence the probabilities assigned to various outcomes in population genetics models. If such causes are not fundamentally indeterministic ones, then treating them probabilistically will yield probability assignments different from the objective ones. Nest parasites are one case of such a cause, and the oceanographic conditions under which some marine organisms reproduce are another. Consider the latter more closely.

Hedgecock suggests that some marine organisms, such as oysters, face "a sweepstake-chance matching of reproductive activity with oceanographic conditions conducive to spawning, fertilization, larval development, and recruitment" (1994, 124). These oceanographic conditions produce a massive drop in effective population size, the variable that controls the variance of the distribution of next-generation allele frequencies in classical population genetics models (see Hedrick 2005). Provided variations in oceanographic conditions do not result from fundamental indeterminism, their probabilistic treatment would have a significant impact on the probabilities assigned by evolutionary theory such that these no longer match the objective ones.

Considerations of this last sort provide, I think, moderately weighty evidence that the probabilities assigned by evolutionary theory will not match the objective ones,

at least sometimes. If we suppose, then, that the value of $\Pr(Y|X)$ as assigned by Eq. (1) is not the same as the value that that same quantify is assigned by evolutionary theory, even in the indeterministic case, then not only does Sober's argument contain a lacuna, but that lacuna also cannot be filled.

Sober derives Eq. (1) for the purpose of showing that macroprobabilities are derivable from microprobabilities and hence, if the latter are objective, then the former must be, too. The most that Sober's argument shows is that *some* objective macroprobabilities are derivable from microprobabilities. But the Laplacean already believes in the objectivity of some macroprobabilities. What Sober would have to show to secure the objectivity of probabilities assigned by evolutionary theory is that the derived probabilities are identical to the ones assigned by evolutionary theory. But Sober does not show this; he does not even try to show this. Moreover, the objective probabilities he derives for probabilities of macrostates conditional on other macrostates are demonstrably the same as the ones that the Laplacean already regards as objective, the ones assigned on the basis of microstates alone. Accordingly, the derivation does nothing to show that the Laplacean must concede the objectivity of the probabilities assigned by evolutionary theory, or the special sciences more broadly.

Objections and replies

Before turning to consider Sober's other argument against the Laplacean position, I consider some brief objections to the critique made above.

Relativity

Sober takes the stance that statements involving probabilities that conditionalize on different propositions may be simultaneously true, despite taking different values. Thus, to use his example, the probability that a coin comes up heads given that it is flipped is 0.5, while the probability it comes up heads given a complete description of the initial conditions of the toss is 0 or 1 (Sober 2011, 137). In a helpful analogy, Sober writes that probability is like distance. There is no such thing as absolute distance: the distance from New York to Madison is different from the distance from Los Angeles to Madison. The measurement point for distance is analogous to the conditionalizing proposition in probability.

This aspect of Sober's position might be used by him to fend off the above critique. In particular, the right-hand sides of the above equations, including Sober's Eq. (1), conditionalize on different propositions than do their left-hand sides. Accordingly, one might argue that no matter what the value taken by the unconditional probabilities and probabilities that conditionalize on microstates on the right-hand sides of the equations above, the probabilities that conditionalize on different propositions on the left may take different values and nonetheless statements involving them may remain objectively true. Indeed, Sober expects that probabilities that conditionalize on microstates will often not be the same as the ones that conditionalize on macrostates alone (Sober 2011, 185).

This response would undermine the above critique of Sober, but it would equally undermine Sober's own derivability argument. Sober's Eq. (1) identifies probabilities conditional on macrostates with unconditional probabilities and probabilities conditional on microstates. Sober argues that the objectivity of the left-hand side of (1) must be conceded by someone who concedes the objectivity of the right-hand side of (1). But the objectivity of the probabilities on the right of (1) cannot be used to affirm the objectivity of the probabilities on the left while it is simultaneously being allowed that these probabilities may take the different values because they feature different conditionalizing propositions. If the macroprobabilities on the left of (1) and microprobabilities on the right in (1) take different values, and these value assignments are not incompatible, then the probabilities are assigned to different things. If that is so, then the objectivity of the right side of (1) is simply irrelevant to the objectivity of the left.

A more modest version of the relativity thesis would allow that inter-derivable probabilities refer to the same thing. While the distance to Madison from Duluth and the distance to Madison from Chicago are different, the latter distance and the distance to Madison from the Windy City are the same. Allowing that inter-derivable probabilities have identity of reference would restore Sober's argument, but it would equally restore the critical response developed here as well. Indeed, the view would seem to force Laplaceanism.

Multiple systems

Above, we considered how (1) might be used to make inferences about the dynamics of individual systems. As noted above, Sober sums over possible microrealizations of the macrostates of the system, and this led me to note that in order for the Laplacean to accept the microstates as possible realizers of the macrostates, they must be metaphysically distinct possibilities. But another way to provide multiple microstates over which to sum using Eq. (1) is to consider multiple systems that each fall under a given evolutionary law. There will be a great many neutral genes whose replication can be inferred using the binomial sampling equation, and these systems will vary in terms of the microstates they do, or could, instantiate.

There are few reasons to resist this use of Sober's derivation. For one thing, Sober's presentation of the Laplacean position is clear: it is a stance on the objective probabilities that individual systems will be in particular states or that individual events will occur. Moreover, researchers applying evolutionary theory do apply the theory to individual systems and treat their dynamics as probabilistic. But most importantly, the Laplacean should already be committed to objectivity of probabilities in evolutionary theory when multiple systems are used to supply the distinct possible realizers of its macrostates.

We have good reason, independently of Sober's derivation argument, to think the probabilities assigned by means of (1) and those assigned by evolutionary theory will roughly match in many systems case. Evolutionary theory is a reliable theory and hence it must get the probabilities at least roughly correct in the many systems case. For inferences about the behavior of an arbitrary evolutionary system to be

reliable, the probability it is assigned of a given outcome conditional on a given initial state must roughly conform to the fraction of systems that exhibit the outcome given the initial state when a great many systems are considered. If the objective probabilities for next-generation allele frequencies failed to match, at least roughly, the binomial distribution, then evolutionary theory would fail to yield good predictions and explanations about the behavior of individual systems.[2] This means that the Laplacean should concede the objectivity of macroprobabilities in evolutionary theory prior to, and independently of, the derivation of (1), when many systems are under consideration.

It is perhaps worth pointing out how objectivist intuitions about probability in the multiple systems case are compatible with the Laplacean view. As far as the Laplacean is concerned, the objective probability than an arbitrary neutral allele at frequency 0.5 remains at frequency 0.5 a generation later in a discrete generation population of 100 individuals is just what the binomial sampling equation says it is, 0.08. But the probability that *this particular allele* turns up in half the population members of *this particular population* is something else entirely; it is 0 or 1 in deterministic contexts, and it is whatever fundamental microstate randomness implies in indeterministic ones.

Pragmatics and semantics

Sober also criticizes the Laplacean position from another direction. Sober argues that L_2 trades on an illicit inferential connection between the practical needs of particular agents to the objectivity (or not) of probabilities (Sober 2010, 147–48; Sober 2011, 186). L_2 uses facts about whether an agent is justified in using a probability as grounds for determining whether or not a probability is objective. The former is a pragmatic matter, while the latter is a semantic one.

To show what is wrong with inferring semantics from pragmatics, Sober puts forward a counterexample. On the frequency interpretation of probability, the probability of an event is just the frequency with which it occurs. Sober does not endorse the frequency interpretation, but his point is that it is an objective interpretation and yet also one that an individual is only justified in using if she does not know the system's microstate or does not know the probability of its later macrostate given its earlier one. If, in principle L_2, one substitutes "the actual frequency of *Y*-type events given earlier *X*-type events" in the place of "the macroprobability $\Pr(Y \text{ at } t_2 | X \text{ at } t_1)$," one thereby makes the antecedent of L_2 true and the consequent false.

The legitimacy of the counterexample hinges on the legitimacy of the substitution, but no matter what, I think the Laplacean should grant the broader principle that semantic facts do not rest on pragmatic ones and therefore reject L_2. As Sober sets out the Laplacean position, L_1 and L_2 together entail the Laplacean position on objectivity, specifically that the only objective probability an event has is the one assigned to it by a complete description of the relevant microparticles. But

[2] See Glymour (2006) for a critique of the reliability assumption made here.

Sober's derivation of the Laplacean stance on objectivity from L_1 and L_2 is his own. Though he attributes Laplaceanism to a couple of authors (Horan 1994; Rosenberg 1994), Sober does not quote any particular author undertaking L_1 and L_2.[3] And, of course, the Laplacean stance on objectivity may remain true even if some would-be proof of it invokes false premises.

A sturdier version of Laplaceanism would not derive the non-objectivity of probabilities in special sciences from any agent's needs or justifications, but instead from the fact that they differ from objective probabilities. On this version of the Laplacean position, the core Laplacean tenet about objectivity holds: the only objective probability an event has is the one assigned to it by a complete description of the relevant microparticles. Moreover, L_2 is rejected while this conditional is endorsed:

> If a probability assigned to an individual system being in some state is different from the objective probability, then that probability is not objective.

Call this *the sturdy conditional*. On this approach, that probabilities in evolutionary theory are not objective follows from a semantic fact about them, their difference from objective probabilities, not a pragmatic fact about the needs of some agent.

There remains the question of why researchers in the special sciences would assign probabilities that are not the same as the objective ones. And here pragmatics does come into play: researchers' limited knowledge explains why they find it useful to assign probabilities that are different from the objective ones. But researchers' epistemic constraints explain their probability assignments in a causal fashion, much as scientists' understanding, and its limits, helps to explain what views they undertake quite generally. There is a sense, then, in which researchers assign non-objective probabilities "because" of their epistemic limitations and pragmatic needs, but that "because" is not a logical one but a causal one.

In sum, on the robust version of Laplacean that I propose best captures the view, epistemic constraints explain what agents find useful (causally and partly). What's useful to constrained agents explains the probabilities that they assign to individual systems, too (again, causally and partly). But the objectivity (or not) of such assignments is a function of the difference (or lack thereof) between these assignments and the objective ones, and has nothing to do with the causal story explaining why anyone assigns them.

Sober's demon argument

Sober offers another argument designed to defeat L_2, one that invokes a demon who I will call *Sober's demon*:

> Consider a hypothetical being that has perfect precognition. Unlike Laplace's demon, it doesn't need to observe the present state of the universe and then compute its future; this being knows the whole history—past present, and

[3] Rosenberg has in fact changed his views since his 1994 work (Bouchard and Rosenberg 2004; Rosenberg 2001a, b; Rosenberg and Bouchard 2005); Sober notes this, too.

> future—directly. This super-demon would not need to use any dynamical law—micro or macro, deterministic or indeterministic—to predict the future. But surely this does not show that dynamical laws (e.g., those of quantum mechanics) are never objectively true—that they are just useful fictions. Here again, what a hypothetical demon needs does not settle what is objectively true. (Sober 2011, 182–38)

The first thing to note about the demon argument is that it does not show that L_2 is false by means of an instance making the antecedent true and the consequent false. If we grant the objectivity of some natural laws (which we shall do heretofore), then Sober's demon argument shows only that this claim is false: If an agent has no need for some law, then that law is not objective.

Sober's demon is meant as a foil to Laplace's demon. A Laplacean who contends that some probability or natural law is not objective if some agent would have no use for it is vulnerable to Sober's argument. Such a Laplacean makes the mistake of inferring semantic facts about objectivity from pragmatic facts about what an agent finds useful. But the Laplacean who eschews this error need not leave herself vulnerable to Sober's demon argument. As above, the Laplacean who treats probabilities in evolutionary theory as subjective because they are different from the objective ones is not vulnerable to Sober's demon argument.

To see this, consider a true deterministic law being used by an ordinary agent in a deterministic setting. While Sober's demon will foresee, without using the law, what the future will hold, the ordinary agent who makes capable use of the law as an inferential tool will infer the exact same thing. The Laplacean need not grant that probabilities inferred by objective fundamental natural laws are subjective just because Sober's demon can foresee what we must infer with those laws, because the probabilities inferred by means of the fundamental laws are the same as those assigned by the demon.

In those respects important to the Laplacean, Sober's demon and Laplace's demon are alike. Neither one assigns probabilities that are different from those assigned by ordinary agents who use fundamental laws of nature that yield objective probabilities; both demons assign probabilities that are different from those assigned by ordinary agents who use non-fundamental laws of nature. The demons are different insofar as Laplace's infers the probabilities he assigns, while Sober's does not, but this difference does not make a difference to the Laplacean who argues that non-fundamental laws assign subjective probabilities because these probabilities are different from the objective ones.

It is worth noting that while L_2 is false, it turns out that the following conditional (L_3) is true: if Laplace's demon has no use for some probability, then that probability is not objective. But this conditional should not be endorsed on the basis of the more general principle that if some agent (real or imaginary) has no use for something, then that thing is not objective. Instead, it turns out that Laplace's demon is a queer sort of agent who knows just enough to have no use for non-objective probabilities but not so much as to have no need for objective natural laws. It is only because the demon is this queer sort of agent that L_3 holds. It turns out that the subjective probabilities and the ones Laplace's demon eschews are identical. But the

reason that the useless probabilities lack objectivity is that they are different from the objective probabilities, not that they are useless to the demon.

Considerations about Laplace's demon serve best to illustrate the causal role of epistemic constraints in probability assignments: the demon, lacking constraints, assigns objective probabilities to events to which we mere mortals, burdened with such constraints, must assign subjective probabilities. *Of course* the probability assignments we make on the basis of evolutionary theory are not objective, says the Laplacean. Someone with none of the evolutionary theorist's epistemic constraints, Laplace's demon, say, would assign different values to the same probabilities. Probability assignments different from objective ones cannot be objective, and surely the demon knows the objective assignments.

Conclusion

I have shown that Sober's arguments fail to undermine the Laplacean stance on the objectivity of probability in evolutionary theory, and the special sciences more broadly. The Laplacean need not formulate her stance such that she licenses semantic facts from pragmatic ones, and while she must concede the objectivity of some macroprobabilities, Sober has not provided an argument to show that these are the same as the ones assigned by the laws of the special sciences.

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