The Untenability of A Priori Prior Probabilities in Objective Bayesian Conditionalization

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Abstract

The problem of theory confirmation has been an issue in the philosophy of science for decades. Many valiant attempts have been made to formulate a generally accepted criterion for determining the validity of a scientific theory. Bayesian probability theory has been utilized in numerous attempts to examine the epistemic nature of theory confirmation and Jonathan Weisberg offers a formulation of Bayesian Conditionalization that he believes to be both objective and successful.

In this paper I intend to show the defects in Weisberg's theory of objective Bayesian confirmation by utilizing the arguments of both W.V. Quine and Bas van Fraassen to support the claim that the epistemic difficulties presented against Weisberg are numerous and formidable and ultimately undermine his formulation of objective Bayesian confirmation.

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Preliminary Remarks

In "Laws and Symmetry," van Fraassen presents us with a formulation of subjective Bayesian conditionalization that he thinks can confirm the degree of posterior belief an agent would have in a hypothesis based on the prior belief she had in the hypothesis, H, which is then conditionalized upon the relevant evidence at hand, E.[1] The formulation of van Fraassen's criterion is thus:

> **Subjectivist Conditionalization (SC):** When you gain new evidence *E*, your new degree of belief in a hypothesis *H*, call it $q(H)$, should be your old degree of belief in *H* conditional upon *E* : $q(H) = p(H \mid E)$.[2]

Van Fraassen goes on to argue that Inference to the Best Explanation (IBE) is incompatible with his formulation of SC due to the fact that IBE finds its usefulness in determining explanatory goodness whereas SC is concerned with degrees of belief. Many attempts have been made to present an argument for the compatibility between IBE and SC, but none has met the challenge thus far. Weisberg, in "Locating IBE in a Bayesian

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1. Bas C. van Fraassen, *Laws and Symmetry*, (Oxford: Oxford University Press, 1989.)
2. Ibid.

Framework" brings to our attention that in order for IBE to be compatible with SC, we would have to rob IBE of much of its uniqueness and utility by converting explanatory goodness into degrees of belief.[3] So as it stands, we are forced to choose between IBE and SC, for theory confirmation cannot be based on both.

But Weisberg offers a different alternative. Rather than simply settling for the van Frassenien subjectivist option, there might be a different formulation of Bayesian conditionalization, which is more objective in nature and ultimately evidences itself as being compatible with IBE. Weisberg calls his formulation of Bayesian conditionalization the "Objectivist" option which is presented thus:

> **Objectivist Conditionalization (OC):** At any given time, your credence in an arbitrary proposition H ought to be $p(H \mid E)$, where p is the correct a priori probability distribution, and E is your total evidence at that time.[4]

What should immediately be significant to the reader is Weisberg's reliance on the phrase "correct a priori probability distribution." If what it is to be an a priori probability distribution were quite clear, then OC would be perfectly acceptable. As it stands, the concept of an a priori probability distributions is far from clear and must be

3. Jonathan Weisberg, "Locating IBE in the Bayesian Framework," *Synthese* 167 (2009): 126.

4. Ibid., 137.

explicated if we are going to be able to provide an adequate analysis of Weisberg's suggestion.

Laurence BonJour defines "a priori" as "prior to or independent of experience."[5] With this definition in mind, it is difficult to see what an a priori prior probability distribution would look like. If the prior is independent of experience, then it seems that any value given to the prior would be arbitrary; and if the prior were simply prior to the experience (and here I mean experience of E, the evidence), then background evidence would surely be taken into account. If by a priori Weisberg is referring to the second notion I have outlined, then an obvious problem arises. How can we be certain that each cognizer has access to the same background information? As Patrick Suppes points out, "...if [it] is an experiment in physics, it's likely that an experienced experimental physicist will have a much more interesting prior about the outcome of the experiment than will, for example, the most distinguished professor of philosophy or English."[6] Suppes goes on to note that "we believe well beyond any requirements of coherence or consistency, as it is sometimes called, there is the really much more important matter of

5. Laurence BonJour, and Robert Audi, "A Priori," In *The Cambridge Dictionary of Philosophy*, Second ed. (Cambridge: Cambridge University Press, 1999), 35

6 . Patrick Suppes, "Where Do Bayesian Priors Come From?," *Synthese* 156, no. 3 (2007): 445.

the background experience which led to the formation of the individual's prior."[7] What Suppes is indicating here and which he goes on to explicate is that if we use background evidence as a criterion for formation of priors then we are ultimately confronted with psychological matters that inform our priors.

On the other hand, if Weisberg is accepting the first notion I outlined, then serious epistemic problems arise. For the remainder of the paper I will assume Weisberg to be accepting the first notion. The intent of the paper is to explicate the difficulties present in the notion of an a priori prior probability and to argue that ultimately the suggestion is untenable and should be rejected.[8]

My method of argumentation will be thus: in section I, I will argue against the "a priori probability distribution" Weisberg proposes based on Quine's all too infamous critique of the analytic-synthetic distinction. The argument will, I hope, support the contention that a conception of an a priori prior is far from clear and that the lack of an epistemic criterion for choosing a certain a priori prior probability distribution, as well as

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7. Ibid., 445

8. While the primary intent of Weisberg in his paper is to show that IBE and Bayesian Conditionalization are conceivably compatible, his argument revolves around OC and thus if we are to evaluate the rest of his argument, we must offer a critical look at his pivotal criterion. Hence, I am not ignorant of the remainder of his argument, but simply focusing on what I consider to be the core claim rather than the argument as a whole.

setting reliable parameters, leads to significant problems. Section II will consist of an argument against the use of the Principle of Indifference in conjunction with conditionalization that Weisberg implicitly relies upon in his argument for the compatibility of IBE and OC. The Principle of Indifference undermines OC in that the attribution of a prior probability distribution of 1/n gives us no reason to prefer one probability distribution to another. This lack of criterion for choosing between priors becomes a significant problem in Weisberg's current formulation of OC and results in insurmountable epistemic barriers. Section IV will be devoted to emphasizing the quantitative problems present in an objective Bayesian conditionalization. Finally, section V will address several further difficulties concerning ontology and the truth-value of prior probability propositions.

A Quinean Argument Against A Priori Prior Probabilities

If reference to an a priori prior is going to be made in theory confirmation, it is imperative that a thorough comprehension of the notion of analyticity be attained.[9] Yet it appears difficult for us to specify the criteria for determining a priori probabilities. When

9. Typically "analytic" refers to semantic statements where as "a priori" refers to epistemic statements as Saul Kripke points out. However, in assuming the interpretation of a priori that I am, a posteriori analytics are out of the question due to the lack of evidence contributing to the a priori. Thus, my interaction is strictly with analytic a priori propositions, which do present a semantic element, but also a strong epistemic element relevant to my subsequent argument.

Weisberg uses "a priori" in his formulation of OC, it is not at all clear how he is employing the phrase "a priori." However, as I mentioned previously, I will assume that by "a priori" Weisberg is referring to analytic statements that are independent of experience and attribute some truth-value to the probability distribution referred to by the proposition. My justification for this is his own claim concerning "an objectively correct distribution of 'a priori' probabilities, p, which describes the degrees of belief an agent with no evidence (analytic) whatsoever ought to have."[10] So it seems that in order for us to correctly appropriate the coherence of the way in which Weisberg uses the a priori in his conditionalization, we must ask whether there really is the possibility of an a priori prior probability, and if so what is it and how does one go about objectively determining it?

Quine first questioned the existence of analytic statements in his earth-shattering article "Two Dogmas of Empiricism."[11] While I have neither the time nor the eloquence to explicate the matter as Quine does, several of his insights will be crucial in our dealings with the question of a priori prior probabilities. Quine's modus operandi is an appeal to the circularity of the terms "definition," "synonymy," and "semantical rules"

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10. Weisberg, "Locating IBE," 137.

11. W.V. Quine, "Main Trends in Recent Philosophy: Two Dogmas of Empiricism," *The Philosophical Review* 60, no.1 (1951).

typically used to explain the concept of analytic propositions. Since we are dealing with probabilities, it is not necessary that we examine the analytic in regards to definition or synonymy. However, an examination of semantical rules in an artificial language may be of some use. Quine asks us to consider an artificial language (using Carnap's notation) L_0.[12] From here the notion of analyticity, as typically understood, may be able to be appropriately assessed within the context of artificial languages. If we state "S is an analytic proposition for L_0," then we are forced to remove the variables "S" and "L_0" in order to understand the conjunction "an analytic proposition for…" between the two variables. But we don't have a sufficient conception of universal analyticity in order to make an assessment of the analyticity of particular variables. Therefore, even if the above proposition is qualified by introducing the preposition "for" so that the newly phrased proposition reads "analytic-for-L_0" we have only explained the concept behind "analytic-for-L_0" not "analytic" or "analytic-for."[13]

However, this appeal to "analytic-for-L_0" results in a problem. Perhaps our language is L_0, but perhaps not. There are L_n languages and there is no way of determining which proper subset contains our language. Thus, an appropriation of

12. Rudolf Carnap, *Logical Foundations of Probability*, 2nd ed. (Chicago: University of Chicago Press, 1962).

13. Quine, "Two Dogmas," 32.

analyticity in our language (perhaps L_1) becomes an arbitrary appropriation without logical foundation. If we cannot find a concept of analyticity that holds for the entire set L_n, then the use of analyticity can never be warranted due to the inevitable underdetermination of an infinite set of languages. This is quite a conundrum. Either we determine a conception of analyticity that is necessary and holds in all possible languages, or our appeal to the analytic is doomed to arbitrariness and vagueness, which does not result in the criterion that is being sought.

Now this notation can be translated from possible languages to that of possible hypotheses.[14] For any arbitrary hypothesis, H_1, there should (according to Weisberg) exist such a prior probability, p, which is devoid of any reference to evidence and appropriates the degree of belief in H_1. Since the qualifier "devoid of reference to evidence" is inserted, we give p the status of being an a priori; and as we already stated, a priori can be translated into "analytic." Thus the statement can be rewritten, as "p is an analytic probability distribution for H_1." Now, as was noted above, there is no clear conception of analyticity that would hold for the entire set H_n. Thus, it may be possible to conclude what "analytic-for-H_1" might mean, but this does not entail that we are able to understand

14. Remember that Weisberg's formulation of OC is in reference to arbitrary hypotheses which makes the problem of analyticity that much more evident.

what "analytic-for" would like for an infinite number of possible hypotheses, H_n; and since H_1 is arbitrary, how can we be certain we are applying the correct conception of "analytic-for" that corresponds to H_1 and not a conception that corresponds to one of the other H_n possibilities? The problem here is not that we are unable to understand an a priori prior in regards to any specific hypothesis, H (though this is unlikely). The problem resides in the equivocation of the terms "analytic" and "a priori" between a multiplicity of hypotheses, as well as the lack of a criterion for determining the appropriate definition of analyticity to attribute to any hypotheses from the set H_n.

If we grant the objectivist Bayesian her a priori, even in a single instance, her assumption of the appropriate definition of "analytic-for" in that instance is made questionable by the uncertainty of the parameters, or rules, set for OC. Allow me to allude back to Quine. When he is discussing the relation of analyticity to artificial languages and semantical rules, he offers us a revised definition that the semanticist might provide: "Derivatively, afterward, analyticity can be demarcated thus: a statement is analytic if it is (not merely true but) true according to the semantical rule."[15] But the problem, as Quine notes, is that we have no clear concept the phrase "semantical rules." So there now exists a vicious circle of either being unclear about the term "analytic" or

15. Quine, "Two Dogmas," 33.

unclear about the phrase "semantical rules." And one might ask: must we not have an appropriate definition of the semantical rules in order to be able to assess a statement as analytic in reference to this criterion? Thus, if we are to have any understanding of analyticity, a set of semantical rules must inform our understanding. However, these semantical rules are assumed to be known a priori within the framework of an artificial language, which assumes a clear concept of analyticity. Thus a criterion for determining the a priori is yet to be achieved and an appeal to semantical rules results in circularity.

This also seems to be the case with scientific hypotheses. In order to comprehend what is meant by "p is analytic-for H_0" there must be some concept of what H_0 entails and the parameters (rules) within which the analytic p is supposed to fall. Thus, in determining what analyticity of p would be for H_0, the parameters of H_0 must already have been assumed, which is supposed to be done analytically. And if we are dealing with a different hypothesis, perhaps even a contradictory one, then we must already assume the different parameters for that hypothesis are known analytically as well. It is conceivable, then, that all the languages within the set of L_n have different semantical rules and this would require us to individuate a priori semantical rules in order to assess the analyticity of a statement S for any specific language. The same holds for the set of hypotheses H_n. Therefore, the inclusion of a priori prior probabilities in Bayesian

conditionalization presents epistemic difficulties, which require an appropriate criterion of determination, which Weisberg fails to provide.

Perhaps a different line of argumentation may be taken which will allow an appeal to the analytic to be preserved.[16] If a cognizer simply understands the propositions H and E she should be able to grasp the inferential relationship between the two sentences devoid of direct prior experience, as Carnap suggests.[17] This would result in the conditionalization of H on E but without the subjective element. But Carnap's faith in the objective understanding of the logical relation between H and E*,* which should produce the appropriate probability concerning the confirmation q(H)*,* is misguided. Carnap's contention that one need not assent to the truth or falsity of the sentence in order to recognize a logical relation is reasonable and important to conditionalization. However, the assumption that each cognizer will correctly understand the propositions, and thus the relation, is unwarranted. Perhaps her background assumptions skew her interpretation of the data regardless of her understanding what is being expressed in the propositions She

16. Weisberg does not take Carnap's position given in his *Logical Foundations of Probability*. I am utilizing Carnap's argument in order to provide a possible solution to the problem I have presented above in order to preserve OC.

17. Carnap, *Logical Foundations,* 20.

may overlook the meaning and impose meaning that she would find to confirm her hypothesis based on her interpretation of the evidence.[18]

Quantum mechanics is a perfect example of the interpretation of evidence based on preconceived commitments to other hypotheses regardless of an understanding of the propositions expressed. In the De Broglie interpretation of the famous two slit experiment, it is the indirectly identified low energy waves that we can use to account for the directedness of the particles. Further investigation and work, however, have shown that this is not the case and those waves, in this sense, are not physically manifested in this instance. Thus, the evidence does not confirm the hypothesis of low energy waves posited by De Broglie. Yet De Broglie, in order to preserve his hypothesis of the wave-particle duality in quantum mechanics, insists that the evidence does offer support and modifies his system to preserve his prior commitments. Here we have a case where one understands the propositions, yet brings in background assumptions to confirm (disconfirm) the hypothesis.[19]

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18. I am not suggesting that this is how scientific theorizing actually transpires, but rather that an understanding of the words of a propositions does not entail the confirmation of the inferential relationship.

19. Hilary Putnam, *Mathematics, Matter, and Method*, (London: Cambridge University Press, 1975), 122.

Carnap might respond to the above criticism by claiming that De Broglie did not properly understand the propositions being expressed in the new hypothesis, but that seems unlikely. First of all, are we in any epistemic position to judge whether or not another correctly understands the propositions at hand? I think not. But in the case of De Broglie, if he were a high school physics student perhaps we could accept such a rebuttal. As a Nobel Prize physicist, however, it is highly unlikely that he did not understand what was being proposed and the results of the experiment. The truth of the hypothesis is irrelevant here as well. De Broglie merely needed to deny the inferential relationship between H and E for Carnap's suggestion to be refuted. Carnap's contention, therefore, does not give us warrant for appealing to analyticity in our theory confirmation. A criterion of determination for a priori probability distributions must still be established, but it cannot be achieved through semantics alone.

Epistemic Issues Concerning A Priori Probability Distributions

An appropriate criterion of determination will only be possible if a compatible epistemology is developed. The utilization of an a priori probability distribution would require two things: 1) That the human mind is in a privileged position to arrive at the correct a priori priors and 2) that the mind can differentiate between beliefs formed

directly on the basis of experience and those formed on the basis of other beliefs within one's epistemic structure in order to appropriately assess the justification of each belief.

Van Fraassen offers two counter-arguments against epistemic privilege that meet both the naturalist's and the rationalist's lines of argumentation. Epistemic privilege cannot arise from Darwinian naturalism because the evolutionary process provides no strategic mechanism from which any epistemic framework is chosen over any other. Therefore, there is no good reason for us to think that our evaluation of any hypotheses is any more accurate than any other based *only* on the fact that it was a human mind that arrived at a hypothesis.[20] This argument does not commit us to denying our reliance on any of our current theories; it says nothing about justification based on experience or experimentation. But if we rely on a naturalistic account to explain the methodologies of science, then only a strict externalist theory confirmation is possible. An influx of sense data provides experience upon which to develop theories and to develop a system of beliefs; and it is these external empirical facts that justify us in accepting (confirming) one theory over another. But an internalist theory confirmation is not tenable on a naturalistic model, for any attempt to ground theories in our internal mental states results in epistemic unreliability.

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20. van Fraassen, *Laws and Symmetry*, 143.

A similar problem is present for the rationalist. Van Fraassen calls attention to Descartes' claim that ideas present in the mind correspond to reality.[21] Thus our theory confirmation, though it begins in the mind, results in a correspondence with reality. Based on the rationalist's concept of innate ideas, which inevitably correspond with reality, it appears reasonable to conclude that we have a privileged position towards the development of theories in which our theories due in fact correspond with reality. Van Fraassen meets this challenge with one question: why should we suppose that our minds are predisposed towards speculative knowledge?[22] Perhaps our mental predispositions are merely towards the sensible world. The rationalist might answer this challenge by drawing our attention to our "innate" comprehension of mathematics.[23] An appeal to mathematics, however, does not answer the challenge of speculative knowledge posed by van Fraassen; for the rationalist conceives of mathematics, not as speculative, but as abstract realities.[24] Even if the realm of speculative mathematics is referenced, it is not at all clear that our minds have an innate comprehension of irrational or imaginary numbers.

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21. Ibid., 143.

22. Ibid., 144.

23. For the sake of the argument I assume the rationalist is correct, though certainly there is much controversy as to the status of mathematical knowledge. I also assume that the rationalist affirms a platonic notion concerning such entities, though it is certainly possible to be both a rationalist and a nominalist.

24. I am also here assuming a form or realism concerning numbers, but there is much that could be said concerning nominalist interpretations as well.

Thus we have no justification, on a rationalist account, for supposing that our minds are predisposed (privileged) towards speculative knowledge.

The appeal to epistemic privilege presents another difficulty. As was mentioned above, there are an infinite number of a priori probability distributions available for an infinite number of competing hypotheses. Problems of underdetermination aside, if one draws an arbitrary hypothesis from the set $H_{n,}$ what justification is offered for supposing that a correct a priori probability distribution has been apprehended for such a hypothesis? But an even more crucial question is how can the finite human mind account for the entire set of a prioris that correspond to the infinite set H_n? It is clear that we run into a significant problem with the epistemic commitments of OC. Consider a finite set of a priori prior probability distributions

$$\sum_{i=m}^{n} x_{\mathrm{i}}$$

in which n is the final finite value of a priori prior probabilities available, x is any variable of the set at any given time and m is the degree to which each x differs from other x's. At the end of the summation of the set of finite a priori probabilities available to the human mind there still exists a possible set of a priori probability values that are not capable of being comprehended by the finite human mind.

Now consider a set of infinite hypotheses

$$\sum_{i=m}^{\infty} x_{\mathrm{i}}$$

At some point, the hypotheses extend beyond the summation of the prior probabilities that are capable of being comprehended by the finite mind. Thus we are left with a subjective judgment as to the correspondence between an a priori prior probability distribution, p, and any arbitrary hypothesis, H. Perhaps p corresponds to H, but it is not necessarily the case that one could know this. And if p does not correspond to H, then OC is useless for determining any sort of conditionalization because the "correct a priori probability distribution" has not been apprehended. Based on the above epistemic problems, any attribution of p to H becomes arbitrary and thus OC is reduced back to a subjective formulation based on SC. Therefore an appeal to epistemic privilege is not tenable and offers no support for the development of an epistemic criterion for an a priori probability distribution.

A difficulty that arises in an attempt to formulate a criterion of determination apart from an appeal to epistemic privilege is the mind's inability to definitively differentiate between beliefs formulated on the basis of experience and those based on reference to other beliefs in a reliable manner. It is often simple to determine those beliefs based purely on experience. Sense data is perceived and a belief is formed about the perception presented to the perceiver and these perceptions justify the formation of the

belief. My belief that the chair is black is not a result of any prior belief but rather simply a belief in response to the apprehension of the chairs sense data. To determine a belief founded simply on another belief, however, is another matter. Given two beliefs X and Y, in which X is formed empirically and Y is formed on the basis of other beliefs, it is difficult to determine the origin of Y due to the fact that the experience of the foundational beliefs is regarded. Thus, any appeal to a strictly internal belief is difficult to justify with the lack of a mental criterion of determination. A good illustration of this tension is found in Weisberg's example of Joel on the train.[25]

In Weisberg's example the reader is presented with the following situation. Joel is traveling by train and must arrive at the Montauk station precisely at four, where his good friend Clementine will receive him. Clementine will not wait a minute past four, however, and Joel's train leaves at three. The question posed is "how confident should Joel be that he will arrive at 4 o'clock?"[26] A proposed answer to this question takes the form of the Principle of Indifference (PI). Since PI posits that any individual possibility taken from an infinite set of possibilities is equally likely a priori, each possible prior is given a probability of 1/n.[27] The question is which a priori probability should be preferred

25. Weisberg, "Locating IBE," 140.

26. Ibid., 140.

27. Ibid., 140.

if each is equiprobable? Well, Joel may take into account the speed of the train, the distance traveled, etc. to place parameters from which to determine the preferred a priori probability distribution.

However, both PI and an appeal to experiential factors present problems. First of all, Weisberg admits that there are an infinite number of possible parameters capable of being set by Joel.[28] Since this is the case, then any subset of parameter's Joel chooses to place on his probability distribution appears to be unjustified; which offers no aid in the determination of the *correct* a priori probability distribution. A solution to this problem would be for Joel to apply empirical data, such as the speed of the train and the distance traveled, in order to inform his choice of parameters as Weisberg has suggested.[29] But this leads to the second problem. If Joel utilizes empirical data in setting his parameters, then the belief is justified a posteriori rather than a priori. There must be some internal a priori beliefs present in the assignment of parameters if Weisberg's contention is to be supported. Yet, if Joel contends that his parameters have been justified on the basis of previous beliefs (which does not adhere to what Weisberg's OC seems to be advocating) or no beliefs at all then the problem of uncertainty arises. As was mentioned above, there

28. Ibid., 140.

29. Ibid., 140.

is no epistemic criterion for differentiating between these externally justified and internally justified beliefs. Therefore, it appears that to avoid the problem of differentiation Joel must set his parameters devoid of external justification if an internal a priori is to be ascertained. Yet, this results in the problem of underdetermination due to the equiprobability of an infinite number of a prioris and the inability of experience to inform the decision in any manner.[30]

Consider another example, this one a bit more scientific. Suppose Martin performs anew the double-slit experiment misinterpreted by De Broglie. Given Heisenberg's Uncertainty Principle, it is highly unlikely that Martin will be able to predict the location of the particle's impact on the screen in each instance. Now suppose he proposes a hypothesis stating that, "particle X will hit location Y on the screen at time T_1." Martin is then confronted with an infinite number of equiprobable distributions indicating where the particle might hit the screen. Since there is no a priori criterion for distinguishing between the infinite probability distributions, Martin must assign a value of 1/n to each distribution, making none more likely than the next. This is quite uninformative and Martin can in no way suppose that he has hit upon the appropriate prior probability distribution corresponding to his hypothesis. Now suppose that Martin

30. This includes the experience of the foundational beliefs as was indicated above.

decides to take into account the fact that the photon hitting the central region has an exponentially higher probability rating than the surrounding locations on the screen based upon prior experimental data. Martin now has sufficient a posteriori justification for setting his prior probability. Thus, Martin must either decide on an a posteriori prior probability distribution or resign himself to the underdetermined probability distributions offered by PI.

Biological theorizing also runs into the same problem. Suppose it were possible to accurately model the evolutionary process in a controlled laboratory setting and suppose Russell is attempting to determine the probability distribution accorded to the next random genetic variation. Since indeed the variations are considered to be random, there is no good reason for him to prefer one probability distribution to another for any genetic variation available (which is also practically infinite). Thus any probability distribution attributed to the genetic variation must be 1/n. If Russell wishes to narrow the set of possible probability distributions perhaps he observes the trend in the genetic variations that occurred prior to his experiment. Yet again, however, the observation is an appeal to experimental factors and thus the resulting preference of probability distributions is a posteriori.

For a more colloquial example exempt from the high degree of seeming randomness, consider a local meteorologist. Immediately when she awakens in the morning, she has no empirical evidence upon which to determine the probability of rain that day and thus cannot prefer one distribution to another from the set of infinite distributions present. Upon a reading of the Doppler radar and a glance out the window, she is now justified a posteriori in applying parameters to inform her attribution of a probability distribution to the chance of rain; and the chance of rain is certainly not random. Thus, PI constrains the attribution of probability even in cases that are not random but are nevertheless epistemologically underdetermined. Hopefully it is apparent to the reader through the above situations that any appeal to PI must ultimately rely on external justification in order to determine any preference of one probability distribution over another, which undermines the very nature of PI.

In sum, Weisberg's OC fails to provide us with the appropriate criteria which it demands of itself. The lack of a universally necessary notion of analyticity undermines the appeal to a priori prior probabilities. Further, the epistemic problems presented by the question of privilege and belief differentiation provides a challenge to OC that it fails to meet. PI offers no solution and any appeal to experience results in the epistemic problem of differentiation and undermines OC entirely. If a formulation of OC is to be tenable, a

revision is needed in which the unwarranted appeal to the a priori is removed and a criterion of probability determination is clearly defined in order to meet the epistemic demands of the above problems.

Quantitative Difficulties Concerning A Priori Probability Distributions

Since we have seen the difficulties in utilizing an a priori prior probability in Bayesian conditionalization, it would be useful to see the outcome of these difficulties on the assigning of quantitative values to the variables in the OC equation. One major problem in the process of quantitative valuation is the criterion OC utilizes for attributing numerical values to the subsequent evidence, E. SC makes no claim to established objectivity in providing numerical values for E. Since what is being measured is the posterior degree of belief in the proposed hypothesis, the cognizer can easily apply a subjective value to E. An opponent of the validity of this numerical substitution might argue that since this assignment of a value is purely subjective it is simply uninformative. But if the user of SC is a rational agent, which I propose she is, then her assignment of value to E will not be completely arbitrary. Consider two scientists using SC to confirm a hypothesis. If scientist 1 attributes .8 to E and scientist 2 attributes .75 to E, then the difference in posterior probability is negligible. Why? Because SC does not reference a standard variable as OC does. What we are looking for in SC is the conditionalization of

H based on the new evidence E. If both scientists' degree of belief in the hypothesis reasonably increases based on E, then the degree of confirmation offered is substantial.[31]

This method of quantitative assignment, however, becomes a problem for the objective Bayesian. According to OC, one's attribution of confirmation for any given hypothesis should be p(H | E). Since on the OC model the range of values of p is already assumed given a priori, the quantitative value of E is what remains. But how would one go about obtaining this value? If one arbitrarily assigns a value to E, then OC is violated. If, however, one is certain of an objective value that corresponds to E, then we are back in the same epistemic mess we started with. If there is an objective corresponding range of values to E, and these values are taken to be universal, then it must be known a priori. But since E is an empirical discovery taken to explain H, then how could E be a priori? And if E is not a priori, how can one be certain that the correct value has been attributed to E? Any attribution of a quantitative value to E is going to be subjective because evidence does not come with a number range attached to it. Since E must inevitably be

31. I am not here stipulating that every instance of conditionalization will be conducted bias free; the example given above of the De Broglie problem evidences that this is not the case. Rather, I am suggesting that more often than not, the conditionalization is conducted by rational agents seeking to confirm or disconfirm the hypothesis in a scientifically honest fashion and the results I have outlined follow from such conduct.

subjective, OC's formulation of the oughtness of p(H | E) defeats itself in its insistence upon a universally recognized range of numerical values for E.

Since the majority of the paper has been focused on showing the difficulties involved in the notion of an a priori prior, the difficulties concerning the quantitative calculations of such priors must also be explicated.

Let us consider an example that takes into effect the notion of quantitative objective probability from a scientific standpoint. Tim Maudlin provides the example of the radioactive decay of Tritium atoms over time.[32] According to Lucas and Untwenger the average half-life of a tritium atom is 4499 days.[33] Maudlin attributes to this what he calls a "fixed probability density." From this probability density we are able to calculate the probabilities of decay for any number of tritium atoms. In fact, given sufficient data, we can input the data into a stochastic equation:

$$\frac{\sum w_i(x_i - m)^2}{v} = \frac{x^2}{v} = R^2.$$ [34]

32. Tim Maudlin, "What Could Be Objective About Probabilities," *Studies in the History and Philosophy of Modern Physics* 38 (2007): 276-277.

33. L. Lucas, and M. Unterweger, "Comprehensive Review and Critical Evaluation of the Half-Life of Tritium," *Journal of Research of the National Institute of Standards and Technology* 105, no. 4 (2000): 542.

34. Ibid., 545.

Now, if we translate this example from a statistical probability framework to a Bayesian probability framework the notion of objective probability takes on a new sense. Rather than corresponding to a set stochastic probability density, which can be calculated differentially, the conditionalized probability obtains quantitative value by measuring degrees of confidence or belief in a given proposition H. On a subjective interpretation of Bayesian conditionalization, the prior probability takes into account sufficient background evidence, which would include the statistical frequency associated with the half-life of tritium.[35] However as was mentioned above, on Weisberg's formulation of an objective interpretation, this background evidence cannot be taken into account.[36] I think it would be a false statement to claim that objective Bayesians couldn't take into account background evidence in their calculations of priors. However, if the objective Bayesian asserts an a priori prior probability distribution, then this background evidence must be disregarded; and it is by no means clear how one could formulate a prior degree of confidence in a proposition such as "the half-life of tritium is 4499 days" without an external justification and thus an a posteriori prior probability. Since this is the case, then

35. The subjective formulation would utilize a Bayesian formula such as this: p(H | E&B) = [p(E | H&B) x p(H | B)] / p(E | B).

36. The objective formulation of Bayes theorem would be formulated thus: p(H | E) = [p(E | H) x p(H)] / p(E).

it is again by no means clear how one would calculate and assign a quantitative value to such an a priori probability. Even more of a detriment to such a notion is Weisberg's addition of the qualification "correct" to his a priori probabilities. Any attempt to assign quantitative value to such an a priori is epistemologically underdetermined and thus entirely unreliable for a foundation of conditionalization.

Problems of the Ontological Grounding of Objective Prior Probabilities in Propositions

There are two further problems with our epistemic access to a priori prior probabilities. Let's assume that these probabilities take the form of a proposition. Then, the proposition must either have a positive or negative truth-value. But as has been stated, we are in no epistemic position to adjudicate between one prior probability proposition and any other prior probability proposition. Perhaps it is possible to develop a range of possibilities; say between .15 and .65. But this still offers us no access to the truth-value of the propositions corresponding to each prior probability. Shortening the range of possibilities either does not solve the problem.

But suppose that we could know the truth-value of a give probability proposition, say "the prior probability of H is .47"; and suppose this proposition happens to be true. The underdetermination of hypotheses presents a problem for this yet again. Suppose the same hypothesis is taken, but a minor modification is made to the hypothesis such that it

becomes H+x. However, in adding the modification x to H, we can no longer use the truth-value of the above proposition because the hypothesis is no longer the same, even though H+x is incredibility similar to H. Suppose now, instead of the above proposition being true a different proposition is true about H+x, say "the prior probability of H+x is .57." Perhaps again we may be able to determine the truth-value of this new proposition. But, there are a seemingly infinite number of possible modifications, n, that could alter the prior probability in an infinite number of ways. This presents an epistemic quandary yet again. If the addition of any n to H is made, it seems quite impossible (or exponentially unlikely) to determine which prior probability proposition would correspond to the newly modified H+n. But in order for a priori priors to be objective they must be ontologically grounded in something, such as a proposition, and we need access to the probability proposition corresponding to any arbitrary hypothesis in order to make any conditionalization upon the evidence. Thus, this seems to be a possible defeater for objective prior probabilities.

Concluding Remarks

Any attempt to formulate an objectivist account of Bayesian conditionalization is inevitably going to meet a variety of epistemic difficulties. If the objective Bayesian is going to appeal to the a priori, then a criterion of differentiation of the a priori probability

distributions is necessary. The Principle of Indifference offers the objective Bayesian no help, for as Elliot Sober remarks, "there is no unique way to translate ignorance into an assignment of priors."[37] But what is also needed is a concise and universal conception of the analytic or any appeal to the a priori by the objectivist Bayesian will meet such difficulties. I am not asserting a claim so bold as to say that objective Bayesian conditionalization is out of the question. But, objective Bayesian conditionalization, formulated with an appeal to a priori probability distributions does not meet the epistemic demands placed upon it. If objective Bayesianism is going to be a viable option for theory confirmation, it must be formulated apart from an appeal to the a priori and must appeal to different criteria for formulating objective prior probabilities upon which to base conditionalization.

37. Richard Swinburne and Elliot Sober, "Bayesianism - its Scope and Limits." In *Bayes's Theorem*, (Oxford: Published for the British Academy by Oxford University Press 2002), 21-28.

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