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BAYESIANISM AND THE INFERENTIAL SOLUTION TO HUME'S PROBLEM

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Introduction

In the second half of the twentieth century, many Bayesians began to hold that they had a solution to the problem of induction, in a rule of inference known as *conditionalisation*. The classic defence of this view appears in Colin Howson's *Hume's Problem: Induction and the Justification of Belief* (2000). The problem of induction, Howson claims, is that of "characterising soundness for inductive inferences" (2–3); and Bayesianism, by "supplying the logic of consistent reasoning" (121), or "supply[ing] a model of inductive reasoning" (173), "solve[s] Hume's problem" (239). Howson's book represents the culmination of decades of Bayesian thought, the statement of a view long espoused in Bayesian circles. Thus almost four decades prior, Ian Hacking, in an overview of Bayesian ideas, had written:

> The subjective theory on probability seems to solve the main problem about induction. That is, it both analyses the inferences which intelligent people draw from experience, and offers excellent reasons for thinking that those inferences are sound. (1966: 334)

Leonard Savage had claimed that Bayesianism "contain[s] a model of how opinion is modified in the light of experience—a phenomenon of vast importance—which some might call induction" (1967a: 307). And Jon Dorling had written that

> The practical problem of induction is that of how to modify pre-existing expectations about the future in the light of incoming evidence. ... The Bayesians claim to have found such a recipe in Bayesian conditionalisation. (1981: 109)

So by the time Howson writes *Hume's Problem*, the view that he defends has been on Bayesians' minds for decades; but although mentions of it are, as we've just seen, commonplace, the view itself is to my knowledge not worked out anywhere in print. For Howson to elaborate on this widely held instinct is therefore a significant event, and

his text becomes the reference work for the view. Michael Strevens, in a discussion of Howson's book, writes that "it is standard to interpret [Bayesianism] as being a kind of inductive logic" (2004: 366). And Jan-Willem Romeijn defends a "logical solution to the problem of induction", which he calls "very much in line" with Howson's, on which Bayesianism supplies a logic which "generates predictions from the assumptions and observations together" (2004: 360).

Howson's idea is seductive: it promises a simple and elegant answer—conditionalisation!—to a vexing problem. But despite its ubiquity and striking potential, the idea has not been worked out in serious detail, not even by Howson himself. In order to turn this tempting idea into a fully fleshed account of inductive reasoning, I turn to Howson's historical sources. He claims that his view is a mere "elaboration of those of other people, and of two in particular: Hume and Ramsey" (2000: 3). I follow these threads, and use them to reconstruct an interpretation of the problem of induction, from Howson's sketch. Although I give substance to some of Howson's remarks by drawing on his historical sources, the resulting picture is resolutely new: it stands at odds with the views that both Hume and Ramsey (and indeed, Peirce, who turns out to be important) have on induction; in fact, it goes beyond what Howson himself claims.

Howson gives us several thoughts to work with: that the problem of induction concerns inductive inferences rather than their products (§1); that inductive inferences are non-ampliative, just like deductive ones (§2); that the premises of inductive inferences need not themselves be justified (§3); and that a logic of inductive inference takes priors as its premises and posteriors as its conclusion (§4). By following Howson's nods to his historical forebears, I knead and develop each of these thoughts until a picture of conditionalisation as a solution to the problem of induction emerges. Unfortunately, once the account Howson had gestured at is fully constructed, it becomes apparent that conditionalisation cannot be a solution to the problem of induction, by the account's own lights. This is because it relies on the contention, widespread amongst Bayesians, that a justification of conditionalisation as an updating rule can be given independently from a justification of priors; a contention which I show does not hold (§5). This forces us to choose between conditionalisation (and thus, orthodox Bayesianism) and the picture of induction that Howson's book intimates (§6).

Much of this paper (§§1–4) consists in the reconstruction of Howson's view in historical context. The reader who prefers to skip over the historical material and dive directly into the presentation and evaluation of Howson's view is welcome to skip to the Recapitulative Interlude prior to §5.

1. The Inferential Approach to Induction

Howson's first move is to adopt what I shall call an *inferential approach* to the problem of induction.[1] He writes:

> We are already familiar with and accept the idea that deductive soundness is a property of inferences and not their conclusions; ... the correct analysis of Hume's problem, and Hume's own view of inductive reasoning, forces us to view inductive soundness in the same way, a property of inferences rather than of what we conclude from them. (2000: 2)

The primary object of study when it comes to induction, on this approach, is inference.

The idea that inference ought to be the induction theorist's main focus is one that has been defended outside of Bayesian circles,[2] but

1. There is no obvious connection between the inferential approach to induction (the view that the problem of induction concerns inductive inferences rather than their products) and semantic inferentialism (the view that the meaning of a word, sentence, or concept is determined by the role it plays in inference rather than what it refers to).
2. See e.g. Nelson Goodman: "The genuine problem cannot be one of attaining unattainable knowledge or of accounting for knowledge that we do not in fact have. A better understanding of our problem can be gained by looking for a moment at what is involved in justifying non-inductive inferences. How do we justify a *de*duction? Plainly, by showing that it conforms to the general rules of deductive inference. ... Analogously, the basic task in

Bayesians have perhaps been the ultimate champions of this approach. As Hacking writes in his overview work *An Introduction to Probability and Inductive Logic*:

> The Bayesian says to Hume: ... The question is not whether [our] opinions are 'rational'. The question is whether we are reasonable in modifying these opinions in light of new experience, new evidence. (2001: 256)

Howson's assertion that what matters is not "what we conclude from" (2000: 2) inductive inferences and Hacking's claim that "the question is not whether [our] opinions are rational" (2001: 256) both elucidate what the inferential approach to the problem of induction does: it shifts the emphasis from the *result* of induction to its *process*—from the rationality, justifiability, or knowledge-status of various beliefs, to the procedures that generate them. Thus the inferential approach is best understood by contrast to what we might call the *doxastic approach* to induction, on which the primary inductive anxiety concerns the epistemic justification of beliefs one has about the unobserved. For instance, David Johnson proposes the following statement of the problem of induction, which is characteristic of the doxastic approach: "If we are to have beliefs about the unobserved, what ought we to believe? Should we expect the next emerald we examine to be green, or [bl]ue?" (1991: 399). These are questions Howson refuses to entertain.

Confusingly, many Bayesian proponents of the inferential approach have adopted the doxastic approach in other work. For instance, Savage, who I cited above describing induction as "how opinion is modified in the light of experience" (1967a: 307)—an inferential question—also maintains that "the riddle of induction can be put thus: What rational basis is there for any of our beliefs about the unobserved?" (1967b: 602)—a resolutely doxastic one. Even Howson himself, in his collaboration with Peter Urbach, writes that he wants "reasonable confidence in [scientific] theories" (2006: 1) from induction. It isn't surprising that the two approaches have been considered in such close proximity to one another, indeed even sometimes amalgamated, since the inferential approach seems in some sense subordinate to the doxastic approach: presumably, it is because we want to know what to believe about the unobserved that we care about the inferences that lead us there. But in *Hume's Problem*, Howson is adamant that the two approaches must be kept separate: what we might call his *gambit* is to insist on "*divorcing* the justification for inductive reasoning from the justification of its consequences" (2000: 239, emphasis added).

Howson claims that the adoption of a strictly inferential approach is faithful to Hume, that it is "Hume's own view of inductive reasoning" (2000: 2), and according to Hume's *descriptivist* interpreters (Garrett 1997, 1998, 2014; Owen 1999), he is right.[3] Hume studies what he calls "probable reasoning" (T 1.3.6.6) in the *Treatise of Human Nature* and "reasonings concerning matters of fact" (EU 4.4) in the *Enquiry Concerning Human Understanding*. These are inferences from the observed to the unobserved—from "those objects, of which we have had experience, [to] those which lie beyond the reach of our discovery" (T 1.3.6.11), or from "the present testimony of our sense or the records of our memory" to what lies "beyond" them (EU 4.3). They constitute a "step or progress of the mind ... one proposition is an inference from the other" (EU 4.21). This inference or "process of argument", he writes, "wants to be explained"; or again, he wants to "learn the foundation of this inference", its "logic" (EU 4.21).

justifying an inductive inference is to show that it conforms to the general rules of *in*duction." (1983: 63)

3. The descriptivist approach is also defended by Broughton (1983) and Allison (2008). It stands in opposition to the more classical normativist interpretation of Hume's work, according to which Hume's concern is that of whether and how our epistemic attitudes towards the unobserved are justified. The normativist interpretation, in the lineage of Russell (1912), was broadly accepted throughout the twentieth century (Stove 1973, Stroud 1977), and is defended by contemporary Hume scholars such as Winkler (1999), Millican (2002), Loeb (2002), and Qu (2020). Howson could clearly not be drawing on the normativist Hume, who asks after the justification of our beliefs—that would stand in tension with his adoption of the inferential approach. Hence my focus here on the descriptivist Hume.

According to descriptivists, Hume's overarching philosophical project is what he describes in the *Enquiry* as that of producing a "mental geography, a delineation of the distinct parts and powers of the mind" (EU 1.13). In both the *Treatise* and the *Enquiry*, he is concerned with mapping out the contents of the mind and the mental operations performed on these, by the various faculties whose "secret springs and principles" (EU 3.9) he seeks to expose. Thus he proposes a "science of human nature" (EU 1.1), one that seeks to "know the different operations of the mind, to separate them from each other, [and] to class them under their proper heads" (EU 1.13). Induction is one of these operations. It follows that when Hume wonders what the "foundation" of this operation is or which "medium ... join[s] propositions so very wide of each other" (EU 4.21), he wants to know which faculty performs the inductive operation, or drives this "step taken by the mind" (EU 5.2). And his answer is that "this transition of thought ... proceeds not from reason" (EU 5.20), but from "CUSTOM or HABIT" (EU 5.5); or again, that "all inferences from experience ... are effects of custom, not of reasoning" (EU 5.5).

Since the descriptivist Hume seeks to discover which of the faculties performs inductive inferences, it is hardly surprising that he adopts an inferential approach: where the normative status of various beliefs about the unobserved simply do not concern him, inductive inferences obviously do. This might have helped us understand Howson's strict separation of the inferential and the doxastic approaches to induction: if, like the descriptivist Hume, Howson was interested in giving a cognitive science of induction, his unqualified focus on inferences would make sense. But Howson's project, regardless of what he explicitly claims, is not a mere "elaboration" (2000: 3) of Hume's. He does not care about the means, understood as human faculties, by which inductive inferences are drawn. Instead, he wants to know where to reason to: what to inductively infer. This is why he seeks a "logic" (2000: 239) of inductive inference, why he wants to "characterise soundness" (3) for it. Some inductive inferences, according to him, are sound, and some are not. The question he is concerned with, and to which he thinks Bayesianism provides an answer, is that of which are "demonstrably sound" (2). Thus, unlike the descriptivist Hume, Howson is interested in the *normative* features of inductive inference.

In light of this, Howson's gambit, his driving a sharp wedge between the inferential and doxastic approaches to induction, is very striking. For if he seeks to establish which inference one ought to draw (a normative question about inferences), he will presumably thereby establish what one ought to conclude (a normative question about beliefs). But he is adamant that he wants to do the former without the latter: that he can "divorc[e] the justification for inductive reasoning from the justification of its consequences" (2000: 239). Howson's sharp separation of the inferential and doxastic approaches to induction is therefore much harder to make sense of than the descriptivist Hume's.

2. Inductive Inferences as Non-Ampliative

To render Howson's gambit intelligible, we will first need to understand how he thinks of inductive inference. Proponents of the inferential approach to induction suggest that progress can be made by considering inductive inferences in parallel to deductive ones: as we saw in the previous section, Howson asserts that both should be "viewed in the same way" (2000: 2). This parallel is encoded in much of contemporary philosophy, where deduction and induction are often presented as different "types" or "kinds" of inference. The idea, endorsed by Howson, is that these inferences should be interpreted through the lens of the three-part schema of premises, rules of inference, and conclusions. To supply a "logic" is to determine the correct rules of inference for deriving conclusions from premises.

Historically, the hope was that probability theory could supply a rule that would govern the inference from premises encoding the beliefs one has about the observed (that is, one's evidence), to a conclusion encoding the partial beliefs one ought to have about the unobserved. This view is best theorised by and most often associated with John Maynard Keynes. He writes:

> Given the body of direct knowledge which constitutes our ultimate premisses, [probability] theory tells us what further rational beliefs, certain or probable, can be derived by valid argument from our direct knowledge. (1921: 3)

Keynes's theory retains much from Hume: where Hume, as we have seen, takes inductive inferences to proceed from "those objects, of which we have had experience, [to] those which lie beyond the reach of our discovery" (T 1.3.6.11), Keynes takes it to proceed from our "direct knowledge" to "further rational beliefs" (3). In both cases, inductive inference is inference from what we know about the observed to what we believe about the unobserved. The main difference is that Keynes allows for the beliefs which feature in the conclusion to be "probable" or *partial* rather than "certain" (3). This is intended to express the fact that, although our evidence cannot ever warrant certainty about empirical unobserved facts, it can warrant particular partial beliefs about them.

Understood the Keynesian way, probability theory is a *logic of evidential support*: it specifies the degree to which a certain body of evidence supports or confirms a conclusion, and therefore, the degree to which one ought to believe the conclusion provided one possesses the evidence. In Keynes's words, it gives "the various degrees of rational belief about a proposition which different amounts of knowledge authorise us to entertain" (1921: 2). Probability theory can do this, according to Keynes, because it encodes "*purely logical* relations between the propositions which embody our direct knowledge and the propositions about which we seek indirect knowledge" (1921: 3, emphasis added). These "objective and logical" (3) relations are crucial to Keynes's account because they are what "entitle us to probable beliefs" (3). So it is, according to him, because there is a logical relation of a certain specific degree between any two sets of proportions, that we are "entitled" (3) to form partial beliefs of a particular degree about one set provided we know the other set.

Bayesianism is best understood as a complete rejection, in the lineage of Frank P. Ramsey, of this idea. Ramsey's "fundamental" criticism of Keynes's view "is the obvious one that there really do not seem to be any such things as the probability relations he describes" (TP 57): "I do not see what these inconclusive logical relations can be" (81). He explains that the logical relation "which justifies [deductive] inference is that the sense or import of the conclusion is contained in that of the premisses" (82). But it is "absurd", he writes, to conceive of inductive inferences in such a way that "the sense of the conclusion is partially contained in that of the premises" (82). It follows that, if there is a parallel between deductive and inductive inferences, it cannot be the one intimated by Keynes. Probability theory cannot supply a logic of induction that takes one from fully believed premises about the observed to a partially believed conclusion about the unobserved. It is, as Ramsey claims, "impossible to represent [an inductive argument] as resembling a deductive argument and merely weaker in degree" (82).

Instead, Howson proposes another way to make sense of the idea that probability can constitute a logic of inductive inference. He writes that inductive inference is "non-ampliative" (2000: 134), which is to say that the conclusion of an inductive inference does not have greater semantic content than its premises. This is extremely striking, for inductive inference is often defined precisely in terms of its ampliativeness. But this is the way, according to Howson, in which inductive inference resembles deductive inference: they are both governed by non-ampliative rules of inference, which take synthetic judgments as both premises and conclusion:

> Inductive reasoning is justified to the extent that it is sound, given appropriate premises. ... Like sound deductive arguments, [inductive arguments] don't give you something for nothing: you must put synthetic judgments in to get synthetic judgments out. (239)

Or again, just like with deductive logic, "whose failure to deliver categorical assertions we are familiar and even happy with",

> ... a successful theory of credibility should not be strong enough to make ... categorical assumptions without equally strong assumptions. (171)

Just like we do not expect deductive inferences to yield a "categorical assertion" but a "conditional statement" (171–172)—so too we must expect a conditional statement and not a categorical assertion from a sound inductive inference.

Immediately after stating that a logic of inductive inference cannot be ampliative, Howson cites Ramsey's essay "Truth and Probability" in a way that's meant to be elucidating of the idea he's just expressed:

> As Ramsey, emphasising the similarly conditional nature of probabilistic inferences, clearly puts it: 'This is simply *bringing probability into line with ordinary formal logic*, which does not criticise premisses but merely declares that certain conclusions are the only ones consistent with them'. (2000: 171–2, emphasis added)

Following this lead will be illuminating as to what conception of inductive inference Howson can possibly be working with. But this specific citation is an odd part of Ramsey's corpus to draw from. Indeed, just a few pages before, Ramsey writes:

> We can divide arguments in *two radically different kinds*, which we can distinguish in the words of Peirce as (1) 'explicative, analytic, or deductive' and (2) 'ampliative, synthetic, or (loosely speaking) inductive'. (TP 82, emphasis added)

This seems puzzling. Why is Ramsey both saying that probability is "in line" with ordinary formal logic, and following Charles Sanders Peirce in stating that induction and deduction are "radically different"?

Ramsey's essay turns on the Peircean distinction between two types of logic:[4]

> Logic must ... fall very definitely into two parts: ... we have the lesser logic, which is the *logic of consistency*, or formal logic; and the larger logic, which is the *logic of discovery*, or inductive logic. (82, emphases added)

The *logic of consistency* is "concerned simply to ensure that our beliefs are not self-contradictory" (87). This is a synchronic, formal notion. But it is, Ramsey says, "obviously not enough; we want our beliefs to be consistent not merely with one another but also with the facts" (87). This is given, not by the logic of consistency, but by what he calls the "*logic of discovery*" (82) or indeed the "human logic, or logic of truth, which tells men how they should think" (87). This logic of truth governs the diachronic processes of "argument and inference" (81), and it is "not ... reducible to formal logic" (89).

But, he writes,

> What we have now to observe is that this distinction *in no way coincides* with the distinction between certain and partial beliefs; [...] there is a theory of consistency in partial belief just as much as of consistency in certain beliefs. (82, emphasis added)

We are now in a position to make sense of the passage Howson points to, in which Ramsey claims to bring "probability into line with ordinary formal logic" (2000: 189). The main goal that Ramsey sets himself in "Truth and Probability", and indeed what has been remembered as its most significant achievement, is the demonstration that the axioms of probability give a "theory of consistency in partial beliefs" (TP 82). He shows, by means of a representation theorem that prefigures Savage's (1954),[5] that "the laws of probability are laws of consistency [for] partial beliefs", that they "distinguish those sets of [partial] beliefs which obey them as consistent ones" (78). This is where Ramsey draws the parallel between probability and formal logic. Just like ordinary formal logic is a logic of consistency for full beliefs, probability is

4. See Misak (2016) for a superb analysis of Peirce's work and influence on Ramsey. She discusses this passage and its roots in Peirce in 179–81.

5. See Bradley (2004) for a detailed treatment.

a logic of consistency for partial ones. As he says, "the laws of probability are laws of consistency, an *extension* to partial beliefs of formal logic, the logic of consistency" (78, emphasis added), or again, "the theory of probability is ... a *generalisation* of formal logic" (82, emphasis added). So, the "probability" that Ramsey brings "into line with ordinary formal logic" in the quote to which Howson refers are the synchronic norms of consistency encoded in what is now known as *probabilism*.

But inductive logic concerns, to use the words Ramsey borrows from Peirce, not "consistency" but "discovery" (TP 82). Thus if Bayesianism is going, as Howson argues it does, to "supply a model of inductive reasoning" (173), it will have to specify how to make one's thoughts "consistent ... with the facts" (Ramsey TP 87). And it does contain a rule for, as some of the Bayesians cited above put it, "how opinion is modified in the light of experience" (Savage 1967a: 307), or "how to modify preexisting expectations about the future in the light of incoming evidence" (Dorling 1981: 109), or how to "modify [our] opinions in light of new experience, new evidence" (Hacking 2001: 256): a diachronic rule known as *conditionalisation*. Thus, where probabilism is a logic of consistency for partial beliefs, conditionalisation might be interpreted as a logic of discovery for them.[6]

	Logic of consistency (Deduction)	**Logic of discovery** (Induction)
Full Beliefs	Classical Logic	—
Partial Beliefs	Probabilism	Conditionalisation

Conditionalisation, on this account, is a logic of induction in the sense that it specifies, how, upon encountering new evidence, "initial assignments of positive probability" or *priors*, which are considered "premises" of inductive inferences (Howson 2000: 239), ought to be amended so as to yield new probability distributions, or *posteriors*, which are considered conclusions or "consequences" (239) of these inferences. It constitutes a rule of inference for how to modify one's partial beliefs in the face of new evidence.

3. Against Pedigree Epistemology

Ramsey discusses conditionalisation as a candidate inductive logic, or logic of discovery, or "logic of truth" (TP 86). He speaks of the fact that it is "frequently credited with [the] power" to "lead to truth" (88). But, he points out, in order for the partial beliefs yielded by conditionalisation to be justified, "the corresponding initial degrees of belief [must themselves be] justified" (88). And to ask whether these prior probabilities are justified is, just like with Keynes's logical probabilities, "a meaningless question, and even if it had a meaning [he does] not see how it could be answered" (88). Ramsey therefore dismisses the view later endorsed by many Bayesians and defended by Howson, that conditionalisation could be an inductive logic, and thus, a solution to the problem of induction.

Ramsey's objection is widespread among Bayesians, especially more contemporary ones. Thus Samir Okasha writes:

> Requiring an agent to update her probability function by conditionalising on new evidence only determines her posterior probability function given her prior probability function, and Bayesian theory is silent on what the latter should be, beyond demanding that it be coherent. ... So the positive response to Hume ... looks simply unavailable to the Bayesian. (2005: 184)

Or, as Marc Lange puts it:

> Suppose it could be shown ... that rationality obliges us to update our opinions by conditionalisation. ... Such an argument would still be far from a justification of induction. ... All depends

6. This raises the question of whether there exists an inductive logic, or logic of discovery, for full beliefs. The Bayesian position on this question must be that there isn't. For full belief, according to the classical Bayesian, corresponds to certainty, and it is widely accepted that certainty can never be achieved about the unobserved.

> on the prior probabilities plugged into Bayesian conditionalisation along with our observations. So in order to explain why we must reason inductively, ... the rationality of Bayesian conditionalisation would have to be supplemented with some constraints on acceptable priors. (2011: 80)

The idea shared by all these philosophers is that conditionalisation can only constitute a solution to the problem of induction if it provides a justification for the posteriors. And it can only yield justified posteriors provided it is fed justified priors. It follows that conditionalisation is, at best, a *partial* solution to the problem of induction, and at worst, no help at all—for it is widely accepted that the problem of justifying the priors does not admit a solution.

This analysis betrays an attachment to the doxastic approach to the problem of induction. Indeed, all these philosophers seek, as a solution to the problem of induction, a justification for the partial beliefs one ought to have in light of one's experiences. Ramsey, for instance, says explicitly just before his discussion of conditionalisation that he is concerned with "what [men] ought to believe, or what it would be reasonable to believe" (TP 89). But Howson is adamant, as we have already seen, that the problem of induction should be approached inferentially: what matters to him are "inferences *rather than* ... what we conclude from them" (2000: 2, emphasis added). He is well aware that conditionalisation does not output "categorical assertions" (171). What he wants, by analogy with deduction, is "conditional" statements (172).

The analogy is surprising because, unlike deduction which "does not increase our knowledge, but only brings out clearly what we already know in another form" (Ramsey TP 81), or which "is merely a method of arranging our knowledge" (82), induction amends what we believe. It is supposed to "tell men how they should think" (87), to ensure that "our beliefs [are] consistent not merely with one another but also with the facts" (87). To get a sense of how conditionalisation might achieve this goal, even if understood as a mere rule of inference whose premises are "not justified in any absolute sense" (Howson 2000: 239), I propose drawing from Peirce again (but this time, without Ramsey as an intermediary).

Peirce insists that inquiry proceeds, not from a normative void in which every belief we appeal to must be justified—a "study" which "begins with doubting everything!" (EP 1.115)—but from a particular place:

> There is but one state of mind from which you can 'set out', namely, the very state of mind in which you actually find yourself at the time you do 'set out'—a state in which you are laden with an immense mass of cognition already formed, of which you cannot divest yourself if you would. (EP 2.336)

Thus Peirce believes that "we cannot begin with complete doubt, [but] must begin with all the prejudices which we actually have" (EP 1.29).

If subjects cannot but proceed from the priors they happen to have, the doxastic approach to induction, that is, the general question of what they ought to believe, appears absurd. That question could only make sense in the presence of what Peirce calls "a real and living doubt" (EP 1.115), doubt which simply does not exist when Ramsey and the contemporary Bayesians cited above demand a justification for the priors they in fact have. Instead we must proceed from the beliefs that subjects do actually have, in which case the only astute question to ask is that of how they ought to modify or amend this mass of cognition as they progress through the world. Thus Peirce rejects what Isaac Levi calls *pedigree epistemology* (Levi 1980), on which the task of epistemologists is to supply justifications for already held beliefs. Instead, he is "a fan of the principle ... according to which there is no need to justify current beliefs, only changes in belief" (Levi 1998: 179).

This aspect of Peirce's approach allows us to give some substance to Howson's project.[7] Howson, we have seen, views inductive inference

7. It might be jarring to Peirce scholars that I am drawing on his work to produce an interpretation of Bayesianism. After all, Peirce notoriously rejected, with vehemence, all subjectivist interpretations of probability. But as Stewart and Sterkenburg (2022) show in an excellent paper, Peirce's rejection

as something in which "you must put synthetic judgments ... to get synthetic judgments out" (2000: 239): conditionalisation doesn't "give you something for nothing" (239), but it does tell you how to amend your beliefs as you experience new aspects of the world. Drawing on Peirce allows us to interpret Howson's project in such a way that this is not a weakness, as the proponents of the doxastic approach to induction would have it, but a strength, for it captures the fact that a subject never offers up all of their "mass of cognition" for evaluation. Thus induction consists, not in the justification of all of their beliefs about the unobserved from a doxastic void, but in the critical emendation of their cognitive world, in the light of new experience. As Peirce puts it: "in induction [one] simply surrenders [one]self to the force of facts" (CP 5.589).

We obtain an account of inductive inference that differs in a rather important sense from pre-Bayesian accounts. As we've already seen, Hume and Keynes both anchor inductive reasonings on premises that the subject endorses, in some thick sense: for Hume, they proceed from "the present testimony of our senses or the records of our memory" (EU 4.3), and for Keynes, they proceed from "our direct knowledge" (1921: 3). The Bayesians who adopt a doxastic approach follow Hume and Keynes in this respect: for them, a suitable inductive inference would be one based on priors which are justified. But I submit that the most fruitful way to read Howson and his gambit is as rejecting this pedigree requirement, in the lineage of Peirce. Inductive inference proceeds from the priors the subject simply happens to have, even if they are "prejudices" (Peirce EP 1.29), even if they are "not justified in any absolute sense" (Howson 2000: 239).

of subjectivist interpretations of probability is inconsistent with his resistance to pedigree epistemology. Since his non-pedigree epistemology plays such a central role in his overall outlook, his project might have had greater internal coherence (and possibly, reach, as Ramsey's extension of Peirce's insights to partial beliefs shows) had he not rejected subjectivist interpretations of probability. In any case, I am drawing from a part of Peirce's corpus that is rather independent from this rejection.

4. Induction as the Amendment of One's Worldview

We are now in a position to fully flesh out the account of human reasoning on empirical matters, that is, the interpretation of Bayesianism, that Howson's remarks hint to. The first thing to remark is that inductive inference does not proceed from one isolated set of beliefs to another. This contrasts with pre-Bayesian accounts like Hume's and Keynes's. Indeed, on Howson's account, inductive logic is given by conditionalisation, and conditionalisation does not take singular beliefs, nor restricted sets thereof, as input or output. Instead, at one proposition's prompt, it turns a prior, which is a probability function over all the propositions that the subject entertains, into a posterior, a whole new probability function over the same universe. These probability functions, which are both premises and conclusions of inductive inferences, range over the entire set of propositions the subject countenances: these probability functions constitute the subject's whole view of the world. On Howson's view therefore, inductive inference doesn't proceed from an observed particular to an unobserved one; it isn't local but *global*: in the course of induction, the subject's whole worldview is modified.

Moreover, the particular partial beliefs that, taken together, make up this worldview, are intimately linked to action. Although this is not something that Howson emphasises, it is a central part of both Ramsey's work and of the ensuing Bayesian tradition. For Ramsey, "it is evident that the importance of beliefs ... lies not in their intrinsic nature, but in their causal properties" (FP 44). This, as Cheryl Misak (2016: 18–21, 168–173) shows, can be traced directly to Peirce's influence, who writes that "every ... belief manifests itself in ... ways of acting" (CP 5. 510).[8] In fact, Jérôme Dokic and Pascal Engel (2003: 7) argue that it can even be traced back to Hume, who asserts that "as our reasoning

8. Misak insists that neither Peirce nor Ramsey take belief to be *reducible* to dispositions to act: for Peirce, belief "is something that we are aware of" (EP 1.129), it "is certainly something more than a mere feeling; yet there is a feeling of believing" (EP 1.158); and for Ramsey, belief often comes with "introspectable feelings" (TP 66).

varies, our actions receive a subsequent variation" (T 2.3.3.3), or that beliefs are "the governing principle of our actions" (EU 5.12) in that they enable us to "adjust means to ends" (EU 5.21).[9] In this lineage, Ramsey asserts that beliefs are connected to action in the sense that the degree with which a belief is held is measured by "the extent to which we are prepared to act on it" (TP 65), or again, by "how far we should act on these beliefs" (66).

This intimate connection between belief and action, which has continued to be a core aspect of the Bayesian tradition beyond Ramsey, illuminates the way we should conceive of induction following Howson. The probability functions which are amended by conditionalisation do not merely encode worldviews but also dispositions to act. It follows that inductive inferences amend not only the subject's view of the world but what we might call their *dispositional profile*; they change not simply how the subject conceives of empirical matters but what has often been characterised in Ramsey's words as "the map ... by which [the subject] steer[s]" (GPC 146). Moreover, this network of partial beliefs, or map, gives subjects their instructions not only for action, but also for making sense of and reacting to new experiences. It is the foil against which the subject acts, interprets, and reacts to new experiences, that is, it is the background from which they interact with the world. On the picture of human reasoning intimated by Howson's remark, then, we should understand induction as follows. Rather than viewing it as an ampliative inference from an isolated set of actively endorsed beliefs about the observed to another isolated set of beliefs, this time about the unobserved, we should see it as the emendation of the whole "system" with which a subject "meets the future" (Ramsey GPC 149).[10]

9. See Loeb (2002) and Marui (2011) for a debate whether Hume is a dispositionalist about belief. See fn. 8.

10. In the citations from "General Propositions and Causality" (1929), Ramsey is making claims about general as opposed to atomic propositions. This distinction was commonplace in his intellectual context, and, as Misak convincingly argues, this essay of Ramsey's was an attempt to collapse it, such that his claims can be understood as holding of all beliefs (2016: 193–195). In his lineage, the distinction between atomic and general propositions does not exist for Bayesians, except perhaps in a formal way, for they consider all individual beliefs to be of the same kind: the application of a probability function to an element of a Boolean algebra.

Recapitulative Interlude

The problem of induction is often conceived as the problem of which beliefs to have about the unobserved, on the basis of one's knowledge about the observed. One has observed the sun rise every day; should one believe that it will rise tomorrow, or that it won't? According to the most plausible reconstruction of Howson's views, we should think of the problem entirely differently. Subjects proceed through the world with myriad interconnected beliefs about both observed and unobserved. These form a system that stands in no need of justification. What does require justification is the way in which the subject amends this system, as they encounter new particulars. *This* is the problem of induction. And Bayesianism provides a solution to it by specifying that subjects ought to modify their system through *conditionalisation*.

5. Conditionalisation as a Solution to the Problem of Induction

Time has come to examine the details of conditionalisation, so as to evaluate whether it can indeed solve the problem of induction. Conditionalisation governs what ought to happen to the subject's worldview, encoded in their prior probability function, as they observe a particular that was heretofore unobserved. It commands the subject to replace their prior probability function p with a new, posterior probability function p', defined such that $p'(\cdot) = p(\cdot \mid E)$, where E encodes the subject's just acquired evidence. Less formally, it imparts the following instructions. First, the subject must be *responsive* to the new evidence: their view of the world must accommodate the new particular. As they observe that the sun has risen on a specific, now passed day, they must become certain of the associated proposition. Second, the subject must

remain *conservative*: their view of the world must change *just enough* to remain consistent; they must believe the closest possible thing to what they previously believed that does not contradict the newly encountered particular.

There are several ways to precisify the idea that conditionalisation is conservative,[11] but the general idea is the following. The subject's prior probability function specifies an unconditional probability value (a degree of belief) for every proposition entertained by the subject. Moreover, the *ratio formula,* which states that $p(A \mid B) := p(A\&B)/p(B)$, enables the definition of *conditional probabilities* out of these unconditional probabilities. Thus, the subject not only has unconditional degrees of beliefs in all the propositions they entertain, but they also have conditional degrees of belief in all pairs of such propositions. For instance, the subject has a degree of belief in the propositions that the die will land on a 6, and in the proposition that the die will land on an even number. But they also have a conditional degree of belief in the proposition that the die will land on a 6 *given* that it will land on an even number. In the course of conditionalisation, the subject adopts the probability function that ascribes to each proposition the same value that the prior probability function had ascribed to these propositions *conditional on the newly acquired evidence*. So, if the subject's prior probability function had specified that their credence in the die landing on a 6 given that it landed on an even number was $1/3$, conditionalisation specifies, now that they have learnt that the die landed on an even number, that their unconditional degree of belief ought to be $1/3$.

In more general terms, we should conceive of the Bayesian subject as having, at any given time, a fully specified sense of how they would think about things, were they to obtain such-and-such evidence. Conditionalisation commands the subject to adopt that sense when they do in fact obtain a particular piece of evidence. So, in the course of conditionalisation, the subject essentially rules out what is inconsistent with the newly acquired evidence, and retains everything else: their new system of beliefs is forged out of the editing of their old system of beliefs for consistency with the evidence. In this way, conditionalisation "demands that *one should be true to one's former self*" (Hacking 1975: xxxii), that one's system of belief be "changed *consistently* by observation" (Ramsey TP 88, emphasis added). Howson thus proposes the following solution to the problem of induction: the problem is that of how to amend the system with which the subject meets the world in light of new particulars, and the solution is to amend it as conservatively as possible, to retain as much as one can of one's former system.

Not all formulations of conditionalisation can serve as an answer to the problem of induction however. Christopher Meacham (2016) differentiates between two formulations:

> *Wide-scope.* It ought to be the case that if the subject has priors p, then they adopt posteriors p' upon learning E. [O(A→B)]
> *Narrow-scope.* If the subject has priors p, then they ought to adopt posteriors p' upon learning E. [A→O(B)]

The wide-scope formulation is the conclusion of some of the most popular arguments for conditionalisation, including the Dutch strategy argument (Teller 1973, Lewis 1999) and the epistemic utility dominance argument (Briggs and Pettigrew 2020). But it does not entail, from the fact that the subject has priors p [A], anything determinate about which posteriors they should adopt [either O(B) or ¬O(B)]. In that sense, it cannot constitute a logic of inductive reasoning in the way that Howson requires. For remember that, in order for conditionalisation to be a solution to the problem of induction in the way Howson envisages, conditionalisation must be a *rule of inference*: it must specify how to change one's worldview, that is, it must state which posteriors one ought to adopt given that one has particular priors. Howson's project therefore requires the narrow-scope formulation of conditionalisation,

11. For instance, some show that conditionalisation minimises the distance between prior and posterior probability distributions, relative to some measure of distance (e.g. Diaconis and Zabell 1982); others remark that conditionalisation is *rigid*, i.e. it preserves probabilities conditional on the newly acquired evidence (Jeffrey 1983: 80, Bradley 2005), and others still show that conditionalisation preserves probability values over which the evidence is 'silent' (Dietrich et al. 2016).

which can be used to derive a recommendation about the posteriors one ought to have [O(B)] based on the priors one does have [A], and which is supported most prominently by the expected epistemic utility argument (Greaves and Wallace 2006).

On the narrow-scope formulation, specific priors [A] and conditionalisation [A→O(B)] seem to entail that the agent ought to have particular posteriors upon learning some evidence [O(B)] regardless of whether the priors were justified [either O(A) or ¬O(A)].[12] Although Meacham claims that this "seems strange" (2016: 781) and takes it to count against the narrow-scope formulation, we have seen that it is precisely how conditionalisation needs to be understood for Howson's project. For Howson, conditionalisation is a rule of inference, akin to deductive rules of inference, which proceeds from where the subject "sets out" (Peirce EP 2.336), a place that does not need to be "justified in an absolute sense" (Howson 2000: 239). The question of how to proceed with one's inquiry, that is, the question of which inductive inferences to draw, is categorically independent from any kind of justification of one's belief system at the outset.

But although the semi-formal characterisation just given provides the illusion of independence between the justification of the priors and that of conditionalisation, attention to their content will reveal that this is a mistake. We have just seen that to justify conditionalisation is to justify staying "true to one's former self" (Hacking 1975, xxxii): it is to justify retaining as much as possible of one's priors in the light of new evidence. So, to say that conditionalisation can be justified independently from a justification of the priors is to say that it is consistent to hold both 1) that one should deviate as little as possible from one's priors, and 2) that these priors hold no normative force. This is a conceptually incoherent set of views: the injunction to remain faithful to one's priors contains within it an endorsement of these priors. Indeed, why should one attempt to stay as close as possible to mere "prejudices" (Peirce EP 1.29)? To use Meacham's formulation: "it's hard to see why the subject should have to [deviate as little as possible from their priors] in worlds in which [their priors are not justified]" (2016: 781). In other words, a justification of conditionalisation qua rule of inference requires a justification of the priors.[13]

This is deeply problematic for Howson's attempt at solving the problem of induction. For we have seen that his entire approach relies on his gambit: his "divorcing [of] the justification for inductive reasoning from the justification of its consequences" (2000: 239), so that he can posit conditionalisation as a rule of inference for inductive reasoning, without having to present a solution to the problem of justifying the priors—one he recognises orthodox Bayesianism cannot supply. This might have worked, we saw, if the priors were adopted by the subject in a way that didn't necessitate any kind of justification or endorsement; if they simply happened to be the place from which the subject's inquiry starts. But reflection on what is involved in a justification of conditionalisation when conditionalisation takes the form of a rule of inference (that is, on its narrow-scope formulation) reveals that, in insisting that subjects amend their worldview by conditionalisation, one insists that they endorse their priors in a substantive way: one insists that subjects retain as much of their priors as possible as they move through the world. It follows that the justification of conditionalisation and that of the priors cannot be separated in the way Howson needs them to be.

12. This property of narrow-scope requirements of rationality is known as *detachment* in the literature on structural rationality; see Kiesewetter and Worsnip 2023 for an overview.

13. This is encoded in the very structure of Greaves and Wallace's (2006) argument for narrow-scope conditionalisation. Their argument seeks to establish that the posteriors acquired by conditionalisation will be the most accurate ones by the subject's prior lights. In other words, they transfer the normative weight contained in the subject's prior outlook to their posteriors. If the priors have no normative weight, neither will the posteriors.

6. Conclusion

Howson's gambit was to insist that the problem of induction could be solved by approaching it as the insulated problem of how to draw inductive inferences. Inductive inferences, on the account his remarks intimate, are revisions to the subject's worldview at the prompt of new particulars. He posited conditionalisation as the answer to that problem. But because of the particular injunction contained within it—*to thine own self be true!*—conditionalisation cannot live up to this expectation. For to say that one ought to update by conditionalisation assumes that the priors are justified. This stands in direct contradiction to Howson's gambit: that of separating the inferential and the doxastic aspects of induction. It follows that Howson's idea, that conditionalisation could constitute a solution to the problem of induction without requiring a justification of the priors, fails on its own terms.

This failure leaves Howson, and the Bayesian who follows him, with two options. They could insist that subjects ought to reason inductively according to conditionalisation, in which case they would be claiming that subjects ought to endorse their own priors. This would entail giving up on Howson's gambit, and accepting that the problem of induction has not just an inferential but also a doxastic dimension. As such, it would mean retreating to the view expressed by Ramsey, Okasha, and Lange, that a Bayesian solution to the problem of induction requires a solution to the problem of justifying the priors: an answer to the question of which priors one should have. But orthodox Bayesianism, understood as the conjunction of probabilism and conditionalisation, notoriously has nothing to say about evaluating the substantive features of the priors. This risks proving Okasha right when he claims that "the positive response to Hume ... looks simply unavailable to the Bayesian" (2005: 184).

Alternatively, one could hold on to Howson's gambit, continue to insist that the problem of induction is a purely inferential problem, and give up on conditionalisation as the logic of inductive inference. This is a big loss to accept for someone who was initially attracted to Howson's idea, for it amounts to giving up at least on an orthodox form of Bayesianism. This is not to say however that greener pastures might not lie this way. Although this is not a topic for the present time, it might be interesting to remark that Ramsey adopts this strategy: as we have seen, he doesn't believe that conditionalisation can constitute a logic of truth, and turns instead to the habits of mind, which, in his words, "work" (Ramsey TP 93), i.e. which produce beliefs that "are for the most part true, or more often true than those which alternative habits would lead to" (94). This, according to him, involves calibrating one's degrees of belief to frequencies, and adopting a form of enumerative induction. As with much of his work, these ideas take inspiration from Peirce.[14]

Despite its ultimate failure, and regardless of how one opts to resolve the dilemma its analysis generates, Howson's idea will have given rise to a picture of human reasoning, that is, an interpretation of Bayesianism, which is both substantive and philosophically rich. On this picture, subjects are understood as meeting the world from an integrated system, which encodes their partial beliefs in every proposition, and therefore, their dispositions to act and to interpret new experiences. The reading of Howson presented here posits the question of how to revise this integrated system in the light of new particulars as the principal philosophical question when it comes to induction. However one decides to answer it—whether by rejecting conditionalisation or by seeking a justification for the priors—the question itself, I maintain, should be preserved, for it encodes an interpretation of both Bayesianism and the problem of induction that has the benefit of being both systematic and evocative.[15]

14. For Ramsey's account of reasoning on empirical matters, including on Peirce's influence on his views, see work by Dokic and Engel (2003: 13–18) and Misak (2016: 180–183). For Peirce's account of reasoning on empirical matters, see work by Cheng (1966, 1967), Hookway (1985: ch. VII), and Misak (2013: 32–35, 47–50; 2016: 43–48).

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