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BELIEF IS CREDENCE ONE (IN CONTEXT)

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1. Introduction

In this paper, I argue for the following two theses:

> (CONTEXT) Degrees of belief change from context to context, depending on the space of alternative possibilities.
>
> (UNITY) Outright belief is belief to degree 1.

I call the conjunction of (CONTEXT) and (UNITY) *credence-sensitivism*, or sometimes just *sensitivism*. Exactly what is meant by "space of alternative possibilities" will be made clearer once we get to §5, in which I give an outline of a formal framework. Informally, the idea is that one's credences in a particular context are given by a function assigning weights to each of the possibilities one takes seriously in that context; when one comes to take more or fewer alternative possibilities seriously, one's credences are given by a different function.

Roughly speaking, the argument will go as follows: If (CONTEXT) is true, the standard reasons for dismissing (UNITY) are undermined; (UNITY) allows nice solutions to the standard problems for the most popular account of the connection between outright belief and degrees of belief; and we can still fruitfully apply formal methods to modelling degrees of belief while respecting (CONTEXT). If all this is true, credence-sensitivism should be rather attractive. What is conspicuously absent from the plan, of course, is a positive argument for adopting (CONTEXT). Over the course of the paper, however, a plausible story will emerge on which (CONTEXT) not only is true but does some explanatory work. Furthermore, I argue in Clarke (MS) that an adequate account of what makes an assertion sincere requires an analogue of (CONTEXT) for outright belief — what I call *belief-sensitivism*, as opposed to the view advanced here, credence-sensitivism. If that is right, it provides some reason for thinking that (CONTEXT) is true; but that argument is beyond the scope of this paper.

Now, a less rough version of the plan. In §2, I briefly survey the dominant views on degrees of belief (standard Bayesianism) and their relation to outright belief (the threshold view and the Lockean view).

Then I go on to claim (§3) that (UNITY) provides a nice resolution of Kyburg's (1961) lottery paradox and (§4) that (CONTEXT) resolves the usual problems with (UNITY). In §5, I describe my proposed way of modelling degrees of belief. This section is more technical than the rest of the paper, but less formally inclined readers can safely skip it and still understand the rest of the paper; the point is simply to show that the sort of context-sensitivity I advocate can be made formally respectable. The framework presented in this section can be seen as a modification of the subjective Bayesian approach to degrees of belief, so I will argue in §6 that taking credences to be context-sensitive does not threaten the usefulness of modelling degrees of belief probabilistically: the major explanatory triumphs of Bayesianism still go through on my sensitivist revision of the Bayesian framework, and my version of Bayesianism has some advantages over orthodoxy. Along the way, some non-trivial questions arise (for future work) about how best to fit probabilism and conditionalization into this sort of context-sensitive framework. Finally, in §7, I briefly argue for some further virtues of my view: it allows outright belief to have some bearing on action, it answers Kaplan's (1996) Bayesian Challenge, and it takes seriously the thought that credences are *degrees of belief*.

2. Orthodox Formalism

I have already let on that the way of modelling degrees of belief I favour is a modification of the standard subjective Bayesian framework. It makes sense, then, to begin with a brief summary of the Bayesian framework.

The Bayesian deals with ideally rational agents. Such an agent's degrees of belief are modelled by a personal probability function, $\Pr(\cdot)$. (Bayesians thus endorse probabilism, the thesis that rationality requires one's degrees of belief to obey the probability calculus. We will have much more to say about probabilism in §6.) The function takes propositions as arguments and returns real numbers between 0 and 1 as values. $\Pr(p) = 1$ means the agent has the highest confidence in p, or is certain that p is true; $\Pr(p) = 0$ means the agent is certain p is false; and $\Pr(p) = 0.5$ means she thinks p is as likely to be true as to be false. Values in between 0.5 and 1 indicate that the agent takes p to be more likely true than false, with increasing degrees of strength, and values between 0.5 and 0 indicate the reverse. Because $\Pr(\cdot)$ is a probability function (i.e., it obeys the axioms of the probability calculus), we know a few things about the degrees of belief of an ideal Bayesian agent: for instance, every tautology gets credence 1 and every contradiction gets 0; any two logically equivalent propositions get the same credence; if p entails q, then q gets at least as high a credence as p; and so on.

So much for statics. Diachronically, a Bayesian agent revises her degrees of belief only when she gains new evidence, and does so through the process of updating by conditionalization. If she learns some new evidence proposition, e, then she replaces her old personal probability function $\Pr_{old}(\cdot)$ with a new one, $\Pr_{new}(\cdot)$, defined by

$$\Pr_{new}(p) = \Pr_{old}(p|e),$$

where $\Pr(a|b)$ is the probability of a conditional on b, defined as $\frac{\Pr(a \wedge b)}{\Pr(b)}$, provided $\Pr(b) \neq 0$. Two consequences of this updating rule are worth pointing out. First, if $\Pr_{old}(e) = 0$, then $\Pr_{new}(p)$ is undefined.[1] So once one has assigned probability 0 to a proposition, one cannot learn that it is, after all, true. Second, if $\Pr_{old}(p) = 1$, then $\Pr_{new}(p) = 1$ as well: $\Pr_{old}(p|e) = 1$, for any proposition e with $\Pr_{old}(e) \neq 0$. So once one has assigned a proposition probability 1, one's credence in it can never drop any lower. This should seem, at first, to be a problem for (UNITY); in §4, I shall use (CONTEXT) to offer a way out.

1. There are, of course, ways of dealing with this problem, e.g., by taking conditional probabilities as primitive and defining unconditional probabilities in terms of them, rather than the other way around (Popper 1959). See Hájek (2003) for a compelling argument against taking $\Pr(a \wedge b)/\Pr(b)$ as a *definition* of $\Pr(a|b)$ rather than a *constraint* on $\Pr(a|b)$ in cases where $\Pr(b)$ is defined and non-zero. However, there is no consensus on how best to deal with this problem; even if one takes conditional probabilities as primitive, there is no consensus on which axiomatization of conditional probability is correct. See also note 15 on page 12.

This is a standard view of credences. Now let's examine a standard view of how credences fit together with outright belief, which I'll call *the threshold view*. The threshold view has it that outright belief is belief to a degree higher than some threshold value $x < 1$: one believes that p (outright) if and only if $Cr(p) \geq x$, where $Cr(\cdot)$ is one's credence function. (We drop the assumption of probabilism for the moment, so we drop the "Pr" notation.) (UNITY) can, of course, be seen as a limiting case of the threshold view: if the threshold x is set to 1, then the threshold view coincides with (UNITY). However, there are qualitative differences between the views that result from setting the threshold at 1 and setting the threshold below 1, so it is best not to think of (UNITY) as a threshold view.

The threshold view is often coupled with a view about rational belief which I'll call *the Lockean view*, following Foley (1993), according to which one is rational to believe p outright if and only if one is rational to have a degree of belief that p higher than some threshold value y.[2] To be perfectly clear: the threshold view has to do with the relationship between outright belief and degrees of belief; the Lockean view has to do with the relationship between rational belief and rational degrees of belief. Generally, those who endorse both the Lockean view and the threshold view, as Foley (1993) does, take it that the two thresholds, x and y, coincide: that is, that one is rational to believe that p outright just in case one is rational to have a degree of belief high enough to constitute or entail outright belief. But it is not obviously necessary that the two thresholds should coincide.

There are some authors who endorse the Lockean view without endorsing the threshold view. This, I think, is the best way to understand Hawthorne and Bovens (1999), which aims to derive rules for rational belief from the Lockean view plus probabilism on degrees of belief. That is, Hawthorne and Bovens aim to answer the question, "Given my degrees of belief, what ought I to believe outright?" But this question makes no sense if one's degrees of belief determine one's outright beliefs, as the threshold view would have it.[3] On the other hand, I know of no one who endorses the threshold view without endorsing the Lockean view; but, of course, this should not be taken to mean that the one view entails the other.

3. Problems for the Threshold View

3.1 The Lottery

Here is a problem for the threshold view, based on Kyburg's (1961) lottery paradox.

You own a lottery ticket. You know that there are n tickets in the lottery, that exactly one winner will be selected, that each ticket has an equal chance of winning, and that each ticket's winning or losing is independent of each other ticket's winning or losing. You have credences corresponding to these propositions: For any ticket i, let W_i be the proposition that i wins and L_i the proposition that i loses; then for all i, you have $Cr(L_i) = 1 - Cr(W_i) = \frac{n-1}{n}$. Furthermore, for any set of tickets S with m members, you have $Cr(L_S) = (\frac{n-1}{n})^m$, where L_S is the proposition that all of the tickets in S lose. These credences simply reflect your (accurate) beliefs about how the lottery is set up.

Now here is the problem: Is it possible for you *not* to believe that your ticket will lose? On the threshold view, if n is sufficiently high, this is impossible. For whatever the value of the threshold of belief,

2. This can be read in either a permissive or an obligatory way: one is rationally required/permitted to believe that p iff one is rationally required/permitted to have $Cr(p) > y$. Bayesian orthodoxy has it that rational degrees of belief are precise, and so (once one's prior credence function is fixed) exactly one credence is rationally permitted and hence also required. (Subjective and objective Bayesians differ over whether there are multiple permissible prior credence functions.) There are a number of authors who have argued that credences are best represented by sets of probability functions, but most of them do not discuss the relation between outright belief and degrees of belief (or at least, not in the same place). See, e.g., van Fraassen (2006), Joyce (2005), Levi (1980), and Weirich (2001). Sturgeon (2008), notably, endorses the threshold and Lockean views but thinks that degrees of belief are best represented by sets of probability functions; so for him, there is a real difference between what credences are rationally permissible and what credences are rationally obligatory.

3. Weatherson (2005) makes essentially the same point.

x, there will be some n such that $\frac{n-1}{n} \geq x$. This is strikingly unintuitive. Certainly there are cases of people who fail to believe that certain particular tickets (their own or others') will lose what they believe to be large, fair lotteries; it is hard to make sense of the idea that none of these people can have credences that accurately reflect their beliefs about the fairness and size of the lotteries in question.

(UNITY) lets us avoid this problem. There is no lottery large enough to make $\frac{n-1}{n} = 1$.

Note that the version of the paradox here is distinct from a related version of the paradox widely discussed in the literature (and which is closer to Kyburg's original formulation of the paradox).[4] I have in mind the version of the paradox used to make trouble for the Lockean view, possibly but not necessarily in combination with the threshold view. For clarity, let us refer to the two versions of the paradox as the *threshold lottery paradox* and the *Lockean lottery paradox*, respectively. Whereas the threshold lottery paradox described above is a problem for certain accounts of belief, the Lockean lottery paradox is a problem for certain accounts of rational belief. Here, the problem would be as follows: For each ticket i, your knowledge that the lottery is fair makes it rational for you to have $Cr(L_i) = \frac{n-1}{n} \geq y$, where y is the threshold for rational belief. Thus, you are rational to believe L_i outright, for each ticket i. However, you are also rational to believe that exactly one ticket will win; thus, you are rational to believe that at least one of the L_i is false. Given some additional assumptions, [5] it follows that you are rational to believe a contradiction. This conflicts with the intuitive principle of noncontradiction. One response to this problem, taken by Foley (1993) and Hawthorne and Bovens (1999), is to reject the principle of noncontradiction.

The threshold lottery paradox is more difficult than the Lockean lottery paradox. It will not do simply to reject the principle of noncontradiction — or any other principle of rationality for that matter. The problem has nothing to do with what beliefs are rational for an agent; rather, it has to do with what beliefs are even *possible* for an agent. According to the threshold view, if you believe that the lottery is fair and that it is sufficiently large, and if your degrees of belief reflect this, then you must believe of each ticket that it will lose. According to the threshold view, it is not merely irrational but impossible not to believe that your lottery ticket will lose. An advantage of the threshold view over eliminativism (the Jeffrey-1992-style view that we should eliminate the notion of outright belief in favour of credences) is that it holds on to belief-talk — it counts talk about outright belief as legitimate. This is an advantage because much of our ordinary and theoretical reasoning about knowledge and rationality appeals to outright belief. But the threshold lottery paradox shows that this advantage of the threshold view is overblown, for the threshold view forces a radically revisionist view of some of our belief-talk: it turns out that nobody ever believes that she owns a ticket which *might* win a fair lottery of any size. This is still not quite so bad as saying that all belief-talk is illegitimate or must be reinterpreted as credence-talk, but the difference is one of degree,

4. Kaplan (1981) makes essentially the distinction to come in this paragraph, between the threshold and Lockean versions of the lottery paradox.

5. Notably, the assumption that it is rational to believe the conjunction $p \wedge q$ if it is rational to believe p and rational to believe q often features in the presentation of the problem. However, if this assumption is correct, and if rational degrees of belief satisfy the probability calculus, then the Lockean view must be false. For any two independent propositions p and q, the rational agent will have $Cr(p \wedge q) = Cr(p) \cdot Cr(q)$, which will be lower than either $Cr(p)$ or $Cr(q)$ if neither is believed to degree 1; thus, if $Cr(p)$ and $Cr(q)$ are only slightly above the threshold y, then $Cr(p \wedge q)$ will be below y. Thus, we would have a case where it is rational to believe p and to believe q but not rational to believe their conjunction $p \wedge q$.

However, rejecting the above assumption is itself an intuitive cost to the Lockean view. Furthermore, it is not necessary to rely on this assumption to run the paradox. For example, one can massage the principle of noncontradiction so that it rules out rationally believing all the members of an inconsistent set, instead of just ruling out rational belief in a logically false proposition.

not of kind.[6]

3.2 *Other Problems*

In this subsection, I will survey some other (at least *prima facie*) problems for the threshold view which have arisen in the literature and argue they are not problems for (UNITY). I will not attempt to push any of these problems as a decisive objection to the threshold view — in fact, in one case I argue that the supposed problem is no problem at all for the threshold view — but it is an advantage to be able to avoid easily a number of problems which have been put forward in print.

First, note that there is a clear qualitative difference between belief and lack of belief, but there is no clear qualitative difference between, say, credence 0.9001 and credence 0.8999. If the threshold for belief is 0.9, then the former credence amounts to outright belief, but the latter does not. To put the problem another way, here is Stalnaker (1984, 91):

> One could easily enough define a concept of acceptance[7] which identified it with a high subjective or epistemic probability (probability greater than some specified number between one-half and one), but it is not clear what the point of doing so would be. Once a subjective or epistemic probability value is assigned to a proposition, there is nothing more to be said about its epistemic status. Bayesian decision theory gives a complete account of how probability values, including high ones, ought to guide behavior, in both the context of inquiry and the application of belief outside of this context. So what could be the point of selecting an interval near the top of the probability scale and conferring on the propositions whose probability falls in that interval the honorific title "accepted"? Unless acceptance has some consequences, unless the way one classifies the propositions as accepted, rejected, or judgment suspended makes a difference to how the agent behaves, or ought to behave, it is difficult to see how the concept of acceptance can have the interest and importance for inquiry that it seems to have.

If we know an agent's credences, it is not clear what point there is to asking the further question of what the agent believes outright. Any question that might be answered using information about the agent's outright beliefs could be answered as well or better using information about the agent's credences, if the threshold view is correct. If we take it for granted, as I think we should, that belief-talk is genuinely useful and important, then this is a problem for the threshold view: the threshold view threatens to render belief-talk pointless.

It should be clear that (UNITY) does not have this problem. There is a qualitative difference between believing p to degree $1-\epsilon$ and believing it to degree 1: it is the difference between having some doubt that p and having no doubt that p. One who believes p to degree 1 will not regard a bet on p as risky; this is not so for one who believes p to degree $1-\epsilon$. To be sure, if ϵ is small enough, the agent may wind up making all the same p-related decisions, but one reasons differently under risk than otherwise. One who believes p to degree 1 will not seek further evidence for or against p, but one who believes p to degree $1-\epsilon$ will do so, provided the cost of seeking evidence is not too great and the prospects of finding such evidence is good enough. There is a clear point to distinguishing the propositions an agent believes to degree 1; belief-talk is not pointless if (UNITY) is true.

There is another qualitative difference between credence 1 and any lesser credence, of particular interest to Bayesians: if you give p cre-

6. In discussions of the threshold or Lockean view and the lottery paradox, it is common to see a discussion of the preface paradox (Makinson 1965). The threshold and Lockean views are widely seen as giving a nice resolution of the preface paradox, so it may seem convenient that I do not discuss the preface in this paper. However, I omit discussion of the preface here because I discuss it in another paper: to put it briefly, my account of outright belief itself allows a tidy resolution of the preface paradox without appeal to talk of credences at all; this, I take it, is an advantage of my approach, since the preface paradox concerns the rationality of a certain collection of outright beliefs, not of credences.

7. For Stalnaker, belief is a species of acceptance, though there are other species, such as assumption, supposition, and presumption. The difference between belief and acceptance is irrelevant to the point being made in the quoted passage.

dence 1, and your credences change only via conditionalization, then you will never give p any lesser credence, as we saw in §2. We cannot say the same for any credence lower than 1, except for 0. However, I cannot wholeheartedly endorse this argument, because the status of updating via conditionalization is less clear on my view than it is on the orthodox Bayesian view; see §6 for more on this point.

Second, Fantl and McGrath (2009, 141) list the following "apparent facts about outright belief":

> *The truth standard.* If you believe p and p is false, then you are mistaken about whether p, and if you believe p and p is true, then you are right about whether p.
>
> *Transparency.* Strength of justification for p is directly proportional to the strength of justification you have for believing p.
>
> *Resolution.* If you believe that p, then your mind is made up that p.

Fantl and McGrath then go on to argue that the threshold view cannot account for these apparent facts; I will consider each of their arguments and conclude that given (UNITY), we can account for all three apparent facts.

The truth standard. The trouble for the threshold view here is that giving p high credence does not seem to mean commitment to the truth of p. If one's credence in p is 0.99, then one thinks that p is very likely, but one allows that p might be false. As Fantl and McGrath write: "If you are told: 'Ha, so you were wrong about whether p, weren't you?' you could reasonably say in your defense: 'Look, I took no stand about whether p was true or not; I just assigned it a high probability; I assigned its negation a probability, too' " (2009, 141).

On the other hand, if one believes p to degree 1, and p turns out to be false, it is hard to see how one could reasonably claim not to have been wrong about p. There was no alternative to p to which one assigned a non-zero probability; one did not take not-p to be a live possibility. In particular, the response Fantl and McGrath offer above is not available.

Fantl and McGrath also point out that in high-stakes situations, agents who give p high credence may nevertheless say things like "I don't want to be wrong that p" and refuse to rely on p in their actions. They claim that this is "some evidence that ordinary folk are thinking of a belief state that isn't [threshold] belief but is more closely tied to action" (2009, 142). I take it the idea is that these agents refuse to rely on p in their actions because to do so when p is false would mean that they are wrong that p; and this is the same sort of being wrong about p which applies to outright belief that p.

I find this argument unconvincing.[8] First, it seems to me there is a clear sense of being wrong that p or about p which has nothing to do with belief. One who performs an action which is beneficial or optimal if and only if p is true was wrong to do so if p is false, in a certain sense; and this is still true even if the agent did not believe that p. For example, suppose the A train would take me where I want to go, and the B train would take me away from where I want to go. Suppose I have 60% confidence that the train in front of me is an A train and 40% confidence that it is a B train. I certainly do not believe that the train is an A train; I have not formed an outright belief. Nevertheless, if I get on the train, and it turns out to be a B train, it is natural to describe me as having been wrong about whether it was an A train or wrong that it was an A train. It does not matter to this sense of being wrong what my beliefs are.

Transparency. The crucial claim in Fantl and McGrath's argument here is that something might justify one in increasing one's credence that p without giving any justification for having a high credence that p. But according to the threshold view, believing that p outright is the same as having a high credence that p; so something might jus-

8. Though, to be fair, Fantl and McGrath only claim that there is "some evidence" for an action-centric notion of belief here. It is possible that the following only answers a bolder argument than the one they mean to endorse; nevertheless, I think it is worthwhile to explore alternative ways of explaining the phenomenon in question.

tify increasing one's credence that p without giving any justification for believing that p. This violates Transparency, provided that giving justification for increasing one's credence that p entails giving justification for p. The example Fantl and McGrath give is of buying a lottery ticket: buying a lottery ticket in a large lottery, they say, slightly increases your justification for believing that you will win the lottery; however, they claim that it does not give any justification at all for having a high credence that you will win the lottery. Note that this argument weighs against (UNITY) as well as the threshold view, for credence 1 is a species of high credence.

I think the argument for Transparency is too quick. Plausibly, if one's evidence requires one to have credence x that p, then one is more justified by one's evidence in having credence $x + \epsilon$ in p than in having credence $x + \delta$ in p if $|\epsilon| < |\delta|$. That is, if one's credences deviate further from the rationally required or optimal credence, then one's credences are less justified. It follows, then, that if one receives some evidence that justifies raising one's credence in p by some amount, then that evidence also justifies one in having a high credence that p, although this may not be a very high degree of justification. If one buys a ticket in a fair lottery of 1,000 tickets, one thereby comes to be (fully) justified in having a credence of 0.001 that one will win the lottery (provided one keeps one's ticket, etc.). But one also gains some justification for having a credence of 0.9 that one will win the lottery: whereas before buying the ticket, such a credence would differ from rationality by 0.9, now it differs from rationality by only 0.899. This is a small increase in justification, to be sure, but it is an increase.

Of course, the argument of the preceding paragraph relies on a certain view of justification of credences for which I have not argued. However, my point here is that Fantl and McGrath need to supply some conflicting view of justification of credences in order for their objection to the threshold view to go through. It is not obvious that this can be done unproblematically.

Resolution. Here it is fairly clear what the problem is for the threshold view and why there is no problem for (UNITY). An agent who has a high, but sub-unity, credence that p may well do things like seek further evidence that p and refuse to act on the assumption that p without further evidence. (This is particularly likely in high-stakes cases.) It is hard to describe such an agent as having her mind made up that p. On the other hand, if an agent gives p credence 1, she will not engage in any such activities, since there are no live not-p possibilities for her.

4. (CONTEXT) Makes (UNITY) Plausible

It is standardly held that (UNITY) puts too strict a condition on outright belief: if outright belief requires the highest possible degree of belief, it is thought, then ordinary people rarely or perhaps never have any outright beliefs, and rational people might believe only tautologies outright. Here are some representative passages:

> Indeed, it might not even matter much where the threshold is as long as we are consistent in applying it. There are some restrictions, of course. We won't want to require subjective certainty for belief. So, the threshold shouldn't be that high. ... Suppose that degrees of belief can be measured on a scale from 0 to 1, with 1 representing subjective certainty. Let the threshold x required for belief be any real number less than 1. ... [W]e have already agreed that x need not be 1. Subjective certainty is not required for belief. (Foley 2009, 38–9; cf. Foley 1993, 143–4)

> What is the relation between acceptance and probability? One suggestion would be to identify acceptance of a hypothesis with assignment of probability 1 to that hypothesis. But this view is untenable. For to give hypothesis H probability 1 is to be willing to bet on it at any odds; for example, a person who gave H probability 1 would be willing to accept a bet in which the person wins a penny if H is true, and dies a horrible death if H is false. I think it is clear that scientists are not usually this confident of the hypotheses they sincerely categorically assert, and thus that probability 1 is not a necessary condition for acceptance.
>
> (Maher 1993, 133)

> [T]he usual view seems to be that you do not need to be absolutely certain of H (give it probability 1) in order to believe it. For one thing, it is usually supposed that there is very little we can be rationally certain of, but that we can nevertheless rationally hold beliefs on a wide range of topics. (Maher 1993, 152)

> The Certainty View [is as follows:] You count as believing p just if you assign [$Cr(p)$] the value 1. ... [T]he Certainty View takes belief to entail so great a commitment that (i) for each of your beliefs, you must be prepared, for no gain, to gamble any sum that it is true, (ii) you must be prepared to make a like gamble, for each hypothesis that is incompatible with one of your beliefs, that this hypothesis is false, and (iii) you must be prepared to make a like gamble that you haven't even one false belief. Given this much, it is hard to see how there can be very much you have any business believing. The conclusion is inescapable. If, in focusing on what we are justified in believing (rational to believe), traditional epistemology is concerned with anything at all central to our lives as inquirers, then the Certainty View must be mistaken. (Kaplan 1996, 91, 93)

> [(UNITY)] is, I think, less plausible [than the threshold view]. If the binary conception of belief derives its plausibility from our habit of making unqualified assertions, and from our ordinary ways of thinking and talking about belief, then the plausible notion of binary belief is of an attitude that falls far short of absolute certainty. We often assert, or say that we believe, all kinds of things of which we are not absolutely certain. This is particularly clear if the plausibility of the graded conception of belief is rooted in part in how belief informs practical decision. Insofar as degree of belief is correlated with practical decision-making, the highest degree of belief in P is correlated with making decisions that completely dismiss even the tiniest chance of P's falsity. For example, having degree of belief 1 in Jocko's having cheated would correlate with being willing literally to bet one's life on Jocko's having cheated, even for a trivial reward. Surely this level of certainty is not expressed by ordinary unqualified assertions; nor is it what we usually want to indicate about ourselves when we say, e.g., "I believe that Jocko cheated," or what we want to indicate about others when we say, e.g., "Yolanda believes that Jocko cheated." (Christensen 2004, 21)

Consider first the suggestion that flat-out belief is maximum confidence — a view reflected in the frequent use of the term "full belief" for flat-out belief. The problem here is that one can believe something, in the everyday sense, without being certain of it. I believe that my grandmother was born on the 3rd of August, but I am not absolutely certain of it. I may have misremembered or been misinformed. Nor is this lack of certainty necessarily a bad thing; a fallibilist attitude to one's own beliefs has much to recommend it. Another difficulty for the full-belief view arises in connection with practical reasoning. On Bayesian principles, to assign a probability of 1 to a proposition is to cease to contemplate the possibility that it is false and, consequently, to ignore the undesirability of any outcome contingent upon its falsity. One consequence of this is that if one is certain of something, then one should be prepared, on pain of irrationality, to bet everything one has on its truth for no return at all. For one will simply discount the possibility of losing the bet. ... Yet we can believe something, in the everyday sense, without being prepared to stake everything, or even very much, on its truth. (I would bet something, but not a great deal, on the truth of my belief about my grandmother's birth date). So flat-out belief is not the same thing as maximum probability.[9]

9. Frankish continues:

> A third problem for the full-belief view is that it does not extend to desire. One can desire something, in the everyday sense, without assigning it maximum desirability. I want a new car, but I do not regard a new car as the most desirable thing in the world.

(Frankish 2009, 79)

> [(UNITY)] is problematic for obvious reasons: it threatens robust skepticism about belief (many of the things we thought we believed, we don't) and if the view is true then fallibilism about justified belief is false. (Fantl and McGrath 2009, 134)

There are, I think, two main versions of the worry that (UNITY) sets too strict a standard for outright belief (with some overlap between the two): the *betting* worry and the *certainty* worry.

The betting worry starts from some sort of connection between partial beliefs and betting behaviour or betting dispositions.[10] Roughly, one believes that p to degree x if and/or only if[11] one is inclined to regard as fair a bet where one would win $\$S \cdot (1 - x)$ if p is true and lose $\$S \cdot x$ if p is false, where S is some appropriate real number representing a stake. The idea is that, using x as the probability that p is true, the expected value of such a bet would be zero. On this picture, believing p to degree 1 would mean regarding as fair a bet where one would stand to win nothing or nearly nothing should p turn out to be true but would lose some substantial amount should p turn out to be false. If it is part of the picture that S can take very large values, it is particularly unintuitive that ordinary people would regard bets at such long odds as fair, when p is some commonplace contingent proposition. Few people would regard as fair (in the sense of not favouring either side) a bet where they stand to gain a penny or lose their home on the proposition that Barack Obama was once elected president of the United States, but surely most people should count as believing this proposition outright.

Given (CONTEXT), the betting worry looks much less plausible. The key insight is that offering a bet means changing the context. When the practical importance of p changes, as it must when a bet is offered, the space of salient alternatives to p may also change. When I am offered a bet on p at very long odds and/or very high stakes, I am likely to worry more about whether p is true after all and consider a wider range of alternative possibilities. For example, if I am offered a bet where I would win a dollar if Barack Obama is the current president of the United States or lose my home if he is not, I will think something like the following to myself: "Am I *sure* that I'll win this bet? Is there something I might have been overlooking? I don't want to lose all that money, and I don't stand to gain much in comparison." I will probably think of scenarios in which Obama is no longer president which I was previously ruling out or ignoring (maybe he resigned just a few minutes ago and the news has yet to reach me); I will be more careful about ruling those possibilities out and may decide not to rule all of them out after all. If I do not rule out all unignored counterpossibilities to the proposition that Obama is president, then I will no longer give that proposition credence 1. I will also no longer believe that proposition, according to (UNITY).

I think this fits the standard intuitions about these extreme betting cases: when one stands to lose a lot if p is false, one is less likely not only to act on p but to assert sincerely that p. Having had the thoughts above, I am still likely to be comfortable saying things like "Obama is probably president" or "I'm pretty sure that Obama is president," but I am not likely to say flat-out, "Obama is president." One is especially likely to say the former sort of thing — that p is probable — if one is criticized for refusing a bet on p: "I thought you said that p — how can you turn down this bet?" — "Well, I really only think it's very likely that p, but it's not *that* likely." All of this suggests that someone

I will not address this problem.

10. Some connection of this sort is often given as an analysis, or interpretation, of the subjective probabilities found in the orthodox Bayesian formalism; however, see Eriksson and Hájek (2007) for a convincing argument that no such analysis can be satisfactory.

11. There are various versions of the connection between credences and betting behaviour/dispositions attested in the literature. For present purposes, the differences among them — whether the property of interest is betting behaviour, or betting dispositions, or dispositions to regard certain bets as fair, or indifference between sides of a bet; whether betting behaviour/dispositions/etc. are supposed to provide an analysis of credence, or a way of measuring credence, or some other kind of connection — make no difference. In all versions, the problem with credence 1 is similar.

rejecting an extreme bet on p does not believe p while rejecting the bet.

(Of course, it's also likely that I will reject the bet simply on the grounds that I do not want to risk my home at all, no matter how sure I am that the relevant proposition is true. But this is just to say that the betting worry about (UNITY) has somewhat less intuitive appeal than it might seem at first.)

Here is my response to the betting worry again, in a bit more detail. Assume (CONTEXT) is true. Suppose I have $Cr_1(p) = 1$, where $Cr_1(\cdot)$ is my probabilistically coherent credence function. Now suppose I am offered a bet according to which I would gain \$1 if p or lose my home if $\neg p$. The expected value of this bet, according to $Cr_1(\cdot)$, is \$1, no matter what utility I assign to losing my home, for the expected value of the bet is given by $Cr_1(p) \cdot \$1 + Cr_1(\neg p) \cdot u(nohome)$, where $u(nohome)$ is the (large negative) utility I assign to losing my home; since $Cr_1(p) = 1$ and $Cr_1(\neg p) = 0$, the expected value of the bet is $1 \cdot \$1 + 0 \cdot u(nohome) = \$1$. Therefore, I should accept the bet, since doing so has positive expected value.

But being offered this bet changes the practical importance of p for me. Before the bet was offered, I had no reason to think the falsity of p might lead to my losing my home (or at least, we can easily choose p so that this is the case). The dramatically increased practical importance of p can lead me to take erstwhile-ignored possibilities seriously; I may be more careful about what I am willing to rule out. Thus, my credences will no longer be given by the function $Cr_1(\cdot)$ but by a new function $Cr_2(\cdot)$, defined over the expanded space of possibilities. (For a more precise account of the shift from $Cr_1(\cdot)$ to $Cr_2(\cdot)$, see §5.) The fact that in the new context, where my credences are given by $Cr_2(\cdot)$, I take seriously some possibilities I ruled out in the old context, where my credences were given by Cr_1, means that there are some propositions q such that $Cr_2(q) > Cr_1(q) = 0$. If there is such a proposition q which I take to entail $\neg p$, and $Cr_2(\cdot)$ is probabilistically coherent, then it will be the case that $Cr_2(p) < Cr_1(p) = 1$. If $Cr_2(p)$ is low enough, then the bet under consideration will have negative expected value according to my revised credences, and so I will not accept it.

Here is an objection to the line of argument above, due to an anonymous referee. Consider sayings like "She talks the talk, but she doesn't walk the walk" or "He is not prepared to put his money where his mouth is." The familiar, standard criticism expressed by these sayings seems to involve a tie between belief and willingness to bet. We might reasonably say that one is worthy of criticism if one is willing to assert a proposition but not willing to make a bet at non-trivial stakes that the proposition is true. Moreover, a natural interpretation of the criticism takes it to involve a sort of insincerity: the criticized person represents herself as having a greater confidence in the proposition asserted than her actions reveal her to have. Therefore, our practice of employing criticisms of this sort presupposes that our actions reveal our credences — that there is a closer tie between betting behaviour and belief/credence than the sensitivist wants to admit.

My response to this objection leads naturally into my response to the certainty worry, which we come to presently. We can understand the criticisms of the previous paragraph as complaining about a lack of stability in the criticized person's beliefs. People who don't "walk the walk," I claim, have the same sort of failing as people who don't stick around "when the going gets tough". The problem with people who won't "put their money where their mouth is" is not that they do not genuinely believe the things they say but that they cease to believe them when their beliefs become important. (Recall that the sensitivist does think there is a tight connection between one's current credence and one's current willingness to bet; what the sensitivist denies is that we can easily infer one's willingness to bet in one context from one's credences in another context.) The lesson here, which is the lesson of the sensitivist response to the certainty worry, is that there is more to one's belief state than one's current beliefs or current credences; a person can be criticized for other kinds of doxastic facts, so to speak.

The certainty worry is vaguer than the betting worry but less closely tied to problematic views about partial belief and betting behaviour/dispositions. Here, the trouble is that believing p to degree 1 is interpreted as being certain that p — but sometimes people believe

things without being certain. This worry is misguided: while it is true that mere belief does not require certainty, belief to degree 1 should not be taken to entail certainty. A fully satisfying response to the certainty worry along these lines would require a more precise interpretation of just what it means to have degree of belief 1 than I am prepared to give here,[12] but some remarks on certainty will give the flavour of a more complete response.

For one thing, being certain that p seems to require stability of opinion, just as with being willing to "put one's money where one's mouth is". If one is certain that p, then it must be difficult to move one to abandon belief in p. For example, part of what it means for me to be certain that the Earth is not flat, or that I did not answer to the nickname "Speedy" as a child, or that there are no genuine psychics, is that it would be very hard to bring me to disbelieve these propositions. It would take more, stronger, and better-presented evidence to make me doubt that I was not nicknamed "Speedy" as a child (either believing that I did have that nickname after all or withholding belief in either proposition) than it would to convince me that, say, my mother was nicknamed "Speedy" as a child. I believe that my mother had no such nickname, but all it would take to make me believe otherwise would be reliable-seeming testimony from one or two people who knew her as a child; this would not suffice to make me even doubt whether I ever answered to that nickname. The difference is that while I believe both propositions, I am certain of only one. On the standard Bayesian formalism, degree of belief 1 is maximally stable for rational agents: as we saw in §2, if one has $Cr_1(p) = 1$, then there is no way to update by conditionalization to get $Cr_2(p) < 1$ (but see §6). Thus, at least for rational agents, if one ever gives a proposition credence 1, one can never give it a lower credence; if either the threshold view of belief or (UNITY) is correct, then one will never withhold outright belief, either. But this need not be so if (CONTEXT) is true. For according to (CONTEXT), an agent's degrees of belief vary with features of context other than her evidence. In particular, on the modified Bayesian formalism I propose below, credence functions are not always obtained by conditionalization on previous credence functions. It is possible to have $Cr_1(p) = 1$ and $Cr_2(p) < 1$, as we will see in §5 Therefore, if (CONTEXT) is true, it should be possible to believe p to degree 1 without being certain that p, for certainty requires a stability of opinion that $Cr(p) = 1$ does not.

Thus, we see that neither the betting worry nor the certainty worry give good reason to reject (UNITY), provided that (CONTEXT) is true. I know of no other reason to reject the left-to-right direction of (UNITY).

5. New Formalism

I have argued that (UNITY) solves a number of problems faced by the threshold view and that (CONTEXT) makes (UNITY) plausible. Now I will sketch a formal framework for representing credences on which (CONTEXT) and (UNITY) are true. The idea behind the formalism is to represent contexts by sets of points, or possibilities — the possibilities taken seriously by the agent in the context. We define a "global" credence function over the whole space of possibilities and derive "local" credences in each particular context by restricting the global function to the set of possibilities characterizing the context in question.

Let a credal state $\mathcal{S}$ for a set of propositions P be a quadruple $(U_\mathcal{S}, \mathcal{C}_\mathcal{S}, \|\cdot\|_\mathcal{S}, Cr_\mathcal{S})$, where $U_\mathcal{S}$ is a universe of points, $\mathcal{C}_\mathcal{S}$ is a set of subsets of $U_\mathcal{S}$ (contexts), $\|\cdot\|_\mathcal{S} : P \to U_\mathcal{S}$ is a valuation function,[13] and $Cr_\mathcal{S} : D_\mathcal{S} \to [0,1]$ is a conditional credence function (the agent's "global" credence function) whose domain $D \subseteq \mathcal{P}(U) \times \mathcal{P}(U)$ is as follows.[14] Let $\|P\| \subseteq \mathcal{P}(U)$ be the set $\{\|p\| \,|\, p \in P\}$ of the valuations

12. I lean toward the approach to interpreting degrees of belief advocated in Eriksson and Hájek (2007), according to which we take *degree of belief* as a primitive concept and get at its meaning via the "platitudes" we take to be true about it. Thus, I have not much to say about what it means for one to have $Cr(p) = 1$ beyond giving a formal system for working with the function $Cr(\cdot)$.

13. The valuation need not be classical. We are not modelling only rational agents' credences, so we cannot assume, e.g., that contradictions are false at every point. Generally, we can see the valuation as encoding information about the agent's logical beliefs, in a manner of speaking.

14. The subscripts on U, $\mathcal{C}$, $\|\cdot\|$, D, and Cr will be suppressed where there is

of the propositions in P. Then D is a superset of $U \times \mathcal{C}$ and $\|P\| \times \mathcal{C}$. We write the value of Cr on an ordered pair $(X, Y) \in D$ as $Cr(X|Y)$ if $Y \neq U$ and call this value the agent's global credence (or degree of belief) in X, conditional on Y (or given Y). (Note that, despite the notation, we do *not* stipulate that $Cr(X|Y) = \frac{Cr(X \cap Y)}{Cr(Y)}$ when $Cr(Y) > 0$. This is, in part, because we are not dealing only with ideally rational agents.) When $Y = U$, we write $Cr(X)$ and call this value the agent's (unconditional) global credence in X. So, our constraint on D amounts to ensuring that $Cr(\{x\}|C)$, and $Cr(\|p\| \,|C)$ are defined, for $x \in U$, $C \in \mathcal{C}$, and $p \in P$. D will usually be larger than required, with, e.g., $Cr^C(\|p\| \,|\, \|q\|)$ often being defined for $p, q \in P$ and $C \in \mathcal{C}$.[15]

Sometimes, for convenience, we will write as if Cr took propositions, rather than subsets of U, as arguments. In general, for $p, q \in P$, $Cr(p|q)$ is to be understood as $Cr(\|p\| \,|\, \|q\|)$, and likewise for expressions with a name of a proposition in one argument-place and a name of a set in the other. Similarly, it will sometimes be convenient to have a shorthand for the proposition that possibility x is actual. So, for every point $x \in U$, let p_x be the proposition that x is actual; that is, $\|p_x\| = \{x\}$. Call such a proposition the characteristic proposition for the point x. Likewise, for every context $C \in \mathcal{C}$, let p_C be the proposition that one of the members of C is actual; that is, $\|p_C\| = C$. Call such a proposition the characteristic proposition for the context C.

If $C \in \mathcal{C}$ is the current context, then the agent's current degree of belief that $p \in P$ is given by $Cr(p|C)$; in other words, the agent's degree of belief that p in context C is given by the global credence in p conditional on the proposition that one of the possibilities $x \in C$ is actual. We can thus define a function $Cr^C : D \cap [\mathcal{P}(U) \times \mathcal{P}(C)] \to [0, 1]$ giving the agent's credences in context C: let $Cr^C(X|Y) = Cr(X|Y \cap C)$ for all sets X, Y with $(X, Y \cap C) \in D \cap [\mathcal{P}(U) \times \mathcal{P}(C)]$. Call Cr^C a "local" credence function. Where $C \subseteq Y$, write $Cr^C(X)$ instead of $Cr^C(X|Y)$, and call this value the agent's (unconditional) local credence in X.

Now we can state the reason for taking conditional rather than unconditional global credences as primitive. All actual agents' credences are contextual and thus given by a local credence function, not a global one. The global credence function tells us how the agent's various local credence functions hang together, so to speak — it tells us how an agent's credences will change given a change in context. But an unconditional global credence tells us nothing about the agent in any particular context; it has no particular link to any local credence function. Thus, there is no need to ensure that unconditional global credences will be defined. Conditional global credences, on the other hand, tell us how local credence functions will behave, and so are essential to the framework.

So much for (CONTEXT); what about (UNITY)? The latter thesis has to do with the relationship between credences and outright belief, but our framework so far concerns only credences. Therefore, all we need stipulate to make (UNITY) come out true is that the agent believes that p in a context C just in case $Cr^C(p) = 1$. But we should not be quite so cavalier: the framework may then have undesirable consequences for outright belief. I have argued in Clarke (MS) and Clarke (2012) for an independently motivated picture of outright belief which is context-sensitive along the lines of (CONTEXT); roughly put, the view there is that to believe that p in a context C (characterized, as here, by a set of possibilities) is to rule out all possibilities in C where p does not hold. Unfortunately, a full discussion of that account and its relationship to the framework described in this section would take us too far afield. Still, the sketch of a formal account of credences we have here is enough to give the credence-sensitivist view some substance and to allow us to ask whether one can coherently be both a Bayesian and a sensitivist. That is the topic of the next section.

no ambiguity.

15. Since we are not dealing with rational credence, it need not trouble us that there is no agreement on how best to axiomatize conditional *probability* (cf. note 1 on page 2): since the credences we are dealing with here need not be rational, they need not be probabilities.

6. It's Still OK to Be a Bayesian

In the final two sections of this paper, I will give some discussion of the account of belief and credence described above. First, in this section, I argue that my credence-sensitivist view is compatible with a version of Bayesianism. In the next section, I will argue that my view has some further virtues.

What makes a theory of partial belief Bayesian? Well, two main things, as I see it: first, that ideally rational agents' credences satisfy the probability calculus (probabilism); and, second, that ideally rational agents' credences are updated by conditionalization. There are multiple plausible versions of probabilism compatible with the framework of §5. Minimally, probabilism should require that for each $C \in \mathcal{C}$, $Cr^C(\cdot)$ satisfies the probability axioms. But probabilists will generally want more than this, I think. For one thing, there is the constraint that we should have $Cr(X|Y \cap Z) = \frac{Cr(X \cap Y|Z)}{Cr(Y|Z)}$ whenever $Cr(X|Y \cap Z)$, $Cr(X \cap Y|Z)$, and $Cr(Y|Z)$ are all defined and $Cr(Y|Z) > 0$. This constraint does not follow from the probability axioms themselves, but see Hájek (2003, §9) for an argument that it is a good constraint for conditional probabilities. For the orthodox Bayesian, this constraint comes out as trivially true, by the definition of $Cr(X|Y)$; but unlike the orthodox Bayesian, I take conditional probabilities as primitive, rather than defining them in terms of unconditional probabilities. (Cf. note 1 on page 2 and note 15 on the previous page.) We might slightly strengthen the constraint to demand that whenever $Cr(Y|Z)$ is defined and positive, $Cr(X|Y \cap Z)$ and $Cr(X \cap Y|Z)$ should also be defined, for all $Z \subseteq U$ with $Y \cap Z \neq \emptyset$. Finally, we might want the global credence function $Cr(\cdot)$ itself to satisfy the probability axioms. (This last requirement would have to be interpreted as a requirement on how one's credences should cohere across contexts, rather than as a synchronic requirement on one's credences; one's credences at any particular time are given by one of the local credence functions Cr^C. We will return to this point below.) Note, incidentally, that if the global credence function satisfies the probability axioms plus the above identity for conditional probabilities, then it follows that each of the local credence functions will also satisfy the probability axioms; but the converse implication is false. The important thing to note about all of these requirements is that they are all perfectly compatible with the credence-sensitivist framework. Sensitivists can be probabilists.

The credence-sensitivist framework is also compatible with multiple versions of the Bayesian rule of updating by conditionalization. Minimally, we can require that $Cr^C(p|q)$ be defined (i.e., that $Cr(\|p\| \mid \|q\| \cap C)$ is defined for all $p, q \in P$) and then say that when one learns in context C that q, one's new credence that p in context C should be $Cr^C_{new}(p) = Cr^C_{old}(p|q)$. Things get more interesting when we look at how contexts must change, both locally and globally, when one acquires new evidence. Locally, we might say that when one learns that q, one's context must shift in some specified way, say to the largest $C' \subseteq C$ with $\|\neg q\| \cap C' = \emptyset$. Globally, we might require moving from $\mathcal{C}$ to $\mathcal{C}'$, perhaps requiring that all contexts $C' \in \mathcal{C}'$ assign $Cr^{C'}(q) = 1$. There is much to be explored in this direction, but that would be outside the scope of this paper. However, the credence-sensitivist framework advanced here is clearly compatible with updating by conditionalization, in some form.

Aside from the question of whether our framework is compatible with the two main components of Bayesianism, there is of course the question of whether the standard Dutch book arguments for each component still go through. In brief, there is good news and bad news: some Dutch book arguments still go through, but some do not. In particular, the diachronic Dutch book arguments used to justify updating by conditionalization do not work, because gaining new evidence can result in a change of context — new possibilities may come to be taken seriously. This will result in a change of the underlying space on which one's local credence function is defined in what may not be a predictable (and hence, Dutch-book-exploitable) way. On the other hand, synchronic Dutch book arguments may still go through. For example, it is still the case that if, in context C, one has $Cr^C(p) = 0.7$ and $Cr^C(\neg p) = 0.7$, then one will regard as favourable

both of the following bets: (1) a bet that costs \$1 and pays \$1.50 if p; (2) a bet that costs \$1 and pays \$1.50 if $\neg p$. (Expected value of each bet: $(\$1.50)(0.7) - \$1 = \$0.05$.) But if one buys both bets, then one is guaranteed to pay \$2 but win back only \$1.50 — a sure loss of \$0.50. Here we must assume that C is the context one would be in after the bets have been offered. In general, as has been pointed out, offering a bet is a way of bringing new possibilities into serious consideration. So synchronic Dutch book arguments can be expected to work,[16] but only for the context in which a Dutch book has been offered; Dutch book arguments cannot show that one's local credence function in other contexts ought to be probabilistic.

Of course, the so-called non-pragmatic or epistemic arguments for probabilism should also go through exactly as well on a sensitivist as on a non-sensitivist framework. See, e.g., Joyce (1998) and Leitgeb and Pettigrew (2010a,b).

So I would describe the formal framework of §5 as broadly Bayesian, or at least Bayesian-friendly, although it certainly diverges from Bayesian orthodoxy. Note, in particular, that sensitivism lets us preserve the main victories of Bayesianism.

The most celebrated Bayesian success stories — to follow the list from Earman (1992): solving the ravens paradox,[17] explaining the value of surprising or novel evidence and of diverse evidence, and shedding light on the Quine-Duhem problem and Goodman's new problem of induction — depend on the Bayesian account of confirmation. Therefore, my strategy here will be to show that sensitivists can hold on to the Bayesian account of confirmation and thereby hold on to the Bayesian success stories. For a Bayesian, an evidence proposition e confirms (disconfirms, is confirmationally irrelevant to) an hypothesis h relative to background evidence k just in case $\Pr(h|e \wedge k)$ is greater than (less than, equal to) $\Pr(h|k)$. The probability function here is supposed to represent the credences of an ideally rational agent. Typical Bayesian explanatory successes involve showing that, given certain background information about the case to be explained, any agent whose credences are probabilistic and who updates them by conditionalization must have her credence in h raised (or lowered, or unchanged) by learning e; or that her credence in h must be raised more by e_1 than by e_2, or that e raises her credence in h_1 more than in h_2, and so on. Now, given that my sensitivist framework is compatible with requiring that ideally rational agents have probabilistic credences and that they update their credences by conditionalization, it follows that the Bayesian account of confirmation is also compatible with my framework; and if this is the case, then the explanatory successes of Bayesian confirmation theory should carry over when the Bayesian moves to my sensitivist framework.

For example, consider the standard Bayesian solution to the ravens paradox. To be brief and to oversimplify, the Bayesian argues that since non-black things are much more numerous than ravens, discovering that a randomly selected object is a non-black non-raven is much less improbable than discovering that the object is a black raven; accordingly, a rational agent's credence in the hypothesis that all ravens are black — or, equivalently, that all non-black things are non-ravens — should be increased much more by finding a black raven than by finding a non-black non-raven. Here are the sorts of things that need to be true for the Bayesian solution to work (cf. Vranas (2004, §2) for the argument behind the Bayesian solution; here, "Ra" means that a is a raven, "Ba" that a is black, and "H" that all ravens are black.):

1. $Cr(Ra)/Cr(\neg Ba)$ is minute. (Or, $Cr(Ra) \ll Cr(\neg Ba)$.)
2. $Cr(Ra|\neg Ba) > 0$.
3. $Cr(Ba|H) = Cr(Ba)$.

16. Or rather, they can be expected to work exactly as well as they work in a non-sensitivist framework. There are, of course, those who object to Dutch book arguments on other grounds, and their objections will not be any stronger or weaker on the present sensitivist framework.

17. I argue in Clarke (2010) that the Bayesian solution to the ravens paradox is not ultimately satisfying; but this is for reasons independent of sensitivism. The point here is that the Bayesian solution to the ravens paradox works exactly as well for the sensitivist as for the orthodox Bayesian.

4. $Cr(\cdot)$ satisfies the probability axioms.[18]

The Bayesian wants to conclude that any agent whose relevant credences are rational and accurate will find that the hypothesis that all ravens are black is confirmed to a much higher degree by finding a black raven than by finding a non-black non-raven. 1 and 2 constitute the requirement that the agent have accurate credences: she should think that there are many more non-black things than there are ravens (1) but should not already be ruling out the possibility of a non-black raven (2). 4 is a rationality requirement. 3 may fall into either category; the point of Vranas (2004) is that no satisfactory argument for 3 has been offered.

There is no reason why this argument should not go through on my sensitivist framework, given that it goes through on the orthodox framework. So long as an agent's credences are probabilistic, and meet the conditions 1–3, the conclusion of the standard Bayesian solution will hold. An agent who violates 1 or 2 misunderstands the situation of the ravens paradox; the standard Bayesian solution has nothing to say about such an agent. An agent who violates 4 is irrational by the Bayesian's lights; the standard Bayesian solution has nothing to say about such an agent. An agent who violates 3 either misunderstands the situation or is irrational, depending on what the justification for 3 is supposed to be; the standard Bayesian solution has nothing to say about such an agent. It does not matter why the agent violates 1–4: even if it is because some shift in context has caused the agent to revise the possibility space underlying her credences, she still either misunderstands the situation or is irrational. In short: the Bayesian can say what he wants to say about all agents he wants to say it about. Adding context-sensitivity to the picture saps none of the Bayesian's strength.

18. I write "$Cr(\cdot)$" rather than "$Cr(\cdot|\cdot)$" because orthodox Bayesians usually do not take conditional credence to be primitive, as I have, but rather take the equation $Cr(p|q) = Cr(p \wedge q)/Cr(q)$, $Cr(q) > 0$, to *define* conditional credence. Cf. footnote 1 on page 2 and footnote 15 on page 12.

7. Some Further Virtues

In this section, I argue that my credence-sensitivist view has three nice features: it draws a satisfying connection between outright belief and action, it answers the so-called Bayesian Challenge, and it justifies us in calling credences "degrees of belief".

7.1 Belief and Action

Maher (1986) and Kaplan (1996, 103–5) point out that, if outright belief is compatible with credence less than 1, then the following plausible-sounding maxims must be false:

1. If one's beliefs are rational, then it is rational to act on them. That is, if it is rational for one to believe that p, then it is rational for one to act as if p.
2. A rational person ought always to act in accordance with her beliefs, or as if her beliefs were true.
3. To believe that p is to be disposed to act as if p.

Maher and Kaplan gloss "acting as if p," and the other related locutions above, as acting in a way that one believes would be optimal if p is true. 1 and 2 are common-sense principles about rational action and belief; variations on 3 are endorsed by, e.g., Braithwaite (1932) and Marcus (1990, 140), as an analysis of belief.

Here is the reason none of these maxims would hold up. Suppose you believe that p, but your credence in p is $x < 1$, and your credence in $\neg p$ is $(1 - x)$. Now you must choose between an action A which is worth \$0 whether p is true or false, and an action B which is worth \$1 if p is true and $-\$(\frac{x+S}{1-x})$, for some positive number S, if p is false. The expected value of A is 0, and the expected value of B is $x \cdot \$1 - (1 - x)(\$\frac{x+S}{1-x}) = -\$S$; thus, A has a greater expected value than B, and so if you are rational, you should do A rather than B. But if p is true, then B is optimal: if p is true, then A is worth \$0, and B is worth \$1. So if you were to act according to your beliefs, i.e., as if p were true, then you would act irrationally. Furthermore, on some

behaviouristic/dispositional interpretations of credence — e.g., if having $Cr(p) = x$ means being disposed to accept any bet on p at odds $x : 1 - x$ or better — then it follows that you will not act according to your belief that p in this case, regardless of whether you are rational.

It should be clear that this problem does not arise for the credence-sensitivist, thanks to (UNITY). If you believe that p in the context of the bet above, then you must have credence 1 that p. Thus, the maxims 1–3, in some form, are still available on my account. I say "in some form" because there is something importantly right in Maher and Kaplan's arguments. Consider the following two variations on a principle like 1 and 2:

4. If S believes that p at t, then at t, S should act on p.
5. If S believes that p at t, and S has not revised her beliefs between t and $t + \epsilon$, then S should act on p at $t + \epsilon$.

I think 4 is right but 5 is wrong. If S believes that p at t, then S must have $Cr(p) = 1$ at t; therefore, S should regard as optimal whatever action would be optimal if p is true. This is why 4 is right. But between times t and $t + \epsilon$, there may have been some change in S's context so that, despite not having changed or revised her credal state (globally), she no longer has $Cr(p) = 1$ (locally). In particular, if she is offered a bet on p carrying the risk of a heavy loss if it turns out that $\neg p$, S is likely to have her credence in p drop, due to thinking of new $\neg p$-possibilities which she was previously ignoring. Therefore, it might turn out that, at $t + \epsilon$, S should not regard as optimal the action that would be optimal in case p is true, for exactly the reasons Maher and Kaplan point to.

Thus, sensitivism allows us to hold on to some of what is right about both the traditional doctrine that one ought to act on one's beliefs and Maher and Kaplan's arguments against that doctrine.

7.2 Answering the Bayesian Challenge

Kaplan (1996, 98ff) poses what he calls the "Bayesian Challenge". Roughly, here it is: All we need for decision theory, and therefore all we need to explain rational action, is credence, not outright belief; so what is the point of talking about outright belief at all? What work does outright belief do for us? What does it explain?

As Kaplan poses the Bayesian Challenge, it would be acceptable to answer that outright belief is reducible to credence, so talk about outright belief indirectly does the same work that talk about credence does. Sensitivism can easily answer this version of the Challenge: to believe outright that p is to have $Cr(p) = 1$. But I think the Bayesian Challenge generalizes: even if belief is reducible to credence, we still have the question of whether we are ever better off talking about outright belief rather than credence. It would be very unsatisfying if belief-talk could always be replaced with credence-talk without losing anything. (Kaplan presents the Bayesian Challenge only after rejecting the possibility of reducing belief to credence — because he rejects the threshold view and (UNITY) — so it is not surprising that he gives the form of the Challenge that he does.) That is, we can see the sort of objection to the threshold view that I attributed to Stalnaker at the start of §3.2 as a generalization of the Bayesian Challenge. However, I have already addressed that objection in §3.2, so I will not discuss it any further here.

7.3 Degrees of What?

I have already mentioned, in note 10 on page 9 and note 12 on page 11, that I am impressed by the arguments in Eriksson and Hájek (2007) against analyses of credence in terms of betting behaviour (or anything like it), and in favour of taking credence as a primitive, unanalyzed term. Of course, one of the benefits of having an analysis of credence is that we would always know what we mean when we say that some agent has $Cr(p) = x$, or $Cr^C(p) = x$. On the other hand, if we take credence as primitive, then we must rely on general platitudes to tell

us what it means for an agent to have $Cr(p) = x$. Now, some of the most central platitudes about credence have to do with the connection between credence and outright belief: in particular, credences are, in some sense, *degrees* of belief; to raise one's credence that p is to increase the degree to which one believes that p. I think this is one of the most central platitudes about credence, in fact.

This is important for those of us who want to give an account of outright belief in terms of credence, for such an account may conflict with the platitude. In particular, consider Kaplan's "Assertion View" of belief (1996, 109–10): "You count as believing p just if, were your sole aim to assert the truth (as it pertains to p), and your only options were to assert that p, assert that $\neg p$ or make neither assertion, you would prefer to assert that p." The Assertion View is supposed to meet the Bayesian Challenge, because it explains the importance of belief to a certain practice ("asserting hypotheses in the context of inquiry"), but belief as defined by the Assertion View is not reducible to credence. (As Kaplan puts it in stating the Bayesian Challenge, "belief is not a state of confidence".) This is, roughly, because the aim to assert the truth involves weighing the goal of avoiding error against the goal of comprehensiveness, and different people will weigh these goals differently; indeed a single person can be expected to weigh the two goals differently with respect to different propositions. I do not intend to give Kaplan's Assertion View a full treatment here; I certainly agree that highlighting the connection between belief and assertion is important, but the point I want to make here is that the Assertion View seems to violate the platitude quoted above. If belief that p is a disposition to prefer to assert that p rather than assert $\neg p$ or remain silent in a certain sort of context, it is not clear in what sense credences are degrees of belief. To be sure, increasing credence that p makes it increasingly likely that one believes that p, but raising one's credence that p does not mean that one believes that p more than previously.

This is an advantage of both the threshold view and (UNITY) over views like Kaplan's.[19] Given (UNITY) or the threshold view, the sense in which credences are degrees of belief, or partial beliefs, is obvious; and so leaving credence unanalyzed is relatively safe.[20]

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19. The view described in Weatherson (2005) — on which, roughly, one believes that p just in case one's preferences conditional on p are the same as one's unconditional preferences — is in the same boat as Kaplan's, as I read it. However, in two 2010 posts on his blog, at http://tar.weatherson.org/2010/04/03/pragmatics-and-justification/ and http://tar.weatherson.org/2010/03/30/shorter-can-we-do-without-pragmatic-encroachment/, Weatherson describes his (2005) as entailing a version of the threshold view on which the threshold for belief varies across contexts. Such a view (also endorsed by Sturgeon 2008) would be in the same boat as the threshold view and (UNITY), with respect to the argument of the present subsection.

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