Learning from Experience and Conditionalization

Forthcoming in *Philosophical Studies*

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Contents

Abstract

Bayesianism can be characterized as the following twofold position: (i) rational credences obey the probability calculus; (ii) rational learning, i.e., the updating of credences, is regulated by some form of conditionalization. While the formal aspect of various forms of conditionalization has been explored in detail, the philosophical application to learning from experience is still deeply problematic. Some philosophers have proposed to revise the epistemology of perception; others have provided new formal accounts of conditionalization that are more in line with how we learn from perceptual experience. The current investigation argues that Bayesian epistemology is still incomplete; the epistemology of perception and the epistemology of rational reasoning have not been reconciled.

1 Introduction

Bayesian epistemology can be characterized as the position that comprises the following elements: (i) rational credences obey the probability calculus; (ii) rational learning, i.e., the updating of credences, is regulated by some form of conditionalization. The first element of Bayesian epistemology is unproblematic and quickly clarified.

Definition 1 (Rational Credences)**.** *Let $\langle \Omega_{\mathcal{L}}, \mathcal{A}_{\mathcal{L}} \rangle$ be a set of possibilities, and an algebra created by a standard first-order logic $\mathcal{L}$. A function $Cr : \mathcal{A}_{\mathcal{L}} \to \mathbb{R}$ is a probabilistic and, thus, rational credence function on $\mathcal{A}_{\mathcal{L}}$ if and only if for all statements S, $S^* \in \mathcal{A}_{\mathcal{L}}$:*

1. $Cr(S) \geq 0$
2. *If $S = \Omega_{\mathcal{L}}$, then $Cr(S) = 1$*
3. $Cr(S \cup S^*) = Cr(S) + Cr(S^*)$*, if $S \cap S^* = \varnothing$*

The second element is much more problematic. Specifically, to understand rational learning, one needs to link the epistemology of perception with the Bayesian epistemology of rational reasoning. While the formalism behind various forms of conditionalization and its epistemological consequences have been explored in great detail (Brössel 2015a, Pettigrew 2019, Leitgeb and Pettigrew 2010b), the philosophical application to learning from perceptual experience is deeply problematic. The epistemological theories of perception and of rational reasoning have not been reconciled, or, as Döring (1999) puts it, "the psychology of Bayesian learning is incomplete." Since Döring's paper, various attempts have been made to reconcile the epistemology of perception and the epistemology of rational reasoning. Some philosophers have proposed to revise the epistemology of perception (Morrison 2016, 2017; Munton 2016); others have provided new formal accounts of conditionalization that are supposedly more in line with the epistemology of perception (Gallow 2014, Konek forthcoming). The current investigation argues that Bayesian epistemology is still incomplete; the epistemology of perception and the epistemology of rational reasoning have not been reconciled.

In order to reconcile the epistemology of perception and the epistemology of rational reasoning, we need to answer two questions: the **Experiential-Input Question** and the **Post-Experience Credence Question**. The first question, the **Experiential-Input Question**, belongs to the realm of the epistemology of perception and asks what new information the perceptual experience provides, i.e., what the content of one's perceptual experience is. The **Post-Experience Credence Question** aims at linking perception and rational reasoning by asking what the agent's post-experience credences should be in the light of the experiential input and the agent's pre-experience credences.[1] This paper provides an overview of the main epistemological problems plaguing our current Bayesian learning theories from perceptual

[1] Morrison (2016) uses the term 'Post-Perceptual Confidence' to refer to the position that perceptual experiences "do not themselves assign degrees of confidence". Instead, we assign levels of confidence to the content of perceptual experiences only after having the experience. My usage of 'post-experience credences' should be distinguished from this. It presupposes that we assign levels of confidence to various propositions (possibly including the contents of our perceptual experiences) and ask what credence we should assign to them in view of the perceptual experience. It is silent on the question of whether perceptual experiences themselves assign degrees of confidence. If they would, then I am interested in the question of how they inform one's post-experience credence in the same evidential statement.

experience. In particular, it shows that our current theories of how to apply the most widely known update rules—Bayes-, Jeffrey-, Field-, Gallow-, and Konek-Conditionalization—to learning from experience cannot answer the above two questions adequately.

2 The Standard Forms of Conditionalization and their Shortcomings

2.1 Learning from Perceptual Experience and Bayes-Conditionalization

Suppose Alma is a perfect Bayesian in the sense that a probability function can represent her credences in the various statements of her language. Now assume Alma rushes to catch the morning bus. Based on the information she receives from looking at her watch, which she is sure is very reliable, Alma is pretty confident she will catch the morning bus. Assume that Alma's credence that her watch is working is .9 and her credence that she will catch the bus given that her watch is not working is .1. In this paper, I refer to these as pre-experience credences. Assume that shortly before she arrives at the bus station, Alma perceives that the hands of her watch have stopped moving. The question is: how confident should Alma be that she will catch the bus now that she has learned that her watch is not working correctly, or how should Alma form her post-experience credences?

For the general case, the received answer to this question is that Alma's post-experience credence in any statement A should be her pre-experience conditional credence in A given the new information E; here E is an evidential statement with the same content as Alma's perceptual experience. Thus, the post-experience credence should be the pre-experience conditional credence. The following rule—Bayes-Conditionalization—captures this received answer.

Updating Rule 1 (Bayes-Conditionalization)**.** *If Cr is the agent's rational pre-experience credence function at time point t_0, E is the evidential statement that describes the content of the agent's only perceptual experience PE between time points t_0 and t_1, and $Cr(E) > 0$, the agent's rational post-experience credence function should be Cr_{PE}, which is defined as follows:*

$$Cr_{PE}(S) = Cr(S|E)$$

for all statements S in the agent's language $\mathcal{L}$.

To judge whether or not this answer is adequate, we need to study how advocates of Bayes-Conditionalization (could) answer the **Experiential-Input Question** and the **Post-Experience-Credence Question**. The answer to the **Experiential-Input Question** is straightforward: the content of the perceptual experience is identical to the content of the evidential statement E and, thus, is belief-like. Very few philosophers of perception and almost no epistemologists of perception object against this so-called same content thesis, according to which the contents of perceptual experiences could be the content of a belief (Siegel 2010, 2015). Furthermore, this assumption is presupposed by phenomenal conservatism and other epistemological theories of perception (Pryor 2000; White 2006).[2] Most importantly, this characterization of perceptual

[2]I have reservations agreeing with the same content thesis. My preferred view is that the content of perceptual experiences is not belief-like but much richer and more picture-like (see Brössel 2018; and also Marr 1982, Gauker 2011).

information satisfies two highly intuitive requirements. Satisfying these two requirements is an essential precondition for obtaining a suitable connection between the perceptual experience and one's post-experience credences. First, it characterizes the experiential input independently of the agent's pre- and post-experience credences and allows us to speak of different agents with different credences but identical perceptual experiences. Second, it allows us to understand why it is irrational to choose certain more theoretical statements such as "Only communism can lead to a free and just society"[3] as one's evidential input upon having a perceptual experience. The epistemology of perception underlying Bayes-Conditionalization ensures the latter criterion is satisfied. The same content thesis states that all contents of perceptual experience are statements that could also figure in beliefs; it does not claim that all statements that could figure in beliefs could be the content of a perceptual experience. Even though philosophers of perception are still debating whether the contents of perceptual experiences are "thin" or "rich" (Siegel 2010, Toribo 2015), everyone agrees that statements of the form "Only communism can lead to a free and just society" cannot figure in the contents of perceptual experiences. This statement's logical form is too complex, and the concepts figuring in it are too rich.

Epistemologists typically object to how Bayes-Conditionalization answers the **Post-Experience-Credence Question**. In particular, by applying this rule, Bayesian agents become certain of the evidential statement that describes the content of one's perceptual experiences; their post-experience credence in the evidential statement is 1. This is not typically true for rational learning episodes of epistemic agents. Epistemologists have described various skeptical scenarios in which we do not want to completely accept the evidential statements of our perceptual experiences. Even in everyday life, we admit that the evidential statement may be false; thus, we do not trust them completely. Suppose our Bayesian agent Alma has a perceptual experience with the false content E^*, e.g., such as in the Müller-Lyer illusion in which the perceptual experience seemingly comes with the false evidential statement that one line is longer than the other. If Alma follows Bayes-Conditionalization, the credence in E^* increases to 1 (since the old conditional credence of E^* given E^*, $Cr(E^*|E^*)$, is always 1). This is problematic since Alma cannot learn another statement such that she lowers her credence in E^*. If $Cr(E^*) = 1$ there is no statement S such that $Cr(S) > 0$ and $Cr(E^*|S) < 1$.

A further related criticism is that Bayes-Conditionalization conflicts with a philosophical insight by Duhem. Duhem's Holism (Christensen 1992; Weisberg 2009) is thus a specter that haunts Bayesian epistemology. Applied to perceptual experiences, it requires the following:

> No sentence, holds the holist, is tied so immediately to experience that our belief in it is entirely independent of our other beliefs. Some of our beliefs are less directly dependent on theoretical considerations than others, but even at the limit of observationality—even for those sentences at the "periphery" of our theory—connections to other beliefs can undercut the force of experience. (Christensen 1992: 545)

Holism requires that perceptual experiences alone do not determine a statement's post-experience credence. The post-experience credence for any statement should not be independent of one's pre-experience credence in other statements. If the agent had had different

[3]This example is due to Jonathan Weisberg, who used it in a talk back in 2009. I have not found it in print.

pre-experience credences, then the post-experience credence might have looked different. Christensen (1992: 542) invites us to consider the example of two agents who both have identical expectations concerning the color of the tablecloth next door before they go next door and examine it. However, only one of the agents believes that "she is a subject in a perceptual psychology experiment, in which the lighting has been manipulated to give misleading color impressions." Intuitively, the agent with this background belief should end up with different post-experience credences than the agent without that belief, even if they both had identical perceptual experiences of the tablecloth's color. Bayes-Conditionalization violates this requirement since the perceptual experience alone determines the new credence of the evidential statement.

The final criticism is that even if we restrict ourselves to cases where we can trust our perceptual experiences completely, it is well known that Bayes-Conditionalization is not always suitable. Adapting the above example from Christensen, imagine we see a tablecloth in perfect lighting conditions; to us, it seems to be black, but we still do not become certain of its blackness, e.g., because we are not certain that it is not some shade of dark blue. Still, we might want to increase our credence in the statement that it is black. Even in cases of clear and vivid perceptual experiences and without any skeptical scenario in the background, it is hard to name which evidential statement we become certain of in virtue of perceptual experience and which explains all the changes in our credences. In the case described, one might argue that the evidential statement that we become certain of is: "the tablecloth is black or dark blue". However, this could not explain why we are increasing our credence in "this tablecloth is black" more than in "this tablecloth is dark blue". For a discussion of related criticisms, see Jeffrey 1975, Christensen 1992, and Morrison 2016.

We conclude that Bayes-Conditionalization provides the wrong answer to the **Post-Experience-Credence Question**. For most applications to particular epistemological cases, it is overly idealized. An update rule should not necessitate assigning probability 1 or 0 to evidential statements. Furthermore, an adequate update rule should not require assigning a post-experience credence based only on the experiential input. Adequate update rules would also take the pre-experience credences in the evidential statement and other statements describing "more theoretical considerations" into account.

In light of this criticism, it does not suffice that Bayes-Conditionalization does satisfy a highly desirable additional requirement for answering the **Post-Experience-Credence Question**: namely the commutativity requirement, i.e., that the order in which the experiential input is taken into account should be irrelevant to which post-experience credences one should adopt.

2.2 Learning from Perceptual Experience and Jeffrey-Conditionalization

In reaction to the main criticism directed at Bayes-Conditionalization, Jeffrey (1983) proposed a more general update rule to incorporate the idea that an agent's perceptual experiences do not always make the agent certain of an evidential statement. Formally, Jeffrey-Conditionalization assumes that the input parameter $\mathcal{I}$ is a pair consisting of mutually exclusive and jointly exhaustive evidential statements $\{E_i\}$ that are directly affected by the perceptual experience and a set of new credences $\{Cr_{\mathcal{I}}(E_i)\}$ for these statements. Relying on such input parameters, Jeffrey (1983) suggests the following update rule to model Bayesian learning.

Updating Rule 2 (Jeffrey-Conditionalization)**.** *Let Cr be the agent's rational pre-experience credence function at time point t_0. Let PE be the agent's only perceptual experience between time points t_0 and t_1. Let $\{E_i\}$ be some set of mutually exclusive and jointly exhaustive statements (with $Cr(E_i) > 0$ for all E_i), and let $\mathcal{I}$ be the experiential input parameter of the agent's only perceptual experience PE between time point t_0 and t_1 (with $\mathcal{I} = \langle\{E_i\}, \{Cr_{\mathcal{I}}(E_i)\}\rangle$ and $\sum_i Cr_{\mathcal{I}}(E_i) = 1$). Then the agent's post-experience credence function should be Cr_{PE}, which is defined as follows:*

$$Cr_{PE}(S) = \sum_i Cr(S|E_i) \times Cr_{\mathcal{I}}(E_i)$$

for all statements S in the agent's language $\mathcal{L}$.

If, according to the input parameter, the post-experience credence for some (evidential) statement E_i is 1, and 0 for all other such statements E_j for $i \neq j$, Jeffrey-Conditionalization is equivalent to Bayes-Conditionalization. Thus, from a formal perspective, Bayes-Conditionalization is a special case of Jeffrey-Conditionalization. Bayesians prefer it to Bayes-Conditionalization because it holds the promise of being applicable in more realistic cases, e.g., when the agent does not become certain of an evidential statement because of her perceptual experience. For applying the rule to cases of perceptual learning, we need to answer the **Experiential-Input Question** and the **Post-Experience-Credence Question**.

Jeffrey (1968) famously refuses to answer the **Experiential-Input Question**. He exiles the questions of what the content of one's perceptual experience is from the realm of normative epistemology to that of psychology. The same holds for the question of how the content of the perceptual experience, together with the agent's previous credences, determines rational post-experience credence. Strictly speaking, the set $\{E_i\}$ of mutually exclusive and jointly exhaustive statements is not a set of evidential statements in the sense that one of them describes the content of the agent's perceptual experience. (The "whole point of [Jeffrey's] probability kinematics is to deal with that sort of situation where there is no proposition in the agent's language that is the epistemic input of the evidential experience", Skryms 1987: 7.) They are only evidential statements in the sense that these are the statements that are directly affected by the perceptual experience. Jeffrey assumes that somehow perceptual experiences, together with the agent's previous epistemic state, cause new credences for certain statements. The perceptual experiences and "patterns of irritation of our sensory surfaces are not reasons or evidence for any of our beliefs, any more than irritation of the mucous membrane of the nose is a reason for sneezing" (Jeffrey 1968: 176). For Jeffrey, the input parameter describes what he takes to be the output of a perceptual-psychological process: the post-experience credence for these statements. According to him, these post-experience-credences are compulsory in the sense that "I cannot decide to have a different degree of belief in the proposition, any more than I can decide to walk on air" (Jeffrey 1968: 176). For this reason, Jeffrey-Conditionalization (exclusively) prescribes how to adjust one's other credences to the compulsory post-experience credences for some statements. Consequently, Jeffrey-Conditionalization satisfies a property called **Rigidity**. Jeffrey-Conditionalization is rigid in the sense that for all statements S, the conditional credences in various statements S given one of the statements E_i of the evidential input remain unchanged: $Cr_{PE}(S|E_i) = Cr(S|E_i)$. Accordingly, we are to treat perceptual experiences as providing information "about which of the E_i is true, but not about what else is true given that E_i is true" (Konek forthcoming). By assumption, $\{E_i\}$ is the set of mutually exclusive and jointly exhaustive statements whose

credences are directly affected. Since the credences in the statement $S \cap E_i$ are not directly affected, we require that $Cr_{PE}(S|E_i) \neq Cr(S|E_i)$. If the perceptual experience required changing these conditional probabilities, then the set of statements that had been directly affected would have been $\{E_i \cap S, E_i \cap \neg S\}$.

Jeffrey's refusal to answer the **Experiential-Input Question** seems to arise from the idea that there is no epistemology of perception; there is only an epistemology of rational reasoning. Most epistemologists and philosophers of perception, however, disagree. They want to ask and answer both questions, the **Experiential-Input Question** and the **Post-Experience Credence Question**. Consequently, Jeffrey's account of learning from perceptual experience cannot satisfy our first two requirements. Jeffrey does not characterize the experiential input independently of the agent's pre- and post-experience credences. And he does not allow us to understand why it is irrational when one's perceptual experiences directly influence one's credences in certain more theoretical statements such as "Only communism can lead to a free and just society." Intuitively, if Alma has a perceptual experience of the hands of her watch and matching "patterns of irritation on one's sensory surfaces", it would be irrational if one adopted a high post-experience credence in the "evidential" statement that only communism can lead to a free and just society, even if this post-experience credence is psychologically compulsory. For Jeffrey, however, such a judgment of irrationality is beyond the scope of normative epistemology. Agents such as Alma are rational if they adjust their credences in other statements whenever they are compelled to adopt a specific post-experience credence for some statement.

A related criticism of Jeffrey's account of learning from perceptual experience is that Jeffrey-Conditionalization is not commutative. Domotor (1980), Döring (1999), and van Fraassen (1989) are among those philosophers who reject Jeffrey-Conditionalization based on this property. Commutativity requires that it is not crucial in what order an agent's perceptual experiences are taken into account. Suppose one day our perfect Bayesian agent Alma has a sequence of perceptual experiences $\{PE_i\}$. Instead of immediately updating her credences, she decides to postpone updating them until the evening after the last perceptual experience has been had. In the evening, Alma asks herself in what order she is permitted to take the different perceptual experiences into account to update her credences. According to the commutativity requirement, it should not make a difference in what order she takes them into account. Whether Alma starts with the latest perceptual experience or the earliest one should not matter. The idea is that once the information or content of the perceptual experiences is specified, we can consider them in whichever order we like.

The problem is that Jeffrey-Conditionalization does not generally satisfy this intuitive requirement.[4]
According to Jeffrey-Conditionalization, an agent must take into account the different effects of the perceptual experiences $\{PE_i, \}$ in precisely the order in which the experiences were made. All other update-sequences can lead to a different credence function.

Some philosophers oppose this commutativity requirement. However, in my view, their opposi-

[4]Diaconis & Zabell (1982: 825) explain the narrow conditions under which Jeffrey-Conditionalization is commutative. These conditions are extremely implausible for realistic cases of learning from perceptual experience.

tion is based on misunderstanding the requirement. An example of this misunderstanding can be found in the works of van Fraassen (even though he defends the criterion!).

> Two persons, who have the same relevant experiences on the same day, but in a different order, will [according to Jeffrey-Conditionalization] not agree in the evening even if they had exactly the same opinions in the morning. Does this not make nonsense of the idea of learning from experience? (van Fraassen 1989: 338)

The order of experiences can and should make a difference to an agent's epistemic state. It is relevant whether our agent Alma sees a man in the morning in a green suit and in the evening in a blue suit or the other way around. Typically the credence states resulting from such a change in the order of perceptual experiences are mutually incompatible. Hence, Lange is almost right when he notes that

> Although Jeffrey's rule is formally noncommutative, this does not represent a defect in the rule. On the contrary, this kind of non-commutativity is exactly right. The key point will be that in switching the order in which numbers are plugged into Jeffrey's rule, we are not really switching the order in which the same two sensory experiences are taken into account. Rather, we are dealing with entirely different pairs of observations. That is why they should generally yield different final degrees of belief. (Lange 2000: 393)

However, Lange is wrong when he rejects the commutativity requirement based on this observation. The point is that changing the order in which perceptual experiences are taken into account is not the same as changing the perceptual experiences or, respectively, the order in which they were made. According to the best story that defenders of Jeffrey-Conditionalization can come up with, this is necessarily the same thing. However, the commutativity requirement only requires that the order in which the perceptual experiences are taken into account is not essential for the result of the learning process. The fact that Jeffrey-Conditionalization cannot distinguish between both requirements demonstrates its inadequacy. It cannot differentiate between the two requirements because we have not yet received an adequate answer to the **Experiential-Input Question**. If we could characterize the experiential input independently of the agent's pre- and post-experience credences, we could satisfy the commutativity requirement.

One possible answer to the **Experiential-Input Question** is that the input parameter is part of one's perceptual experience. According to this picture, perceptual experience not only has an evidential statement E as its content but also assigns perceptual credence $Cr_I(E)$ to that statement. $Cr_I(E)$ is, thus, the experiential input. This view has never been proposed in the context of the philosophy or the epistemology of perception; or at least not until recently. For in light of the phenomenology of perceptual experiences, the view is not attractive, let alone immediately plausible. Nevertheless, the view that perceptual experiences come with such a kind of input has recently been defended mainly for epistemological reasons, especially by Morrison (2016, 2017), but also Munton (2016) and Moss (2018). (For criticism of this view, see Beck 2020; and, most comprehensively, Raleigh and Vindrola 2020. The main focus of their criticism is that it gets the philosophy of perception wrong. The present paper additionally argues that it does not provide an adequate foundation for understanding rational learning from experience.) Morrison (2016) dubs this view **Perceptual Confidence** and argues that

it "best explains what happens when we completely trust our experience." Morrison invites us to imagine we completely trusted our experience of an approaching man whom we, step by step, recognize to be Isaac. Morrison writes that even if we trusted our senses completely, we would not "suddenly transition from zero percent doxastic confidence to one hundred percent doxastic confidence it's Isaac. Instead, at some point [we]'ll end up with slightly more doxastic confidence that it's Isaac than not. Say: fifty-five percent. What explains [our] slightly asymmetrical distribution of doxastic confidence? **Perceptual Confidence** can offer a simple and plausible explanation." Let us grant for the sake of argument that perceptual experiences do not only have an evidential statement E as their content but also assign perceptual credence $Cr_I(E)$ to that statement; we accept this as the answer to the **Experiential-Input Question**. But how should we answer the **Post-Experience-Credence Question**?

This is precisely the question Carnap tried to tackle in a letter to Jeffrey (see Jeffrey 1975). Christensen summarizes Carnap's findings as follows:

> Carnap discovered difficulties as soon as he considered which rule should be used for computing the agent's post-experience probabilities from her pre-experience probabilities plus the input. [...] Suppose that the degree of support an agent's [perceptual experience] lends to [some statement] G is 0.8. Suppose that the agent's probability for G on the rest of her evidence is 0.9. What should the agent's post-experience probability for G be? It should not be simply 0.8—that would ignore all the rest of her evidence. Similarly, it should not simply be 0.9—that would ignore the new evidence. Carnap's guess was that the post-observation probability should be greater than 0.9 since the experience should presumably count as additional evidence in favour of G; however, he saw no particular value as clearly mandated. Carnap reports that he grew so discouraged with the project of formulating a rule for using his inputs that he gave up trying without making a serious effort. (Christensen 1992, 550–551)

Carnap's difficulties emerge for our perfect Bayesian agent Alma even if she trusts her perceptual experiences completely. Suppose Alma's partner has told her that he will be wearing a dark blue suit for the dinner party and that this is the only suit he owns. She forms the following credence: $Cr(\text{He is wearing a dark blue suit}) = 0.9$. Then she arrives at the dinner party and has a perceptual experience that comes with the following input: $Cr(\text{He is wearing a black suit}) = 0.6$, $Cr(\text{He is wearing a dark blue suit}) = 0.4$, and 0 for all other colors. She should not ignore all the previous evidence only because she wants to trust her perceptual experience completely. She also should not ignore the new experiential input. What credence should she adopt as the new post-experience credence?

Carnap's difficulties in finding an answer arise from the challenge of Holism (Christensen 1992; Weisberg 2009), according to which "[n]o sentence [...] is tied so immediately to experience that our belief in it is entirely independent of our other beliefs" (Christensen 1992: 545). Thus, if we interpret Jeffrey's input parameter as being part of one's perceptual experiences, then Jeffrey-Conditionalization violates Holism. The perceptual experience alone determines the input parameter, and the input parameter alone determines one's credence in the evidential statement included in the perceptual experience.

But even if one is inclined to sacrifice Holism for Jeffrey-Conditionalisation, a further problem awaits the user of Jeffrey's update rule. This is emphasized by Trpin (2020) in his "Jeffrey-Conditionalization: Proceed with Caution". Suppose a trick coin c always lands on its head when tossed: $Bias_c(h) = 1$. The task of our Bayesian agent Alma is to learn that it is such a trick coin from a potentially infinite sequence of coin throws. However, suppose Alma forgot her glasses, and therefore her perceptual confidence for each observed head outcome h_i is not 1 but, say .8. So for each coin toss with head-outcome h_i she updates on the input parameter $Cr_{\mathcal{I}}(h_i) = .8$. Intuitively we would want that she can learn $Bias_c(h) = 1$ at least with some probability above .5. Unfortunately, this is not what Alma gets from Jeffrey-Conditionalization. Instead, the more of these uncertain perceptual experiences of heads Alma is experiencing, the more certain she becomes that the hypothesis $Bias_c(h) = 1$ is false: $\lim_{n\to\infty} Cr_{t_n}(Bias_c(h) = 1) = 0$ if the experiential input for Jeffrey-Conditionalization is $Cr_{\mathcal{I}}(h_i) = .8$ (for each coin toss). Instead, she becomes certain that the hypothesis that the bias for heads is 0.8: $Bias_c(h) = .8$. This is not only counterintuitive but also shows that Jeffrey-Conditionalization is deeply problematic and leads us to accept false statements if we use it to model learning from experience.

Thus, if, contrary to Jeffrey, we want to answer the **Experiential-Input Question**, the **Post-Experience Credence Question** cannot be answered by plugging the input parameter into Jeffrey-Conditionalization. Our challenges can only be answered in two ways. First, one can provide a radically different update rule according to which the agent's post-experience credences depend on the input parameter contained in perceptual experience but also on the pre-experience credences in other statements. This would reconcile our update rule with Holism. Second, "we might dissolve the problem by showing that, after all, some epistemically basic [statements] are assigned probabilities (though perhaps not probability 1) directly from experience, and are also rich and precise enough to capture the evidential force of experience" (Christensen 1992: 544). This second reply amounts to hedging Holism. It requires showing that there is an answer to the **Experiential-Input Question** that characterizes perceptual information in such a way that it is (i) "epistemically basic", (ii) "rich and precise enough to capture the evidential force of experience", and (iii) "tied so immediately to experience" that its role in learning from perceptual experience is entirely independent of our credences in other statements. Both options will be explored in the following.

2.3 Learning from Perceptual Experience and Field–Conditionalization

In reaction to the criticisms directed against Jeffrey-Conditionalization, Field (1978) explored the first option, i.e., to propose a radically different update rule according to which the agent's post-experience credences depend not only on the input parameter contained in perceptual experience but also on other factors. To this end, Field provided new answers to both our questions.

In particular, Field proposed keeping the idea that a perceptual experience directly affects certain statements but giving up the idea that the directly affected statements have to acquire a specific credence in virtue of that perceptual experience. Field (1978) suggests associating with each perceptual experience a set of evidential statements that are directly affected by that input/observation and an assignment to these evidential statements of a number (the *input parameter*) that represents the quantity to which the input/perceptual experience affects

the credence in that evidential statement. Thus, Field (1978) depicts a single (perceptual) input $\mathcal{I}$ one receives as a pair consisting of a set of mutually exclusive and jointly exhaustive evidential statements $\{E_i\}$ and an assignment $\{\alpha_i\}$ to each such evidential statement of an input parameter that quantifies the degree to which the input affects it. The only requirement on the input parameters is $\sum_i \alpha_i = 0$. According to this view, it is not the perceptual experience alone that determines the post-experience credence in the evidential statement. Instead, the pre-experience credence and the perceptual experience determine the new post-experience credence.

To study Field's proposal, suppose an agent with credence function Cr receives the input $\mathcal{I} = \langle\{E_i\}, \{\alpha_i\}\rangle$. The question is, how should the agent revise her credence function in light of this experiential input?
For the general case, Field-Conditionalization answers the question of how agents should determine the post-experience credence as follows:

Updating Rule 3 (Field-Conditionalization)**.** *Let Cr be the agent's rational pre-experience credence function at time point t_0. Let PE be the agent's only perceptual experience between time points t_0 and t_1. Let $\{E_i\}$ be some set of mutually exclusive and jointly exhaustive statements (with $Cr(E_i) > 0$ for all i), and let $\mathcal{I}$ be the experiential input parameter of the agent's only perceptual experience PE between time point t_0 and t_1 (with $\mathcal{I} = \langle\{E_i\}, \{\alpha_i\}\rangle$ and $\sum_{i=1} \alpha_i = 0$). Then the agent's post-experience credence function should be Cr_{PE}, which is defined as follows:*

$$Cr_{PE}(S) := \frac{\sum_i e^{\alpha_i} Cr(S \cap E_i)}{\sum_i e^{\alpha_i} Cr(E_i)}$$

for all statements S in the agent's language $\mathcal{L}$.

Accordingly, the post-experience credence $Cr_{PE}(S)$ in a statement S depends on the pre-experience credence $Cr(S \cap E_i)$ and the respective input parameter α_i *for all evidential statements E_i*. It also depends on the pre-experience credences $Cr(E_i)$ and the input parameter α_i for those evidential statements. (The number e is the Euler number which is the base of the natural logarithm.)

Now that we have introduced the relevant machinery, we can study to what extent Field-Conditionalization can account for learning from perceptual experience. How does Field-Conditionalization answer our two questions?

Field's answer to the **Experiential-Input Question** is that perceptual experiences come with an experiential input consisting of the evidential statements affected by the perceptual experiences and an input parameter α that says how strongly the perceptual experience influences the credence in the respective evidential statement. This is a clear and precise answer to the **Experiential-Input Question**. Psychological investigations will have to reveal whether or not perceptual experiences come with this kind of information. I am unaware of any empirically informed literature arguing for or against this position.

For studying Field's answer to the **Post-Experience Credence Question**, let us focus on the particular case in which we ask how the agent should revise her credences in the evidential statements. Restricted to evidential statements, it requires the following:

Updating Rule 4 (Field-Conditionalization for Evidential Statements)**.** *Let Cr be the agent's rational pre-experience credence function at time point t_0. Let PE be the agent's only perceptual experience between time points t_0 and t_1. Let $\{E_i\}$ be some set of mutually exclusive and jointly exhaustive statements (with $Cr(E_i) > 0$ for all E_i), and let $\mathcal{I}$ be the experiential input parameter of the agent's only perceptual experience PE between time point t_0 and t_1 (with $\mathcal{I} = \langle\{E_i\}, \{\alpha_i\}\rangle$ and $\sum_i \alpha_i = 0$). Then the agent's post-experience credence function should be Cr_{PE}, which is defined as follows:*

$$Cr_{PE}(E_i) = \frac{e^{\alpha_i} Cr(E_i)}{\sum_i e^{\alpha_i} Cr(E_i)}$$

for all statements E_i in the set of mutually exclusive and jointly exhaustive evidential statements $\{E_i\}$.

It is evident that the post-experience credence $Cr_{PE}(E_i)$, for some evidential statement E_i, depends on its pre-experience credence $Cr(E_i)$ and its input parameter α_i, but also on the pre-experience credences $Cr(E_j)$ and the input parameter α_j for all other evidential statements E_j. Thus, Field-Conditionalization satisfies one requirement motivated by holistic considerations: the post-experience credence $Cr_{PE}(E_i)$ for some evidential statement E_i does not depend exclusively on the perceptual experience. However, the post-experience credences in the evidential statements cannot depend on the credences of statements other than the evidential statements. In the context of Jeffrey-Conditionalization, Christensen invited us to consider two agents who both have identical expectations concerning the color of the tablecloth next door. By assumption, only one of the agents believed that the lighting had been manipulated to give misleading color impressions. We expected the rational post-experience credence in the evidential statement about the color of the tablecloths to differ between both agents. However, it is hard to understand how we could account for this if they have the same perceptual experience. Presumably, both agents do not change their credences in tricky lighting based on the perceptual experience, and the evidential statements affected by the perceptual experience concern the tablecloth color. Then, if both agents end up with different post-experience credences in color statements, the parameters α_i for the evidential statements must have been different for the agents. This contradicts our assumption that they have the same perceptual experience. We do not want to exclude that there is some set of evidential statements and accordingly adjusted parameters α that can give the desired result for the post-experience credences of both agents. However, this would presuppose that the affected evidential statements are logically much more complex; e.g., x looks black & x is black & x is observed under tricky lighting conditions (see also Christensen 1992 for a discussion). Again, this would be an implausible consequence. Presumably, perceptual experiences do not come with this kind of complex content.

There is a further reason why perceptual experiences cannot determine the post-experience credence as described by Field-Conditionalization and Field's input parameter. Following Garber (1980), suppose that an agent glances briefly in dim lighting conditions at a colored ball. Furthermore, suppose this perceptual experience comes with an input parameter, which requires increasing the agent's credence slightly in the evidential statement that the ball is blue. By assumption, the same (and, thus, also repeated) perceptual experiences come with the same input, including the same input parameter. Thus, the above agent would become very certain that the ball is blue in only a couple of repeated perceptual experiences of the blue

ball; and this is counterintuitive. In conclusion, Field-Conditionalization cannot account for learning from perceptual experiences. Its answers to the **Experiential-Input Question** and the **Post-Experience Credence Question** cannot be correct.

In light of the above arguments against Field-Conditionalization, it does not help that one important advantage of it is that it is commutative (Field 1978). That means, given inputs $\mathcal{I}$ and $\mathcal{I}'$ in the sense of Field 1978, it is irrelevant whether one updates first on $\mathcal{I}$ or $\mathcal{I}'$. The order in which the perceptual experiences are taken into account does not make a difference to how strongly one believes an evidential statement.[5]

3 Recent Forms of Conditionalization and their Shortcomings

3.1 Learning from Perceptual Experience and Gallow-Conditionalization

In recent years, new variations of conditionalization have been developed to provide an adequate theory for learning from perceptual experience. A particularly interesting one is due to Gallow (2014). Gallow's proposal for learning from perceptual experience is motivated by considerations from the philosophy of science instead of the philosophy of perception. Following Popper, Kuhn, and others, many philosophers of science hold that scientific observations are theory-dependent. What observational statements are accepted as the outcome of an experiment depends on one's background theory. Accordingly, in contrast to how Bayes-Conditionalization portrays it, there is not just one evidential statement learned by perception but one for each possible background theory. For capturing the idea of theory-dependent observations, Gallow (2014) suggests that the content of perceptual experiences is relativized to background theories. More specifically, for each background theory T_i (in a set of mutually exclusive and jointly exhaustive theories $\{T_j\}$), there is a specific evidential statement E_{T_i} that we would learn with certainty if we knew the theory to be true. Consequently, Gallow proposes a replacement for Bayes-Conditionalization. Gallow (2014) introduces two variants of his new form of conditionalization in his paper. For our purposes, it suffices to focus on what I want to call Simple Gallow-Conditionalization:

Updating Rule 5 (Simple Gallow-Conditionalization)**.** *Let Cr be the agent's rational pre-experience credence function at time point t_0. Let $\{T_i\}$ be a set of mutually exclusive and jointly exhaustive (background) theories such that for each such theory there is an evidential statement E_{T_i} which is the content of the agent's only perceptual experience PE between time points t_0 and t_1 provided theory T_i is true (with $Cr(E_{T_i}|T_i) > 0$). The agent's rational post-experience credence function should be Cr_{PE}, which is defined as follows:*

$$Cr_{PE}(S) = \sum_i Cr(S|E_{T_i} \cap T_i) \times Cr(T_i)$$

for all statements S in the agent's language $\mathcal{L}$.[6]

[5] Wagner (2002) argues that Field-Conditionalization is the only acceptable conditionalization procedure besides Bayes-Conditionalization, which is commutative.

[6] To understand the definition of Complex Gallow-Conditionalization, we need to introduce two sets. First, suppose that $\{T_i\}$ is the set of mutually exclusive and jointly exhaustive (background) theories such that for each such theory, there is an evidential statement E_{T_i} which is the content of the agent's perceptual experience between time points t_0 and t_1 provided theory T_i is true. Then let $\{\varepsilon_1, \ldots \varepsilon_k\}$ be the set of all evidential statements that at

Simple Gallow-Conditionalization is supposed to capture the idea that evidential statements are theory-dependent. Gallow's answer to the **Experiential-Input Question** is that there is no single evidential statement of one's perceptual experience. Instead, one receives a set of evidential statements as evidence, each conditional on certain background theories: E_{T_1} is the evidence provided theory T_1 is true, E_{T_2} is the evidence provided T_2 is true, etc. Gallow suggests this theory-dependence makes this form of learning from perceptual experiences compatible with Holism (but we will come back to this discussion later). Gallow emphasizes that it is important to distinguish two forms of understanding 'evidence'. "[T]he first is that your evidence is that if [theory] T is true, then E. ... The second is that, if T is true, then your evidence is E" (Gallow 2014: 10–11, notation adapted). It is the second understanding of 'evidence' that he wants to capture with his account of perceptual experience. Gallow claims that "in the back of [his] mind as [he writes] is a Williamsonian theory of evidence, according to which evidence is just knowledge and, since knowledge is not luminous (we are not always in a position to know what we know), evidence is not luminous either (we are not always in a position to know what our evidence is)." Consequently, Gallow seems to distinguish between the evidence conveyed by a perceptual experience and its rational import. In the following,

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least two theories agree upon. (Gallow seems to assume that theories T_i and T_j agree at least on the evidential statements $E_{T_i} \cup E_{T_j}$. However, I am not sure whether every logical consequence of both E_{T_i} and E_{T_j} counts as an evidential statement that the two theories agree upon.) Let τ_l be the disjunction of all theories T_m that agree on the evidential statement ε_l. Let $\{\tau_1, \dots \tau_k\}$ be the set of these disjunctions. Given these two sets, we can now define Δ_i for each theory T_i.

$$\Delta_i = \sum_j \frac{\delta(\varepsilon_j|T_i)}{Cr(\varepsilon_j|\bigcup_j \tau_j)} \times \frac{Cr(\tau_j)}{\sum_k Cr(\tau_k)}$$

and

$$\delta(\varepsilon_j|T_i) = \begin{cases} Cr(\varepsilon_j|\bigcup_j \tau_j) & \text{, if } T_i \nvdash \tau_j \\ Cr(\varepsilon_j|T_i) & \text{, if } T_i \vdash \tau_j \end{cases}$$

For Gallow, Δ_i captures how well a theory T_i predicts the available data compared with alternative theories T_j. In particular, it quantifies how well the theory predicts the evidential statements that it agrees upon with various other theories. With this value for what one might call the systematic power of a theory T_i, we are now able to formulate *Complex Gallow-Conditionalization*:

Updating Rule 6 (*Complex Gallow-Conditionalization*)**.** *Let Cr be the agent's rational pre-experience credence function at time point t_0. Let $\{T_i\}$ be a set of mutually exclusive and jointly exhaustive (background) theories such that for each such theory there is an evidential statement E_{T_i} which is the content of the agent's only perceptual experience PE between time points t_0 and t_1 provided theory T_i is true (with $Cr(E_{T_i}|T_i) > 0$). The agent's rational post-experience credence function should be Cr_{PE}, which is defined as follows:*

$$Cr_{PE}(S) = \sum_i Cr(S|E_{T_i} \cap T_i) \times Cr(T_i) \times \Delta_i$$

for all statements S in the agent's language $\mathcal{L}$.

Gallow proposes this refinement because Simple Gallow-Conditionalization delivers counterintuitive results for most background theories. It is a trivial consequence of the latter form of conditionalization that $Cr_{PE}(T_i) = Cr(T_i)$ for all background theories T_i occurring in the perceptual experience. This consequence is only plausible for definitions and background theories that can neither be confirmed nor disconfirmed by empirical evidence. In the case of definitions, it is reasonable that one receives the evidence that *Flipper is a mammal* if mammals include, by definition, dolphins, and that the evidence says that *Flipper is a fish* if by definition fish include dolphins. Potential background theories that can neither be confirmed nor disconfirmed by the evidence concern scenarios such as 'I am a brain in the vat', 'a benevolent god ensures that my evidence is always true' etc. In most other cases, this seems to be counterintuitive. Scientific theories, for example, can be confirmed and disconfirmed even by (potentially) theory-laden evidence. The new Complex Gallow-Conditionalization is proposed to remedy this flaw. However, it inherits the flaws of Simple Gallow-Conditionalization that we address below.

I use the term 'Experiential-Input' to refer to "the rational import of an experience [which] can be represented as a relation between background theory and evidence" (Gallow 2014: 8). More specifically, the rational import of a perceptual experience consists of the statements of the form 'E_{T_1} is the evidence provided theory T_1 is true, E_{T_2} is the evidence provided T_2 is true, etc.' This "rational import" is what agents with different credence functions agree upon after having qualitatively identical perceptual experiences.

Gallow's answer to the **Experiential-Input Question** stands, at least partially, in contrast to the literature on theory-ladenness of perception in the philosophy of science. The same holds for the literature on the content of perceptual experience in the philosophy of perception.

Philosophers of science hold that proponents of different theories cannot agree on an evidential statement that describes their experiential input, and in that respect they agree with Gallow (2014). However, Gallow understands this to result from something that resembles a conscious inference. Those who fully believe in one theory interpret their perceptual experience to convey a specific evidential statement. Those who fully believe in another theory conclude upon receiving an identical experiential input that they received another statement as evidence. Those who believe in neither theory end up being uncertain about what their evidence has been. Still, they agree on the rational import of the perceptual experience, i.e., the experiential input. Therefore, the theory-ladenness of evidence as envisioned by Gallow merely leads to uncertainty concerning the label 'evidence'; the rational import of the perceptual experience is something that all theoreticians can agree on. This is undoubtedly something that Kuhn did not have in mind when he introduced the notion of 'theory-ladenness' into the discourse in the philosophy of science.

Philosophers of perception typically also hold that the experiential input is not a set of conditional evidential statements (each conditional on some background theory). One reason is that they do not want to separate the notions of 'experiential input' and 'evidence'. (To some extent, this interest is reflected in Simple Gallow-Conditionalization: the agents are not required to update on the actual evidence that they receive (i.e., E_{T_i}, if T_i is true, E_{T_j}, if T_j is true), but on their experiential input, which is understood here as rational import.) The agent's actual evidence (in the sense of Gallow) is normatively irrelevant for Simple Gallow-Conditionalization. Another reason is that philosophers of perception would prefer a notion of experiential input (the content of perception), for which it is plausible that such input does not differ dramatically between children, laypersons, and experts. The idea is that children and adults have approximately the same experiential input when they see a picture. However, only for adults and experts is it plausible that they receive experiential inputs suitably relativized to their relevant background theories. Suppose philosophers of perception posit a difference between the experiential input between children, laypersons, and experts. In that case, it is typically assumed that the content of the perceptual experience of experts (or adults) is richer and logically stronger than that of laypersons (or children). While children might only perceive the tree's shape and color, adults' perception might represent it as a tree, and experts might perceptually represent it as a willow tree.

Even though Gallow's answer to the **Experiential-Input Question** is not immediately compelling for those who do not subscribe to a Williamsonian theory of evidence, let us grant for the sake of argument—as we did with Morrisons's Perceptual Confidence view—that per-

ceptual experiences do not only have an evidential statement E as their content but that the experiential input is a set of statements of the form 'E_{T_i} is the evidence provided T_i is true'. Let us accept this as the answer to the **Experiential-Input Question**. But what consequences does Simple Gallow-Conditionalization entail for the **Post-Experience Credence Question**?

Recall Christensen's (1992: 542) example of two agents who both have identical expectations concerning the color of the tablecloth before examining it next door. By assumption, only one of the agents believes that "she is a subject in a perceptual psychology experiment, in which the lighting has been manipulated to give misleading color impressions." This difference in background beliefs should lead to different post-experience credences. Simple Gallow-Conditionalization is more suitable for answering how both agents should update their credences than Bayes- and Jeffrey-Conditionalization. According to it, the rational import of their perceptual experience are statements of the form 'E_{T_1} is the evidence provided theory T_1 is true, E_{T_2} is the evidence provided T_2 is true, etc.' In this case, for each agent, the relevant theories might be the background beliefs "she is a subject in a perceptual psychology experiment, in which the lighting has been manipulated to give misleading color impressions" and its negation. Relative to the background belief that a perceptual psychology experiment is taking place, the agent does not receive any evidence that pertains to the color of the tablecloth but merely to what color it appears to the agent. Relative to the background belief that no perceptual psychology experiment is taking place, the agent receives evidence pertaining to the tablecloth's color.

To understand in even more (i.e., formal) detail how Simple Gallow-Conditionalization answers the **Post-Experience Credence Question**, let us study what it requires in terms of a more familiar form of conditionalization: Jeffrey-Conditionalization.

Proposition 1. *If*

1. Cr^G_{PE} *is the result of applying Simple Gallow-Conditionalization to the prior credence function* Cr *and the evidential input '*E_{T_i} *provided theory* T_i *is true', for the set of mutually exclusive and jointly exhaustive (background) theories* $\{T_i\}$*, and*

2. Cr^J_{PE} *is the result of applying Jeffrey-Conditionalization to the prior credence function* Cr *and the evidential input* $\mathcal{I} = \langle P, Cr_{\mathcal{I}}\rangle$ *consisting of the partition* $P = \{E_{T_i} \cap T_i, \neg E_{T_i} \cap T_i\}$ *and the new input credences* $Cr_{\mathcal{I}}$ *defined as follows:* $\{Cr_{\mathcal{I}}(\neg E_{T_i} \cap T_i) = 0$ *for all* E_i *and* $Cr_{\mathcal{I}}(E_{T_i} \cap T_i) = Cr(E_{T_i} \cap T_i) + Cr(\neg E_{T_i} \cap T_i) = Cr(T_i)$.

then:

$$Cr^G_{PE} = Cr^J_{PE}$$

From the reformulation of what Simple Gallow-Conditionalization requires, we see that it inherits some vices from both Bayes-Conditionalization and Jeffrey-Conditionalization. As a way of criticizing Bayes-Conditionalization, we required that an update rule should not necessitate assigning probability 1 or 0 to some statement. At first sight, Simple Gallow-Conditionalization seems to satisfy this requirement. Upon having a perceptual experience of the form 'E_{T_1} is the evidence provided theory T_1 is true, E_{T_2} is the evidence provided T_2 is true, etc.' we do not become certain of any of the evidential statements E_{T_i}. However, Simple Gallow-Conditionalization requires that we assign probability 0 to some statements. In

particular, Simple Gallow-Conditionalization requires that we become certain of statements conditional on some background theory: $Cr_{PE}(E_{T_i}|T_i) = 1$. Consequently, upon having such a perceptual experience, we must assign probability 0 to all statements of the form '$\neg E_{T_i} \cap T_i$', and we have to assign probability 1 to their negation. Thus, applied to the above tablecloth example, Simple Gallow-Conditionalization requires an agent to become certain that the tablecloth has a certain color *provided* no perceptual psychology experiment is taking place. However, we already argued that even in the hypothetical case of a clear and vivid perceptual experience and without any skeptical scenario in the background, it is hard to decide which evidential statement one becomes certain of based on one's perceptual experience, where that statement explains all the changes in our credences. In the case described, one might argue that the evidential statement one becomes certain of on the assumption that no psychological experiments is taking place is: 'the tablecloth is black or dark blue' or 'the tablecloth is black'. However, both options are unsatisfying if, based on one's perceptual experience, one wants to increase one's credence in "this tablecloth is black" more than in "this tablecloth is dark blue" without becoming certain that the tablecloth is black.[7] Thus, Simple Gallow-Conditionalization is subject to a similar objection that led us to reject Bayes-Conditionalization.

Similarly, as a way of criticizing Jeffrey-Conditionalization, we followed philosophers such as Christensen (1992) and Weisberg (2009) in requiring that the post-experience credence of no statement should depend exclusively on the experiential input; rather it should also depend on the pre-experience credences in that statement and other statements describing "more theoretical considerations." Intuitively, Simple Gallow-Conditionalization seems to satisfy this requirement since the contents of perceptual experiences are sets of conditional evidential statements. Unfortunately, it is a consequence of the previous consideration that Simple Gallow-Conditionalization cannot satisfy this requirement. Statements of the form '$\neg E_{T_i} \cap T_i$' will get assigned probability 0 independently of all other statements. Applied to our example, Simple Gallow-Conditionalization requires an agent to exclude with certainty that the tablecloth has a certain color *while* no perceptual psychology experiment is taking place. This assignment of probability zero is mandatory independently of one's previous credences in that or other statements. However, according to Holism, even this statement should not be tied so immediately to experience that our post-experience credence in it does not depend on one's credence in other statements. It might depend on one's credences in other background theories/statements such as: "I am prone to hallucinations", "Previously I obtained contradicting information about the color of the tablecloth", "My beliefs and desires might permeate the content of my perception" etc. And the holist would point out that one's credences in those statements depend again on many other statements. Thus, Simple Gallow-Conditionalization is subject to a similar objection that leads us to reject *Jeffrey-Conditionalization*.[8]

[7] However, as indicated by Proposition 1, this problem could be sidestepped by combining Simple Gallow- and Jeffrey-Conditionalization. Instead of specifying for each background theory T_i (in a set of mutually exclusive and jointly exhaustive theories $\{T_j\}$), a specific evidential statement E_{T_i} that we would learn with certainty (if we knew the theory to be true), we would have to specify a Jeffrey-style experiential input parameter for each theory. However, the resulting account of conditionalization would make it apparent that Simple Gallow-Conditionalization inherits the defects of Jeffrey-Conditionalization.

[8] One way to reconcile Strict Gallow-Conditionalization with Holism would be to argue that the statements '$E_{T_i} \cap T_i$' and '$\neg E_{T_i} \cap T_i$' are maximally specific in the sense that each statement describes exactly one possible world. Consequently, for logical reasons alone, there is no other statement on which the probability of '$\neg E_{T_i} \cap T_i$' could depend. However, this is not an attractive option in the context of Strict Gallow-Conditionalization. According

3.2 Learning from Perceptual Experience and Konek-Conditionalization

In "The Art of Learning" (forthcoming), Konek proposes a new form of conditionalization for learning from experience. The main aim is to develop a form of conditionalization compatible with Holism, as described by Christensen and Weisberg. To understand Konek-Conditionalization in detail, it is best to contrast it with Bayes-Conditionalization. The latter form of conditionalization requires that the agent's post-experience credence $Cr_{PE}(S)$ in some statement S equals the agent's old conditional credence, $Cr(S|E)$, in S given E, where E is the logically strongest proposition that one became certain of between time points t_0 and t_1 via perceptual experience (for details see section 2.1). According to Bayes's Theorem, we then obtain:

$$Cr_{PE}(S) = \frac{Cr(E|S) \times Cr(S)}{Cr(E|S) \times Cr(S) + Cr(E|\neg S) \times Cr(\neg S)}$$

Applying Bayes-Conditionalization presupposes that the perceptual experience has some evidential statement E as content and that we have prior credences for this statement being true and for what else is true given the evidential statement is true and vice versa.

Konek (forthcoming) offers many valuable insights concerning the epistemology of rational reasoning and conditionalization. In particular, he presents his form of conditionalization in terms of estimates of objective chances and relates it to rational credences, rational conditional credences, and the principal principle. Furthermore, he provides an accuracy-based chance-dominance argument for his version of conditionalization. However, the present paper focuses specifically on Konek's attempt to reconcile the epistemology of perception and the epistemology of rational reasoning. For this purpose, it is more expedient to focus on a simplified version of Konek-Conditionalization, like in the case of Gallow-Conditionalization. For the simplified version, the underlying framework of chances, estimates of chance, and the principal principle are ignored.[9] In addition, it is also more expedient to focus on single credence shifts based on a single perceptual experience. Konek, in contrast, studies sequences of credence shifts based on learning experiences.

In contrast to Bayes-Conditionalization, Simplified Konek-Conditionalization requires that changes in credences in response to a perceptual experience PE proceed *as if* we would update our credences in two stages. The first stage is called "the expansion stage". It requires Bayesian agents to invent or contrive new conditional credences, $Cr_{Ext}(E|w)$, for the perceptual information E in each possible world w. The background for this expansion stage is that Konek does not assume that we have prior credences for the content of the evidential experience or for what else is true given the content of one's perceptual experience. Furthermore, here E does not stand for the content of the perceptual experience but simply for having *that* perceptual experience. More specifically, Konek understands the relevant evidential information E as a set of possible worlds, which we describe or single out using a formulation such as "agent A had *that* learning experience". This is because Konek, like Jeffrey, does not provide details concerning how to answer the **Experiential-Input Question**.

to Strict Gallow-Conditionalization, the post-experience credences in the background theories T_i that figure in the content of perceptual experiences are never higher or lower than the pre-experience credences in those theories.

[9] In this regard, I followed the advice of Richard Pettigrew when he commented on an early version of this paper.

> Given how rich and varied learning experiences are, it is a fool's errand to try to pin down any single property, or even a cluster of properties that we can always use to characterise them. . . . [W]e will describe learning experiences using propositions E of the form agent A had *that* learning experience. Of course, this is the sort of proposition that you are only in a position to have opinions about once you have already had the learning experience. This would be problematic if [Simplified Konek-Conditionalization] required you to have prior credences about E. But it does not. (Konek forthcoming: 10.)

The second stage of Simplified Konek-Conditionalization then answers the **Post-Experience-Credence Question**. It answers it in close similarity to how Bayes-Conditionalization answers it. It requires us to use the newly contrived conditional credences as if they were one's old conditional credences. Effectively, this requires the following:

$$Cr_{PE}(S) = \frac{Cr_{Ext}(E|S) \times Cr(S)}{Cr_{Ext}(E|S) \times Cr(S) + Cr_{Ext}(E|\neg S) \times Cr(\neg S)}$$

We can formulate Konek's suggestion for learning from perceptual experiences by taking these two steps together.

Updating Rule 7 (Simplified Konek-Conditionalization[10])**.** *Let Cr be the agent's rational pre-experience credence function at time point t_0. Let E be the statement that the agent had* that *learning experience, where the word 'that' refers to the agent's only perceptual experience PE between time points t_0 and t_1, and assume that E is not part of the agent's language $\mathcal{L}$. Then the agent's post-experience credence function Cr_{PE} should be such that there is a rationally coherent extension Cr_{Ext} of the credence function Cr for the extended language $\mathcal{L} + E$ such that:*

$$Cr_{PE}(S) = \frac{Cr_{Ext}(E|S) \times Cr(S)}{Cr_{Ext}(E|S) \times Cr(S) + Cr_{Ext}(E|\neg S) \times Cr(\neg S)}$$

for all statements S in the agent's language $\mathcal{L}$.

For applying Konek's simplified rule to cases of perceptual learning, we need to study how it answers the **Experiential-Input Question** and the **Post-Experience-Credence Question**. The former question belongs to the realm of the epistemology of perception and asks what the content of one's perceptual experience is, i.e., what new information the perceptual experience provides. The latter question aims at linking perception and rational reasoning by asking what the agent's post-experience credences should be in the light of the experiential input and the agent's pre-experience credences.

As already said, Konek (forthcoming) does not provide details on how to answer the **Experiential-Input Question** because it would be "a fool's errand to try to pin down any single property, or even a cluster of properties that we can always use to characterise them." However, it

[10] In the full version of Konek-Conditionalization, the first stage, i.e., the expansion stage, requires contriving chance estimates for the evidential proposition E, $est_{Ext}(ch(E|w)|w)$, for all possible worlds w. These new estimates are required to be coherent and to satisfy the principal principle. The second stage is identical to the one presented here. Simplified Konek-Conditionalization is a form of Jeffrey's superconditioning or, as it is also labeled by Konek (forthcoming), austere superconditioning. The full version of Konek-Conditionalization he calls a form of gilded superconditioning. The gilded form ensures that one updates as if one's contrived chance estimates for the evidential proposition E have not been 0 (quasi-regularity) and overall had satisfied the principal principle.

also might be a fool's errand to try to pin down a cluster of properties for characterizing the rich and varied statements in all our natural languages. This does not discourage linguistics from trying to provide details characterizing the syntactical structure of many of our natural language statements. And it does not discourage philosophers from considering simplified fragments of our natural language when they study rational reasoning. Similarly, philosophers should study how psychologists characterize perceptual experiences and work with suitable simplifications for providing a theory of rational learning from perceptual experience. More importantly, many philosophers do so: Douven et al. (2013), Gärdenfors (2000, 2014), Gauker (2011), Green (2016, forthcoming), and Nanay (2010, 2015, 2016).

Konek's "expansion stage" suggests one ramification for answering the **Experiential-Input Question**. In particular, the information acquired via perceptual experiences is necessarily a statement/proposition that we can single out as the content of a credal state only after we have had the perceptual experience. The relevant evidential statement/proposition is not one we express with the help of the language $\mathcal{L}$ for which our credences are defined. Philosophically, this provokes many questions and leaves most of them unanswered. Is there another way to single out the same statements/proposition, e.g., by perceptual imagination (Nanay 2015)? Can such evidential statements/propositions stand in the relation of logical entailment to other statements I have credal states about? If learning experiences are so rich and varied, why is it not sometimes the case that one has a learning experience whose content one has prior credences about? Finally, what notion of 'possible world' is presupposed here?[11] Answering these questions would require us to provide more details on the **Experiential-Input Question**. Thus, concerning the epistemology of perception, the philosophical background of Konek's proposal is unsatisfying (but, admittedly, not more so than what is provided by Jeffrey in defense of his account of conditionalization).

Let us turn to the epistemology of rational reasoning and, thus, to the **Post-Experience-Credence Question**. This asks what the agent's post-experience credences should be in the light of the experiential input and the agent's pre-experience credences.

First, let us focus on the question of how Simplified Konek-Conditionalization restricts the credences of the perceptual information E, i.e., a statement of the form 'the agent had *that* learning experience'. Konek assumes that the relevant evidential statement/proposition E is not expressible via a statement S of the agent's language $\mathcal{L}$ and that the agent does not have any prior credences concerning it. In addition, it is essential to note that Simplified Konek-Conditionalization prescribes how to update credences in statements of the language $\mathcal{L}$ only. The requirement is that one updates as if one would be updating a credence function on a richer language, which includes not only the statements of the original language but also the information provided by the perceptual experience. Consequently, after applying Simplified Konek-Conditionalization, the agent has no credence concerning the evidential statement/proposition.[12] As Konek (forthcoming) emphasizes, for exemplifying the above

[11] They cannot be understood as maximally consistent sets of statements of the agent's language $\mathcal{L}$. Presumably, they cannot be understood as recombinations of states of affairs either, because what would justify the assumption that some states of affairs cannot be expressed in our language except with demonstrative pronouns?

[12] Interestingly, if the agent were actually to extend her language to include the evidential statement/proposition E provided by the perceptual experience, then Simplified Konek-Conditionalization would require that the agent's new credence in that statement/proposition E is one. Roughly put, unofficially Simplified Konek-Conditionalization

property Simplified Konek-Conditionalization should be considered a form of Jeffrey's Superconditioning, respectively a form of Bayes-Conditionalization that treats the experiential input as if it were hidden in a black box. Clearly, this assumption is problematic: agents do have expectations concerning the experiential input of perceptual experiences. For example, when we shop for groceries and choose to buy apples, we have expectations about how they will taste. Admittedly, these expectations of perceptual experiences should not be understood as credences in statements containing coarse-grained categories like 'sweet', 'sour', and 'apple'. These expectations concern perceptual contents that are as rich, fine-grained, and varied as perceptual experiences. If we admit that we judge some of our perceptual imaginations as more rational than others (Nanay 2010, 2016), then how else can we explain this if not by having expectations or credences concerning perceptual experiences?

Second, let us focus on the question of how Simplified Konek-Conditionalization restricts the credences of all other statements S in one's language $\mathcal{L}$. What speaks in favor of Konek's approach to understanding conditionalization is that it circumvents many of the problems of alternative accounts of learning from perceptual experience. Unlike Bayes and Gallow-Conditionalization, it does not necessitate assigning extreme probabilities (i.e., zero or one) to evidential statements. In addition, unlike Jeffrey-Conditionalization, the post-experience credence of any statement does not depend exclusively on the perceptual experience but may also depend on the pre-experience credences in the statement and other statements describing "more theoretical considerations." Indeed Simplified Konek-Conditionalization is even more liberal. Even agents with identical credence functions and perceptual experiences can end up with different posterior credence functions, and the post-experience credences of rational agents are not restricted in any way at all—anything goes (and in the context of learning from experience, this is not desirable).

The reason for the anything-goes feature of Simplified Konek-Conditionalization lies in Konek's "expansion stage". The agent's new credence for some statement S, $Cr_{PE}(S)$, is determined by two factors, the old credence $Cr(S)$ and the newly contrived likelihoods $Cr_{Ext}(E|S)$. Since these likelihoods can be arbitrarily chosen, the resulting final credences $Cr_{PE}(S)$ can be arbitrarily chosen (provided the prior has not been zero). As long as the new credence function obeys the probability calculus and one minor additional restriction, rational agents can adopt whatever credence they want for a statement without violating Konek-Conditionalization. (The minor requirement is that there is some constant $c \geq 1$ such that for all possible worlds $w \in \Omega_{\mathcal{L}}$: $Cr(w) \times c \geq Cr_{PE}(w)$, see Diaconis & Zabell 1982: 824. Even the full version of Konek-Conditionalization does not impose any substantial constraints on one's final credence in some statement S (respectively, one's corresponding chance estimate). Konek's gilded superconditioning merely ensures that agents update as if they had had chance estimates that satisfy the principal principle. This is consistent with any concrete value for $Cr_{PE}(S)$ or $est_{PE}(ch(S))$. In addition, this constraint arises from Konek's commitment to the principal principle. Perceptual experiences do not impose any additional constraints on the new post-

requires that there is a statement/proposition of the form 'the agent had *that* learning experience' that an agent learns with certainty when having a perceptual experience. It also requires that the credence for that statement/proposition is determined solely by the perceptual experience. It is not a statement that the agent can express with the help of her language $\mathcal{L}$. And since Konek does not answer the **Experiential-Input Question**, we do not know what 'that learning experience' refers to and why it cannot be expressed with the help of any of the languages for which rational credences can be predetermined.

experience credence.)[13]

A consequence of the anything-goes feature of Konek-Conditionalization is that agents with identical priors are allowed to react differently to identical perceptual experiences. When they "expand" their prior credence function, they are not restricted on how to do this, and agents might choose different expansions. Consequently, asking whether Konek-Conditionalization satisfies commutativity is also idle. Agents can satisfy commutativity, but they do not have to. It is up to the agents to decide how they react, given the different order in which they take the perceptual experiences into account. If they make different decisions in the "expansion stage" when the experiences are taken into account in different orders, then this will lead to different post-experience credences.

To see more clearly how liberal Simplified Konek-Conditionalization is and how it differs from Jeffrey-Conditionalization, let us consider a trivial consequence of a theorem discussed in Diaconis and Zabell (1982: 824 Theorem 2.2).

Proposition 2. *Let Cr^K_{PE} be the result of Simplified Konek-Conditionalization on the prior credence function Cr based on the perceptual experience PE. Then there is*

1. *a set $\{E_i\}$ of mutually exclusive and jointly exhaustive statements (with $Cr(E_i) > 0$ and $E_i \in \mathcal{A}_\mathcal{L}$ for all E_i) and*
2. *an experiential input parameter $\mathcal{I} = \langle \{E_i\}, \{Cr_\mathcal{I}(E_i)\} \rangle$ (with $\sum_i Cr_\mathcal{I}(E_i) = 1$ and $Cr_\mathcal{I}(E_i) = \dfrac{\sum_{w \models E_i} Cr_{Ext}(E|w) \times Cr(w)}{\sum_w Cr_{Ext}(E|w) \times Cr(w)}$ for some rationally coherent extension Cr_{Ext} of the agent's prior credence function Cr)*

such that:

$$Cr^K_{PE}(S) = \sum_i Cr(S|E_i) \times Cr_\mathcal{I}(E_i)$$

for all statements S in the agent's language $\mathcal{L}$.

We recall Jeffrey and Konek do not provide details on how to answer the **Experiential-Input Question**. Jeffrey considers one specific input parameter compulsory for the agent in the light of a perceptual experience. Konek leaves it up to the agent to contrive likelihoods and decide how the perceptual experience changes their credences. Proposition 2 shows that proponents of Jeffrey-Conditionalization could emulate Konek-Conditionalization by stating that each agent can contrive their individual input parameter based on their perceptual experience. Thus, a small change in the assumptions concerning how experiential input and post-experience credences are related renders Jeffrey-Conditionalization epistemologically as liberal as Konek-Conditionalization and, for the problem at hand, equally satisfactory.[14] In both approaches, one is not restricted by one's previous credences or the content of one's perceptual experiences.

[13] A further consequence of this assumption is that the mentioned minor requirement effectively only forbids that: $Cr(w) = 0$ and $Cr_{PE}(w) \neq 0$.

[14] Presumably, Wagner (2013) had this interpretation of the application of Jeffrey-Conditionalization in mind when he defended Jeffrey's solution against Weisberg's (2009) criticism that it does not satisfy Holism.

To sum up, Konek-Conditionalization does not complete the Bayesian psychology of rational learning from perceptual experiences. The main reason is that Konek's answer to the **Post-Experience Credence Question** is: (almost) anything goes. There is no credence that an agent should adopt, but there are very few credence functions that the agent should not adopt in response to a credence function. Thus, strictly speaking, Konek (forthcoming) does not answer the question of what one's post-experience credence *should be*; it states what your credence *can be*. We might compare Konek's account of rational learning from perceptual experience to van Fraassen's view on rationality in general[15], which Okasha describes as follows

> [For van Fraassen r]ationality is a concept of permission, not obligation, he maintains: it concerns what you may believe, not what you must. Therefore, rational belief change need not be governed by rules which tell you how to respond to evidence; two agents can respond very differently to the same evidence, without one of them being irrational. (Okasha 2000, 693)

Konek's account of conditionalization might be considered a permissive account of diachronic rationality that fits into van Fraassen's general picture of rationality. If one finds van Fraassen's general picture of rationality attractive, one might not see any drawbacks in the "anything goes feature" of Konek-Conditionalization. However, to the extent that an account of rational learning from experience should explain which credences one should adopt, Konek-Conditionalization fails. This anything-goes feature of Konek-Conditionalization helps Konek to avoid many of the objections against other forms of conditionalization. But it cannot explain why it would be irrational for our perfect Bayesian Alma to adopt a high post-experience credence in the statement that only communism can lead to a free and just society when she has a perceptual experience of the hands of her watch and matching "patterns of irritation on one's sensory surfaces."

4 Summary

Bayesian psychology is still incomplete. Our best theories of how to apply update rules to learning from experience are still deeply problematic. We have been unable to link the available update strategies for rational credences with our best epistemological accounts of perception. This is true for the well-known update strategies such as Bayes-, Jeffrey-, and Field-Conditionalization, and it is true for the new forms of conditionalization such as Gallow-, and Konek-Conditionalization.

5 Acknowledgement

I am thankful to Matteo De Benedetto, Anna-Maria Asunta Eder, Insa Lawler, Matías Osta-Vélez, Thomas Raleigh, Corina Strößner, and Filippo Vindrola for helpful comments at various stages of the writing process. I am also thankful to the members of two workshops (Bochum Epistemology Seminar and the Bochum-Rutgers Workshop in Philosophy) at which I presented ideas of this paper. Especially the comments of Frances Egan, Branden Fitelson, Brian McLaughlin, and Richard Pettigrew had a great influence on the paper. Research on this paper has been

[15]For a discussion of van Frassen's Permissivism with respect to rationality see also Brössel 2015b.

generously supported by an Emmy Noether Grant from the German Research Council (DFG), reference number BR 5210/1-1 and the DFG Research Training Group "Situated Cognition" (GRK 2185/1).

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