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On the Relationship between Epistemology and Science: Synergies between Experience-First Epistemologies and Agent-Centered Interpretations of Quantum Mechanics

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Abstract

Although contemporary analytic epistemology continues to be dominated by externalist accounts, an alternative internalist approach has recently emerged that emphasizes the epistemic role of consciousness, in particular of conscious experience. According to the phenomenological experience-first epistemology (PEFE) discussed in this paper, certain experiences constitute a source of immediate justification as well as our ultimate evidence. One reason why internalist approaches are less popular in current debates is the common assumption that externalism fits better with scientific practice. In this picture, the natural sciences are typically understood as adopting a third-person perspective that successfully abstracts away from the subject and her personal experiences. Here, I discuss an alternative view of science, namely science as understood within the framework of agent-centered approaches to quantum mechanics. More specifically, my focus will be on QBism, a highly controversial but increasingly popular interpretation of quantum mechanics, whose defining feature is the interpretation of quantum probabilities as subjective Bayesian probabilities. The objective of this paper is to clarify the relationship between epistemology and science under the assumption that both PEFE and QBism are correct.

Key words: epistemology; experience-first epistemology; philosophy of science; quantum mechanics; QBism

1. Introduction

The relationship between epistemology and science has always been of great philosophical interest. On a minimal level, we can say that while epistemologists are concerned with *defining* knowledge (thereby gaining knowledge about knowledge), science is in the business of *producing* knowledge (in the sense of gaining knowledge about the world we live in). On a more substantial and controversial level, it has been argued in the tradition of Plato, Descartes, and Husserl that epistemology provides science with its epistemic foundations. Any individual science makes use of methods and presuppositions that cannot be justified within its own framework. For instance, the physicist cannot use physics to clarify why observations and experiments are a source of epistemic justification. Accordingly, for any scientific result, if you inquire why it is justified to believe in it, ultimately you have to invoke epistemology.

Here I introduce and discuss a much more radical proposal. The thesis of this paper is that the relationship between epistemology and science is significantly closer than commonly assumed if the following two approaches are correct: (i) a phenomenological experience-first epistemology (PEFE) and (ii) Quantum Bayesianism (QBism). PEFE says that all epistemic justification and every piece of knowledge can be traced back to epistemically foundational experiences. Experience-first epistemologies have recently gained considerable momentum from research stressing the epistemological significance of consciousness (e.g., Smithies 2014, 2019) and particularly from works stressing the epistemological significance of an experience's phenomenology (e.g., Bengson 2015, Berghofer 2022, Chudnoff 2013, Church 2013, and Koksvik 2021). PEFE is explicitly endorsed, for instance, in (Berghofer 2022 and Dougherty & Rysiew 2014). QBism is a novel interpretation of quantum mechanics that places the notion of subjective experience at its core. Its defining idea is that quantum probabilities should not be understood as objective probabilities but as subjective Bayesian probabilities. Having recently attracted the interest of philosophers of various backgrounds (see, e.g., Barzegar 2020, Berghofer & Wiltsche 2023, Bitbol 2020, French 2023a, Glick 2021, Healey 2022, Myrvold 2020, Timpson 2008, 2013, and Zwirn 2022), among its main proponents are the physicists Christopher Fuchs, David Mermin, and Ruediger Schack (see, e.g., Fuchs et al. 2014, Fuchs & Stacey 2019, and Fuchs 2023).

Importantly, the objective of this paper is *not* to argue in favor of PEFE or QBism. Both have been introduced, motivated, and defended independently and in more detail by various epistemologists as well as physicists and philosophers of physics. (Of course they remain highly controversial.) However, to my knowledge, there does not exist a single paper on how these theories relate to each other. This is hardly surprising, since the former is an approach discussed in contemporary epistemology and the latter a novel interpretation discussed in (philosophy of) physics. The objective of this paper is to investigate what it would mean for the relationship between epistemology and science if both PEFE and QBism are true. I will address several substantial similarities and synergies between PEFE and QBism but also point toward an important discrepancy.

Here is how the paper is structured. Section 2 introduces PEFE, clarifying the epistemic role experience plays according to this approach and what this implies for our understanding of epistemology. Section 3 discusses how (textbook) quantum mechanics differs conceptually from objectivist scientific theories such as classical mechanics and provides some motivation for agent-centered interpretations. Section 4 introduces QBism, clarifying the role experience plays in this framework and what this implies for our understanding of science. In Section 5, I discuss a discrepancy between QBism and PEFE and how it could be resolved. In Section 6, I show what PEFE + QBism implies for the relationship between epistemology and science.

2. The cornerstones of a phenomenological experience-first epistemology

Imagine you are walking down an avenue flanked by chestnut trees. You are particularly fond of one tree on your right. You look at it closely, undergoing a perceptual experience that presents you with the tree and some of its features (such as its shape and color) in a clear and distinct manner. It is natural and in accordance with common sense to assume that in such a situation you are justified in believing that there is a tree on your right. Most epistemologists agree. I take it that it is also natural and in accordance with common sense to assume that in this example your justifier (i.e., the entity that justifies your belief that there is a tree) is your tree *experience* and that this experience justifies by virtue of its *phenomenology*.[1] Most epistemologists *disagree*. This is because contemporary epistemology is dominated by *externalist* accounts.

This externalism comes in many forms and flavors. For instance, with respect to justifiers or evidence, externalists typically deny that our basic evidence is constituted by entities that are internally accessible to us (such as our experiences). Instead, it is prominently argued that only *facts* can be evidence (Littlejohn 2013, Williamson 2000, Mitova 2018). In particular, externalists deny that an internal factor such as the phenomenology of an experience can be of central epistemological significance. Instead, justificatory force is linked to external factors such as truth or reliability, reliabilism being the most popular approach to epistemic justification.[2] Reliabilism, too, comes in many flavors, process reliabilism being the most common and most widely discussed version. Its basic idea is that a belief is justified if and only if the belief is formed by a reliable process. This is to say that a belief is justified if it is objectively true that the underlying belief-forming process produces mostly true beliefs. It does not matter whether the subject knows that the belief-forming process is reliable.

In this picture, epistemically speaking, there is nothing intrinsically special about the process of experiencing. Epistemology (more precisely: epistemic justification) and consciousness (more precisely: conscious experience) are typically treated as separate topics. This is to say that the fact

1 By "phenomenology," I understand the *phenomenal character* of an experience. "It is definitional of experience, as the term is used here, that they have some phenomenal character, or more briefly, some phenomenology. The phenomenology of an experience is what it is like for the subject to have it" (Siegel 2016; see also Tye 2015).

2 "Since the 1960s, Anglophone epistemology has undergone a paradigm-shift: 'the Reliabilist Revolution'" (Williams 2016, 3). Bishop and Trout name reliabilism as one of the "theses that have dominated English-speaking epistemology for about the past half-century" (Bishop & Trout 2005, 696). See also Goldman & Beddor 2021. In the face of the dominance of externalist accounts, it has become popular to speak of a "factive turn in epistemology" (Mitova 2018).

that your experience presents the tree the way it does and the fact that you are justified in believing that there is a tree is, in a certain sense, a phenomenological-epistemological coincidence. In a possible world in which Lisa's experiences are systematically deceptive but Peter's wild guesses are always true, Lisa's beliefs (if they are based on her experiences) are never justified (this is because reliability is necessary for justification) and Peter's beliefs (if they are based on his wild guesses) are always justified (this is because reliability is sufficient for justification). PEFE is diametrically opposed to this view. According to PEFE, epistemology and consciousness are intrinsically related such that every piece of justification can be traced back to experience and an experience's justificatory force is grounded in its phenomenology.

It is prima facie plausible and in agreement with common sense to assume that experiences justify by virtue of their phenomenology. For instance, if we vary the experience's phenomenology in our example, it also changes what you are justified in believing. If your experience presents you with an avenue flanked by cars instead of trees, it is natural to assume you are justified in believing that there are cars. Undergoing a perceptual experience of an avenue flanked by cars but believing that there are trees (and no cars) would be strange and unjustified.[3] So why is it that externalist accounts are so prominent in contemporary epistemology? One reason, the one that is most important in the context of this paper, is that externalism seems to fit well with what one might call the naturalistic turn that occurred in the second half of the 20th century. This was a turn toward the natural sciences, imposing on philosophy the still prominent view that it should strive to be methodologically similar to the natural sciences. In this context, the natural sciences are typically

3 It is important to note here that it is an *objective* matter of fact whether a subject is *justified* in believing a proposition. One's (experiential) evidence cannot determine what a subject will actually believe. Even in the face of the strongest possible counter-evidence, a subject may ignore or misinterpret the evidence and believe whatever they want to. However, evidence can determine what a subject is *justified* in believing. In this sense, justification is more objective than belief. Experiences and beliefs are mental states that a subject may or may not have. But whether a subject is justified in believing that *p*, based on her (experiential) evidence E, constitutes an objective matter of fact. It is almost universally accepted in epistemology that justification/evidence is objective in this sense. (Although, of course, there is no consensus regarding the nature of evidence/justification.) It is also reasonable and rather uncontroversial that epistemic justification comes in degrees (see, e.g., Berghofer 2022, Section 2.2.1). One can be (objectively speaking) more or less justified in believing *p*, depending on one's respective evidence. Of course, it remains unclear how to quantify objective degrees of epistemic justification (see, e.g., Shogenji 2012). In Section 5, we will discuss the possibility of interpreting quantum mechanics as providing the experiencing subject with the formalism that allows her to quantify what she should believe to experience next.

understood as adopting a third-person perspective that successfully abstracts away from the subject and her personal experiences.[4]

The positions discussed in this paper, PEFE and QBism, radically break with both these preconceptions of how to do epistemology and how to do science. Concerning epistemology, PEFE acknowledges the epistemic role of the subject's *experiences*, locating their justificatory force in the *internal* feature of their *phenomenology*. The following four theses constitute the cornerstones of PEFE:

C1: All epistemic justification and every piece of knowledge can be traced back to epistemically foundational experiences.

C2: All justification-conferring experiences gain their justificatory force by virtue of their distinctive presentive phenomenology.

C3: Experiential justification is always prima facie justification, i.e., justification that could be defeated by undergoing new experiences, gaining new evidence, etc.

C4: There are various types of justification-conferring experiences, including (types of) perceptual experiences, intellectual experiences, evaluative experiences, and introspective experiences, such that every type of justification-conferring experience exhibits a distinctive justification-conferring phenomenology.

C1 implies that certain experiences are a source of immediate justification and identifies these experiences as our ultimate evidence. This is to say that C1 specifies the nature of our justifiers/evidence and tells us something about the *structure* of epistemic justification. More precisely, C1 makes PEFE a foundationalist system that contradicts coherentist approaches in epistemology. C2 provides an answer to the question: Why are certain experiences a source of

4 For a critical discussion of (the impact of) this view, see, e.g., Zahavi 2017, 137f. and Wilson 2022.

immediate justification; what gives them their justificatory force? C2 identifies a factor within experience, namely its phenomenology, as the relevant justification-conferring element. This makes PEFE an internalist system that contradicts externalist approaches that dominate current debates. It also distinguishes PEFE from internalist accounts that do not identify the phenomenology of experience as the relevant justification-conferring factor. C3 ensures that the foundationalism of PEFE is a moderate one. Experiences are a source of immediate but not infallible justification. C4 distinguishes PEFE from competing internalist accounts such as the most popular versions of dogmatism or phenomenal conservatism that pay little or no attention to the phenomenology of (different types of) experiences. I submit that C1-C4 are the cornerstones of any plausible and phenomenologically consistent experience-first epistemology.

In short, PEFE identifies experiences as our justifiers and locates their justificatory force in their distinctive phenomenology. The main task of epistemology, then, is to specify (i) the justification-conferring phenomenology of justification-conferring experiences, (ii) how experiences justify beliefs, (iii) the relationship between experience and evidence/inferential justification, and (iv) how experiential justification can be defeated by further experiences/evidence. Of course, epistemology remains an a priori undertaking. It is silent on what I experience and what I should believe based on my actual experiences. Although, as mentioned above, PEFE remains overshadowed by externalist approaches, it has recently gained significant momentum from works that emphasize the epistemic role of phenomenology and consciousness (Berghofer 2022, Chudnoff 2013, 2021, Church 2013, Dougherty & Rysiew 2014, Koksvik 2021, Smithies 2019). In this paper we investigate what it means for the relationship between epistemology and science if we engage PEFE with QBism.

3. From textbook quantum mechanics to agent-centered interpretations

There is general consensus that quantum mechanics is the most successful physical theory in the history of science. This is due to its accuracy and range of applications. However, despite its great success, quantum mechanics has also prominently been called "the great scandal of physics" (Wallace 2008, 16). This is because there is absolutely no consensus on how to interpret this theory. When it comes to the question of what quantum mechanics tells us about the world we live in, different interpretations come to radically different answers. To see why, it is instructive to begin by contrasting quantum mechanics with classical mechanics.

Typically, we understand physical theories as delivering a purely objective third-person description of how external reality evolves in time. The prime example here is classical mechanics. The ontology of Newtonian particle mechanics, for instance, consists of point particles.[5] Mathematically, these point particles "live" in three-dimensional Euclidean space. They have a definite position and momentum at each point in time and their evolution is governed by deterministic equations (e.g., Newton's second law or the Lagrange/Hamilton equations). It is quite straightforward to interpret these point particles as representing real physical objects in three-dimensional physical space. Classical mechanics amounts to "a purely objective third-person description" in the sense that in the formalism there is no reference to any subjective or operational concepts. The objects in question, their properties, and their dynamics can be governed in purely mathematical terms. The notion of "measurement" does not appear in the formalism and in this framework measurements are to be understood as revealing pre-existing and pre-determined values.

In quantum mechanics, the situation is drastically different. The basic objects of the quantum formalism are not (point) particles but so-called wave functions. Mathematically, wave functions are vectors that "live" in a highly abstract mathematical space, the Hilbert space. In textbook

5 However, it should be mentioned that not even classical mechanics can be interpreted as straightforwardly as it is commonly assumed. Also in classical mechanics the same physics can be formulated in different mathematical frameworks, such as Newtonian, Lagrangian, and Hamiltonian mechanics, which leads to several philosophical challenges (see North 2022, Wallace 2021, Wilson 2013).

quantum mechanics, the state of the system is completely described by the wave function. The evolution of the wave function is governed by the Schrödinger equation, a deterministic second-order differential equation. This part of the formalism has a similar structure to classical mechanics. In classical mechanics, the state of the system is completely described by the positions and momenta of the point particles and the evolution of the system is governed by deterministic differential equations. The main difference, so far, is that the wave function is an abstract mathematical object whose ontological status remains contested, while the point particles of classical mechanics are typically understood as more or less straightforwardly representing physical objects. In other words, it is unclear whether the wave function is or represents something physically real or whether it is, e.g., a mathematical tool to assist agents in navigating the world.

However, what even more radically distinguishes quantum mechanics from classical mechanics is that in textbook quantum mechanics the wave function only evolves according to the Schrödinger equation *unless* a measurement is performed. Once a measurement takes place, the Schrödinger dynamics breaks down and is replaced by a genuinely stochastic process. This is encapsulated in the infamous collapse postulate. The collapse postulate has it that upon measurement the wave function collapses from a state of superposition of several eigenstates to a single eigenstate such that a definite value is measured. This means that textbook quantum mechanics is governed by two types of dynamics. The deterministic Schrödinger dynamics and the stochastic collapse. This, of course, leads to several questions. In particular, this leads to the notorious measurement problem: Why does the Schrödinger dynamics break down upon measurement?

Textbook quantum mechanics (TBQM) does not provide us with a purely objective third-person description of how external reality evolves in time. This is because (i) it is unclear whether the wave function represents a piece of external reality and because (ii) the concept of "measurement" plays a central and irreducible role in TBQM. Here the focus is on (ii). The concept of "measurement" is an operational concept. It is not something that can be expressed in purely mathematical terms. The central role of measurements in quantum mechanics can also be illuminated by asking the following simple question (Griffiths 2018, 17): “Suppose I *do* measure the position of the particle, and I find it to be at point *C*. *Question:* Where was the particle just *before* I made the measurement?” Here is the answer given by Griffiths in one of the most popular textbooks of quantum mechanics:

> The orthodox position: *The particle wasn’t really anywhere.* It was the act of measurement that forced it to ‘take a stand’ (though how and why it decided on the point *C* we dare not ask). Jordan said it most starkly: ‘Observations not only *disturb* what is to be measured, they *produce* it …We *compel* [the particle] to assume a definite position.’ This view (the so-called Copenhagen interpretation), is associated with Bohr and his followers. Among physicists it has always been the most widely accepted position. Note, however, that if it is correct there is something very peculiar about the act of measurement—something that almost a century of debate has done precious little to illuminate. (Griffiths 2018, 17)

Of course, this doesn’t align with the views of many philosophers of science and physics. In philosophy of quantum mechanics, the prevailing interpretations are so-called “quantum theories without observers” (Dürr & Lazarovici 2020, viii; Goldstein 1998). Here the dominant view is that the way quantum mechanics is taught and understood in physics textbooks is not only misleading but plainly unscientific. This is precisely due to the centrality of the notion of “measurement” in textbook quantum mechanics (see, e.g., Dürr & Lazarovici 2020, viii). The mainstream attitude is nicely captured by Tim Maudlin saying: “A precisely defined physical theory […] would never use terms like ‘observation,’ ‘measurement,’ ‘system,’ or ‘apparatus’ in its fundamental postulates. It would instead say precisely *what exists and how it behaves*” (Maudlin 2019, 5).

Importantly, it has become evident that eliminating the concept of measurement from quantum mechanics is *very* difficult and comes at a cost. It is widely accepted that for quantum theories without observers there are basically two options: Either you accept the many-worlds interpretation or you modify the quantum formalism. Many regard the first option as unacceptable because it violates the principle of ontological parsimony as well as the idea that science should not postulate entities that are in principle unobservable. The problem with the second option is that the existing modificatory interpretations, most notably Bohmian mechanics, are less successful in their predictive power than standard quantum mechanics (Wallace 2022). This is because for Bohmian mechanics, in contrast to standard quantum mechanics, we don't have a relativistic extension (see Goldstein 2021, Section 1.4 and Kofler & Zeilinger 2010), which limits its applicability to a narrower range of phenomena. Consequently, opting for the second option and embracing a modificatory interpretation seems to contradict the essence of science in the following manner: it entails prioritizing our (classical) intuitions over our most successful scientific theory. To put it differently, if, on the one hand, you have a highly successful scientific theory, and, on the other hand, a modification of it that is less developed and less successful in its predictive power, you should go with the first one even if it has counter-intuitive consequences. At least this is how scientists seem to approach such controversies. Since the modificatory interpretations violate this line of thought, it is no surprise that Bohmian mechanics remains largely ignored in physics.

So if we neither want to accept infinitely many unobservable worlds nor want to modify the formalism of our most successful scientific theory, what kind option is left? This is the option of embracing the non-objectivist flavor of textbook quantum mechanics. Of course, this also comes at a cost. The price to pay is that we need to rethink the nature of science. Science, at a fundamental level, does not represent an objective world but provides the experiencing subject with the tools to best predict what she will experience next. This contradicts the picture of science we inherited from classical mechanics. However, many physicists, most notably the founding figures of quantum mechanics such as Bohr and Heisenberg, have argued that this is precisely the lesson we should draw from quantum mechanics.[6]

6 For instance, Bohr said that "physics is to be regarded not so much as the study of something *a priori* given, but rather as the development of methods for ordering and surveying human experience" (Bohr 1963, 10). Heisenberg insisted that the mathematics in quantum mechanics "no longer describes the behaviour of the elementary particles

Of course, there are several conceptual problems with textbook quantum mechanics and what is typically referred to as the Copenhagen interpretation. On the one hand, the concept of measurement plays are central role and the collapse of the wave function is understood not as a physical process but as an update in information; on the other hand, physicists (and of course philosophers) traditionally think of the wave function as representing a physical state. But assuming that the wave function represents objective physical reality leads to apparent paradoxes such as the famous Wigner's friend scenario. Here it is to be noted that even proponents of representational interpretations often point out that agent-centered approaches according to which quantum mechanics should be understood as a "single user theory" have the virtue of being capable of providing straightforward explanations of some of the weirdest features/implications of quantum mechanics (see, e.g., Dieks 2022). In particular, from the representational perspective it is, at least prima facie, disturbing that in certain scenarios, such as the Wigner's friend thought experiment, different agents assign different wave functions to the same physical state and use different types of dynamics to describe the same physical process (see, e.g., Baumann & Brukner 2023). There is also some consensus that so-called "extended" Wigner's friend thought experiments "provide support to perspectival interpretations" (Schmid et al. 2023, 30), according to which observed events in quantum mechanics cannot be absolute single events. In the next section, we discuss a prominent agent-centered interpretation that is not only perfectly consistent with but can be motivated by (extended) Wigner's friend scenarios. This is QBism.

4. QBism

QBism is the currently best-developed interpretation of quantum mechanics that embraces the Copenhagen spirit that "*experience* is fundamental to an understanding of science" (Fuchs et al. 2014, 749).[7] The idea is that "quantum mechanics is a tool anyone can use to evaluate, on the basis

but only our knowledge of this behaviour" (Heisenberg 1958, 15).

7 "In many ways, quantum Bayesianism represents the *acme* of certain traditional ways of thinking about quantum mechanics (broadly speaking, Copenhagen-inspired ways). If one hopes to defuse the conceptual troubles over

of one's past experience, one's probabilistic expectations for one's subsequent experience" (Fuchs et al. 2014, 749).[8] The distinctive move of QBism is to apply a personalist Bayesian account of probability, as it has been developed by Bruno de Finetti, to quantum probabilities (Fuchs et al. 2014). This means that probabilities in quantum mechanics are interpreted not as objective but as subjective probabilities. For the QBists, quantum states do not represent objective reality but instead *represent an agent's subjective degrees of beliefs about her future experiences*. Consequently, instead of being construed as (the representation) of something physically real, the wave function is considered to be a mathematical tool that encodes one's expectations about one's future experiences. In short, QBism argues that quantum states do "not represent an element of physical reality but an agent's personal probability assignments, reflecting his subjective degrees of belief about the future content of his experience" (Fuchs & Schack 2015, 1). QBism has a normative dimension in the sense that the Born rule is viewed as a *normative* constraint that "functions as a consistency criterion which puts constraints on the agent's decision-theoretic beliefs" (Schack 2023a, 146).[9] A measurement is understood as an act of the subject on the world and the outcome of a measurement is the very experience that results from this process (see DeBrota & Stacey 2019). Instead of subscribing to a worldview according to which the world is objectively "out there," waiting to be discovered, QBists think of the relationship between world and subject in terms of a reciprocal one. Building on the insight that "reality is *more* than any third-person perspective can

collapse and nonlocality by conceiving of the quantum state in terms of some cognitive state, then the only satisfactory way to do so is by adopting the quantum Bayesian line." (Timpson 2013, 7f.)

8 It is important to note that QBism is to be understood as a research program that has undergone many developments and has not reached a final form (see Stacey 2023 and Fuchs 2023). The version of QBism that I focus on in the present paper is the version introduced by Fuchs, Mermin, and Schack in 2014. What is particularly important to me is that in this 2014 version, the quantum probabilities are understood as "the fundamental output of the quantum theory" (Fuchs et al. 2014, 753). However, prominent QBists have slightly diverged from this picture (Fuchs and Schack, personal conversation). Quantum probabilities are not regarded by Fuchs and Schack as the fundamental output but as part of the subjective input of the Born rule. The output simply is "consistent" or "not consistent" (see Fuchs 2023 and Schack 2023a). The function of quantum mechanics here is to tell the subject whether her decision-theoretic beliefs are consistent. I remain neutral on which version of QBism is to be preferred but I want to point out that the most natural reading of the Born rule, the one that most working physicists presuppose, is that quantum probabilities are the output and not the input.

9 As Fuchs puts it: "The quantum formalism is normative rather than descriptive" (Fuchs 2023, 116). Importantly, however, QBists explicitly deny that the quantum state represents what the subject *should* believe. For QBists, the quantum state should be understood as a judgment, namely a set of probability assignments. These probabilities are personalist Bayesian probabilities. As long as your assignments are consistent, you cannot be wrong about them. This is to say that for an event X, the probability P(X) represents the subject's degree of belief that X will occur.

capture" (Fuchs 2017, 113), they propose a kind of realism that has been aptly labeled a "participatory realism" (Fuchs 2017). Accordingly, one of the QBists' objectives is to put the scientist back into science (Mermin 2014).

Although QBism remains highly controversial, there is some consensus that it constitutes a consistent approach to quantum mechanics that avoids problems surrounding the apparent collapse of the wave function and non-locality. As one prominent opponent puts it: "Any approach according to which the wave function is not something real, but represents a subjective information, explains the collapse at quantum measurement perfectly: it is just a process of updating the information the observer has" (Vaidman 2014, 17). In fact, the main objections against QBism are not technical or conceptual but philosophical in nature. One worry is that there seems to be a lack of a clear philosophical foundation. "Now, as a formal proposal, quantum Bayesianism is relatively clear and well developed. But it is rather less transparent philosophically" (Timpson, 2008, 580). One virtue of engaging QBism with PEFE is that PEFE might be helpful in providing QBism with a philosophical foundation.

I conclude this section by spelling out some implications of QBism regarding the nature of science. Typically, we assume that a scientific theory more or less straightforwardly represents nature objectively, from a third-person perspective. For instance, in classical mechanics the physical objects are represented by point particles in three-dimensional Euclidean space. These point particles have a precise position and momentum and evolve in time according to deterministic differential equations. QBism implies a radically different understanding of science. In this picture, the basic object of quantum mechanics, the wave function, does not represent a physical object or a physical state but a subject's degrees of belief. Quantum mechanics, then, is an instrument that allows the experiencing subject to make the best possible predictions about what she will experience next.[10] Measurement outcomes do not reveal pre-determined or pre-existent values but

10 As pointed out by an anonymous reviewer of this journal, QBists typically don't talk in terms of "best possible predictions" as it invites the common objection that QBism is mere instrumentalism. Importantly, QBists insist (i) that they are involved in a *realist* research program and (ii) that quantum mechanics teaches us important lessons

are the very experiences of the subject that engages with the world. This means that the notion of experience is central and irreducible for science and that science cannot be understood as delivering or operating from a third-person perspective. This, I submit, has crucial philosophical implications not only for our understanding of science or the world but also for epistemology. As mentioned in the previous section, one crucial motivation for externalism is the idea that epistemology (or philosophy more generally) should be modeled according to the natural sciences. But if not even the natural sciences, at a fundamental level, work according to the externalist mindset, then, of course, this motivation breaks down entirely. More precisely, if QBism is right and the concept of experience plays a central and fundamental role in science, then embracing a "naturalist" attitude seems to lead straightforwardly to an experience-first epistemology. In Section 6, I will spell out more clearly what this would mean for the relationship between epistemology and science. Before I do so, I point toward some discrepancies between QBism and PEFE and speculate how they could be resolved.

about *the nature of reality* (see, e.g., Fuchs 2017, 2023). However, according to QBism, "[e]ven though its mathematical structure provides deep insights into the nature of reality, quantum mechanics does not give a description of nature per se, but functions as a guide to decision making. The quantum formalism does not describe nature in the absence of agents, but instead is *normative*, i.e., answers the question of how one *should* act" (Schack 2023b, 2). According to Fuchs and Schack, the quantum formalism is "a decision-theoretic tool which can be used by any agent" (Schack 2023b, 6) in order "to optimize their choice of action" (Schack 2023b, 2). So while my focus in this paper is on the agent as an experiencing subject, the QBists' focus often is on the agent as a decision-making subject. Again, it is to be noted that QBism is not a uniform movement but an ongoing research program. Accordingly, QBists may differ on subtle details and their respective focus. In particular, David Mermin's QBist approach has a different focus than that of Fuchs and Schack. In (Mermin 2019), the term "experience" occurs 182 times, "action" occurs 44 times, and the terms "decision" or "normative" don't occur at all. By contrast, in the longer paper (Fuchs 2023), "experience" occurs 56 times, "action" 72 times, "decision" 15 times, and "normative" 32 times. The following quote by Mermin captures precisely the spirit of the present paper and PEFE in general: "Much of the ambiguity and confusion at the foundations of quantum mechanics stems from an almost universal refusal to recognize that *individual* personal experience is at the foundation of the story *each* of us tells about the world. […] To eliminate the confusion it is necessary to acknowledge that science in general, and quantum mechanics in particular, is a tool that *each* of us uses to organize and make sense of *our own* private experience. I build my understanding of the world I live in entirely out of my own private personal experience. The experiences on which my understanding of my world rests are directly accessible to me and only to me. They underlie everything I know about the world" (Mermin 2019, 2). Since the voice of Mermin is also very recognizable in (Fuchs et al. 2014), it is no surprise that this work is the main QBist point of reference for the present paper.

5. Beyond QBism?

Importantly, QBists explictly deny that quantum states or probabilities can be linked to what the subject *should* believe (personal conversations). Quantum states represent degrees of belief, quantum probabilities simply are degrees of belief, but quantum mechanics remains silent on what the experiencing agent should believe. Even probability-one predictions are considered subjective assignments expressing the agent's highest possible degree of certainty about what they will experience next. In the words of Chris Fuchs, a probability-one assignment "expresses the agent's supreme confidence that the outcome will occur" or "what the agent believes with his heart of hearts" (Fuchs 2023, 107, 109).

Here is an instructive quote:

> For instance, consider an agent who takes the action of placing a Stern-Gerlach device in front of an electron and has just registered spin-up for it in the z-direction as her consequent experience. She will thus assign a quantum state $|z = +1\rangle$ for any subsequent measurements on the electron. However, in QBism this does not amount to a statement of fact but a statement of belief. The assignment of this state amounts to, among other things, a belief—a monumentally strong belief—that taking the same action with the Stern-Gerlach device will give rise to exactly the same consequence, namely the experience of spin-up in the z-direction. (Fuchs 2023, 108)

Of course, for most philosophers and physicists this approach simply is too subjective. Here I only want to mention two problematic features. First, if QBism is true, how could objectivity enter science?[11] This worry has the following structure. Quantum mechanics is our most fundamental scientific theory. If QBism is right, then quantum states are subjective assignments, quantum

11 For different formulations of and approaches to this worry, see (French 2023a, 2023b), (Ryckman 2023), and (Bitbol & de La Tremblaye 2023).

probabilities are subjective degrees of belief, and measurement outcomes are subjective experiences. But how, then, could the sciences lead to objective results? How is intersubjective agreement possible?[12] Second, it is not clear how anything like subjective degrees of belief could be quantified.[13] Above, we saw that QBists consider a probability-one prediction as a subjective assignment that expresses "the agent's supreme confidence," "what the agent believes with his heart of hearts," or "a monumentally strong belief." But what does this even mean?[14] Does it mean that any agent that makes such an assignment actually undergoes such a belief that has such a phenomenal quality? Does it mean that when different agents make the same assignment they all have exactly the same belief? How to understand a situation in which an agent assigns probability 0.74 to outcome A? Does the agent actually believe that it is 0.74 likely that outcome A will occur or does she believe to degree 0.74 that outcome A will occur?[15] Neither seems plausible since beliefs are not that fine-grained.[16]

I mention these two problems because (i) they point toward a discrepancy between QBism and PEFE and (ii) I believe that from the PEFE-perspective there is an easy fix. Both problems can be

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12 For a QBist response to this worry, see, e.g., (Schack 2023b). Here we read: "Nothing in the quantum formalism forces two agents to agree on their respective outcomes. In QBism, intersubjective agreement is not an automatic consequence of the quantum formalism, but a goal that agents might strive for" (8).

13 Of course, this is not to say that QBists don't offer a consistent approach on this matter. As emphasized by an anonymous reviewer of this journal, QBists follow the lead of Frank Ramsey who said: "The old-established way of measuring a person's belief is to propose a bet, and see what are the lowest odds which he will accept" (Ramsey 1931, 172). However, this betting interpretation of degrees of belief has been attacked on many fronts (see, e.g., Eriksson & Ribinowicz 2013 and Eriksson & Hájek 2007). What is more, it has even been doubted that credences (i.e., degrees of beliefs in the relevant sense) exist (see, e.g., Holton 2014 and Byrne 2021). My point here is that objective degrees of epistemic justification can be more straightforwardly quantified than subjective beliefs.

14 An anonymous reviewer of this journal pointed out that "it means precisely what it was defined to mean in Fuchs and Schack's 'Quantum-Bayesian Coherence'," namely that "we say one has (explicitly or implicitly) assigned a probability $p(A)$ [including the assignment $p=1$] to an event A if, before knowing the value of A, one is willing to either buy or sell a lottery ticket of the form worth \$1 if A for an amount \$$p(A)$ [\$1 in the case of $p=1$]. The personalist Bayesian position adds only that this is the full meaning of probability; it is nothing more and nothing less than this definition" (Fuchs & Schack 2013, 1696). Again, I do not doubt that by adopting the betting interpretation of probability and degrees of belief QBists offer a consistent approach. I only point out some problems with this interpretation and raise the question of whether these problems can be avoided by interpreting quantum probabilities as objective degrees of epistemic justification.

15 For a discussion of these two options on how to spell out the nature of credences, see (Moss 2018, 3f).

16 As James Joyce puts it: "numerically sharp degrees of belief are psychologically unrealistic. It is rare, outside casinos, to find opinions that are anywhere near definite or univocal enough to admit of quantification" (Joyce 2010, 283). This is why Joyce champions the orthodox Bayesian view that credences are imprecise. However, it has been argued that the imprecise model of belief, when paired with van Fraassen's "Reflection principle," which has been adopted by the QBists (see Fuchs & Schack 2012), leads to inconsistency (White 2010, Topey 2012).

resolved by postulating that quantum probabilities are not subjective degrees of belief but *objective degrees of epistemic justification*.

In this picture, quantum mechanics is a machinery that has a *subjective input* (the wave function that is supposed to encode the agent's experiential input) but an *objective output* (quantum probabilities understood as degrees of epistemic justification).[17] So the idea is that an agent assigns a wave function based on her experiential input, and then the quantum probabilities quantify the degrees of justification for believing the respective propositions (e.g., that the outcome of this Stern-Gerlach experiment will be X). Importantly, the idea is *not* that experiences lend justification to quantum probabilities. In the ideal case scenario, the agent's wave function assignment is adequately based on what is presented to her in her justification-conferring experiences. But this is always a subjective act. However, in this picture, quantum mechanics (via the Born rule) allows the subject to determine, objectively speaking, what she should believe to experience next, given her assignment. This would constitute an agent-centered interpretation that views quantum mechanics as a single-user theory that allows an experiencing subject to answer the following question: Based on my experiential input, what should I believe to experience next.[18]

This approach would be very similar to QBism but would cohere even better with my phenomenological experience-first epistemology (PEFE). Of course, in the best-case scenario (for

17 As pointed out in footnote 3, experiences and beliefs are subjective in the sense that they are mental states that a subject may or may not have. Epistemic justification is objective in the sense that it is an objective matter of fact whether a subject's (experiential) evidence justifies her in believing certain propositions. (Note that this claim is significantly weaker than the controversial Uniqueness Thesis, which states that "there is a unique rational response to any particular body of evidence" (Kopec & Titelbaum 2016).) Wave functions assignments are subjective in the sense that they are assignments of a subject based on her experiences and beliefs. Degrees of epistemic justification are objective in the sense that they specify what the subject should believe, based on her experiential input.

18 This approach would share many systematic similarities with Healey's pragmatist approach to quantum theory. Both are non-representational interpretations according to which quantum mechanics does not describe the behavior of an external reality but has a crucial normative dimension in telling the agent what they should believe/do. Both consider the agent-centeredness of QBism a virtue but seek to establish an interpretation that is more objective than QBism. For Healey, quantum theory "is a source of objectively good advice about *how* to describe the world and what to believe about it as so described. This advice is tailored to meet the needs of physically situated, and hence informationally-deprived, agents like us" (Healey 2022, Section 4.3). The main differences are that in Healey's pragmatism there is no focus on the notion of experience and no talk in terms of epistemic justification. It is to be noted that when it comes to epistemic justification, I'm not a pragmatist but champion the following "objective" view: The degree of propositional justification a subject has for believing some proposition *p* is an objective matter of fact that is independent of the subject's goals, wishes, or desires. See also Markus Müller's "first-person-first" approach to science (Müller 2020) that also seeks to characterize quantum probabilities in a more objective way than it is done by the QBists.

my approach), it could be shown that the quantum formalism can be reconstructed or derived from phenomenological-epistemological principles about the nature and epistemic role of experience. For recent works that go in this direction, see in particular Berghofer (2024) and Müller (2020). In the following final section, I discuss the synergies and discrepancies between PEFE and QBism.

6. The relationship between epistemology and science

PEFE and QBism share a number of interesting similarities. For both, concepts such as subject/agent, experience, and belief are fundamental. In particular, in both the concept of experience plays a central role. In PEFE, experiences constitute a source of immediate justification and our ultimate evidence. In QBism, wave functions are assignments based on our (previous) experience[19], measurement outcomes precisely are our new experiences, and quantum mechanics is a tool that allows us to quantify what we believe to experience next.

What does QBism imply about the nature of science? As discussed above, according to QBism quantum mechanics is not an objective third-person description of how external reality evolves in time. Instead, this agent-centered approach considers quantum mechanics a single-user theory that allows the agent to make consistent predictions about her future experiences. The central notion of quantum mechanics, the wave function, does not represent an external object or an external state of affairs but represents the belief/judgment of an agent that is based on the agent's previous experiences. Accordingly, if QBism is true, then a truly fundamental scientific theory must incorporate the first-person perspective as well as the scientist and her experiences.

While QBism and PEFE seem to cohere well, we can see that there are no substantial synergies between the QBist understanding of science and externalist approaches to epistemology. As mentioned above, according to externalism there is nothing intrinsically interesting about experience. What matters, for instance, to reliabilism is whether it is objectively true that a certain

19 Importantly, this is *not* to say that wave function assignments are *determined* by one's previous experiences. As pointed out by an anonymous reviewer of this journal, all probability assignments involve a "voluntaristic aspect." See (Fuchs 2018, 12f., fn 11).

belief-forming process yields mostly true beliefs. It does not matter, however, whether the subject knows that her beliefs are based on reliable processes. Externalism is all about how the world is objectively. The subject and her experiences play a subordinate role at best. All of this does not sit well with QBism.

By contrast, PEFE and QBism can both benefit from each other. As discussed in Section 2, one main objection against internalist accounts such as PEFE is that externalism resonates better with the practice of science. This corresponds to the view that the natural sciences successfully abstract away from the subject and her experiences and that philosophy/epistemology should proceed similarly. Of course, if QBism is true, this picture of science is completely wrong. In fact, the success of QBism would turn the tables. As shown in this paper, in order to align philosophy/epistemology with QBist-style science, it would be required to ascribe a central role to the concept of experience. Experience-first approaches would thus clearly suit science better than externalist approaches. On the other hand, as discussed in Section 4, the main objection against QBism is that it lacks a proper philosophical foundation. Given that mainstream analytic epistemology/philosophy of science is dominated by objectivist approaches that ignore or disregard the role of the experiencing subject, this does not come as a surprise. In the light of PEFE, however, QBism may look like a logical continuation of a priori philosophical reflection: While epistemology, PEFE-style, seeks to a priori clarify the epistemic relationship between experience and belief, science, QBist-style, seeks to specify what you should believe based on your actual experiences.

However, such an understanding of science would go beyond QBism. As elaborated in Section 5, there are also some discrepancies between PEFE and QBism. PEFE is about justification. Given an experiential input, a subject has justification to believe certain propositions. QBism, by contrast, is about belief. Given an experiential input, a subject has certain beliefs about the contents of her future experiences. Quantum mechanics helps the subject to be consistent in her beliefs but it does not more straightforwardly tell her what she should believe. This is why in Section 5 I pointed out that the approach to quantum mechanics that would best cohere with PEFE is the interpretation of quantum probabilities as objective degrees of epistemic justification. This would straightforwardly lead to the following picture: Epistemology, at its core, has the objective of clarifying the epistemic role of experiences. This amounts to an a priori analysis of how experience relates to the justification of beliefs. The most basic aim of science, then, is to develop the formalism that allows the experiencing subject to answer the following question: Given my *actual* experiences, what should I believe (to experience next)?

Conclusion

PEFE and QBism share many substantial similarities. Both treat concepts such as subject/agent, experience, and belief as fundamental and are concerned with how experience relates to belief. Both are opposed to third-person approaches. PEFE opposes epistemic externalism by stating that experiences gain their justificatory force by virtue of an internal factor, namely their phenomenology. QBism opposes objectivist interpretations by stating that quantum mechanics is not to be understood as an objective third-person description of how external reality evolves in time but as a single-user theory that allows the agent to make consistent predictions about her future experiences. There are substantial synergies between both approaches. If QBism is correct, this is good news for PEFE because it means it cannot be dismissed for being inconsistent with the third-person spirit of science. If PEFE is true, this might help to provide QBism with a proper philosophical foundation. However, there are also important discrepancies between PEFE and QBism. Epistemology is concerned with what a subject is objectively justified to believe. QBism is silent on this. The relationship between epistemology and quantum mechanics would be particularly intimate if quantum probabilities are not interpreted as subjective degrees of belief but as objective degrees of epistemic justification. It remains to be seen whether such an interpretation is a viable option.

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