Putting Some Flesh on the Participant in Participatory Realism
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Abstract
The history of QBism is interestingly complex (see Stacey 2019) leading to misunderstandings and misapprehensions as to its core features (Earman 2019; Fuchs and Stacey 2020). Fuchs has usefully situated those features within the framework constituted by forms of 'participatory realism' (Fuchs 2016). Within that context I shall consider the claim that measurement devices should be considered to be extensions of agents. Examining that claim, Peinaar (2020) has articulated the conditions that measurement devices must meet to be so considered. However, there has yet been little similar consideration of the conditions that agents must meet in this regard. Here I shall examine claims that adopting a phenomenological stance may fill the gap in the QBists' picture and I shall conclude by exploring certain concerns that arise as a result.

Introduction
Characterising QBism and its history is a contentious business (for an outline and a particular perspective on the history, see Healey 2017; also Stacey 2019). A useful one line summary for my purposes is that it is 'an interpretation of quantum mechanics in which the ideas of *agent* and *experience* are fundamental.' (DeBrota and Stacey 2018). Crucially, the wave-function should be understood solely in epistemic terms, as representing not some state of a physical system but rather that of the agent with regard to their possible future experiences. It does this by encoding the agent's coherent degree of belief in each of certain alternative experiences that result from some act they perform, such as those associated with the outcomes of a measurement procedure. These beliefs are to be updated according to Bayes' Theorem:

$$P(A|B) = P(B|A)\, P(A)/P(B)$$

where A and B are events, P(A|B) is the conditional or 'posterior' probability of A given B, P(B|A) is the likelihood of A with B fixed, and P(A) and P(B) are the 'prior' probabilities of the respective events.

On such a subjectivist interpretation the issue arises as to how the probabilities yielded by quantum mechanics, which are apparently objective, should be understood. This comes down to the question: how should QBists understand the Born Rule, which gives the probability of a measurement yielding a certain result? One suggestion is that it must be taken to be merely a norm of rationality, with Schrödinger's equation rendered as a diachronic constraint on the agent's credences (Healey 2017). As a result, equally rational agents assigning the same initial state may end up with different state assignments because they've applied this constraint in different ways. Thus, 'Quantum mechanics is a single user theory, and any coincidence among states assigned by different users is just that—coincidence.' (ibid.).

Given this, the measurement problem simply dissolves: the observation of the outcome of a measurement becomes nothing more than the acquisition of new information, leading to the reassignment of the 'state' and since that simply expresses the agent's credences, or degrees of belief, any discontinuity between the old 'state' and the new amounts to nothing more than the updating of such credences. Two worries then arise: first, the issue of inter-subjective agreement looms as the deeply personalist features of this view mean that, strictly speaking, two agents observing the same measurement will not have the same experience. However, concordance between credences can be established via appeal to the kinds of devices that Bayesians use in general, such as arguments that show that updating different prior probabilities in the light of new but common information will lead to convergence of the 'posterior' probabilities (although, as is well-known, there are issues with such devices; see for example Talbott 2016 for a general overview).[1]

Secondly, consider Schrödinger's (infamous) Cat: Earman, for example, asserts that the QBist sidesteps the issue of whether the cat should be described as alive or dead before the box is opened because all she is concerned with is the assignment of degrees of belief to the relevant propositions about what will be found (2020, pp.415-416). However, he avers, '[a]lthough it initially seems liberating, the appeal of such sidestepping quickly wears thin.' (ibid., p. 416). In particular, granted that for the QBist the 'collapse' of the wave function is nothing more than a change in the mathematical representation of an agent's degree of belief upon updating with the new information about the measurement outcome, she cannot *explain* why the agent experiences a definite outcome. And although this issue can be avoided as long as we think of the agent as a nothing more than a disembodied probability calculator fed information by an 'oracle', it comes back to bite us once we think of ourselves as '… physically embodied observers … whose information acquisition has to be treated quantum mechanically in terms of an interaction with the (measurement apparatus + object system).' (ibid., p. 416). The failure to provide an explanation then also looms as a major lacuna within QBism and we'll come back to this feature of embodiment, as well as the issue of how we should understand such an 'interaction'.

Of course, the QBist may respond that explanation is not the name of the game as far as they are concerned – all they are interested in is their own personal experiences and how they can be related via the probability calculus. Earman suggests that this leads to a form of 'solipsistic phenomenalism' which, he writes,

'… at least would be an interesting position. Most [QBists] deny that what they are aiming for is phenomenalism. But their subjectivist interpretation of quantum states deprives them of the resources to tackle questions about the relation of agents to a non-phenomenalistic world. Trying to make a virtue out of this seems a stretch.' (ibid., pp. 416-417).

QBists have responded to this dismissal by arguing that '… the portrayal Earman gives has so little to do with the actual language, goals, metaphysics, and mathematical technicalities of QBism as to be unrecognizable.' (Fuchs and Stacey 2020, p. 1). In particular, they claim that Earman's characterisation fundamentally misrepresents the QBist approach to measurement, not least because,

[1] There is an issue here as to whether such convergence among agents should be understood as the 'meat' of Bayesianism or as merely a secondary aspect; see Stacey 2019, p. 14.

‘The trinary decomposition **object + apparatus + agent** [sic] simply does not exist in QBism. QBism is all about the agent and her external world—the decomposition is a binary one.’ (Fuchs and Stacey 2020, p. 9).

They go on to say that whereas other interpretations articulate the measurement process in terms of the apparatus becoming entangled with the system and the observer then becoming entangled with the joint system thus formed, such a ‘story’ contradicts the core tenets of QBism by virtue of ascribing a quantum state to the observer. Instead of thinking of the measurement apparatus as a further ‘system’, possessing its own state and becoming entangled with the observer, who likewise is ascribed a state, it should be regarded as merely an *extension* of the observer-as-agent, or a part of her as an individual.

Apparatus as Extension

This then raises the further question: is it at all plausible to suggest that a Stern-Gerlach apparatus, say, used to measure a particle’s spin, is an actual extension or part of the scientist using it? After all, measurement apparatuses must be calibrated before they can be used. Furthermore, they can also be evaluated and ranked in terms of their precision and accuracy. Finally, more precise apparatuses can, of course, lead to the discovery of new systems (Pienaar 2020). The challenge for QBists is to show how these three features can be accommodated.

Pienaar offers a way of doing this in terms of a two-stage process: the first step involves ‘tuning’ the measurement apparatus to the system under investigation such that measurements on the former can be used to make hypothetical inferences about measurements on the latter; and the second, involves redefining the boundary between the agent and the world so as to include the measurement apparatus as part of the agent (Pienaar 2020, pp. 1906-1907).

‘Tuning’ the apparatus basically encompasses ‘… any and all operations that need to be performed to ensure that the prospective apparatus is in a position ready to measure the target System.’ (ibid., p. 1907). Such ‘tuning’ is deemed to be successful if a direct measurement on the apparatus can be taken to simulate a measurement on the system (ibid., p. 1907).[2] The claim that the measurement apparatus is appropriately tuned can then be taken to express a constraint on the agent’s beliefs about both that apparatus and the system, to the effect that she believes that certain measurements on the apparatus can serve as a *proxy* for measurements on the system (ibid., p. 1909).

The second step then goes further by, in effect, abstracting away the details of the interaction between the apparatus and the system. So, consider trying on a pair of spectacles for example (ibid., p. 1910): at first, if one holds them at arm’s length, say, the image may seem to be ‘in’ the lens, but then, once they’ve been worn for a (short) while, the images are seen through the glass and are taken to be given in perception directly. The example is a useful one because it illustrates what is often taken to be the transparency of measurement in granting us access to the system under investigation. Here the glasses can be understood as an extension of the agent’s eyes. Generalising this, the tuned measurement apparatus can be, in effect, ‘black-boxed’ so that using it can be taken as equivalent to a direct measurement on the system. This corresponds to

[2] Pienaar shows how this can be formalised using the notion of a ‘generalized dilation’ of a positive operator-valued measure (POVM), which represents the most general kind of measurement in quantum mechanics (2020, pp. 1907-1910).

a shift in perception by the agent such that we can say that she has extended herself to incorporate the measurement apparatus (ibid., p. 1911).

Two possibilities then arise: the measurements that the agent can now perform are either an addition to those she could perform on the system previously or a replacement for the latter. These two forms of extension are equivalent in cases where the agent had no prior way of measuring the system directly but could only access it indirectly via the measurement apparatus. Of course, this will be the situation with all 'unobservable' entities throughout the history of science! But within the QBist stance, the agent must initially regard the 'reality' of the system as only hypothetical until the requisite extension and incorporation of the apparatus has taken place. This obviously bears on the issue of where QBism can be situated within the realism-antirealism debate within the philosophy of science that we shall return to below but the point is, this is taken to show how QBism can accommodate the discovery of new systems through the refinement of the relevant apparatus (ibid., p. 1912). In general, then,

'QBism accommodates the idea that a sufficiently practiced scientist using an electron microscope to measure atoms might be said to literally 'sense atoms' and not merely be making inferences about them as abstract or hypothetical entities.' (ibid., p. 1918)

Furthermore, it can clearly be seen that by virtue of certain measurements being lost and others being gained, with regard to the system, this 'extension' of the agent amounts to a shift in the boundary between the agent and the world: 'The World has thus shrunk by losing a System, but the Agent has grown in gaining an Apparatus.' (ibid., p. 1912). Such an extension is regarded as an act of 'free postulation', in the sense that there is no external criterion in terms of which it can be determined to be 'correct' or not. As a result it is deemed to be immune to Dutch book type arguments. And the justification for this is familiar, embodied as it is in von Neumann's principle: quantum mechanics does not prescribe where that boundary should be drawn, only that it must be drawn somewhere, as determined by considerations that lie outwith the theory itself. Having said that, continuity through such an extension can be established by demonstrating that possible measurements post-extension can be obtained from those before the incorporation of the apparatus via this two-step process (ibid., p. 1918).

Finally, the issue of evaluating the accuracy of a measurement apparatus can be framed in decision-theoretic terms and formulated in purely subjectively (ibid., p. 1913). Within such a framework it can be shown that '… an Agent will strictly prefer to use one Apparatus over another, whenever the former can be used to emulate the latter by post-processing of its results, but not conversely.' (ibid.) This yields a partial preference ordering among apparatuses and by drawing on the 'resource theory' of quantum measurements[3] a given apparatus can be defined as more accurate than another whenever it is more 'resourceful' or, equivalently, useful, than the latter.

This is a useful analysis but, of course, for many the suggestion that scientists could be said to literally 'sense atoms' is problematic. Empiricists, for example, may

[3] 'A resource theory is an agent-centric theoretical framework that characterises the possible transformations that can be performed 'for free' on a system.' (Guff et. al. 2019, p. 1). The objects of such a theory are equivalence classes of POVMs and the 'free' transformations are a subset of classical processing operations on POVMs, known as 'post-processing', and derive from the ordering on POVMs that is generated by the ability to 'make up' redundant measurement outcomes or 'confuse' two such outcomes, both of which do not improve the ability of the apparatus to gain information about the system concerned.

insist that there is no such transparency in their terms and that seeing 'through' an instrument is not equivalent to perception with one's eyes (see for example the many discussions surrounding the constructive empiricist stance of van Fraassen and in particular an early exchange with Hacking over 'observing' with a microscope; van Fraassen 1985). Even a realist might balk at the black-boxing of the multiple levels of mediation that hold between, say, the surface of a metal and the tip of a scanning electron microscope.

Interestingly, Pienaar also suggests, 'For this kind of sensing-through-equipment we might borrow the word *Umsicht* from Heidegger.' (ibid., p. 1918 fn. 1). The idea is that the agent is only aware of the measurement apparatus circumspectly so that it effectively disappears in its use – until that is, it breaks down, say, when it obtrudes into our awareness and its 'thingness' becomes apparent again.[4] Again, an empiricist would balk at the equating of such sensing with 'ordinary' perception. Indeed, when van Fraassen was challenged on the way in which he draws the observable-unobservable distinction with the example of someone who has had their eyes replaced with electron microscopes, he famously responded by arguing that such an agent could no longer be regarded as a member of our epistemic community (1985).

Engagement and Entanglement

Before continuing with these considerations it is worth noting that Pienaar's discussion makes it clear just how wide of the mark is the suggestion that we should conceive of the engagement of the observer with the measurement apparatus in terms of entanglement, at least so far as QBism is concerned. On this view, entanglement must be derived, rather than presumed:

'QBism indeed regards agents as embodied; how could a disembodied entity take physical actions and experience consequences? The argument that because agents are embodied their interactions with the world must be treated as the generation of entangled states simply presumes its conclusion.' (Fuchs and Stacey 2020, p. 9)

Again, the characterisation of the observer as an agent must be taken as a conceptual primitive and 'entanglement', or the relevant features of the formalism, obtained as a result, rather than the other way around.

As such a primitive, then, the notion of the agent stands outside the QBist framework – indeed, to expect quantum mechanics to derive that notion is akin to expecting to be able to derive that of the user of logic from the formalism itself, or the reader of a probability textbook from its contents – 'How could you possibly get flesh and bones out of a calculus for making wise decisions?' (ibid., p. 8). Nevertheless, one might still feel that absent some consideration of the nature of the agent, the QBist picture is incomplete (and indeed, Fuchs acknowledges in several places that there is much more to be said).[5] It is here that phenomenology may step in, particularly given the further point that according to QBism, it is in precisely this way that quantum mechanics is different from any theory posed before, namely in being simply an addition to probability theory, understood as normative; that is, as a *theory of knowledge*. Such a re-conceptualisation of quantum mechanics can also be found in

[4] Thanks to Chris Kenny for explaining this.

[5] 'QBism knows that its story cannot end as a story of gambling agents—that is only where it starts.' (2010, p. 27).

London and Bauer's phenomenological approach to the measurement problem, to which we shall return shortly (London and Bauer 1939/1983).

Getting Kicked

Returning to the realism debate, we noted above the QBist claim that despite the core subjectivist elements that are adopted, the 'real world' is still taken for granted. Indeed, according to Fuchs '[w]e believe in a world external to ourselves precisely because we find ourselves getting unpredictable kicks (from the world) all the time.' (Fuchs 2017, p. 121). Nevertheless, as Glick has argued, QBism doesn't sit well with a realist stance in general, not least because it denies that certain central features of the theory, namely quantum states and their evolution, correspond to an aspect of external reality (Glick 2020, pp. 7-8). However, insofar as the Born Rule is taken to express a relationship between probabilities associated with different sequences of measurements, it can be taken to represent '… something that one might want to call 'real'' (Fuchs 2017). As Glick notes, Fuchs also takes the dimension of Hilbert space to be representational (Glick 2020, p. 10) and together with the claim that the elements such as states, their evolution and measurements are related within the theory in a particular way (something that could only have been discovered empirically), this could be construed as expressing a form of structural realism (ibid., p. 10 fn. 11; see also De Brota, Fuchs and Schack 2020, p. 1864). As such, however, the structure that would be posited is metaphysically rather thin (cf. French 2014). Indeed, it has been argued that reality, on this account, is rendered 'unspeakable' or 'ineffable'.[6]

This apparent incompatibility with standard forms of realism is further exacerbated by the emphasis on the creative aspect of quantum measurement: 'At the instigation of a quantum measurement, something new comes into the world that was not there before; and that is about as clear an instance of creation as one can imagine.' (Fuchs 2010, p. 19). Glick reads this as suggesting '… a metaphysical picture in which we construct the world via our interactions with it.' (Glick 2020, p. 15). This does not amount to a form of idealism as the embeddedness of the agent in the world means that, for example, adopting a classical approach to one's expectations regarding measurement outcomes would lead to disaster.[7] It is the combination of features of the world and features of us, as agents that make it the case that measurements can be regarded as acts of creation from the perspective of the agent (ibid.). Glick interprets this as a form of normative realism, familiar from ethics, whereby any metaphysics to be associated with the 'realist' side of things is only relevant insofar as it is needed to account for the constraints imposed by the normativity expressed by the Born Rule.

However, there is tension here: without an appropriate description of the world, what reason do we have for following the given normative constraint? Or, in other words, what grounds the Born Rule? Typically, QBists appeal to a form of 'Dutch Book' argument, whereby the axioms of probability theory are taken to be justified by virtue of the claim that if they're not accepted, a series of bets could be made for which the

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[6] Glick also suggests that QBism does not sit well with the 'No Miracles Argument' for realism, since the fact that the Born Rule latches onto some feature of the world, albeit a fundamental one, hardly seems able to account for the success of the theory as a whole. Indeed, he argues, given that the inputs to the rule must be completely subjective, according to QBism, there is no guarantee that the theory will be successful (Glick 2020, p. 11). However, it's hard to see that as a strong argument given that the QBist will freely admit that success is not guaranteed but the fact that it continues to be achieved tells us something important about the fundamental nature of the Born rule.

[7] Pienaar states that according to QBism 'reality is inherently subjective' (2020, p. 1898) with objectivity secured via the 'holistic structural features of the theory that apply equally to all Agents' (ibid.).

agent is guaranteed to lose money, regardless of the outcomes. The Born rule is regarded similarly such that not to follow it would likewise lead to incoherence. However, given that such a 'Quantum Dutch Book' holds only in worlds where quantum mechanics provides a good guide for agents[8], the issue returns: what is it about our world that makes the Born rule the objectively correct constraint (Glick 2020, p. 20)?

Glick suggests two possible responses that the QBist could make: in accordance with the acknowledgment that QBism is an on-going programme, they could seek the relevant empirical features that would necessitate the rule. However, given that such features would be manifested via measurement outcomes which, again, are regarded as entirely subjective, it is difficult to see what resources the QBist might draw on. Alternatively, they could simply take the Born rule to be a 'brute feature of reality' (Glick 2020., p. 21) that represents, as a constraint, the limit of what we can say about the world. Such 'bruteness' again meshes with a structuralist stance but still yields a 'thin' form of realism, at best.

Indeed, QBism may be deemed to be so 'thin' as to be 'explanatorily inert', particularly if explanation is understood in terms of providing an appropriate mechanism (McQueen 2017, p. 7). However, not all explanations in science involve mechanisms and not all accounts of explanation are mechanistic in nature. Indeed, there's again a whiff of question-begging here (Glick 2020, p. 24).
Consider, for example, the explanation of energy production by the sun (McQueen 2017). Ultimately this is going to involve quantum mechanics – specifically quantum tunnelling – and at this point the mechanistic account of explanation will bump against the very issues that prompted QBism, and of course, will find itself floundering. Indeed, given that 'tunneling' is the name attached to the phenomenon whereby the wave function has a certain probability of being found on the other side of the barrier, this is precisely where QBism gets some purchase. Why is the wave function found on the other side of the barrier? There is no answer to that question except to say what has just been stated, namely that there is a small probability that it will be found there. Why is there that probability? Well, that comes down to the Born Rule and so we return to the issue of what grounds *that* (Glick 2020, p. 25). Ultimately, then, the extent to which QBism can be said to retain the explanatory resources that might at least minimally satisfy the realist depends on the afore-mentioned issue of the basis for the normativity of the Born Rule. Some, of course, might view this as ultimately too high a price to pay for any benefit that the view might bring but the explanatory buck always has to stop somewhere and in terms of what counts as an explanans, there seems little difference in taking that stopping point to be a symmetry principle, say (see French and Saatsi 2018), or the Born Rule.

Nevertheless, there remains a residue of this issue that is both fundamental and not addressed by pointing to the Born Rule: why do *we* experience definite measurement outcomes? It is not enough to simply say that the QBist sidesteps this question by virtue of taking the personal experience of the agent as fundamental, such that 'the occurrence of definite results is a basic postulate that does not need to be derived or explained within the theory.' (Peinaar 2020, p. 1895). Such a response generates the further question, what is it about the personal experience of any agent that leads to those results being definite? There is nothing in the Born Rule or QBism more generally that can supply an answer to this question which requires some

[8] Pienaar distinguishes it from Dutch book coherence as standardly understood and calls it 'World-coherence' (2020, p. 1900).

consideration of what it is to have an experience and how it is of the nature of experience to be definite in the appropriate way. That of course is where phenomenology comes in.

Phenomenological QBism

The suggestion that QBism might find a comfortable philosophical home in phenomenology has been made before, of course. Bitbol, for example, highlights three points of connection: the first is the most obvious, perhaps, namely that just as the QBist regards quantum mechanics from a 'first-person' perspective, so phenomenology requires the adoption of the same in order to identify the contribution of consciousness to experience.[9] Thus, he writes that, 'The project of both phenomenology and non-interpretational approaches to quantum mechanics is to reconstruct a new, self-conscious, type of objective knowledge, starting everything afresh from the first-person standpoint of knowers and agents.' (2020, p. 232).

The second point of contact has to do with the shift in attention that we find, in both QBism and phenomenology, away from the apparently 'external' objects, whether of science or the lifeworld, and towards that contribution of consciousness. It is this shift that marks the phenomenological reduction, of course, and, Bitbol maintains, just as the latter is driven, methodologically, by the epoché, so in QBism we are urged to suspend our judgement with regard to the referential capacity of the symbols of the formalism of quantum mechanics. The third similarity proceeds from the second: the QBist insistence that quantum mechanics only tells us something about the *expectations* we should have concerning the outcomes of experiments is, Bitbol argues, similar to Husserl's understanding of perception, based as it is on his conception of 'horizontal intentionality'. The idea here is that in perception only part of the perceived object is intuitively given to us but we possess an intentional awareness of the other 'profiles' or adumbrations of the object. Thus, our perception is permeated with a horizontal intentionality that intends those absent profiles: although I perceive directly only the screen and keyboard of my Macbook Air, as a *perceived object* it has a co-intended back. Furthermore, I may anticipate my perception of the back of the computer and it is this open manifold of anticipations that constitutes what Husserl calls the intentional horizon.

This third point of contact is then taken up by de la Tremblaye who uses the example of our perception of a cup and suggests that, "[t]he cup is the analogue of the microsystem, the perceptual horizon parallels the QBist quantum state, the perceptual act corresponds to the physicist's measurement and the modification of my possible horizon corresponds to the modification of the state vector after the measurement." (de la Tremblaye 2020, p. 255). Thus, just as perception is a matter of updating the horizon of possibilities associated with our present observation of an object, such as a cup or MacBook Air, so the quantum state, on a QBist reading, expresses a 'bundle of expectations' (ibid., p. 254). Before a measurement, then, the relevant eigenstates correspond to anticipated possible profiles and '[t]he (probabilistic) estimates of subsequent measurements are … analogous to estimates of future perceptions, namely the internal perceptual horizon of an object.' (ibid.). From this horizon only one possible scenario results, of course, and likewise, on a QBist reading, as we've seen, a measurement outcome is considered a personal experience: 'Observing a trace on a

[9] Having said that, Pfänder and fellow members of the Munich school urged the inclusion of inter-subjective relationships.

screen or hearing a click from an experimental apparatus is an experience that is analogous to the sensory nucleus of perception, as it is understood within Husserl's phenomenology.' (ibid., p. 254) On the basis of these parallels between sensory perception as understood by Husserl and measurements in quantum mechanics as understood by the QBist[10], de la Tremblaye proposes that QBism should be understood as a phenomenological reading of quantum mechanics (ibid., p. 255).

Such a proposal is further supported by considering the reflections of Merleau-Ponty, whose work, as Berghofer and Wiltsche note (Berghofer and Wiltsche 2020, p. 32), goes beyond that of Husserl, not least in its consideration of modern physics (Merleau-Ponty 2003; see Barbaras 2001). Thus, Merleau-Ponty raised the fundamental question whether the picture of the world that physics presents could include the physicist *qua* observer herself (Berghofer and Wiltsche 2020, p. 33). Quantum physics, he argued, attempts to do precisely this, by placing the relationship between the subject and object in question (ibid.) and can be accommodated by shifting to a phenomenological stance, according to which the physicist is 'intermingled' with the world.[11] He argued that, in physics a moment comes when it's very development calls into question the presupposition of an absolute spectator and '… "objective" and "subjective" are recognized as two orders hastily constructed within a total experience, whose context must be restored in all clarity.' (1968, p. 20). Such a moment arrived with the advent of quantum mechanics which should be recognised as a physics that situates the physicist physically (!) and '… enjoin[s] a radical examination of our belongingness to the world' (Merleau-Ponty 1968, p. 27; quoted in Berghofer and Wiltsche 2020, p. 33).

In particular, measurement, for Merleau-Ponty, is an *engaged* operation and this is reminiscent of our own situation of embodiment, whereby '… any operation of our own body is an operation within the "flesh of the world"' (Bitbol 2020, p. 239).[12] As a result, he argued, physics cannot be given the standard realist interpretation, and instead he advocated the partial or 'participationist' realism of Destouches-Fevrier.[13] Here once again, of course, one can draw a comparison with QBism (see Berghofer and Wiltsche 2020, p. 33).

Flies in the Ointment

The suggestion, then, is that phenomenology can fill in the gap in the QBist picture by offering an account of the agent and their relation to 'the world'. Certainly, there are points of commonality that are worthy of further exploration but there are also concerns that arise once we begin to probe a little further. Let me begin with Merleau-Ponty's account and the supposed 'situatedness' of the physicist.

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[10] She also notes that in both cases the processes of knowledge acquisition and decision making is dynamic, crucially involving an active role on the part of the agent (de la Tremblaye 2020, p. 256).

[11] Thus, as Bitbol notes, according to Merleau-Ponty, '… no one can truly understand quantum mechanics without accepting a deep transformation of our conception of knowledge.' (Bitbol 2020, p. 239).

[12] Bitbol goes further and asserts that the situation in quantum mechanics is an extension of our situation of embodiment, so that '[a]t the end of the day, quantum physics testifies that the world behaves as a big flesh, of which our flesh is a sample.' (2020, p. 241). As he then acknowledges, it is thought that cuts the measurement chain, thereby yielding a definite outcome.

[13] Paulette Destouches-Fevrier's background was originally in philosophy and mathematics but she was also awarded the diplome d'études supérieures in physics on the basis of her thesis on particle indistinguishability and subsequently published work on the nature of wave mechanics and hidden variables interpretations (see https://fr.wikipedia.org/wiki/Paulette_Destouches-Février).

As Merleau-Ponty makes clear, although such a stance acknowledges that quantum mechanics represents a 'human physics' it does not reduce to a simple kind of idealism (Merleau-Ponty 2003, pp. 97-98). Instead, it transcends the opposition between object and subject and can be said to be broadly structuralist in character in setting the relations presented by the theory at the heart of its conception. Here we recall Glick's suggestion that QBism could be accommodated within a form of structural realism (see also Berghofer and Wiltsche 2020, p. 35).[14]However, the nature of that form depends on how one conceives of these relations. For the QBist they are, fundamentally, embodied in the Born Rule but this not how they were seen by Merleau-Ponty.

Indeed, following Destouches-Fevrier, he asserted that these relations can claim a certain objectivity by virtue of being independent of the measurement process despite being relative to the 'species' of system being studied and refer, not to objects *per se*, but to '… certain mathematical forms that are necessary for the description of the relation of the subject to the object.' (ibid., p. 98; see again Berghofer and Wiltsche 2020, p. 33). Having said that, the fact that they are determined by the theory confers on them a form of reality going beyond the simply mathematical.

Interestingly, Merleau-Ponty draws heavily on the work of London and Bauer (1939/1983) who adopted a phenomenological approach to the measurement problem (French 2002 and 2020). In particular, Merleau-Ponty notes, underpinning this new picture offered by quantum physics, is the non-classical relation between measurement and the observed system. Here he emphasizes the departure from the classical view of the measurement apparatus which, contra, to what the QBists assert, can no longer be regarded as an extension of our senses: 'The apparatus does not present the object to us. It realizes a sample of this phenomenon as well as a fixation.' (ibid.; see also Berghofer and Wiltsche 2020, p. 34). The very act of measurement 'fixes' the object and makes it appear as an individual existent. Here again Merleau-Ponty draws on London and Bauer, in particular their crucial passage where they note 'the essential role played by the consciousness of the observer' in the transition from the superposition to what is taken to be the pure state, in terms of which we characterise a definite result. Looking at that situation from 'outside', as it were, they write: 'Objectively - that is, *for us* who consider as "object" the combined system [object, apparatus, observer] - the situation seems little changed to what we just met when we were considering only apparatus and object.' (1939/1983 p. 251). However, they continue,

'The observer has a completely different impression. For him it is only the object *x* and the apparatus *y* that belong to the external world, to what he calls "objectivity." By contrast he has with himself relations of a very special character. He possesses a characteristic and quite familiar faculty which we can call the "faculty of introspection." He can keep track from moment to moment of his own state. By virtue of this "immanent knowledge" he attributes to himself the right to create his own objectivity - that is, to cut the chain of statistical correlations … ' (p. 252)

This claim as to the possession of a characteristic faculty of introspection has been much remarked upon in the history of discussions over the measurement problem but has not

[14] A suggestion also made by Chris Fuchs at a recent workshop on 'Quantum Bayesianism (QBism) and the Interpretation of Quantum Theory' in the *Harvard Foundations of Physics* series.

generally been understood correctly as indicative of a phenomenological stance (again, see French 2002 and 2020). Crucially, London and Bauer go on to say that,

'… it is not a mysterious interaction between the apparatus and the object that produces a new y for the system during the measurement. It is only the consciousness of an "I" who can separate himself from the former function $\Psi(x, y, z)$ and, by virtue of his observation, *set up* [*'constituer'*] *a new objectivity* in attributing to the object henceforward a new function $y(x) = u_k(x)$.'(L&B)

Thus, rather than consciousness 'causing' in some mysterious fashion, the collapse of the wave-function, the transition from a superposition to a definite state should be more suitably characterised in terms of a mutual separation of both the 'ego-pole' and the 'object-pole' through this familiar act of introspection (French 2002). It is the relational act that is central on this account, and it is of the essence of such an act and of the immanent knowledge that it yields that the ego should appear as one pole – not, crucially, something substantial, over and above or existing prior to this act. Rather it functions as a non-autonomous centre of identity or subject-pole that by virtue of the nature of the relational act, stands at one end of it, with the object under consideration as the other relatum. The latter is then 'made objective', in the sense of having a definite state attributed to it, by this objectifying act of reflection, and the 'chain of statistical correlations' is thereby cut. According to Merleau-Ponty, 'the role of the observer is not to make the object pass from the in-itself to the for-itself (as in Descartes)' (2003, p. 94) but rather, to 'make an individual existence emerge in act' (ibid.) via this cutting of the chain.

The crucial difference between London and Bauer's account, that Merleau-Ponty drew on, and the QBists is that the former, unlike the latter, explicitly take the observer to be entangled with the apparatus and the system.[15] As far as the QBist is concerned this cannot be presumed but must be derived, on the basis of a suitable understanding of the Born Rule. Thus, at bottom, this difference comes down to the terms in which we conceive of the 'kick' of the world, as Fuchs puts it. For the QBists, with their 'first-person' agenda, this is manifested via quantum probabilities, whereas for London and Bauer, and hence also Merleau-Ponty, it is through the entanglement of the system and the observer. This difference in turn marks that between different understandings of phenomenology. Those who highlight the commonalities with QBism have tended to focus on phenomenology's own emphasis on the first-person point of view. However, leaving aside the well-known worries about a descent into solipsism, there are also long-held concerns about the accommodation of inter-subjectivity, a feature that London's teacher Pfänder took to be of central importance.

Intersubjectivity and the Intentional Horizon

This brings us to the second concern with the application of phenomenology to QBism which has to do with the notion of horizontal intentionality and the claim that there is a parallel here with the QBist view of the quantum state as expressing a 'bundle of expectations'. In the case of the cup about to fall off a table, we can anticipate either that it will break or will remain undamaged but never both (de la Tremblaye 2020). Likewise, it is suggested, when we perform a spin measurement, we can anticipate either the outcome 'spin up' or 'spin down' but never both (ibid.). In the former case,

[15] Indeed, they accept what Fuchs denies, namely that consciousness can enter into a superposition.

our anticipations are based on our past experiences with falling cups and on our understanding of the relevant background conditions (whether the floor is carpeted or not, say) and it is on this basis that the horizon of possibilities is determined. In the case of the spin measurement, likewise, the possibilities are determined by our beliefs, at least as far as the QBist is concerned:

'In establishing the state vector, I express in a formal way my beliefs about the future of my measurements; and these beliefs arise by due consideration of my own past experience (including the experience of preparation). The (probabilistic) estimates of subsequent measurements are thus analogous to estimates of future perceptions, namely the internal perceptual horizon of an object.' (ibid., p. 254)

From this horizon only one of the possible scenarios is perceived, giving priority to the role of that present perception in that, by virtue of the perceptual horizon being an integral part of our experience of the cup, say, that present perception has a direct effect on the constitution of that cup, by imposing a determination on that horizon. Likewise, again, in the case of the spin measurement, only one outcome is perceived, with the experience of the flash on the screen, or the click of the counter, taken to be analogous to the 'sensory nucleus of perception' in Husserlian terms.

However, *can* we draw parallels between our everyday experiences, embedded as they are in the 'lifeworld' and those that arise as 'kicks' from the world as displayed in the spin measurement? It is significant that the example given here, of the falling cup, is one with which many of us are reasonably familiar, to the extent that we can claim to have fairly well-formed expectations as to the possibilities in play. Of course, we don't even have to look to cases of quantum phenomena to note that those expectations are based on certain inductive inferences regarding the phenomena in question. And those inferences may well lead us astray – after all, one of the possibilities compatible with (classical) statistical mechanics is that all the air molecules in the room could suddenly be distributed beneath the cup as it falls, thereby cushioning it and even lifting it back onto the table. Of course, that would fall under the 'cup doesn't break' possibility but still, it does give grounds for questioning whether the expectations we form in 'everyday' situations are sufficiently similar to those we could legitimately form in a laboratory, say, so as to justify drawing a parallel between apparently different stances such as phenomenology and QBism. And such grounds are, perhaps, further strengthened by the point, made repeatedly here, that Husserl himself didn't engage with these developments in physics and so all the examples given to help the reader understand the notion of the intentional horizon are drawn from 'everyday life' – granted that advocates of a phenomenological stance claim that that it can be extended to cases in modern physics, still one might well question whether the notion is sufficiently elastic in this respect.

Furthermore, one of the differences between 'everyday' and 'quantum' cases, for want of better terms, is that whereas the cup either has to break or not break, such a disjunction may well not hold in the case of spin 'up' and 'down' – indeed, that the range of possibilities should include a superposition of such disjuncts is precisely what lies behind the Schrödinger's cat thought experiment. Given that, it might be asked, how can we draw the relevant parallels here? However, we need to recall the QBists' response to the measurement problem: to assume that the cat could be in a state of alive-and-dead or the particle in a state of spin-up-and-down is, again, to beg the question as the QBist will deny the attribution of such states to the cat or particle respectively, insisting that all we have to work with are our personal experiences of a definite outcome, together with the Born Rule, taken as primitive of course. It is precisely because of that insistence that the above parallel can be drawn.[16]

Having said that, it may be objected that this parallel cannot be maintained when we consider how we should interpret the notion of the intentional horizon. Thus, Zahavi has argued that this actually requires a certain kind of inter-subjectivity in that such a profile cannot be understood as future-oriented, nor as a current fiction or product of the imagination but '… must be understood as the noematic correlate of the possible perception of an Other.' (1997, p. 3). It should not be taken as future-oriented because that would suggest a conception of the object as a series of temporally separated profiles, but that does not mesh with our experience (ibid., p. 2). Neither can the profile be understood in terms of a product of our imagination: 'Although perception only gives us a partial presentation of the object, the reality of the object is a unified whole which would be annihilated if it were partially composed of fictitious slices (which would be the noematic correlates of the fictitious perceptions).' (ibid., p. 2). Crucially, this imaginative 'filling out' of the profile is 'characterized by a certain arbitrariness' (ibid.), even though it 'unfolds' within the horizontal structure, whose reality it presupposes (ibid.). This 'certain arbitrariness' is an obvious and much discussed feature of the imagination, and even if we grant that it may be constrained, in 'everyday' use, as it were, by our beliefs and habits, based on our 'everyday' experiences, still it is generally accepted that in scientific contexts, the nature of such constraints is significantly different and their extent much greater. As Zahavi says, what the rear of the chair looks like is a matter of contingency, but that it has a backside is a necessity and not one that can be accounted for via a correlation with a fictitious possibility:

'[i]n other words, the reality of the perceptual object implies the reality of its perceptual horizon, that is the reality (and not mere fictitious (or contingent) character) of the absent profiles, although the horizon might be open, i.e., more or less determined …' (Zahavi 1997, p. 2)

According to Zahavi, Husserl himself was aware of these issues and concluded that the absent profiles in the horizon could not be correlated with *my*, or some one individual's, perceptions. The alternative, then, is to introduce the consciousness of another, whose perceptions could underpin the required correlation:

'When I experience someone, I am not only experiencing another living body situated 'there', but also positing the profile which I would have perceived myself if I had been there … Thus, my concrete experience of the Other can furnish my intentional object with an actual co-existing profile.' (ibid., p. 3).

However, there is an immediate objection: surely my perception of the armchair cannot be dependent upon my simultaneous perception of another subject who is also actually perceiving the armchair?! Indeed, there would have to be a huge number of such actual subjects, given the number and variety of possible profiles.

Again, Husserl was apparently aware of the problem and suggested that this insertion of a form of intersubjectivity leads to a certain 'openness' in that it invokes the

[16] That our expectations must be governed by the Born Rule might also be alluded to in these considerations but that point doesn't impact on the parallels drawn with regard to the notion of the intentional horizon at least.

perceptions of numerous *possible* others. Thus, when I perceive a cup, say, that object of perception is constituted by me. However, I am '… only able to perform this activity because my horizontal intentionality entails structural references to the perceptions of possible Others' (ibid., p. 4). On the one hand this interpretation undermines any accusation of solipsism but on the other, the reciprocity involved, in the sense that I must now accept that I am an Other with respect to one of these other perceiving egos, '… implies a dethronement of my own ego as the sole pole of constitution … and this dethronement has far reaching constitutive implications.' (ibid., p. 5). In particular, objectivity, understood as intersubjective validity, can only be established once that reciprocity is acknowledged and the ego perceives itself to be 'one among Others'. That the world, then, has to be understood as constituted inter-subjectively appears to have been acknowledged by Husserl himself (Cairns 1976, pp. 82-83; reproduced in Zahavi 1997, pp. 9-10 fn 24) but more importantly here, it raises obvious concerns about how well-grounded the parallels actually are between phenomenology and QBism.

Conclusion

As we've seen, the compatibility of QBism with phenomenology and hence the degree to which the latter can be appealed to in order to flesh out the former, at least insofar as it comes to our understanding of the role of the agent, hinges on emphasising the 'first-person' perspective. This might be thought to smoothly mesh with taking the Born Rule as a primitive, as far as QBism is concerned, but, as is also well-known, runs into problems when it comes to accommodating inter-subjectivity on the phenomenological side. As we've also seen, appeals have been made to the work of Merleau-Ponty in exploring this commonality between QBism and phenomenology. However, he explicitly drew on the earlier phenomenological analysis of the measurement problem by London and Bauer that meshes with phenomenology's correlative aspect, where this is understood as consciousness and world standing in a mutually dependent context of being (Beck 1928; see Zahavi 2017). This can be taken to generate an alternative approach that sets entanglement at centre stage and hence is less compatible with QBism, as currently formulated.

In either case, the role of the agent is crucial and phenomenology offers an obvious framework in which to explore and develop further aspects of that role. The extent to which this can be taken to fill the gap in the QBist picture then depends on which aspect of phenomenology one chooses to emphasise.

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