



A Quantum Brain Version of the Quantum Bayesian Solution to the Measurement Problem

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ABSTRACT

Quantum Bayesianism makes conventional assumptions about conscious experience and the world, which are “deconstructed” here. Conscious experience is succeeded by Heideggerian *Existenz* as world-thrownness. But unlike Heidegger, *Existenz* is conceived as a monadological dis-closure in the other-tuned, self-tuned and past-tuned “between” of the quantum thermo field brain’s dual mode vacuum state. The wave function is identified with Bayesian expectation conceived as the brain’s “self-tuning” capability subject to informative modification. Physical reality is never worldly but quantum at all scales. Worlds are disclosed only in monadological parallel in the quantum brain’s tuned between. This version of Quantum Bayesianism offers a novel solution to the measurement problem.

Key Words: Quantum Bayesianism, Conscious experience, quantum thermo field, self-tuning, Physical reality

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4

Introduction

Physics seems no closer than ever to reaching a consensus solution for the measurement problem.

“Our first cloud [“on the horizon of physics present and future”] is the quantum measurement problem: that is, the difficulty of explaining completely, in terms of quantum theory, the emergence of a classical world, i.e. a world so accurately described by classical physics with its definite values—a world free of superposition and entanglement” (Briggs, Butterfield & Zeilinger, 2013).

I use this failure—still “our first cloud” after ninety years!—as justification for trying what seems *prima facie* a ridiculous position: the denial of both conscious experience and a transcendent observable world-out-there. I apply this deconstruction to the solution to the

measurement problem known as “Quantum Bayesianism” (QBism) (Fuchs *et al.*, 2010, 2013, 2014; Caves *et al.*, 2002), which is the current face of traditional Copenhagenism.

Now physics takes the observable world as incision point and then rushes away to the underlying dynamics, never doubting the quotidian world as such. Do we not all agreeably see it right there in front of our noses? Conscious experience is accepted uncritically too. Bohr (1963) regarded physics as developing methods for surveying human experience and ordering it. Von Neumann (1955) even gave consciousness the power to collapse the wave function. Planck was unequivocal about the role of consciousness.

“I regard consciousness as fundamental. I regard matter as derivative from consciousness. We cannot get behind consciousness. Everything that we talk about, everything that we regard as

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existing, postulates consciousness" (*The Observer*, 25 January 1931). The role of conscious experience in the measurement problem persists—indeed is featured—in the form of the probabilized conscious expectations of QBism. There a measurement “is an action an agent takes to elicit a set of possible experiences. The measurement outcome is the particular experience of that agent elicited in this way” (Fuchs *et al.*, 2014, p. 4). Thus, the wave function for QBism represents probability-weighted *expectations* regarding future experiences. The measurement *result* is considered an unproblematic conscious experience.

The deconstruction to be undertaken here, of the consciously experiencing observer observing the transcendent world, will be succeeded by monadological *Existenz*. The “first cloud” then dissipates at catastrophic cost to common sense (which has always been physics’ *modus operandi* anyway).

That the notion of conscious experience is so pervasive and unquestioned today makes it an attractive candidate for deconstruction. If we just look at the etymology of ‘conscious experience’ we find something quite different from what that phrase means currently. ‘Consciousness’ (which dates only to the 17th century) is derived from *conscieri*, which is to *know* together, and ‘experience’ (16th century) derives from *experio* meant as an act, literally to try out (as in experiment). So conscious experience, which seems so fundamental to us today, is actually a relatively modern construction traditionally associated with Cartesianism. How could the wise ancients have missed something that seems so obvious to us?

The very phenomenology of consciousness is far trickier than its cavalier use by QBists would suggest. As Heidegger (1927, 1975, 1989) emphasized, in ordinary praxis we are not conscious of the world but operate within it. We are “thrown” (*geworfen*) amidst the world, Heidegger insists, engaged in some endeavor or other, even if merely contemplating the world. It is only when we *reflect* that we bring in consciousness of world. Otherwise we are preoccupied in our engagement with the world at hand. Thus, at this very moment you are thrown amidst this text, perhaps incredulous towards its bizarre claims, with “consciousness” of the text not evident (until you reflect). Heidegger accordingly focuses on *Existenz*, thrown existence in which we always find ourselves already situated for a world of pragmata.

There is still another departure from conventional physics praxis in what follows: Mathematics is barely utilized. This is by no means to diminish the magnificent power, beauty and utility of mathematics in physics. However, mathematics abstracts from consciousness and world, and having accordingly no agenda to deconstruct them, tacitly colludes in this barrier to resolution of the measurement problem. An unencumbered incision to the measurement problem is initiated here.

Quantum Bayesianism

Quantum Bayesianism (QBism) has a certain overlap with a monadological interpretation.

“In QBism ... a quantum state does 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 experiences (Fuchs *et al.*, 2014, p. 1).”

Quantum mechanics becomes here a *tool* which an agent utilizes to assess his probabilistic expectations for experiences to be undergone. So the quantum state does not represent an external physical reality but something subjective: “the agent’s personal degrees of belief about the future content of his experience” (Fuchs *et al.*, 2014, p. 2). Measurement is nothing objective but subjectivized. Subjectivity cannot be excluded from the world picture.

“In QBism, a measurement is an action an agent takes to elicit an experience. The measurement outcome is the experience so elicited. The measurement outcome is thus personal to the agent who takes the measurement action. ... A measurement does not reveal a pre-existing value. Rather, the measurement outcome is created in the measurement action” (Fuchs *et al.*, 2004, p. 4).

The subject, then, is inextricably involved in the world picture. This process is “Bayesian” in that the subject’s personal probability assignments change with the experience elicited.

The subjectivity of QBism in Fuchs’ conception is striking.

“The fundamental primitive of QBism is the concept of experience. According to QBism quantum mechanics is a theory that any agent can use to evaluate his



expectations for the content of his personal experience. ... QBism interprets all probabilities, in particular those that occur in quantum mechanics, as an agent's personal, subjective degrees of belief" (Fuchs *et al.*, 2014, p. 3).

All physical systems at whatever scale are treated in the same way by QBism (including agents). The Bayesianism is realized in the modulation of the subject's future beliefs by further experiences. The commitment of QBism to subjective experience is a deeply philosophical agenda that denies the objective existence of quantum states. Quantum states are pure experiences.

Although this does not appear to be explicitly acknowledged, QBism achieves a certain rapprochement with continental phenomenologists, such as Husserl (1988), Heidegger (1927, 1975, 1989) and Merleau-Ponty (1962), who studied experience as such. (Of course, Heidegger himself would have none of this rapprochement ... he would "leave science to its mania for its own usefulness" (1989, p. 198).) This rapprochement is revealed by Mermin (2013) who complains of "the long-standing exclusion from classical physics of the experience of the perceiving subject" and states that "the goal of science is to bring order and coherence to the experience of the person who uses it" (p. 7). What is missing, however, is the existential turn of Heidegger and Merleau-Ponty, so that QBist phenomenology remains traditional.

QBism has a significant overlap with the monadological interpretation developed here. As will be shown below, the agent's personal probability assignments or subjective beliefs coincide with monadological "self-tuning" which is also responsive in a Bayesian manner to fresh tuning from the environment. But in place of conscious experience, the present proposal substitutes thrown *Existenz*. The more telling difference from the monadological interpretation, however, is QBism's staunch commitment to an external world.

We certainly have no bone to pick with the idea of a world external to the agent. Indeed, it must be as Martin Gardner (1983) says,

"The hypothesis that there is an external world, not dependent on human minds, made of *something*, is so obviously useful and so strongly confirmed by experience down through the ages that we can say without exaggerating that it is better confirmed than any other empirical

hypothesis. So useful is the posit that it is almost impossible for anyone except a madman or a professional metaphysician to comprehend a reason for doubting it" (Fuchs *et al.*, 2013, p. 48).

To the "deconstructive" eye (which has some Freudian inclinations amidst the Derridean gloss), this extraordinary negative hyperbole in the midst of an otherwise sober academic presentation is a *symptom* of repressed conceptions which I seek to bring out here.

Windowless Monads

It is far easier to bracket consciousness than the world we encounter at every moment. But suppose we are actually "windowless monads" along the general lines of Leibniz (Rescher, 1991). Then there would be no transcendent world-in-common that all observers consciously perceived from their own perspective. All worlds lie within monads in parallel, each monad having its own world. Leibniz vitiated this seemingly bizarre position, however. He had a compassionate God *think* a transcendent world into being so that His beloved monadic subjects might be a bit hoodwinked but not truly betrayed, since there really is a world out there after all, even though they never can observe it, closed off as they are as windowless monads.

Sans God's work our quotidian belief in a transcendent observable world might be deconstructed. Then all worlds could at least conceivably be immanent, in parallel within monads. For this proposal superpositions of, say, the Schrödinger cat collapse not to a worldly alive cat or a worldly dead one but to one or the other purely as macroscopic quantum object. *Physical reality is quantum at all scales, never worldly except for the interior of monads* (which is of course not necessarily confined to our species). If we are windowless monads, then the insufferable nine decades of measurement problem are radically transformed and might be simply resolved.

I pursue this quasi-Leibnizean line of thought here. The central task is to explain *how immanent monadological worlds come into being if everything is unworldly quantum at all scales*. It must be something that the brain as quantum macroscopic object accomplishes ... an achievement of the brain, I shall claim, with quantum degrees of freedom in its functioning.

Explaining the Worldly



Physical reality is quantum at all scales, which includes quantum macroscopic objects with sharp boundary structures (Umezawa, 1993). In certain types of macroscopic quantum object there are well-tuned states sustained, states which are real. How a worldly state might obtain if everything is quantum at all scales is the central problematic of this article. The work of Umezawa, Takahashi, Vitiello, Freeman and others on “thermo field dynamics” (TFD) provides a solution to the key question of how the real comes to be, if everything is indeed quantum at all scales (Ricciardi & Umezawa, 1967; Takahashi and Umezawa, 1975; Umezawa, 1993; Vitiello, 1995; Jibu and Yasue, 1995; Vitiello, 2001; Globus, 2003, 2009, 2015; Freeman and Vitiello, 2010; Blasone *et al.*, 2011; Freeman *et al.*, 2012; Capolupo *et al.*, 2013).

In TFD the field degrees of freedom are doubled (Umezawa, 1993). *The vacuum state is accordingly a between*, between dual modes. This doubling of field degrees of freedom is not really peculiar to thermo field dynamics but can also be found in the standard QM formalism of the density matrix (Feynman and Vernon, 1963; Schwinger, 1951), as well as the related Wigner function (Feynman, 1972). The dual modes are labeled ‘non-tilde’ and ‘tilde’, which go forward in time and backward in time respectively. When these motions are equal, the system appears to behave classically, but when unequal the system behaves in a quantum mechanical manner. The dual mode vacuum state in TFD consists in *pairs of particles*. The vacuum state is a *between-two*. Under energy conservation law creation or annihilation of a particle in one mode is yoked respectively with annihilation or creation of a particle in the other mode, resulting in particle-hole and hole-particle pairs.

The between of a diamond is stuck quasi-forever. But the between of our living brains (understood here as quantum macroscopic objects) fluidly changes, continuously modulated in waking and periodically in REM sleep. The field elements are prominently water dipoles. The brain’s vacuum state as water dipole field is continually tuned by three influences; (1) Signals from the environment are transduced at the sensory receptors, dissipate their energy and fall into the ground state. (2) Signals that the brain itself generates also dissipate their energy and fall into the ground. And (3) signals from the past are already traced in the ground, *viz.* memories. So the vacuum state ends up continuously other tuned by the environment, self-tuned by the brain itself and past-tuned by memory traces, including traces of

recognition on signal repetition. *Self-tuning is the actual mechanism for the quantum brain’s QBist “expectations.”* Self-tuning also importantly modulates sensory and motor processes, but the present emphasis is on self-tuning of the vacuum state. Self-tuning is the key to understanding the difference between a diamond as quantum macroscopic object and the brain as a quantum macroscopic object.

The mechanism of memory trace formation is provided by TFD. Other-tuning and self-tuning signals dissipate their energy, fall into the ground state, and break the rotational symmetry of the water dipole field. The lost symmetry is preserved in the formation of near-zero energy Nambu-Goldstone bosons as a condensate. The condensate is dual mode. The creation of N-G particles in our time-forward non~ mode is associated with the annihilation of N-G particles in the reverse time ~mode, so the memory trace is dual mode: non~/~ particle/hole. The memory traces of other-tuning and self-tuning signals consist in the N-G non~/~ ground state dual mode condensate.

When the other-tuning and self-tuning signals are repeated, the N-G particles are energized out of the non~ vacuum state, leaving a hole which is accompanied by particle creation in the ~ mode. The resulting *recognition memory trace* is accordingly distinct from the original memory trace, having the dual mode non~/~ form hole/particle.

Now when the signal is again repeated there is a match with the recognition trace, a match that is real. This is the juncture where the quantum realm is transcended and the state of the between is real: in the match between other-tuning and self-tuning signals on the one hand with traces of recognitions on the other hand. In the match the quantum closure is breached and something real is dis-closed, appears, as existential world-thrownness. The novel idea here is that *world-thrownness is strictly between dual modes of the ground state in virtue of their match: Existenz is between*. The price to pay is the loss of the convivial world-in-common. We are left with the stark fate of our profound existential isolation as monadological entities in parallel, just as Leibniz proposed but *sans* God’s beneficence.

It is noteworthy that there is no talk of consciousness here (which would lead us off into the wilderness of metaphysics). The between’s disclosure is *Existenz*, and so, as Heidegger would phrase it (1962, 1975, 1989), we always find



ourselves already “thrown” amidst a world. (The “throwness” implies the principled unreachability of the dynamic that throws us (*das Ereignis*), since what we are is but a between.) This is our existential state: always finding ourselves already amidst some world or other, waking and dreaming both. What is added to Heidegger here is the *mechanism* of existential world-throwness. World-throwness is the real three-way match in the ground state between: the match between other-tuning, self-tuning and past-tuning, the real match which is existential world-throwness. (In dreaming with its creation of the dream world the other-tuning is sharply truncated to what Freud (1900) called “day residues.”) The closure of the quantum realm is breached, is dis-closed by us, by the *Daseins*, beings who are “there” (*Da*) in virtue of the match ... the *Da* as *Existenz*. (“There” is not meant in the spatial sense of over there on the table but what is meant when we shake the sleepy-head awake and ask, “Are you there?”)

Counter-Intuitiveness of a Monadology

Quantum physics is so extremely counter-intuitive in its own right that the issue can hardly be raised against a monadology. Still, the seeming transcendence of world and the seeming facticity of quotidian world-throwness is so compelling that doubts regarding the present formulation naturally arise. Could the quantum thermofield brain really construct a world if there is no world out there to copy or in some fashion re-present? There is one common human experience, however, that ameliorates such concerns: *dreaming*.

There are some dreams so vivid—so authentic—so real-seeming—that on awakening we have carefully to *reason out* that such a world-throwness could not possibly have happened; we *infer* that “Whew! It must have been a dream!” Freud (1900) proposed that the dream is a “composition” of memory traces and the composition theory of dream formation remains widely accepted today (Llewellyn, 2013).

Of course, the manifest dream has a relationship to memory traces but not one of composition. How could memory traces of scenes from childhood and incidental memory traces of preceding days, as well as mere allusions in conversation and transitory inner fantasies be seamlessly integrated into a seemingly substantial world at times indiscernable from the world of waking life? Such a synthetic function is miraculously attributed to “composition.” The

well-described phenomenon called “lucid dreaming” (LaBerge, 2009), where the dreamer guides the dream events to authentic world thrownesses never previously experienced, shows the dreamer’s profound capabilities for world-throwness *de novo*. There are indeed *associative* links between the dream elements but “composition” does not explain how diverse elements from different life phases, including distant childhood, could be seamlessly integrated into a vivid authentic dream life at times indiscernable from the world of waking life.

The constitution of world-throwness while dreaming uses the same model as for waking, with the exception that sensory stimuli are mostly blocked. However, there are what Freud termed “day residues,” charged sensory remainders from the immediately preceding day or two which retain some emotional significance and provide a rudimentary other-tuning. Meanwhile self-tuning is given free play (unconstrained during sleep by Bayesian feedback) and the full life-long library of memory traces are available. During the periodic activation of REM sleep, the rudimentary other-tuning, the Bayesian-freed self-tuning and the reservoir of past tuning interplay in the ground state. Then a matching process takes place in the between, a match resulting which is none other than dream world-disclosure. *The difference between the world in waking and the world in dreaming is the mainly unmodulated (non-Bayesian) power of self-tuning in dreaming.* Dreams are so revealing to the clinical dream interpreter precisely because they are expressions of the dreamer’s self-tuning of the between—a self-tuning that Freud showed to be wish-fulfilling—the self-tuning which is revealed when sensory other-tuning and so Bayesian mechanisms are disengaged during sleep. *Dreaming existence, like waking existence, is between.*

Comment

The central insight claimed here—a modification of quantum Bayesianism—is the identification of the wave function with the quantum thermo field dynamical brain’s self-tuning capability (which of course a diamond does not have at all but a hawk does in its own hawkish way). Conventional observation is reinterpreted as dis-closure in the between—the real match between other-tuning, self-tuning and past-tuning—a disclosure which is world-throwness, *Existenz*. This shifts the ontology of QBism to the monadological. Such a



proposal for resolving the “first cloud” on the horizon of physics is uncommonsensical to the extreme, which is only what we should expect from quantum physics.

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