# Clarifications and Specifications. A Conversation with Henry Stapp

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HA: You have been actively interested in the relationship between mind and matter for almost half a century. Shortly after receiving your PhD at Berkeley, you went to work with Wolfgang Pauli at the ETH in Zurich, in 1958, the year Pauli died. During that period, you told me, you drafted a manuscript entitled "Mind, Matter and Quantum Mechanics" which was never published. But its title reappeared in your book of 1993. What stimulated your interest so early on in your career, and what were your ideas at that time?

HPS: 1959 was indeed early in my career as a PhD, but more than a dozen years into my concerns with these matters. Already in high school I had become very interested in the wave-particle puzzle, and my driving motive in becoming a physicist was really to solve that mystery. Looking now at my 1959 essay I find it remarkably mature. I had a solid grasp of the technical and philosophical aspects of the situation. I find in it today nothing that I would emend or consider naive or deficient. It is a well-reasoned and sober assessment of the situation, and ends with the conclusion that quantum theory "primarily is a synthesis of the idealistic and materialistic world views. To some extent it also reconciles the monistic and pluralistic attitudes, provides a natural understanding of creation, and permits a reconciliation of the deterministic aspects of nature with the action of free will." I now say much more about these matters, but nothing contrary to what I said then.

HA: For rather more than a decade, the problem of how to relate consciousness to brain activity has been put back onto the agenda, first in the philosophy of mind, notably due to the courageous efforts of David Chalmers and others. This has led to an increased attention in other fields as well, including cognitive neuroscience, complex systems research, evolutionary biology, and others. However, I think it is fair to say that the mainstream position in the sciences is still that mental activity can be reduced to brain activity in the sense that the mind will be completely understood once the brain is completely understood. Yet there are counterarguments

against this position, for instance the famous qualia arguments. How do you think about them, and which of these counterarguments appear to be most striking to you?

HPS: I believe that the arguments advanced in favor of the idea that "understanding the brain" entails "understanding the mind" are malformed and irrational. What does "understanding the brain" mean? What does the word "brain" mean as opposed to "mind"? The aimed-at, and completely reasonable, meaning in this context of the phrase "understanding the *brain*" is that this understanding should be basically in terms of the laws and concepts of *physics*. If "understanding the brain" is not basically tied into understanding the brain in terms of the laws and concepts of physics then the notions "mind" and "brain" are nebulous and ill-defined, and no sharp conclusions can be reached. But if the phrase means understanding the brain in terms of the laws and concepts of physics then the first question is: *which physics, classical or quantum?*
The answer is clear! The classical laws are fundamentally incorrect at the ionic level at which be basic dynamics occurs, hence one must in principle use the quantum laws and concepts. There is no rational controversy about whether or not quantum effects occur in the brain – of course they do! The crucial question is the extent to which the quantum, as opposed to classical, precepts are essential for the dynamics of the brain; and to what extent a classical approximation is valid in a warm, wet, noisy brain.
To resolve these issues one must examine how well the possible quantum effects can survive in an environment that is potentially lethal to many of them. Careful analysis shows that one particular quantum effect, the "quantum Zeno effect", can survive and indeed can play an essential role in the causal relationship between a mind and its brain.
Of course, understanding *any* aspect of nature "completely" may very well entail understanding all of nature completely. But this does not mean that understanding what physics alone can say about the mind-brain system completely entails understanding the psychologically described aspects completely. In fact, in the orthodox quantum description neither of the two kinds of aspects is, by itself, dynamically complete – rather, they complement each other. A specific problem is that within contemporary quantum theory the physical description does not by itself determine the occurrence or the character of certain *interventions* that are needed to complete the dynamics. In actual scientific practice the causal roots of these interventions are described in psychological terms, e.g., in terms of the intentions of experimenters. Thus, according to contemporary orthodox basic physical theory, but contrary to many claims made in the philosophy of mind, *the physical domain is not causally closed*. A causally open physical description of the mind-brain obviously cannot completely account for the mind-brain as a whole.

HA: In your articles you emphasize that your way to address the mind-matter problem does not go beyond what you like to call "orthodox quantum theory". However, quantum physics in its usual understanding excludes anything like mind, mental

states, psyche, etc. even if issues of observation and measurement are discussed. Obviously, most experiments today are carried out in an entirely automatized way, so conscious human observers are not at all needed to register a measured outcome.

HPS: By "orthodox quantum theory" I mean, specifically, versions of quantum theory –such as the original pragmatic Copenhagen interpretation, validated by actual scientific practice, and also von Neumann's extension of it – that explicitly recognize the fact that, *prior to the appearance of an experimental outcome*, a particular experiment needs to be set up. This "setting up" *partitions* a continuum of quantum potentialities into a finite set of discrete possibilities. A simple example of such a partitioning is the placing of a detector of some particular size and shape in some particular location. The distinction between the firing and non-firing of this detector during some specified temporal interval then induces a bifurcation of a continuous space of potentialities into two subspaces, each correlated with a distinctive event, or lack thereof.
Von Neumann referred to this essential physical act of partitioning as "process-1" and represented it in terms of projections onto different subspaces. Quantum theory depends upon the injection of such process-1 *interventions* into the dynamical evolution of the state of the system under study, which, except at the moments of these interventions, is controlled by the Schrödinger equation (which von Neumann called "process-2"). An adequate theory of nature must accommodate physical process-1 actions even in situations in which no human agent seems to be involved. These interventions into the physical dynamics are perhaps the most radical innovation of quantum theory, *vis-à-vis* classical physics.

HA: If the formal structure of orthodox quantum theory remains unchanged in your approach, this can only mean that it also remains restricted to the material aspects of reality. This implies that, in order to include the mental domain, you have to invoke truly substantial additions to your framework of thinking, which are outside the realm of established physics. For this purpose you must have an ontology which (i) is consistent with our knowledge of (quantum) physics; (ii) allows a plausible incorporation of the mental, and (iii) provides ideas about how the two are related to each other – quite a program! How would you briefly sketch such an ontology?

HPS: In the first place, the structure of orthodox quantum theory allows us to make statistical predictions about correlations between initially known experimental conditions and the knowledge gleaned from their experienced outcomes. In Bohr's words (Bohr 1963, p. 60): "Strictly speaking, the mathematical formalism of quantum mechanics and electrodynamics merely offers rules of calculation for deduction of expectations about observations obtained under well-defined experimental conditions specified by classical physical concepts". In this sense, quantum theory concerns *directly* (i) the creation and experiencing of "well-defined conditions specified by classical physical concepts"; (ii) the experiencing of outcomes of these actions; and (iii) certain predictions concerning relations among these two kinds of experiences. An adequate conceptual framework must provide an understanding of our role in

the creation of conditions that will allow us to make quantum predictions pertaining to our resulting experiences.
In short, already the orthodox version of quantum mechanics, unlike classical mechanics, is not about a physical world detached from experiences; detached from minds. It is about predictions of relationships – entailed by a particular theoretical structure – between certain specified kinds of experiences.
The natural *ontology* for quantum theory, and most particularly for relativistic quantum field theory, has close similarities to key aspects of Whitehead's *process ontology*. Both are built around psycho-physical events and objective tendencies (Aristotelian "potentia", according to Heisenberg) for these events to occur. On Whitehead's view, as expressed in his *Process and Reality* (Whitehead 1978), reality is constituted of "actual occasions" or "actual entities", each one of which is associated with a unique extended region in space-time, distinct from and non-overlapping with all others. Actual occasions actualize what was antecedently merely potential, but both the potential and the actual are *real* in an ontological sense. A key feature of actual occasions is that they are conceived as "becomings" rather than "beings" – they are not substances such as Descartes' res extensa and res cogitans, or material and mental states: they are processes.

HA: So what you suggest is to start from the ontologically neutral Copenhagen interpretation and supplement it with an ontology that is different from all other ontological interpretations of quantum theory that we know of. It combines Heisenberg's ontology of potentia with Whitehead's process ontology. Let us first talk about Heisenberg's ideas, and how they go beyond the picture of a materially tangible reality.

HPS: In his *Physics and Philosophy*, Heisenberg (1958, p. 50) asked: "What happens 'really' in an atomic event?" He referred to events as happenings: "Observation ... selects of all possible events the one that has actually happened ... Therefore, the transition from 'possible' to 'actual' takes place during the act of observation" (Heisenberg 1958, p. 54).
Heisenberg's ontology is about sudden events and about "objective tendencies" for such events to happen. The natural ontological character of the "physical" aspect of quantum theory, namely the part described in terms of a wave function or quantum state, is that of a "potentia" or "tendency" for an event to happen. Tendencies for events to happen are not substance-like: they are not static or persisting in time. When a detection event happens in one region, the objective tendency for such an event to occur elsewhere changes abruptly. Such behavior does not conform to the philosophical conception of a substance.
Thus, neither the event nor its tendency to happen are ontologically substantive or self-sufficient: they are intrinsically connected to one another. Descartes' identification of two different "substances" in reality is neither helpful for nor concordant with quantum theory. However, the conception of two differently described *aspects* of reality accords with both the theoretical and the practical elements of quantum theory.

HA: Whitehead's ontology is particularly radical insofar as it considers *process* as primordial, not substance – substance as understood in a philosophical sense. This is in contradistinction to all established sciences and almost all mainstream philosophy. How do you see the chances to establish a process ontology in the sciences?

HPS: Heisenberg never fully reconciled his ontological ideas with the epistemological stance of the Copenhagen interpretation. Chapter 3 of *Physics and Philosophy* (Heisenberg 1958) is clearly an effort to bring these two aspects together. But to bring them successfully together in a rationally coherent and intellectually satisfying scheme requires one to say something about how the particular event that actually occurs comes to be selected.
Heisenberg did not address this issue, but Whitehead's account aims to explain it. Whiteheads fundamental process is the process of combining the pre-existing psychologically and physically described aspects of reality together to form a new psycho-physical actual entity, or actual occasion, that is identifiable as an actual event (à la Heisenberg), whose physical manifestation is represented by a von Neumann process-1 action. I am merely proposing that Heisenberg's incomplete ontology be completed by accepting what I regard as Whitehead's main ideas. The aim of this approach is to understand how the psychological and physical aspects of reality conspire to select the events that actually occur. It allows the basically anthropocentric features of the pragmatic epistemological Copenhagen interpretation to be embedded within the general framework of a non-anthropocentric world process. (For more details see Stapp 2006.)

HA: So introducing Whitehead not only brings in process; it also, at the same time, integrates the psychologically described and the physically described aspects of reality into an overall processual dynamics.

HPS: Yes. And getting now to your question about the possibility of infiltrating these ideas in science, I need to stress that the core idea that the events in our streams of consciousness are two-way causally linked to events in the physical world lies at the intuitive heart of our daily dealings with reality. A theory that breaks this link is highly counterintuitive, and is also difficult to really make sense of either in everyday life or scientific practice.
School children during the mechanical age were readily able to accept the idea that the solid appearance of a table was an illusion; that the table was "actually" mostly empty space, with tiny particles whirling around inside. How much easier will it be for future scientists growing up in the age of information, computers and flashing pixels to accept the idea of a world made of events and of potentialities for these events to occur?
My point here is that our most profound and deeply held intuition is not about the nature of the external physical world. It is rather that our human thoughts and efforts can make a difference in the behavior of our bodies. Our entire lives are based squarely on this perpetually re-validated intuition, as opposed to the proclamation of some philosophers, that our direct awareness of the physical efficacy of our thoughts

is an illusion. The Heisenberg/Whitehead quantum ontology is thus concordant with both our most basic intuitions and with actual scientific practice. For this reason, I don't see why it should be difficult to shift science over to this improved way of conceptualizing nature and our role in nature.

HA: Whitehead treats matter and mind in terms of physical and mental poles of an actual occasion. This has the flavor of a dual-aspect approach, for which a number of other examples exist, such as Pauli's, Bohm's, Chalmers', or Velmans'. How do they differ from Whitehead's thinking, and from your own?

HPS: Pauli, in his discussion with Bohr about the notion of a "detached observer", emphasized that the questions we pose cause nature some "trouble". The actions that instantiate these questions are the logically needed process-1 partitionings described by von Neumann. My work carries forward Pauli's emphasis on this crucial point, but I remain so far uninfected by his speculations about archetypes and the like. Bohm's approach to consciousness brings in an infinite tower of explicate and implicate orders, each one "in-forming" the one below and "in-formed" by the one above. This picture is altogether different from the much more concrete Whiteadian quantum ontology. Chalmers appears to be moving in the right direction, but I believe he lacks a sufficiently firm grasp of quantum theory to be able to develop his approach in a way that I think would be fruitful. Velmans proposes an "ontological monism combined with an epistemological dualism" in which the quantum-induced failure of causal closure at the microphysical level is compensated for by a causal closure at the neurophysiological level. However, our conscious experiences are ontological realities in their own right, not mere epistemological bits of knowledge. So the claim of ontological monism seems unnatural, and the possibility of uncontrolled microscopic fluctuations exploding into uncontrolled neurophysiological fluctuations makes problematic the claim of dynamical completeness at the neurophysiological level.
But why go that route at all when quantum theory offers the possibility of *bona fide* straightforward real influences of conscious efforts upon physical brains, and consequently upon bodily behavior, without any demand of a causal closure of the physical at any level? Why hang onto one of the most controversial aspects of a materialist worldview, namely the notion that the causal efficacy of our conscious efforts is an illusion, when quantum theory seems to say just the opposite, and even provides the technical means for implementing the causal efficacy of our efforts?

HA: What about panpsychism, a key feature of both dual-aspect types of approaches and Whitehead's ontology? At which point in biological evolution do you think that the psychological aspect, the mental pole of actual occasions, becomes manifest? Or does it go all the way down to elementary particles?

HPS: Reduction events cannot act microscopically on individual particles. That would destroy the oft-observed interference effects. So we do not have end-to-end "panpsychism". Indeed, von Neumann's analysis of the measurement problem shows that it is nearly impossible to establish, below the level of human involvement, any

failure of the unitary law (process-2) of purely physically determined evolution. The need for actual occasions even at the human level derives only from the philosophical commitment to accept as the foundation of objective science the outcomes of experiments "regarding which we are able to communicate to others what we have done and what we have learned" (Bohr 1963, p. 3). At present, we lack the empirical evidence needed to specify, on objective scientific grounds, the details of the embedding non-anthropocentric ontology which Whiteheads ideas demand. But we are certainly not at the end of science yet.

HA: As to the physical pole of Whitehead's actual occasions, you suggest a drastic reinterpretation, or better a major extension, of von Neumann's account of quantum measurement (von Neumann 1932, Chaps. 5,6). While von Neumann discussed the physical aspects of measurement only, you refer to Bohr's and Heisenberg's distinction of (i) choices made by an observer (or experimenter) in terms of questions that are posed to nature and (ii) choices made by nature in order to answer those questions. The second aspect clearly refers to physics and places us in the role of detached observers, i.e., as "impotent witnesses". However, the first aspect introduces intentional actions by conscious human beings, at least if controlled experiments are discussed. As such, it escapes a purely physical discussion and points to the causal gap that you indicated above.

HPS: Von Neumann, the mathematician, described the purely physical aspect of the probing action, whereas Bohr, as physicist-philosopher, described the enveloping conceptual structure needed to tie the mathematical formalism to the activities and the knowledge of human beings. Bohr's pragmatic epistemology rationally accommodates the process-1 partitioning that is not understandable from within the causal framework provided by the mathematical formalism alone. This deficiency in the purely physical description is the causal gap. Bohr's pragmatic epistemology, eschewing ontological commitments, fills this gap by referring to the free choices of human beings. But Whiteheadian quantum ontology accepts *in reality* what Bohr accepts only pragmatically, namely the idea that our conscious intentions cause, at least in part, our intentional actions. This can be achieved by regarding the quantum reduction events to be the physical manifestations of the termination of a psycho-physical process. Bohrs free choices are the psychological correlate of such a process-1 action, and, conversely, von Neumanns process-1 actions are the physical correlates of these conscious choice. The physical and psychological aspects of reality are thus tied together in the notion of a quantum event.
Within orthodox thinking, the physical process-1 action results from, as von Neumann's words emphasize, an intervention from outside the physically described domain. This process has, according to contemporary quantum theory, no sufficient causal roots in the physical alone. The experimenter's "free choice" *participates* in the selection of the needed partition that physical processes alone are unable to achieve. It is then the job of a satisfactory ontology to place these anthropocentric elements of human effortful attention within a broader non-anthropocentric conception of reality.

Ontological uniformity requires, plausibly, every such quantum event to have *some* experiential or felt component. But it does not require every actual occasion to have the full richness of a fully developed "high-grade" human experience. The richness of the experience would naturally be expected to be correlated with the complexity of the physical system upon which von Neumann's process-1 acts.

HA: The correlation between physical state reduction (via projection) and mental subjective experience is posited as an assumption in your ontology, but it certainly does not follow from quantum theory! It is very much analogous to von Neumann's assumption of a psycho-physical parallelism of brain and mind. Although von Neumann sometimes alludes to the mind ("abstract ego"), he actually refers to the brain in his discussion of quantum measurement.

HPS: Von Neumann focused on the mathematics, and avoided getting overly enmeshed in philosophical issues of interpreting quantum theory. But Heisenberg, speaking from the pragmatic epistemological perspective, said: "The observation itself changes the probability function discontinuously; it selects of all possible events the actual one that has taken place" (Heisenberg 1958, p. 54). Thus, Heisenberg tied the mathematically described reduction events to the process of "observation". In order to have a useful scientific theory one needs to link the mathematics to the perceptual aspects of our experience. The mathematical structure of quantum theory is such that the classical materialist accounts of the physical aspects of nature simply do not work. To achieve a conceptualization that ties the new mathematics to actual empirical scientific practice, in a rationally coherent and practically useful way, the founders of quantum theory switched to a conceptualization of the physical world based on empirical events, such as the click of a Geiger counter, and on potentialities for such events to occur. The mathematics thereby becomes linked to empirical phenomena.

HA: The notion of an interaction between mind and matter, as in your recent paper (Stapp 2005) on "interactive dualism", may be somewhat misleading. It seems to me that things are much more subtle than a straightforward interaction between the mental and the physical (which one might naively interpret as basically similar to a collision of billiard balls). The proposal by Eccles, whose physical features were worked out by Beck, has this overly simplistic appeal because some "mental force" is assumed to act directly on synaptic, i.e. material, transport processes. Your picture is definitely much more subtle: the requirement that physical and mental outcomes of an actual occasion must match, i.e. be correlated, acts as a constraint on the way in which these outcomes are formed within the actual occasion. So the notion of an interaction should be replaced by the notion of a constraint set by mind-matter correlations.

HPS: It would indeed be misleading to understand the "action of mind upon brain" directly via a "force". The effect is associated with a modulation of the frequency of certain process-1 actions that act directly upon large-scale (brain-sized) patterns of neurological activity. This modulation of frequencies is achieved, strictly within

the pragmatic framework (that is, without any of Whiteheads ontological superstructure) by exploiting certain human "free choices" that are allowed within that pragmatic framework. This language suggests that the conscious act is the cause, and the correlated physical process-1 action is the effect. This interpretation ties the theory most naturally and directly to actual scientific practice. In actual practice the experimenter chooses on the basis of reasons and goals which of the experimental options will be pursued, within the array of possibilities that the structure of the physical theory provides. Bohr (1958, p. 73) spoke, accordingly, of "the free choice of experimental arrangement for which the mathematical structure of the quantum mechanical formalism offers the appropriate latitude". We are dealing here with the sophisticated way in which mental intention influences quantum processes in the brain. *Ideas* do not simply push classically conceived particles around!

HA: A major point in your ontological framework is that physical state reduction and mental subjective experience jointly constitute the transition from the continuous and the potential to the discrete and the actual. Another significant issue is the contrast between instantaneous projections, which von Neumann introduced as an idealization that he characterized as "not enjoyable", versus an objective dynamical process of measurement that takes time, as advocated by a number of physicists. For instance, Penrose strongly argues that way in his speculations about mind and matter. Of course, this would require an individual rather than a statistical description of quantum measurement, of which no broadly accepted version is available so far.

HPS: The mathematical neatness of instantaneous (along a space-like surface) reduction makes it the better option, technically and mathematically, and I see no reason to complicate the dynamics by smearing out in time the reduction events. Indeed, to do so would confuse everything, since the smearing would not be strictly confined, and hence process-2 would never hold rigorously.
The fact that we experience process as involving duration is adequately explained by James' "marching band metaphor". Each instantaneous "snap shot" corresponding to a single experience would catch the components of brain activity correlated with the various stages from just beginning to be experienced, to full blown vivid consciousness, to fading out. This structure creates the impression that the experience has duration, although it is really instantaneous – or confined to a space-like surface – when mapped into real space-time (Stapp 1993).

HA: For details of what happens at the mental pole of an actual occasion, the notions of attention and intention according to William James in combination with your concept of a "template for action" figure prominently in your work, e.g. in Stapp (1999) and in Schwartz, Stapp, and Beauregard (2005). Could you outline how these terms are related to one another?

HPS: A *template for action* is defined to be a macroscopic (extending over a large portion of the brain) pattern of neurological activity that, if held in place for a sufficiently long period, will tend to produce a brain activity that will tend to produce

an intended experienced feedback. This pattern of brain activity is the neural correlate (specified by a process-1 action) of a conscious effort to act in an intended way. William James (1892, p. 227) says that "no object can catch our attention except by the neural machinery. But the amount of attention that an object receives after it has caught our attention is another matter. It often takes effort to keep mind upon it. We feel we can make more or less of the effort as we choose. ... This feeling ... will deepen and prolong the stay in consciousness of innumerable ideas which else would fade away more quickly."
Effort is a particular feature of consciousness that we feel we can control, and that has the effect of intensifying experience. Hence it is reasonable to suppose that increasing effort increases the rate at which conscious events are occurring. If the rate becomes sufficiently great then the quantum Zeno effect will, according to the quantum laws, kick in, and the repetitious interventions of the probing actions will tend to hold in place the template for action. That effect will, in turn, tend to make the intended action occur. By virtue of this dynamically explained causal effect of willful conscious effort upon brain activity, trial-and-error learning should hone the correlation between the consciously experienced intention and an associated template for action that produces, via the physical laws, the intended feedback. This *explains* dynamically the capacity of an effortful intention to effect its intended consequence.

HA: From a psychological point of view, one might distinguish a series of steps: from a mental state with a particular intensity of attention to the shift of that attention and finally to an intention to make a decision, which is correlated with a neural template for action. This template precedes the action – it is not already the action itself. Are there empirically accessible psychological observables for these different steps?

HPS: Actions include brain actions that control or guide other brain actions. The theory says that each of the different experienced stages should occur in conjunction with a different template for action. For instance, the actualization of one early template could tend to set in motion a multi-component sequence leading from neural activity somewhere in the cortex to activity in the motor cortex to muscular activity.

HA: Concerning the neural correlates of such psychological states and observables, we need the notion of a neural assembly. If you assume that such neural assemblies are subject to a quantum Zeno effect, this requires that they be in an unstable state, such as a quantum superposition, or an entangled state. How do you think this condition can be realized for an assembly of thousands of neurons?

HPS: Environmental decoherence effects will reduce the entire brain state in question (represented by a reduced density matrix) to a statistical mixture of states each of which is essentially a slightly smeared out classically conceived possible state of the entire brain. This decomposition of the state of the brain into a mixture of almost-classical states is very useful in connection with this theory. It allows

neuroscientists to quite accurately conceive of the brain as a collection of almost-classical possibilities that continually diffuse into more diversified collections, but that are occasionally trimmed back, in association with a conscious experience, to the subcollection compatible with that experience. These processes all involve, or can involve, assemblies of thousands or millions of neurons.

HA: What do you mean by "slightly smeared out" and "almost-classical"? If you have some remaining quantum features in the brain state – which you need for the quantum Zeno effect to act – you must assume that the brain state was a quantum state to begin with. How is such a state constituted, or prepared? Or do you assume that *every* system is fundamentally a quantum system which, under the influence of its environment, decoheres more or less rapidly into classical subsystems?

HPS: By "slightly smeared out" and "almost-classical" I mean what you would get from a classically conceived state if you replaced each point particle by a very tiny continuous cloud of possibilities. Each physical system – including a brain or a template for action – inherits quantum features from the quantum state of the universe as a whole. In the case of a brain, decoherence mechanisms are acting strongly at all times, and they never allow its state to be anything other than a mixture of almost-classical (i.e., slightly smeared out) states. Hence the classical intuitions of neuroscience about the brain are generally valid, except for two things. Firstly, at almost every instant the cloud of possibilities is growing and diffusing into a wider set of possibilities which, however, every once in a while (at a reduction event) gets reduced to a subset. Secondly, the diffusing action can be curtailed by the quantum Zeno effect which arises from the small, but nonzero, quantum smearing of each one of the almost-classical components.
In this way, the brain is described strictly quantum mechanically, yet it can be understood to be very similar to a classical statistical ensemble. Importantly, the relevance of the quantum aspects for consciousness is not due to some macroscopic quantum superposition effect, which would be extremely hard to realize. The pertinent non-classical feature is the occasional occurrence of a sudden reduction of the ensemble to a subensemble that is compatible with the content of a co-occurring conscious experience.
The occurrences of such reductions are logically *possible* because the state of the brain represents not an evolving material substance but rather an evolving set of potentialities for a psycho-physical event to occur. The occurrences of such reductions are logically *necessary* because the expanding ensemble of almost classical states is a continuous structure that must be decomposed into a collection of discrete alternatives, each associated with a distinct kind of experience. It is only by means of this partitioning that the theory is tied securely to human experiences, and to the empirically validated rules of quantum theory. The smear of almost-classical possibilities must be partitioned, prior to each experience, into a specified collection of components at least one of which corresponds to a distinctive experience, or lack thereof.

HA: As you said before, brain states or templates for action cannot be Zeno-stabilized simply by the direct action of something like a mental force – this would lead to the same basic problem that Eccles has with his proposal for a direct mental influence on synaptic processes. So what do you concretely assume at the neural level that is capable of exerting a quantum Zeno effect upon the template for action?

HPS: As an example, let us suppose that the occurring process-1 action partitions the state of the brain into two parts. One of them, the "yes" part, is the neural correlate of the mental intent to, say, "raise the arm". This neural correlate is a template for action. The immediately felt psychological effect of an increased intentional effort is an intensified experience of the projected intended feedback. (These *projected* experiences are constructed from the memories of earlier experiences, as discussed in Stapp (1993).)

Now the *timings* of the process-1 actions are an aspect of the "free choice" on the part of the human observer. It is therefore plausible to conjecture that the effort-induced increase in the intensity of the projected intended experience is *caused* by an increase in the observer-controlled rate at which the associated process-1 actions are occurring. If a sequence of essentially identical process-1 actions occur in sufficiently rapid succession, then the associated neural correlate (i.e., the template for action) will be held in place by the quantum Zeno effect. The resulting *persistent* neural pattern of activity will then tend to cause the intended action to occur. The *effect* of the effort-induced increase in the rate of the process-1 probing actions is thus to hold in place the entire macroscopic template for action. The dynamical effect, via the neural machinery, of this holding in place is the likely occurrence of the intended action.

This scenario differs in two important ways from the proposal by Beck and Eccles. First, the action does not take place at the synaptic, i.e. *microscopic*, level: the effect is directly upon the entire template for action, specified by von Neumanns process-1 action. And, in answer to your question about "mental force", there is no action of any forces, mental or otherwise, upon the parts of a material substrate: no pushing around of the atoms that produces, in some totally miraculous and unaccountable way, the action that the person has in mind. No! The effect of the effort is on an entire macroscopic neural pattern of brain activity. This pattern has been singled out by von Neumanns process-1 action and is held in place by the quantum Zeno effect. By coupling von Neumann's dynamical rules to learning, one can rationally account for the observed – and essential for human life and survival – correspondence between experienced intent and experienced feedback.

HA: After all, this amounts to an overall theoretical picture that offers a strong sense of formal and conceptual coherence and is intuitively appealing in a number of respects, but also confronts us with a remarkable degree of complexity. What do you think: Is there any chance that empirical work can confirm or falsify particular features of your approach?

HPS: First of all, it is evidently forever impossible to falsify, by empirical data alone,

the opposing blatant assertion that the apparent causal efficacy of our conscious efforts is an illusion. It is impossible to disprove empirically the physicalist contention that our conscious experiences are merely causally irrelevant pyrotechnics that *seem to be* influencing the course of bodily events, but are, in reality, merely impotent by,-products of causally self-sufficient neural activities. But what rational argument could adequately justify such an outrageous and completely unsupported claim? Like solipsism, such a claim cannot be empirically falsified, but only rejected on the grounds of its lack of reasonableness and utility.

During the nineteenth century, before the precepts of classical physics had been shown to be *fundamentally* false, scientists and philosophers had some sound reasons to conjecture that the physical aspects of reality were causally closed. However, even then this led to an unreasonableness noted by William James (1890, p. 138): consciousness seems to be "an organ, superadded to the other organs which maintain the animal in its struggle for existence; and the presumption of course is that it helps him in some way in this struggle, just as they do. But it cannot help him without being in some way efficacious and influencing the course of his bodily history." James went on to examine the circumstances under which consciousness appears, and ended up: "The conclusion that it is useful is, after all this, quite justifiable. But if it is useful it must be so through its causal efficaciousness, and the automaton-theory must succumb to common-sense" (James 1890, p. 144).

That was James's conclusion even at a time when classical physical theory seemed irrefutable, and the thesis of brains as mechanical automatons was rationally supported by physics-based legs. Today, however, classical physics has been superseded by a theory with causal gaps that *need to be* filled in some way, and that *can be* filled by allowing our efforts to do what they seem to be doing. Embedded in an adequate ontology, quantum theory has the technical capacity to explain how a person's conscious efforts can influence his or her bodily actions. Consequently, there is now no rational reason whatsoever to reject William James's persuasive argument.

Beyond these philosophical considerations one can reasonably claim that the entire body of neuropsychological experimentation is confirmatory of this theory. All the data, to the extent that it is precise enough to say anything about the relationship between mind and brain is in line with this theory. A large number of particular empirical findings in neuropsychology and in the psychology of attention are discussed in Schwartz, Stapp, and Beauregard (2005).

HA: The current support for this novel picture, especially as far as cognitive neuroscience is concerned, is merely qualitative though.

HPS: Well, there are plenty of ways to falsify the quantum model. It demands close connections between the psychological and the physical aspects of psycho-physical events. This includes, in particular, the putative attention-induced quantum Zeno effect of holding in place the templates for intentional action. But there is evidently no way to counter the claim that *whatever* connections are empirically found are exactly what the *it's-all-an-illusion* proponents could claim that their theory allows. For that position has no theoretical foundation in established physics, and hence no

basis upon which to falsify it.
Many scientists and philosophers have forced themselves to accept the rationally unsatisfactory and unsupported physicalist position in the mistaken belief that this is what basic physical theory demands. But the converse is true: contemporary physical theory demands certain interventions into the physical! The associated causal gap in a purely physically determined causation provides a natural opening to an interactive but non-Cartesian dualism.

HA: Since your approach does emphatically refer to attention, intention and, if I may use this term, "free will", it must have ethical implications. Would you say that proper ethical behavior can be facilitated or even entailed by reflecting and realizing the ontological conditions of a given situation? Or, conversely, that ethical misbehavior is a consequence of lacking insight of appropriate ontological conditions? Might a processually conceived quantum theory, comprehending both psychological and physical aspects of nature, provide insights that could underpin a science-based rational ethical theory?

HPS: Behavior, insofar as it concerns ethics, is guided by conscious reflection and evaluation. It is not mere unreflective response. The output of such reflections and evaluations depends, of course, on the input, and the core of the effective input is the individual's self-image in relation to his or her conception of the situation in which he or she is embedded. One's weighting of the welfare of the whole, and one's sensitivity to the feelings of others will surely be enhanced when the individual sees his or her own judgments and efforts as causally effective – hence important – inputs into a cooperative effort to develop the vast yet-to-be-fixed potentialities of a quantum universe that, as Bohr emphasized, can be properly conceived only as an intricately interconnected whole.
Such a comprehension of self stands in strong contrast to an image of the self as a cog in a pre-ordained mechanical universe – a cog that thinks of his or her strenuous efforts to choose rightly as making no actual difference whatever in the course of physical events. Such a degradation in self-image will undoubtedly be correlated with a debasement in behavior. Conversely, what you call ethical misbehavior would surely be diminished by a shift in self-image from mechanical cog to quantum player.

HA: If this is extended beyond individual human beings, it must also have implications for human societies and their ways to interact with each other.

HPS: The proposition, foisted upon us by a materialism based on classical physics – that we human beings are essentially mechanical automata, with every least action and thought fixed from the birth of the universe by microscopic clockwork-like mechanisms – has created enormous difficulties for ethical theory. These difficulties lie like the plague on western culture, robbing its citizens of any rational basis for self-esteem or self-respect, or esteem or respect for others. Quantum physics, joined to a natural embedding ontology, brings our human minds squarely into the dynamical workings of nature. With our physically efficacious minds now integrated into the unfolding of uncharted and yet-to-be-plumbed potentialities of an intricately in-

terconnected whole, the responsibility that accompanies the power to decide things on the basis of one's own thoughts, ideas, and judgments is laid upon us. This leads naturally and correctly to a concomitant elevation in the dignity of us as persons and the meaningfulness of our lives. Ethical theory is thereby supplied with a rationally coherent foundation that an automaton account cannot match.

But beyond supplying a rational foundation for Western culture, the rooting of ethics in science, with its universal character and appeal, shifts values toward the ecumenical, and away from those aspects of religions that are hostile to, and preach violence against, followers of other faiths. Such a shift is sorely needed today.

References:


Bohr N. (1958): *Atomic Physics and Human Knowledge*, Wiley, New York.

Bohr N. (1963): *Essays 1958/1962 on Atomic Physics and Human Knowledge*, Wiley, New York.

Heisenberg W. (1958): *Physics and Philosophy*, Harper & Row, New York.

James W. (1890): *The Principles of Psychology, Vol. 1*, Dover, New York 1950.

James W. (1892): *Psychology: The Briefer Course*. In *William James: Writings 1879–1899*, ed. by G.E. Myers, Library of America, New York 1992.

Neumann J. von (1932): *Mathematische Grundlagen der Quantenmechanik*, Springer, Berlin. Translated as *Mathematical Foundations of Quantum Mechanics*, Princeton University Press, Princeton 1955.

Schwartz J., Stapp, H., and Beauregard, M. (2005): Quantum Physics in Neuroscience and Psychology: A Neurophysical Model of Mind/Brain Interaction. *Phil. Trans. Roy. Soc. B360, 1309-27*

Stapp H.P. (1993). A quantum theory of the mind-brain interface. In *Mind, Matter, and Quantum Mechanics*, Springer, Berlin, pp. 145–172.

Stapp H.P. (1999): Attention, intention, and will in quantum physics. *Journal of Consciousness Studies* **6**(8/9), 143–164.

Stapp H.P. (2005): Quantum interactive dualism: an alternative to materialism. *Journal of Consciousness Studies* **12**(11), 43–58.

Stapp H.P. (2006): Whitehead, James, and Quantum Theory. Submitted to *Mind and Matter*.

Schwartz J.M., Stapp H.P., and Beauregard M. (2005): Quantum theory in neuroscience and psychology: a neurophysical model of mind/brain interaction. *Philosophical Transactions of the Royal Society B* **360**, 1309–1327.

Whitehead A.N. (1978): *Process and Reality*, corrected edition by D.R. Griffin and D.W. Sherburne, Free Press, New York. Originally published 1929.