European Journal of Parapsychology
Volume 23.1, pages 3–30

ISSN: 0168-7263

A New Quantum Theoretical Framework for Parapsychology

Chris Clarke
School of Mathematics, University of Southampton

Abstract

An account is given of a recent proposal to complete modern quantum theory by adding a characterisation of consciousness. The resulting theory is applied to give mechanisms for typical parapsychological phenomena, and ways of testing it are discussed.

Introduction

A succession of writers (see Radin, 2006, for a popular survey) have associated parapsychological phenomena and quantum theory, their core motivation perhaps being the strong but imprecise feeling that, in Radin's words, "Experiments have demonstrated that the worldview implied by classical physics is wrong . . . in just the right way to support the reality of psi." The adoption of a worldview that is essentially quantum mechanical lends itself to two new approaches to parapsychology. On one hand is the "Weak Quantum Theory" approach of Atmanspacher et al. (2002) in which quantum theoretic ideas are applied directly to the phenomenology of parapsychology. On the other hand one can examine ways in which quantum physics acting at a more traditional physical level can lead to large scale effects relevant to psi. It is this latter approach that will be taken here, though it is to be hoped that the two approaches will converge.

Correspondence details: Chris Clarke, School of Mathematics, University of Southampton, Southampton, SO17 1BJ, U.K. Email: cclarke@scispirit.com.

Early attempts to implement this hunch as a testable quantum theory of psi tended to be phrased in terms of substance dualism, inspired by the original formulations of quantum theory in the early 20th century. This involved an interaction between mind and matter which either causes and directs a collapse of the quantum state (e.g. Walker, 2000) or determines the nature of an (effective) "measurement" performed by the mind on the brain (Stapp, 2005). From the late 50s onwards, however, a wide range of alternative formulations of quantum theory have been developed, not involving collapse, which now offer the possibility of producing a firm, testable link between physics and parapsychology. I will first outline the development of these new theories and then formulate particular applications to psi.

Quantum theory was first developed in the context of laboratory physics. Here there are clear demarcations between the physicist (the observer), the apparatus used for the observation and the observed system itself. In the early days of the theory the system was a small object such as an atom or a particle. It was accepted that the apparatus was adequately described by "classical" (nineteenth century) physics, and the aim was to produce a new physics to describe the small system. This was done by introducing the idea of a *quantum state* (in some particular cases also known as a "wave function") which when observed *collapsed* into a different state where the quantity being observed had a definite value. The majority view seems to have been that this resulted from the interaction between the apparatus and the system, but a significant minority held that it was due to the interaction between the human observer and the apparatus-plus-system.

Subsequent work, most crucially by Everett (1957) and Daneri et al. (1962), started to indicate that, in the context of laboratory physics, the notion of collapse could be unnecessary, though at this stage quantitative detail was lacking. The crucial final step was then made by Zeh (1970) who showed that, if one included the very weak but always significant interaction between the apparatus and its larger environment, then, as a result of a phenomenon known as "decoherence", the statistical results of quantum physics could be derived entirely within the formalism of quantum theory without any notion of collapse (see also Zurek, 2003; Giulini et al., 1996). To reinforce this conclusion, experimental examination of progressively larger systems has failed to show any trace of the operation of any collapse mechanism. As a result the dominant view of workers in the foundations of quantum theory is what Schlosshauer (2006) has termed “minimal no-collapse quantum mechanics”.

While this works well for laboratory physics, the project of science is not to explain physics laboratories but to account for the whole structure of reality in which we find ourselves, a project which has succeeded remarkably well at the classical level. When, however, cosmology reached the point of having to treat the entire universe as a quantum system, then the strategy of using decoherence failed. At the simplest level, it fails because the universe has no external environment. The most decisive argument, however, arises from the fact that the most likely initial quantum state for the universe is one that completely symmetrical (Hartle & Hawking, 1983). The interestingly non-homogeneous universe in which we live is then supposed to arise from “quantum fluctuations” (Turner, 1999; Linde, 2001); but with no observer external to the universe (in conventional science), with no grit in the oyster, there is nothing to begin the breaking of this symmetry and produce a transition from pure symmetric vacuum to “things”. Leibniz’s question, “why is there something rather than nothing?” (Leibniz, 1714) remains unanswered. Decoherence is a large part of the story, but more is needed.

I can now list the principal theoretical elements (not mutually excluisve) that have emerged to deal with this current situation, and to which I will be referring in connection with parapsychology.

1. *Go back to collapse.* There are a number of problems with this. First, it conflicts with the argument from cosmology just given; but one could argue that, because there is at present no widely accepted adequate theory of the very early quantum universe, arguments referring to this era carry little weight. Second, it involves some “double causation”: decoherence is a definite and well studied phenomenon, so if collapse is introduced alongside it we would need to understand the relationship between two competing processes doing much the same thing. Third, and most importantly, the traditional form of collapse cannot be reconciled with the observed behaviour of “entangled systems”: systems that are separated in space and are described by a joint quantum state, but do not have separate quantum states (see the section on “Time in quantum theory”).

   Despite these difficulties, it is not unreasonable to suppose that quantum physics behaves *as if* there were a collapse, in the sense that I will describe in the section on "Time in quantum theory". There I will also explain how this solves the difficulty concerning entangled systems. I will refer to such approaches (including dualistic approaches involving a consciousness or soul in a different ontological category from matter) as *quasi-collapse* approaches.

2. *Selection by sensation.* This theoretical strand is similar to, though much weaker than, the application of an "anthropic" principle in cosmology. Whereas with the anthropic principle it is stipulated that we are only interested in those universes that contain life, in theories that use selection by sensation we are only interested in universes that are observable, in the sense that they contain something that could be identified as sensation. The principle is well discussed by Page (2001), though he himself then takes the rather extreme, ultra-solipsistic position of requiring only that the universe contains one moment of sensation, a position not followed by others as far as I know. Other writers consider the situation where there are many moments of awareness in the universe. These moments are necessarily subject to consistency conditions; if two such moments quickly succeed each other, for instance, then they should not be mutually contradictory.

   The following sub-classification roughly charts the various approaches of this form. It is based on the distinction made in consciousness studies between the *functional view* that consciousness depends on the brain's function, on how it processes information; and the *subjective view* (cf. Chalmers, 1995) that consciousness is essentially a subjective, qualitative aspect of some particular life-based systems, distinct from their objective function.[1]

   (a) *Sensation as information processing.* This takes a functional view, identifying consciousness with sensation. It supposes that, to be experienced in any normal sense of the word the universe must contain something that is, in some generalised and formal sense, a brain (Donald, 1990, 1995). A brain is regarded as a complex switching mechanism (the switches in animal brains

[1]The idea of consciousness as an aspect has entered neuropsychology and consciousness studies through the influence of Spinoza on Antonio Damasio (2003) and others. Chalmers proposes in particular that consciousness is a qualitative aspect of *information*, but I do not make that restriction here.

being ion channels in the axons of neurons) and the consistency conditions determine the likelihood of each switch being in the quantum state corresponding to the switch being "on", depending on the information conveyed by other switches in the brain at preceding[2] moments.

(b) *Sensation as moments of consciousness.* In this theory (Clarke, 2007), which I shall call *conscious quasi-collapse*, or CQC, the probabilities of various particular contents of consciousness are conditioned by *all* preceding sensation events. The connection between moments of consciousness in a given system (what is "my" consciousness rather than "yours") is determined by their physical biological context and is not imposed as an intrinsic restriction of the theory. The mathematical structure of this theory is identical with the system of *Generalised Quantum Theory*, a quasi-collapse theory, introduced by Hartle (1991), and widely used since in cosmology, except that Hartle does not adopt the restriction to states where there is awareness.

In addition to the structure just described, the CQC approach to be used here adopts the view of Stapp (2005) that consciousness has a particular effect on the world. Namely at each moment of awareness consciousness selects one out of the many possible Boolean Algebras within which the contents of awareness can emerge. I explain (and somewhat modify) this in the next sub-section. The CQC approach can thus be seen as the combination of the systems of Stapp (2005) (modified) and Hartle (1991).

The following account is in three parts. Firstly, the section on "Theoretical Context" describes in more detail the quantum mechanical formalism to be used. Following that, there is a section presenting mechanisms for typical parapsychological phenomena in terms of this formalism. Finally, there is a section outlining some salient aspects of possible future parapsychological experiments to test these ideas.

Theoretical context

What consciousness does

As noted above, the particular approach I focus on here is one where consciousness plays an active dynamical role in the world, rather

[2]See the section "Time in quantum theory" later in this paper.

than being an "epiphenomenon" in the sense of a byproduct of dynamic process that are complete in themselves. Its first such role is to single out the particular subsystems of the universe that can support consciousness. It is these, and only these, that enter into the quantum formalism and thereby break the symmetry of the initial state of the universe. What these particular subsystems are, whether they are in some sense "like" brains or whether they are more general, does not affect the applications I shall make to parapsychology, though for completeness I will discuss a proposal for this in the section on "Extensive Coherence" below.

The second role for consciousness is more subtle. It depends on the fact that, in quantum theory, in any given state of a system there can exist many different but incompatible types of observation that can be made, the different types being referred to as "complementary". The standard example of such complementarity in quantum theory is that of the incompatible observations of the position or of the momentum of a particle. In the current situation complementarity is exhibited in the different types of sensations that can be had. To discuss this further requires some technical language. First, it turns out to be sufficient to restrict attention to observations that can yield one of only two possible outcomes, TRUE or FALSE. Such observations are called *propositions*. This restriction is possible because any other observation can be built up from these elementary ones.[3] A collection of propositions together with the usual logical connectives OR, AND and NOT, is called an *Algebra*, and a *Boolean Algebra* if these connectives satisfy the rules of classical logic.

Where the observation is a measurement made by a piece of laboratory machinery, then finding NOT-A to be TRUE is equivalent to finding A to be FALSE. Thus in this case if A is in the set of propositions that can be observed, so NOT-A must also be in this set. It is different with consciousness, where A is sensation, when very often NOT-A does not make sense. In most contexts it does not, for instance, make sense to suddenly experience not-(the smell of roses), but it would make sense if you have already been experiencing them for the last ten minutes. The structure of the contents of consciousness is context-dependent. I am persuaded that the most appropriate formulation of this structure is actually the "bilogic" of Matte Blanco (1998) and subsequently clarified

[3]An alternative to this logic-based language is a language based on concepts from linear algebra, where a proposition is represented by a projection of the space of quantum states into itself, and the proposition is true if this projection leaves the current state unchanged, and false if it projects the current state to the zero vector in state space.

by Bomford (2005), which does not possess the standard negation operation, and has a structure analogous to, but distinct from, quantum logic (Clarke, 2006). Here, however, it is sufficient to take the simpler course of making only a minor modification to Stapp's system by supposing that, rather than selecting a whole Boolean logic σ, consciousness selects a subset ς of a Boolean algebra. I will refer to the propositions in the selected subset as being *asserted* by this dynamic of consciousness.

Time in quantum theory

The relation between the treatments of time in relativity theory and in quantum theory poses the most profound problems in modern physics (for example, see Barbour, 1999). Here I will merely mention some key points. Because of the effects of relativity, there is no natural definition of time (that is, a universal time-coordinate) in the universe, only a range of conventional definitions used for convenience in different contexts. One can naturally define, however, a relation between two events x and y, saying that x *precedes* y, when the time-coordinate of x is less than that of y for all definitions of time.[4] I will say that events x and y are *chronologically related* if either x precedes y or y precedes x.

In conventional (Bohr) quantum theory the quantum state of a system is defined at a particular time, and when an observation is made the state collapses at a particular time. If the quantum state describes a system that is distributed in space, this implies that a change in the quantum state is manifested instantaneously at all points in the system. The statement of this is often repeated in discussions of entanglement, where the system in question consists of two or more separated particles. In view of the foregoing account of relativity, however, this depends implicitly on a particular time-definition. In a laboratory context the time definition is set by the laboratory environment (though even this becomes ambiguous for particles separated by several kilometres, as in modern experiments). In any wider context there may be no natural choice available.[5] Since it is not possible to ascertain the quantum state at a single instant, there is no direct way of determining when a state "collapses" so there need be no conflict with experiment here. But equally there is (unless one takes a more sophisticated ap-

[4]I here ignore technicalities such as the existence of space-times in which it is not possible to define any time coordinate in a stable manner.

[5]In many cosmological *models* a natural choice of time is defined by a conformal Killing vector, but the actual universe only approximates to such a model and so this is only helpful when considering quantum phenomena taking place on the (large) scale at which the approximation is justified.

proach) no way of determining that the Bohr account is correct in one time-definition rather than another. The best that can be said is that the system behaves *as if* a collapse takes place with respect to some indeterminate time-definition. At an intuitive level this is often helpful; but for an accurate discussion it is often preferable to rephrase the physics in terms which do not refer to collapse. Later in this paper I do this by reference to the *apparent state* of the particular subsystems (loci) that arise in one form of quasi-collapse, defined as the restriction to the locus, on its maximal space-like surface, of the quantum state on any time coordinate that extends this surface. I am assuming that, in any viable version of quantum theory on space-time, this state is independent of the remaining freedom of choice of time coordinate.[6]

As just indicated, this situation has consequences for the discussion of entanglement. I use this term in the original sense (Schrödinger, 1935) of the situation of two systems A and B, separated in space, not having separate quantum states[7] but only a joint state which depends on a choice of time definition. For many purposes this drawback is removed by noting that this definition of entanglement is equivalent (for pure states only) to the violation of a set of inequalities called the Bell inequalities, and these can be generalised so as to apply to local states at any events, including chronologically related events. This gives rise to a generalisation of this definition of entanglement that is used by many authors (Paz & Mahler, 1993; Mahler, 1994). Here, however, I will retain the older definition in which entanglement is defined in terms of a joint state using an unspecified time definition.

Quantum Histories

The formalism of Hartle (1991) to be adopted here, widely accepted in cosmology, associates observations with regions of space-time and assigns to their possible outcomes probabilities which, as I have already noted, are as if there had been a series of collapses, even though the notion of collapse does not make sense. I will now elucidate this rather paradoxical remark. A series of observations with an assigned probability is a generalisation of the concept of a *history* first formulated by Griffiths (1984). The evolution of the idea can be characterised as a sequence of successive reformulations of quantum theory:

[6]I further modify the apparent state by averaging over the duration of the locus in a previous paper (Clarke, 2007).

[7]For the reader familiar with this distinction: in this section I am referring to *pure* quantum states, whereas in later sections I will be referring to mixed states.

1. from *probabilities for outcomes of a single measurement* (original quantum theory), to
2. *correlations between outcomes of successive measurements*, to
3. *probabilities for sequences of measurements* (original history interpretation), to
4. *probabilities for an array of measurements in space-time* (Hartle's "generalised quantum theory"), to
5. *probabilities for an array of moments of consciousness in space-time* (CQC).

I will first give (in outline) the definition of how a history represents "an array ... in spacetime", closely following (Hartle, 1991), and then indicate briefly how probabilities are linked into this. Fuller details are in Clarke (2007).

1. **Loci**. The basic elements that form the basis for a history, termed *loci*, are specifications of a particular subsystem of the universe over a particular region of space and time-interval — i.e. over a particular space-time region U. An example of a locus drawn from Hameroff and Penrose's theory of consciousness (Hameroff & Penrose, 1996) might be as follows. U would be the union of regions $U_1, \ldots, U_n$ each corresponding to one of a collection of cells (not necessarily connected) making up an organ or organs in the brain, all considered over a (variable) interval of time, and the subsystem associated with consciousness is described by a quantum space $\mathcal{H}$ of states of the conformational structure of the microtubules in the cells of U, together with a complementary space $\mathcal{H}'$ describing all the other degrees of physical freedom over U.

   So formally,

   (a) a *locus* consist of a triple $(U, \mathcal{H}', \mathcal{H})$, where U is a space-time set and $\mathcal{H}$ and $\mathcal{H}'$ are Hilbert spaces associated with U. The total quantum Hilbert space $\mathcal{H}_0$ over U can be represented as a subspace of $\mathcal{H}' \otimes \mathcal{H}$.

   (b) It is also maximal in its extent in time while having the property that all events in U are determined by data at a single moment of time (a property known as global hyperbolicity).

Property 1b results in a time extent that in the centre of the region is of the order of magnitude of the time taken for light to cross the region, reducing to zero at the edges. This is the closest one can get in modern physics to an "instantaneous moment", since the latter cannot be defined in relativity theory. Note that this condition also enables us to single out, in general, a unique "instant of time", namely the maximal space-like surface in the locus.

2. In addition to the above conditions, each locus must satisfy a condition for its being conscious. What this property is is not critical for parapsychology: it can, for example, be based on the detailed specification of Donald (1990), though this is normally used with a different quantum formalism. The version that I find persuasive (and on which I shall expand in the section on "Extensive Coherence" below) is, however, the following. It is required that each locus in a history is a region such that any two spatially defined non-overlapping parts making up the whole are fully entangled with one another. I call this property *extensive coherence* (see Clarke (2007)). Each locus is also maximal — as large spatially as it can be — while still exhibiting extensive coherence.

3. **The consciousness** of a locus results in there being specified ("asserted") at each locus a particular subset ς of a Boolean algebra σ of propositions (i.e. projections) on $\mathcal{H}$. As described above, ς will in general not be full algebra.

4. **A history** consists of a set $(P_1, \mathfrak{L}_1), (P_2, \mathfrak{L}_2), \ldots$ of pairs in which

    (a) $\mathfrak{L}_1, \mathfrak{L}_2, \ldots$ are loci which are partially ordered with regard to their mutual causal relations (given any two $\mathfrak{L}_1$ and $\mathfrak{L}_2$ either $\mathfrak{L}_1$ is causally[8] prior to $\mathfrak{L}_2$, or vice versa, or they are entirely space-like related to each other), and

    (b) $P_1, P_2, \ldots$ are propositions from the sets ς associated with the respective loci.

The propositions $P_1, P_2, \ldots$ appearing in a history will be referred to as *realised* at their associated loci. The combination of a realised proposition and its locus is interpreted as a *moment of consciousness*.

[8]Note that "causal" is used here in the sense of relativity theory, as asserting the existence of a time-like or light-like connection between events, and not in the philosophical sense of causation considered later.

Probabilities (or, more precisely, "weights" that can be interpreted as probabilities when the logic of the propositions in the history is classical) are then attached to histories by means of a function[9] $p((P_1, \mathfrak{L}_1), \ldots, (P_n, \mathfrak{L}_n); \rho)$ which associates a real number between 0 and 1 with each history, and where ρ is the initial state of the universe. In cases where the histories satisfy a classical logic (as can be shown to be usually the case) the values of this function reproduce exactly the probabilities for ordinary quantum theory. This function is a special case of the *decoherence functional* in conventional history theory (modified to this relativistic setting), which packages together the time evolution of quantum theory, its probability interpretation, and the criteria for there being a classical logic.

Zeno effects

Henry Stapp (Stapp, 2005) introduced a concept similar to CQC (in a dualistic context) and emphasised the importance of the Zeno effect in understanding how consciousness acted in the world, rather than being a mere epiphenomenon. The conventional Zeno effect, which has now been well studied experimentally (Sudbery, 2002) refers to the situation where an unstable state is prevented from decaying by being observed continuously (an example of "a watched pot never boils"). It can easily be shown that if τ is the normal half-life for the decay of a state, and the state is observed at time intervals δt where this is significantly less than τ, then the half-life is extended to a time of order $\tau^2/\delta t$. In Stapp's dualistic setting, mind observes the brain in this way and thereby maintains preferred brain states that would otherwise be transitory. A similar process can occur in the CQC approach, but by the inclusion of a succession of projections in a history. As discussed in the next section, δt is in the case of CQC a time depending on gravitational effects, introduced by Penrose.

The question for parapsychology is, can the observed data from parapsychology experiments be explained by some such mechanism as this, involving applying Zeno-like observations or acts of consciousness to the entangled brain states of their subjects? If the Zeno process takes

[9]This has the form

$$p(P_1, P_2, \ldots, P_n; \rho) = \mathrm{Tr}(\Lambda_n(P_n)\Lambda_{n-1}(P_{n-1}) \ldots \Lambda_1(P_1)\rho\Lambda_1(P_1)^\dagger \ldots \Lambda_{n-1}(P_{n-1})^\dagger\Lambda_n(P_n)^\dagger) \quad (1)$$

where the function Λ describes a time evolution from one moment of consciousness to the next, followed by an averaging over the duration of the succeeding proposition.

place by observations (Stapp) or by repeated moments of consciousness but using a full Boolean algebra of propositions, then it is hard to produce a plausible explanation of psi. If the minds of two subjects are entangled in a way that is implicitly (i.e. unconsciously) "known" to them, and they then observe/are aware of their own states and announce the results, then, with or without resorting to Zeno techniques, there will be an interesting correlation between what they say (see discussion on "Empathic Telepathy" below). This is, however, not the most common protocol of a parapsychology experiment. More typically, the content of the consciousness of one subject is controlled by an input from an external random number generator — a completely different situation. The only way round this might be to use a "moving Zeno process" in which the Boolean algebra describing the observation is continuously rotated by the brain so that the projections initially describing A and not-A can be interchanged, the process being steered so as to produce the required final result. While this is conceivable, in the light of the argument in the section "What consciousness does", it seems much more likely that the mind uses consciousness with an incomplete set ς, and it is this option that I explore below.

If we allow ς to be less than a full algebra, generating the algebra σ, there are then two variants on the Zeno effect, which I will call *forcing* and *entrainment*.

1. *Forcing* is achieved by consciousness asserting, at a sequence of loci with time-spacing δt, a set ς which includes a projection P but not its negation not-P. This can be done, even when the quantum state in $\mathcal{H}$ is initially not in P, but merely has a non-zero component in P. With the conventional Zeno effect, as it occurs in laboratory observations, the first application of P could either produce the realisation of P or NOT-P, and subsequent applications would maintain it. In CQC, if NOT-P is not in ς then NOT-P will not be realised. The corresponding state will not be included in the history, and the moments of consciousness will continue until eventually either P is realised or the probability of P is reduced to nearly zero through interaction with external systems.

2. *Entrainment* is the result of including in a history a realised projection onto a state that is entangled with a particular state in the environment.

Suppose that the apparent state (see section on "Time in quantum theory") α associated with a locus $\mathfrak{L}$ can be decomposed as

$$\alpha = \sum_i a_i \phi_i \otimes \epsilon_i \tag{2}$$

with $\phi_i \in \mathcal{H}_1$ and $\epsilon_i \in \mathcal{H}_2 \otimes \mathcal{E}_U$ where $\mathcal{E}_U$ (the environment of U) consists of the states outside U. The states ϕ_i are a basis for $\mathcal{H}_0$ consistent[10] with ς. A moment of consciousness realised at $\mathfrak{L}$ can produce an apparent state (see section "Time in quantum theory") of the form

$$\alpha_k = \sum_{i \in s_k} a_i \phi_i \otimes \epsilon_i$$

where all the ϕ_i for $i \in s_k$ are a basis for a single element A_k of ς (Clarke, 2007).

This new apparent state will then be effective in determining the states at all subsequent loci. In other words, the local moment of consciousness entrains all aspects of the environment that are entangled with it into the subsequent manifest universe, which emerges as a result of the joint interaction with the initial state of the universe through of the whole network of living systems. Consciousness, though it acts on the ϕ_i, necessarily restricts also the ϵ_i.

It will be clear that the conjunction of forcing and entrainment enables a living system to exercise a determining influence on the whole of the subsequent manifestation of the universe. Repeated inclusion in the history of a projection on a state in $\mathcal{H}$ that is entangled with an environmental state will in principle eventually bring about the manifestation of that environmental state unless this is countered by the competing effect of other organisms. In the next section I will describe how this can appear as phenomena such as psychokinesis and telepathy; I will, however, first conclude this section with a further explanation of the particular condition of extensive coherence which I suggest for selecting conscious systems, following the more expanded account in Clarke (2007).

Extensive coherence

I take the philosophical position of *dual aspect panpsychism*, in the following sense. First, I am entirely persuaded by the argument of

[10] That is, the ϕ_i either lie in the atomic elements of ς or lie in the complement of the subspace spanned by ς

Chalmers (1995) for the subjective view of consciousness as a quality that is distinct from the objective, functional properties or processes of the thing possessing consciousness. To paraphrase Velmans (2000), given any objectively defined process the two possibilities of its being accompanied by subjective awareness and of its "going on in the dark" are equally consistent. Thus the basis for what is conscious and what is not is not to be found in objective function and structure. Second, if one adopts this position then, following the reading of Spinoza by Damasio (2003), the only explanation for the existence of consciousness that seems to me coherent is the proposal that substance has two aspects: that of extension (materiality) and that of consciousness. Third, in applying this to the actual world we experience and which is explored by science, this gives rise to the panpsychism of Mathews (2003), Skrbina (2005) and many others, according to which *everything* has both a material and a conscious aspect.

Under this position, "everything" means, in effect, "every thing"; and so one has to determine what is a "thing". With Mathews (1991, 2003), for example, a thing is defined within a systems theory approach in which any region can be conventionally regarded as a subsystem of the universe, but the only naturally defined things are organisms, singled out by particular dynamical properties. While this seems to match the world in which we find ourselves, I am not convinced that the dynamical properties she appeals to can be given precise definition. Indeed I would claim that the only property corresponding to the nature of an organism which is both clearly definable and universally applicable is the notion of *coherence* used by Ho (1998). If, as seems to be the case (Schlosshauer, 2006), the universe is at all length scales a quantum universe (classical physics being a particular case of quantum physics) then out of the possibilities suggested by Ho the primary instance of coherence is quantum coherence, of which the definition in the second point 2 in the section "Quantum Histories" seems the most natural.

On the face of it, this philosophical argument (which itself would be contested by many at each stage) leads to a result that is physically impossible on two grounds. First, microscopic systems such as atoms would be conscious, and hence subject to the Zeno effects described in the previous section, which would contradict the observed decay times for excited atoms. Second, the size of a region that can exhibit coherence in this sense is limited by the mechanisms of decoherence to a length scale that is minute compared to the size of a biological cell (Hagan et al., 2002; Tegmark, 2000), whereas the physical aspect of the conscious system that is our awareness needs to be sufficiently extensive to integrate neural processes across the whole brain.

The first problem is present for most versions of quantum theory using a histories approach with selection criteria. It is sometimes evaded by requiring that all histories are “consistent”, but this is defined in such a way that it is essentially ruling out the problem by fiat rather than finding an actual mechanism for achieving this (Dowker & Kent, 1996). In essence the solution to this would appear to lie in the use of gravitation theory by Penrose (2004) though the actual mechanism still needs to be fully elucidated. There and in earlier works he points out that general relativity (which must be included in an eventual integrated quantum theory, although it is still far from clear how this might be done) implies that quantum states which differ sufficiently in their gravitational fields cannot be superposed. Thus any future theory that integrates gravitation with the approach being used here will contain a lower limit for the time separation of moments of consciousness which matches the time scale on which the difference between the gravitational fields of alternative states reaches the level identified by Penrose. This limitation makes the theory consistent with data for atomic systems, while producing differences from conventional theory that should already be detectable for large conscious systems. Note that this differs from Penrose (2004) for which only the size of the system, not its consciousness, is relevant, a criterion that may already be falsified (Schlosshauer, 2006).

The second problem is central to understanding this particular proposal, in that it involves the characteristics of living systems. It can plausibly be supposed that having a sophisticated consciousness confers some evolutionary advantage on an organism, so that there would be evolutionary pressure for an organism to enlarge structures that integrated processes in its nervous system. This it could do by using the Zeno mechanism, repeatedly asserting particular quantum states that entangled parts of its nervous system, these parts varying through a succession of patterns. On this basis one would expect that, in an evolved system, the main activity of consciousness would be to maintain the integrity (extensive coherence) of itself.[11] As the size of an exten-

[11]It must be borne in mind that the “consciousness” that is being talked of here, which is common to wide range of systems, is much more general that the particular reflective component of it which we normally focus on in introspection. Thus we are “conscious” in this sense even in deep sleep or coma.

sively coherent system increases, so its Penrose time (determining the frequency of moments of consciousness) increases and its decoherence time decreases. There is thus a critical size to which conscious systems can grow, determined by the equality of these two time scales, which turns out to be of the order of a few centimetres for filamentary structures at room temperature.

Prototypic examples from parapsychology

In this section I will briefly describe the application of CQC to examples representative of some main experimental categories in parapsychology, after which I will discuss how the theoretical insight afforded by the theory here can open up new lines of enquiry for examining both quantum theory and its parapsychological effects. One interesting point to emerge, subject to future examination in more detail, will be that in the approach here the concept of entanglement seems less applicable than is the case for the weak quantum theory approach (Lucadou et al., 2007).

Psychokinesis

As an example here I will use Peoc'h's chick experiment (Peoc'h, 1988). Although it has been criticised (Johnson, 1989) and the criticism has been countered by Peoc'h (and the controversy has continued since), I will be using it here as an illustrative example of the sort of effect that is to be expected under the present theory rather than as evidence for the validity of PK.

The report concerns a batch of chicks who were hatched in the presence of a "robot": a cylindrical device which moved in a straight line punctuated by random changes in direction, under the control of a random number generator. The chicks imprinted on the robot, so that when free they would follow it around. For the experimental sessions they were confined in a cage which was placed on a randomly chosen side of a compound in which the robot moved (see figure 1). The experimenter reported that, on a statistically significant proportion of occasions, the robot's movements were mainly confined to a region close to the side of the compound where the chicks were installed. Moreover (Fenwick, 1996) he further claimed that the same results were obtained when the robot was controlled not by a direct connection with a random generator, but with a signal that had been pre-recorded on a floppy disc six months earlier!

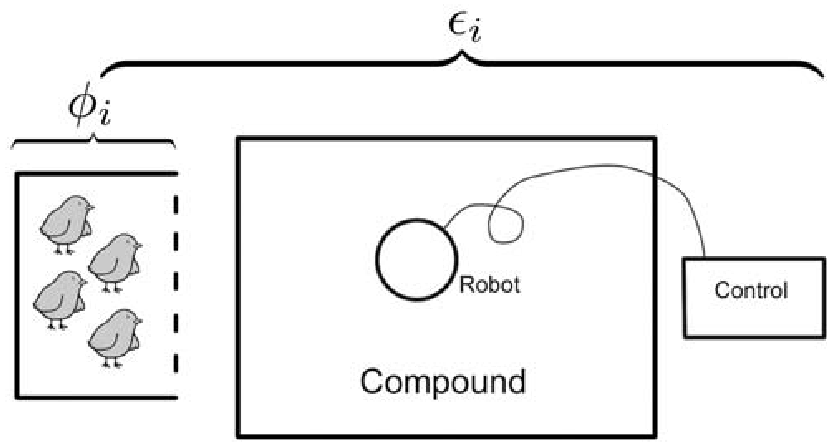

Figure 1. Schematic diagram of Peoc'h's chick experiment. ϕ_i and ϵ_i, corresponding to equation (2) above, indicate respectively the states of the conscious system of the chicks and of the environment together with the other systems of the chicks.

A complicating factor in analysing this experiment is the multiplicity of organisms involved: do we regard the chicks as independent organisms each engaging with the robot, or could their brains, through a mutual entanglement of their states, become jointly coherent, as a single organism? Is the experimenter Peoc'h watching the experiment and also exercising his own influence (raising the intriguing possibility that the chicks might in fact be irrelevant to the effect)? The CQC formalism is explicitly designed to accommodate such simultaneous loci of consciousness; but for simplicity let us here think in terms of only a single organism, the joint-chicks.

We have here the conjunction of forcing and entrainment described in the previous section. Taking the later variation described by Fenwick, let us suppose that the movements of the robot are based on a random number generator controlled by a quantum mechanical effect such as nuclear decay (alternative mechanisms are discussed below). The output of this generator is recorded as low intensity variations in the magnetisation of a floppy disk, which has been safely locked up so that no living system has become aware of these data prior to the experiment. The apparent state prior to the chicks experiment will then include a superposition of states $\sum_i a_i\psi_i$, each component of which describes a position and velocity of the robot, together with a corresponding matching set of data on the floppy disk.

The chicks visually observe the robot and thereby entangle their (joint) brain-state with this external superposition (see equation (2) above and figure 1). As a result of their imprinting the chicks devote a major part of their conscious process to the assertion of a projection of their joint state onto a state where they perceive the robot to be nearer to them than some critical comfort distance.

Forcing and entrainment then restrict the subsequent apparent state to a superposition containing only positions less than this distance. The subsequent operations of Peoc'h, acting at a causally succeeding locus, further reduce this superposition to a particular sequence of positions and a particular (necessarily consistent) content of the disk.

This example demonstrates that the CQC framework give a very natural account of the process. Without such a framework, it would seem that the chicks had somehow exercised psychokinesis retroactively on the detailed mechanics of the random number generator, defying both the laws of physics and the intellectual power of chicks. With this framework, it is apparent that all they were doing was concentrating hard on their "mother" and wanting it to be near. We can also note that most of the foregoing analysis can be applied, *mutatis mutandis*, to many other standard (and more replicable) psychokinesis protocols, though for most of these the strength of the effect (though not necessarily its statistical significance) is much lower than that reported by Peoc'h.

Target guessing

Figure 2 depicts in broad outline a protocol for a variety of parapsychological experiments. Many variation can be made: the random number generator controlling the process could act on many principles, feedback could be immediate after each "guess", or be given after the whole session, or be omitted, the "transmitter" person could be omitted for pure clairvoyance, and so on. I shall assume that there is at least one instance of feedback in each session. In broadest terms, however, the basic structure remains similar to Peoc'h's experiment in involving a random number generator whose influence is subsequently entangled with consciousness; but we now have an explicit succession of moments of consciousness linked to the outcome, making it appropriate to describe the process in terms of a history. The process could thus be described as involving a sequence $\{P_i \mid i = 1, 2, \ldots, n\}$ (with at least one member) of propositions at moments of consciousness (loci) by the "receiver", and at least one proposition P_E at a moment of consciousness by the exper-

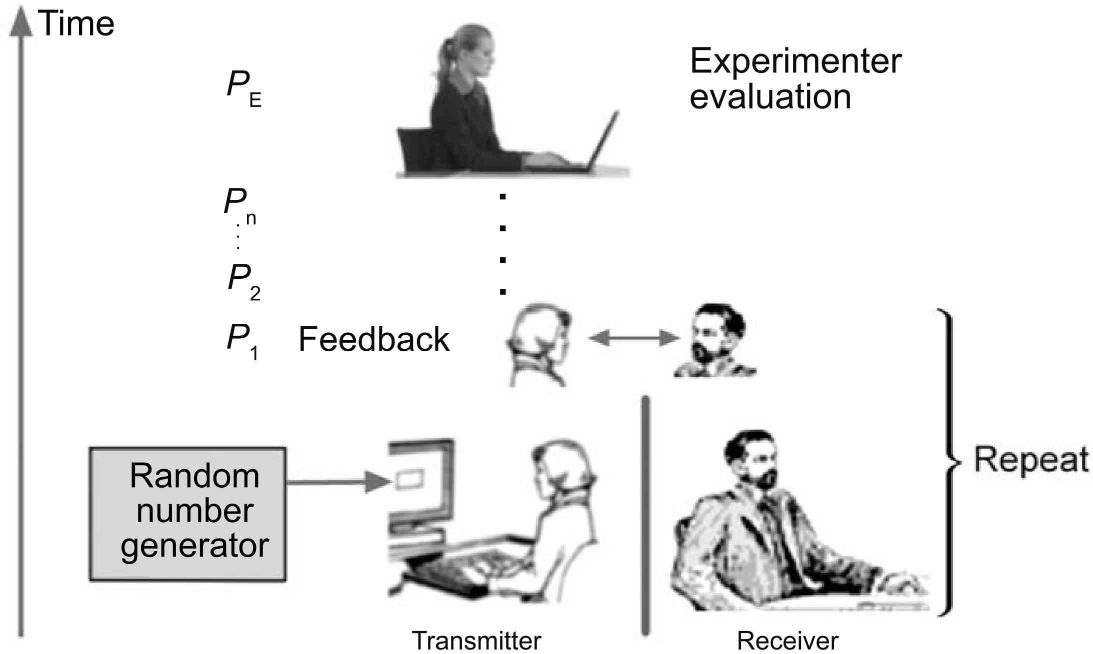

Figure 2. Schematic depiction of a typical target-guessing experiment. P_1, P_2 etc. indicate propositions asserted by the receiver or the experimenter at successive moments of consciousness (loci).

imenter. For example, the proposition P_E in the set ς_E being asserted by the experimenter might be the occurrence of a statistical significance of better than 1%. The probability of some or all of these propositions being satisfied is then given by a function (see footnote 9) which links all the propositions. Because of the entanglement of the effective state at the locus of P_i with the receiver's memory state, the entanglement of the effective state at P_E with the final record of the whole series, and the causal connections between these and the individual random number generator states, there will be a positive correlation between the probabilities of each of the P_i and P_E.

Two effects arise from this positive correlation: (a) The individual probabilities of the P_i are enhanced by the effectiveness of the assertion of the set containing P_E by the experimenter, producing an "experimenter effect", and (b) The probabilities of each of the P_i (success in individual sessions) will be enhanced by the feedback. Both of these effects might be regarded as a form of retroactive causation, in the sense of causation that operated in a direction opposite to the usual arrow of time (Reichenbach, 2003). This would, however, be a misleading way to think about it. The arrow of time enters into the histories interpretation through the time-displacement maps Λ in equation (1). These represent normal dynamical causation with is made unidirectional by thermodynamic effects that are ultimately traceable to the expansion of the universe. The correlation between the different Ps is of a logical nature: it is identical to the correlation existing between logically connected propositions asserted a single moment of time but is in itself independent of time. This non-causal correlation is analogous to Jung's concept of synchronicity. On this viewpoint there is, because of the time-independence of this structure, no essential difference between precognition and telepathy.

Spontaneous psi

I will examine here two general types of spontaneous occurrence, the first suggesting a different sort of mechanism from the forgoing cases ("empathic telepathy") and the second suggesting an instance of the previous mechanisms ("spontaneous precognition").

Empathic telepathy: By this title I mean the spontaneous occurrence of apparently paranormal communication between two connected individuals. This is a large category, and I will examine only the phenomena exemplified by the "but *I* was just about to phone *you*!" syndrome, when a particular idea or image occurs to two individuals, well known to each other, at the same time. This case differs from target-guessing in that the random number generator is replaced by a second organism, so that both organisms select the apparent state as part of the history before there is any comparison between them. An explanation through forcing, applied to a state which is not yet selected, is therefore ruled out.

This sort of occurrence seems to be most frequently reported among pairs of organisms, hereafter referred to as Alice and Bill, who have close and sympathetic relationships. In that case we could postulate what might be called a common or shared (component of) mind. By this I mean that there exists a locus $\mathfrak{L}_{AB} = (U, \mathcal{H}', \mathcal{H})$ in which U consists of two disconnected parts U_A and U_B, one in the brain of Alice and one in the brain of Bill.[12] By definition of extensive coherence (item 2 on

[12]Hitherto I have allowed a tacit assumption that within a human being there exists a unique physical system that carries a coherent state, and that this constitutes "the" consciousness of the person. There is, however, significant evidence that this is not so (Teasdale & Barnard, 1993; Douglas-Klotz, 2001;

12), the states over these two components will be highly entangled. In particular, if we denote states that correspond to particular ideas over U_A by $\alpha_A^1, \alpha_A^2, \ldots$ and similarly for B, where the superscripts label the same idea for A and B, then we can expect the occurrence of states of the form $\sum_i a_i \alpha_A^i \otimes \alpha_B^i$. If in addition we suppose that the occurrence of a situation where communication is appropriate results in the repeated assertion within $\mathfrak{L}_{AB}$ of a projection on states of this form, then forcing will take place as in the previous example, and the result will be a raised probability of Alice and Bill entertaining the same ideas at a given time.

This example is of particular theoretical interest, because, unlike the mechanisms just described for parapsychology experiments, it involves the entanglement of minds — or more precisely, the entanglement of two parts of a system that is being maintained in a state of extensive coherence as a result of being a mind. This maintenance has to be achieved by the repeated assertion of propositions that project onto particular entangled states of the two parts, which is part of the *conatus*[13] that characterises minds. Since entanglement, as I am defining it here (see section "Time in quantum theory") is by definition between states that are not time-related, it brings in a condition of simultaneity, which again distinguishes it from the previously discussed effects.

A further distinction from the previous cases is that the underlying mechanism here could give rise to a distance effect. This is because of condition 1b in section "Quantum Histories", which implies that the temporal extent of a locus is (approximately) the light-crossing time of its spatial extent. Each component of the joint mind would thus have to maintain its quantum phase, through internal shielding against decoherence, for up to 40msec in the case of long-distance telepathy on earth — a very severe constraint. The mechanism just described is also the most likely candidate for the possible correlation (Grinberg-Zylberbaum et al., 1994; Sabell et al., 2001; Wackermann et al., 2003) of EEG records between distant subjects, where time-synchronisation is a vital aspect.

Spontaneous precognition: This case is of interest because it appears to combine the time independence in the section on "Target Guessing"

Lockwood, 1989).

[13]Spinoza defined the concept of *conatus* (Spinoza, 1925, Ethices p.102) through which an organism expresses its definitive goal of the maintenance of its own essential being — an idea which was developed in the pan-psychist picture of Mathews (2003).

with the spontaneous empathic connection of "Empathic Telepathy" above. It seems to be of widespread occurrence, and happens to be a phenomenon that I have found striking in my personal experience in the form of precognitive dreams that I have either reported to others or recorded in my journal at the time of their occurrence. I will therefore take precognitive dreams as a particular example of spontaneous precognition in what follows.

When a later experience matches salient points of an earlier dream, this is felt to be remarkable because the subject thinks that such a match would be "extremely improbable by chance". If one were to try to make quantitative this subjective impression (and the area is notoriously difficult to analyse statistically), one might suppose that both our dreams and our experiences of events combine a number of elements whose possible range, though large, is finite, so that one could, at least very roughly, assign probabilities to particular combinations. For instance, one dream of mine contained the following elements: a book bound in a distinctive yellow ochre colour without other ornament, a Catholic mass, and myself weeping (together with other elements strongly correlated with the Catholic mass element). These elements were all fairly rare in my experience, and there seemed only weak correlations between them, so that the dream itself appeared curious enough to be noted. When, a couple of weeks later, an event occurred that combined all these elements at the same moment of time, then *if the dream and the event were uncorrelated* the occurrence of both would seem very unlikely indeed, and this in turn might suggest that there was in fact some causal mechanism operating which did correlate the dream and the subsequent event.

Setting aside the question of whether the statistical guesses just made are in fact reliable (something that in this particular case could indeed by seriously challenged) we can examine the light shed on this by the present theory. First, entanglement (or its generalisation in which the Bell inequalities are violated as in the section on "Time in quantum theory") between the consciousness of the dream and the consciousness of the later event, as described in the previous section, is ruled out because entanglement on this theory could only be maintained by the assertion of a proposition between events that are not chronologically related. Second, the theory as at present articulated deals only with moments of consciousness and not with the concept of an enduring self or soul (see point 2 in the introduction); so that from the point of view of the mental aspect of the world no significance attaches to two experiences belonging to the same person. (The theory thus differs significantly from the ideas of, for example, Sheldrake, 1988). There is thus no basis for the physical connection between the two loci that characterised the previous case in the section “Empathic Telepathy”.

On the other hand, part of the mechanism of the target guessing protocol in the section on “Target Guessing” matches well with what is happening with the dream. The delight and fascination that I feel when a dream is verified is similar to that which I experience when a scientific prediction is verified, and in both the case of the experimenter in a target-guessing experiment and the case of my experience of significant events in daily life it could be said that a pre-conscious or unconscious assertion of a desire for a meaningful outcome (i.e. a “proposition”) was satisfied. In both cases the two moments of consciousness are in fact correlated by virtue of their entanglement with contemporary records and memory traces. History theory does give a mechanism that connects them, although it is not strictly speaking a causal mechanism.

Experimentally testing conscious quasi-collapse

Untestable theories are not worth the name, and one impetus behind the present work is to open up a theoretical area that will enable one to formulate possible areas for testing more precisely. Caution is, however, called for in this particular domain, because of the way in which the effects operate at the human level, all participants necessarily being involved, including the experimenter, in a strongly interlinked way. The distinctive features of this theory (presented here as a summary of what has gone before), which make it particulary open to refutation are as follows:

1. No physical forces other than those of conventional physics are being introduced.
2. Reality is jointly determined by all conscious organisms, within the constraints imposed by the probabilities of conventional quantum mechanics, by their asserting sets of propositions dependent on their effective quantum state, with a frequency of assertion limited by the Penrose time τ_P.

A feature that allows the theory to be refined is:

3. Conscious organisms are identifiable as all systems that satisfy a general criterion such as extensive coherence (see section on "Quantum Histories") or the conditions on a switching network indicated by Donald (1990).

I shall focus here on parapsychological tests applicable to 1 and 2. I have already described ("Emapthic Telepathy" above) an area where there might be an observable distance effect. Here I explore another line of inquiry suggested by the dominant role of the experimenter effect in these experiments, which in this theory stands in contrast to their usual analysis in terms of the transmission of information from one place/person to another. It is a prediction of this theory that an experimenter who is strongly motivated to obtain a particular result will consistently achieve that result more readily than an experimenter motivated to obtain the reverse result, even when their protocols are exactly identical. This possibility, which has often been reported in parapsychology and cited as evidence against all parapsychological effects, deserves careful investigation as means for distinguishing the mechanism presented here from information-passing mechanisms for parapsychology.

The mechanism involved in psi effects is, as we have seen, different in the randomised trials required for experimentation and spontaneous phenomena. Thus the nature of randomisation is a key factor in this approach. The previous examples have been phrased in terms of randomisation using a "quantum event" such as radioactive decay. This is sometimes contrasted with a "classical event" such as the generation of a large integer by an iterative process seeded by the clock time. This assumed distinction between quantum and classical randomness was taken for granted until the development of the modern theories described in the introduction. Before then, it was supposed that quantum mechanics took place only among microscopic objects (or arrays of such objects between which an unusual coherence had been established) and that there was an unambiguous distinction between the quantum world and the classical world, with the collapse of the quantum state mediating between the two. Quantum randomness was an inherent aspect of collapse, whereas classical randomness was a result of our ignorance of the exact initial state of the process giving rise to it.

Within this new picture as described in the introduction, a "classical" uncertainty is one deriving from a process, such as tossing a coin, whose physics can be accurately described without reference to quantum mechanics. The initial conditions of any such process, however, stem from unmeasurably tiny fluctuations in the conditions of the whole environment within which the process takes place, fluctuations that are part of a causal chain that stretches back to the earliest phases of the universe when it was a homogeneous quantum entity. In this sense, all uncertainty is of quantum origin, and in the CQC approach it is explicitly represented as such. The important distinction in that theory is not between classical and quantum uncertainty, but between situations that are still malleable and open to influence through consciousness, and those that have entered consciousness and become public. Here "public" means that the consequences of the situation have significantly impinged on the consciousness of a wide range of disinterested organisms, or have made multiple stored impressions on a single organism. For example, in the Peoc'h experiment involving pre-recording data that controlled the robot, the data was still malleable and subject to influence by the chicks or the experimenter because it had been "locked up" in low-energy imprints on a magnetic disc. Even if it had been printed, as a long list of binary digits, say, and disseminated in a scientific journal it might still have been malleable, because the information that could have been extracted from it into the consciousness of any reader would still have left more than enough freedom for there to have been a wide range of quantum states available for a behaviour of the robot that would yield a positive result.

Thus one way of testing the theory would be to compare "locked" data with "public" data. But is it possible to arrange randomisation in terms of data this is public in all its details (particularly in view of the potentiality of the experimenter to capitalise effortlessly on any lacunae in the prior determination of the data) while still carrying out a well controlled experiment? The challenge is that of making the data used for randomisation impinge fully on consciousness while at the same time removing any possibility of a person asserting a proposition that could influence the result. As an example of a public quasi-randomisation, one could generate a sequence of digits by applying an algorithm to the text of a specified book (the algorithm designed to remove as far as possible the strong non-randomness of letters in a book) starting at the first occurrence of the eighteenth noun in the leader of a specified newspaper on a specified date. If this procedure consistently nullified the results of experiments with the general structure of those in sections

"Psychokinesis" and "Target Guessing", irrespective of the views of the experimenter, then this could be construed as evidence against point 2 at the beginning of this discussion, which is an essential part of the whole theory.

Acknowledgments

I am grateful to Prof. H. Walach and other referees for their valuable contributions to this paper.

References

Atmanspacher, H. and Römer, H. and Walach, H. (2002). Weak quantum theory: Complementarity and entanglement in physics and beyond. *Foundations of Physics*, *32*, 379-406.

Barbour, J. (1999). *The End of Time*. London: Weidenfeld and Nicolson.

Bomford, R. (2005). Ignacio Matte Blanco and the logic of God. In C. J. S. Clarke (Ed.), *Ways of knowing: Science and mysticism today* (pp. 129–142). Imprint Academic.

Chalmers, D. J. (1995). Facing up to the problem of consciousness. *J. Cons. Studies*, *2*, 200–19.

Clarke, C. J. S. (2006). *On the nature of bilogic: the work of Ignacio Matte Blanco.* (URL http://www.scispirit.com/matteblanco5web.htm)

Clarke, C. J. S. (2007). The role of quantum physics in the theory of subjective consciousness. *Mind and Body*, *5*, 45–81.

Damasio, A. (2003). *Looking for Spinoza: Joy, Sorrow, and the Feeling Brain*. Harcourt.

Daneri, A., Loinger, A., & Prosperi, G. (1962). Quantum theory of measurement and ergodicity requirements. *Nuclear Physics*, *33*, 297-319.

Donald, M. J. (1990). Quantum theory and the brain. *Proceedings of the Royal Society (London) Series A*, *427*, 43–93.

Donald, M. J. (1995). A mathematical characterization of the physical structure of observers. *Foundations of Physics*, *25*, 529-571.

Douglas-Klotz, N. (2001). *The Hidden Gospel: Decoding the Message of the Aramaic Jesus*. Quest Books.

Dowker, F., & Kent, A. (1996). On the consistent histories approach to quantum mechanics. *J. Stat. Phys.*, *82*, 1575.

Everett, H. (1957). 'Relative State' formulation of quantum mechanics. *Rev. Mod. Phys.*, *29*, 454.

Fenwick, P. (1996). Chickens don't lie. *Network: the Scientific and Medical Network Revue*(62), 12-13.

Giulini, D., Joos, E., Kiefer, C., Kupsch, J., Stamatescu, I.-O., & Zeh, H. D. (1996). *Decoherence and the appearance of a classical world*. Berlin and Heidelberg: Springer-Verlag.

Griffiths, R. (1984). Consistent histories and the interpretation of quantum mechanics. *J. Stat. Phys.*, *36*, 219-272.

Grinberg-Zylberbaum, J., Delaflor, M., Attie, L., & Goswami, A. (1994). The Einstein-Podolsky-Rosen paradox in the brain: the transferred potential. *Physics Essays*, *7*, 422-427.

Hagan, S., Hameroff, S., & Tuszynski, J. (2002). Quantum computation in brain microtubules? decoherence and biological feasibility. *Physical Review E*, *65*, 061901.

Hameroff, S., & Penrose, R. (1996). Orchestrated reduction of quantum coherence in brain microtubules: A model for consciousness? In S. Hameroff, A. Kaszniak, & A. Scott (Eds.), *Toward a Science of Consciousness – The First Tucson Discussions and Debates* (pp. 507–540). MIT Press.

Hartle, J. (1991). The quantum mechanics of cosmology. In S. Coleman, P. Hartle, T. Piran, & S. Weinberg (Eds.), *Quantum cosmology and baby universes.* World Scientific.

Hartle, J., & Hawking, S. (1983). Wave function of the universe. *Physical Review D*, *28*, 2960-2975.

Ho, M.-W. (1998). *The Rainbow and the Worm*. Singapore: World Scientific.

Johnson, M. H. (1989). Imprinting and anpsi: An attempt to replicate Peoc'h. *Journal of the Society for Psychical Research*, *55*, 417-419.

Leibniz, F. v., Gottfried Wilhelm. (1714). Principles of nature and grace, based on reason. In *Philosophical Essays* (p. 210). Cambridge, Indianapolis: Hackett.

Linde, A. (2001). Inflation. In P. Murdin (Ed.), *Encyclopedia of Astronomy & Astrophysics.* IOP Publishing Ltd. (Article 2135)

Lockwood, M. (1989). *Mind, Brain and the Quantum*. Blackwell.

Lucadou, W. von, and Römer, H. and Walach, H. (2007). Synchronistic phenomena as entanglement correlations in generalized quantum theory. *Journal of Consciousness Studies*, *14*, 50-74.

Mahler, G. (1994). Temporal Bell inequalities: A journey to the limits of consistent histories. In H. Atmanspacher & G. J. Dalenoort (Eds.), *Inside Versus Outside* (p. 196-205). Berlin: Springer.

Mathews, F. (1991). *The Ecological Self*. Barnes & Noble Books-Imports.

Mathews, F. (2003). *For Love of Matter: A Contemporary Panpsychism*. State University of New York Press.

Matte Blanco, I. (1998). *The Unconscious as Infinite Sets: An Essay in Bi-logic*. H. Karnac.

Page, D. (2001). Mindless sensationalism: A quantum framework for consciousness. In Q. Smith & A. Jokic (Eds.), *Consciousness: New Philosophical Essays* (p. 468-506). Oxford: Oxford University Press.

Paz, J. P., & Mahler, G. (1993). Proposed test for temporal bell inequalities. *Physical Review Letters*, *71*, 3235-3239.

Penrose, R. (2004). *The Road to Reality: A Complete Guide to the Laws of the Universe*. Jonathan Cape.

Peoc'h, R. (1988). Chicken imprinting and the tychoscope: An anpsi experiment. *Journal of the Society for Psychical Research*, *55*, 1-9.

Radin, D. (2006). *Entangled Minds*. Pocket Books.

Reichenbach, H. (2003). *The Direction of Time*. Dover.

Sabell, A., Clarke, C., & Fenwick, P. (2001). Inter-subject EEG correlations at a distance – the transferred potential. In C. Alvardo (Ed.), *Proceedings of the 44th Annual Convention of the Parapsychological Association* (p. 419).

Schlosshauer, M. (2006). Experimental motivation and empirical consistency in minimal no-collapse quantum mechanics. *Ann. Phys.*, *321*, 112-149.

Schrödinger, E. (1935). Discussion of probability relations between separated systems. *Proceedings of the Cambridge Philosophical Society*, *31*, 555-563.

Sheldrake, R. (1988). *The Presence of the Past*. Collins.

Skrbina, D. (2005). *Panpsychism in the West*. The MIT Press.

Spinoza, B. (1925). *Spinoza opera; im Auftrag der Heidelberger Akademie der Wissenschaften*. Heidelberg: Carl Winters. (Edited by Carl Gebhardt)

Stapp, H. O. (2005). Quantum interactive dualism: An alternative to materialism. *J. Consc. Studies*, *12*, 43-58.

Sudbery, T. (2002). Diese verdammte Quantenspringerei. *Stud. Hist. Phil. Mod. Phys.*, *33*, 387-411.

Teasdale, J. D., & Barnard, P. J. (1993). *Affect, Cognition, and Change: Re-Modelling Depressive Thought*. Hove, UK: Erlbaum.

Tegmark, M. (2000). Importance of quantum coherence in brain processes. *Physical Reviews E*, *61*, 4194-4206.

Turner, M. S. (1999). Large-scale structure from quantum fluctuations in the early universe. *Phil. Trans. R. Soc. A*, *357*, 7-20.

Velmans, M. (2000). *Understanding Consciousness*. London: Routledge.

Wackermann, J., Seiter, C., Keibel, H., & Walach, H. (2003). Correlations between brain electrical activities of two spatially separated human subjects. *Neuroscience Letters*, *336*, 6064.

Walker, E. H. (2000). *The Physics of Consciousness*. Cambridge, Massachusetts: Perseus Books.

Zeh, H. D. (1970). On the interpretation of measurement in quantum theory. *Foundations of Physics*, *1*, 69-76.

Zurek, W. H. (2003). Decoherence, einselection, and the quantum origins of the classical. *Rev. Mod. Phys.*, *75*, 715.