Quantum Holism and the Philosophy of Mind

Michael Esfeld[1]
University of Konstanz, Center for Philosophy of Science
PO Box 5560 D24, D–78457 Konstanz, Germany
Michael.Esfeld@uni-konstanz.de

(published in *Journal of Consciousness Studies* **6** (1999), pp. 23–38)

Abstract

This paper attempts to build a bridge between the interpretation of quantum theory and the philosophy of mind. In contrast to other such attempts, the bridge which this paper suggests does not consist in extending features of quantum theory to the philosophy of mind. The argument of this paper is that the discussion about a revision of the Cartesian tradition in current philosophy of mind is relevant to the interpretation of quantum theory: taking this discussion into account sharpens up the task for the interpretation of quantum physics as far as the scope of what is known as quantum holism is concerned. In particular, considering this discussion makes out a strong case against the interpretation that considers quantum holism to be universal in the physical realm.

I: Introduction

There are a number of suggestions for a connection between on the one hand the interpretation of quantum theory and on the other hand the enquiry into the nature of consciousness and the philosophy of mind. Some scientists, notably Penrose (1994), chapters 7–8, propose that quantum theory is important to brain research. Furthermore, since the advent of quantum theory, the process of quantum state reduction, which is presumed indeterministic, has been employed for a solution to the problem how free will can have physical effects (the most elaborate proposal in this respect is Eccles (1994, chapter 9)). This paper also seeks to build a bridge between the interpretation of quantum theory and the philosophy of mind. However, the bridge which this paper suggests does not consist in extending features of quantum theory to the philosophy of mind. *The thesis of this paper is that the discussion about a revision of the Cartesian tradition in today's philosophy of mind along the lines of direct realism and externalism is pertinent to the interpretation of quantum physics when it comes to the question of the extension of what is known as quantum holism*.

The scope of quantum theory including the superposition principle and the Schrödinger dynamics is a subject of much debate: Do the features which are peculiar to quantum theory concern only more or less the microphysical realm, i.e., the realm of atoms and their constituents? Or do these features extend to macroscopic systems and common sense objects, such as measuring instruments, trees, and cats, so that they concern the whole physical realm? I show that if one endorses the latter position, one is committed to certain consequences in the philosophy of mind. I relate these consequences to the discussion on Cartesianism and its revision in today's philosophy of mind. I argue the following: (a) Taking this discussion into

1 For helpful comments on an earlier version of this paper I am grateful to Matthew Donald, Peter McLaughlin and three anonymous referees for *JCS*.

account sharpens up the task for the interpretation of quantum physics. (b) The Anti-Cartesian developments in today's philosophy of mind make out a strong case against conceiving quantum holism as touching the whole physical realm. A further result of my argument is that the attempt to achieve, on the basis of quantum holism, one comprehensive holism, [24] which leads to a revision of the Cartesian tradition in both philosophy of physics and philosophy of mind, is doomed to failure from the start.

The moral of this paper is a plea for caution. In order to be able to keep an open mind on the recent developments in the philosophy of mind, we should regard quantum holism as being limited to more or less the microphysical level of nature. To start with, I briefly sketch out quantum holism (section II) and go into the measurement problem (section III). I then confront the two principal options which we have as regards the scope of quantum holism with the revision of the Cartesian tradition in today's philosophy of mind (section IV). Finally, I propose some conclusions (section V).

II: What Is Quantum Holism?

Quantum physics is widely seen as exhibiting some sort of holism. There are a number of suggestions on what this holism means in philosophical terms (Teller ,1986; Howard, 1989; Healey, 1991). Why do people speak of holism with respect to quantum physics? The states of two or more quantum systems can be in superposition with each other. Consider the simplest example (Bohm, 1951, pp. 611–22). Spin is a physical property which is treated only in quantum theory. There are systems of spin 1/2 such as electrons and neutrons. In this case, the spin in any of the three orthogonal spatial directions can take only two definite numerical values. Call these values 'spin up' and 'spin down'. Imagine that two systems of spin 1/2 are emitted together from a source. After the emission, their interaction ends, because they fly apart in opposite directions. Nonetheless, however far apart in space these two systems are removed, the spin state of the whole, i.e., the joint spin state of these two systems taken together, is a superposition of the first system having spin up and the second system having spin down with the first system having spin down and the second system having spin up in any direction. This state is known as the *singlet state*.

The point is that neither of the two systems is in a state of either spin up or spin down in any direction. Consequently, neither system has a definite numerical value of any local spin observable. A *local observable* is an observable that relates only to one of the two systems. Spin in z-direction of the one system and spin in z-direction of the other system are examples of local observables. Only the whole, which consists of these two systems, has a definite numerical value of a global spin observable, namely the total spin. A *global observable* is an observable that relates to the whole.

Assume that we measure the spin of one of two such systems in an arbitrary direction. Given the direction measured and the outcome of this measurement, the probability for the outcome of a spin measurement on the other system is changed (unless the spin is measured on both systems in orthogonal directions). As regards a spin measurement on the other system in the same direction, it is even possible to predict the outcome with certainty, i.e., either 'spin up' or 'spin down' has probability one. These correlations are well confirmed by experiments—even by experiments which carry out measurements on two such systems at a space-like distance. (The first such experiment is Aspect *et al*., 1982). The famous theorem of

Bell (1964) says, to put it in a nutshell, that the emission of these two systems from the source cannot be a common cause that screens the one measurement outcome off from the other measurement outcome.

[25] Following Schrödinger (1935a), p. 555, cases such as the singlet state are known as *entanglement*. In the case of entanglement, the states of two or more systems are entangled in such a way that only the whole, i.e., these systems taken together, is in what is known as a *pure state*. In the example mentioned, only the whole has a definite numerical value of a spin observable, namely the total spin; but neither of the two systems is in a state in which it has a definite numerical value of a spin observable in any direction. Nonetheless, it is possible to give a description of each of these systems in the formalism of quantum theory. This is a description in terms of a so-called mixed state in the sense of what is known as an *improper mixture* (d'Espagnat, 1971, chapter 6.3). The term 'improper mixture' is misleading: an improper mixture is not a mixture at all. 'Improper mixture' is the name of a description that in the case of entanglement of the states of two or more systems contains all the information that is available about each of these systems considered independently of the other systems.

In the example of the singlet state above mentioned, the description in terms of an improper mixture contains the probability distributions for a measurement of all the local spin observables of each of the two systems. But this description ignores the correlations between the possible values of these observables which can be acquired in measurement. It does not include the information that if the one system acquires the value spin up in a certain direction, the value of the spin which the other system acquires in the same direction is spin down. This description always indicates probability 0.5 for spin up and probability 0.5 for spin down in any direction for each of the systems as the outcome of a measurement, independently of whether or not a measurement on the other system has been carried out. The description in terms of a mixed state is identical for the two systems.

Consequently, in the case of entanglement, the description which relates to each of the systems in question does not completely determine the local observables of this system; for this description does not contain the change in the probability distributions of local observables of this system consequent upon a measurement of another system to which entanglement extends. Furthermore, this description does not determine the state of the whole, i.e., the state of these systems taken together. It is therefore possible that two systems can be described in terms of the same mixed states as in the mentioned case without being in the singlet state. *Hence, in the case of entanglement, it is only the description of the whole in terms of a pure state, such as the singlet state, which completely determines the local properties of the parts and their relations* (to the extent that these properties and relations are determined at all in quantum physics). Therefore, quantum physics exhibits a substantial holism.

Cases such as the singlet state are not at all exceptional. A conceptually similar example can be built up with two systems whose states are entangled with respect to position and momentum (Einstein, Podolsky and Rosen, 1935). Neither system has a definite numerical value of position or momentum. But the two systems taken together have a definite numerical value of the global observables relative distance and total momentum. If position or momentum of both systems are measured, the measurement outcomes are correlated. These correlations are contained solely in the description of the whole. What is more, whenever we consider a quantum whole which has two or more quantum systems as proper parts, quantum theory tells us that, apart from very exceptional cases, the states of these systems are entangled (see, for instance, Scheibe, 1991, p. 228).

[26] All the positions which I shall treat in this paper share two commitments in the interpretation of quantum theory: (a) Their considerable differences notwithstanding, they all endorse an interpretation which is realistic in that it takes quantum theory to tell us something about nature. (b) They all reject attempts to align quantum physics with classical physics by means of hidden variables. If we adopt a realistic approach towards quantum theory and do not assume hidden variables, we are committed to regarding quantum entanglement as an objective feature of nature. As the consideration in the last paragraph shows, we are thus committed to the conclusion that entanglement is ubiquitous at the level of quantum systems.

Taking this conclusion into account, quantum theory demands a revision of central features of the philosophy of classical physics. These features can be traced back to a programme in the philosophy of physics which originates in the second book of Descartes' *Principles of Philosophy* (1644). I shall therefore refer to these features as the *Cartesian tradition in the philosophy of nature*. This tradition is not limited to Descartes' physics. It includes the whole of classical particle physics as well as classical field theories including special and general relativity. The revision of this whole tradition which quantum theory calls for concerns mainly the following three points:

- *Localization*: In classical particle as well as field theories, all instantiations of physical properties can be traced back to property instantiations that are localized at space–time points. Quantum systems and their properties, by contrast, are usually not localized at a point or an arbitrarily small region in space or space–time.
- *Separability*: Classical physics satisfies what is known as the principle of separability (see Howard, 1989). We can attribute a state to each physical system, and this state completely determines the local properties of this system. Furthermore, the joint state of two or more systems is determined by the states which are attributed to each of these systems. Einstein (1948), p. 321, maintains that classical field theories including general relativity accomplish the principle of separability. Quantum entanglement, by contrast, implies a reversal of the principle of separability. The joint state of two or more systems is not determined by the states which can be attributed to each of the systems in question. On the contrary, it is only the joint state of two or more systems which completely determines the local properties of each of these systems and their correlations (to the extent that these are determined at all).
- *Individuality*: Even if we construe classical physics in such a way that space–time points with field properties instead of particles are the ultimate physical systems, we conceive particulars that are distinct individuals. However, quantum systems are not distinct individuals. This is a consequence of quantum entanglement. It is possible to regard quantum systems as individuals; but if the states of two or more quantum systems of the same kind are entangled, there are no properties which introduce a distinction between these systems (French and Redhead, 1988). Consequent upon quantum holism we therefore have to give up the assumption that the ultimate physical systems are distinct individuals. (I elaborate on these points in Esfeld, 1999).

III: The Scope of Quantum Holism and the Measurement Problem

[27] It is largely uncontroversial that quantum theory calls for a revision of our view of nature along the lines of the three mentioned points. The question is: Does this revision concern only our conception of more or less the microphysical realm, i.e., the realm of atoms and their constituents? Or do we have to revise our conception of all physical systems including macroscopic systems such as measuring devices and common sense objects along the sketched lines?

The proposal that even macroscopic systems are in fact subject to entanglement may seem odd. However, this proposal cannot be dismissed out of hand. The reason is the measurement problem: there is no obvious limit to the domain of applicability of the formalism of quantum theory including the superposition principle and the Schrödinger dynamics, which leads to ever more entanglement. The famous examples of von Neumann's chain (1932, chapter VI.1) and Schrödinger's cat (1935b, p. 812) make this clear in a drastic way. In these examples, entanglement propagates from a quantum system to macroscopic devices and finally to the body of an observer or a cat, leaving the cat in a state of being neither alive nor dead. The measurement problem can be conceived as the question how to adapt the following two claims so that they fit together: (a) A measurement yields one definite numerical value as outcome. (b) Applying the formalism of quantum theory including the Schrödinger dynamics to a measurement situation leads to a description according to which the states of all the systems involved are entangled with one another. (For the state of current research concerning the measurement problem, see Busch *et al*., 1996 and Mittelstaedt, 1998).

Since the days of von Neumann's and Schrödinger's formulation of the measurement problem there has been considerable progress in the physics and mathematics of quantum theory, notably the development of decoherence theories. (For an overview and assessment of these theories, see Giulini *et al.*, 1996). Decoherence theories show the following: although only the whole of quantum system, environment, and measuring instrument is in a pure state, each of the parts of this whole can be described in terms of an improper mixture. The point is that this whole rapidly develops in such a way that it cannot operationally be distinguished from a proper mixture. A proper mixture is an ensemble of systems which are in a pure state each, whereby the observer is ignorant of the pure state in which each system is. However, since decoherence leads to an improper mixture that is operationally like a proper mixture – but, ontologically speaking, is not a proper mixture – the decoherence theories which we have at our disposal leave the decisive question open: Shall we adopt an ontology that regards quantum holism as universal in the physical realm and welcome decoherence theories as a means to explain how it comes about that the world *appears* classically to an observer? Or shall we go beyond the scope of decoherence theories and assume a dynamics which is able to dissolve superposed states and entanglement in order to account for the *existence* of a classical level of the world? The options which we have as regards the measurement problem therefore more or less still boil down to two principal options:

(1) One can maintain that entanglement does not propagate to higher levels of macroscopic systems. I refer to this position as the *option for limited quantum holism*, because this position regards quantum holism as being limited to more or less the microphysical level. The most prominent strategy to work this position out is to admit [28] events of state reduction which reduce entangled states to a pure state of each of the systems involved. If we endorse this

position, we are free to consider the ontology of quantum physics to be compatible with the ontological commitments of our other scientific theories of chemistry, biology, physiology, etc. as well as common sense. If there are events of state reduction, nothing hinders that these theories including common sense describe the way in which macroscopic systems exist.

Since decoherence is not sufficient to explain events of state reduction, it is reasonable to envisage a modification of the Schrödinger dynamics if one endorses this option. The aim of such a modification is to achieve a general dynamics which includes the Schrödinger dynamics as well as a dynamics for state reductions. There are two main types of proposals for a change to the Schrödinger dynamics in order to account for events of state reduction:

- The first type of such proposals remains within the scope of current quantum theory. The most elaborate proposal of this type goes back to Ghiradi, Rimini and Weber (1986). Among the problems which this proposal faces are the questions whether it pays tribute to the conservation of energy and whether it admits of a relativistic generalization (but see Ghiradi *et al*., 1991).
- The other type of such proposals envisages going beyond the scope of current quantum theory. The central idea is that as soon as gravitation becomes relevant, a state reduction occurs due to gravitation. Penrose (1994), chapter 6, §§ 10–12, is the most prominent advocate of this approach. However, this approach is still in its infancy.

Because we do not have a fully convincing account of a dynamics for state reductions at our disposal, it is as yet a matter of philosophical argument whether it is plausible to acknowledge a dissolution of entanglement at all.

(2) One can bite the bullet of Schrödinger's cat and von Neumann's chain and conceive quantum holism in such a way that it extends to all physical systems. I refer to this position as the option for *universal quantum holism*: quantum theory including the superposition principle and the Schrödinger dynamics (or a relativistic generalization of this dynamics) has universal application in the physical realm. The physical world is a huge quantum system whose internal structure consists in ubiquitous entanglement. The claim thus is that biological systems, macroscopic instruments, and common-sense objects (such as trees, tables, and cats), have in fact states that are entangled with the states of many other systems. This claim has the following implication: theories of higher level systems, such as theories of chemistry, biology, physiology, etc., as well as common sense do not describe things as they are objectively, since nothing like entanglement is acknowledged in these theories.

The point is not simply that, according to the option for universal quantum holism, macroscopic systems admit of much more states than those states which are taken into account by common sense or any theory of chemistry, biology, physiology, etc. The point is that, according to universal quantum holism, macroscopic systems almost always objectively are in states like Schrödinger's cat, which are nothing like the states that common sense and our scientific theories of macroscopic systems ascribe to them. These theories and common sense contain an ontological commitment which says that these systems always have definite numerical values for all their properties (even if many of our common-sense predicates in particular are vague). [29] By contrast, if one regards quantum holism as universal, one is committed to an ontology according to which the systems in question cannot have a definite numerical value for all their properties at once and usually do not even have a definite numerical value for a significant sample of them (since the only state description that applies to them is a description in terms of an improper mixture). If one subscribes to universal quantum holism, one can take the higher level theories including common sense as correctly describing the way in which macroscopic systems appear to observers. But the point is: one cannot both endorse the option for universal quantum holism and accept the ontological commitments of higher level theories including common sense.

Given this consequence of the option for universal quantum holism, the task is to square the ensuing view of physical reality with our experience of a level of the world that can be described in terms of classical physics and common sense. That is why the option for universal quantum holism calls the philosophy of mind into play. Two main strategies to meet this task can be distinguished in the literature:

- *Abstraction from entanglement by the observer*: In making perceptual experiences, the observer abstracts from entanglement which is objectively there. As a result of this abstraction, the world appears to the observer as described by common sense and classical physics. According to one version of this option, only a subset of properties (observables) of physical systems is accessible to the observer. This limited accessibility is the reason that physical systems appear to the observer as described by common sense and classical physics (see, for instance, Landsman, 1995). According to another version of this option, the observer cannot but introduce a cut between herself and the objects of her experience. By means of this cut, she puts aside entanglement that is objectively there. As a result of such a cut, physical objects appear to the observer as described by common sense and classical physics (see in particular Primas, 1993).
- *Many minds of the observer*: Entanglement touches in a sense even the mind of the observer. In fact, each observer has many or even infinitely many minds in the sense of many incompatible, but non-interfering experiences at once. Each term in a superposition is correlated with at least one mind of the observer. In a measurement which has several possible outcomes, for instance, all the possible outcomes objectively remain in superposition; but each of these outcomes is experienced by at least one mind of the observer. Thus, as far as each mind or experience of an observer is concerned, the world appears classical. The main proponents of this approach are Albert and Loewer (1988), Lockwood (1989), chapters 12–13, and (1996) as well as Donald (1997).

The many minds interpretation proposes an astonishing consequence for the philosophy of mind to say the least: we are expected to admit many minds of each person solely on the basis of arguments from the formalism of quantum physics. However, I do not intend to focus on this thesis, because it is peculiar to the many minds interpretation. Instead, I shall focus on the implications for the philosophy of mind which are common to all those interpretations that commit themselves to universal quantum holism.

Note that in all these approaches the observer has to be a literal observer, i.e., a being who has perceptual beliefs about her environment. As long as quantum holism [30] is taken to be universal, the observer cannot be replaced with a machine that simply processes information. Such a machine cannot be a classical system, unless one introduces a level of systems which are not affected by entanglement. The state of such a machine is objectively entangled with the states of many other systems. Whatever information processing such a machine does, this simply leads to further entanglement. Therefore, a classical level of the world can only be the way in which the world appears to a literal observer.

IV: Universal Quantum Holism and Cartesian Epistemology

When a question arises in the interpretation of a physical theory which cannot be settled by referring to the state of the art of physics, it is reasonable to take broader philosophical considerations into account. In particular, as regards the option for universal quantum holism, if a physical theory is construed in such a way that it has direct implications for the philosophy of mind, it is not only appropriate from a methodological point of view, but even a methodological requirement to judge these implications in the light of arguments that originate in the philosophy of mind. Therefore, I intend to examine in this section the connection between the option for universal quantum holism and the philosophy of mind.

There is a discussion in today's philosophy of mind which centres on Cartesian epistemology and its revision. We have to go into this discussion in order to evaluate the implications which the option for universal quantum holism has for the philosophy of mind. The point of this discussion is not Descartes' ontological dualism of corporeal and mental substance. The point is an epistemology that dominates modern thought from Descartes on down to logical positivism. The central feature of this epistemology can be described as the thesis of *epistemic self-sufficiency of intentional states.* Intentional states are states such as perceiving that something is the case, believing that something is the case, willing that something becomes the case, etc. These states have a content. Intentional states are epistemically self-sufficient if and only if their content is independent of the world in the following sense: the content of our intentional states could be the same if the physical world were totally different from the way it actually is or even if there were no physical world at all. Epistemic self-sufficiency of intentional states thus says that the content of our intentional states is self-contained. We can distinguish two theses within this position:

- *Representationalism*: the content of intentional states consists in mental representations (such as ideas in Descartes and Locke, or sense data in some positivists). A person has epistemic access to the world only by means of mental representations. Mental representations hence act as an epistemic intermediary between the intentional states of a person and the world. Some advocates of representationalism go as far as saying that mental representations are themselves the immediate object of our thinking including our perceiving. Thus, if a person claims to see a tree, what she is directly aware of is in fact a mental representation of a tree; seeing a tree is to be explained as inferring on the basis of being aware of a representation of a tree that there is a tree in the physical environment. It is immaterial to the issue of representationalism whether representations are conceived as irreducibly mental entities or whether they are taken to be identical with neurophysiological entities.
- [31] *Internalism*: the individuation of intentional states and thus their identity depends only on factors that are immanent to the person which has these states. One possibility is to say that each intentional state has its content intrinsically, that is, independent of the other intentional states of the person in question. Another possibility is to say that the content of each intentional state depends on its relations to other intentional states of the person in question.

One can regard these features of the Cartesian tradition in epistemology as being connected with the above-mentioned features of the Cartesian tradition in the philosophy of nature in the following way: the former features can be seen as an attempt to develop a psychology which follows the pattern of explanation in the natural sciences as conceived on the basis of classical physics (compare McDowell, 1986, pp. 152–55).

Anti-Cartesianism or the revision of Cartesianism in today's philosophy of mind consists in replacing these two theses with direct realism and externalism. *Direct realism* is the following claim: causal intermediaries between things in the world and perceptual beliefs notwithstanding, there are no mental representations which act as an epistemic intermediary between our perceptual beliefs and things in the world. When it comes to our epistemic access to the world, we are directly aware of things and events in the physical world. We thus directly perceive physical things such as trees. This direct realism accords with common sense realism. McDowell (1994), in particular lecture 1, is a prominent advocate of direct realism. *Externalism* is the following thesis: it is necessary to be embedded in a physical and a social environment for having intentional states. The individuation of intentional states and their identity depends on the qualitative character of the physical environment in which the subject of these states lives. The content of our intentional states thus is not self-contained.

A broad and differentiated debate about externalism with respect to the physical environment developed in the last two decades (for a helpful introduction, see McCulloch, 1995). Two main types of claims can be distinguished:

a) *Singular beliefs*: Having singular beliefs about particular things in the world depends on the existence of these things. For instance, one can be in the state of believing that there is a fat man over there only if there actually is a man over there (see, e.g., Evans, 1982, in particular chapters 6 and 9).
b) *General beliefs*: The content of general beliefs and general concepts depends on the physical constitution of the things referred to. The main argument goes back to a famous thought experiment of Hilary Putnam (1975): independently of whether or not someone knows that water is H_2O, it is part of the content of her beliefs about water that water is H_2O. On the imaginary twin earth, there is a stuff that is indistinguishable from water on the surface, but XYZ. The content of all beliefs about that stuff is different from the content of all beliefs about water.

This revision of Cartesianism along the lines of direct realism and externalism is sometimes linked with a holism. Such a link is particularly evident in the work of Davidson (e.g. Davidson, 1995). However, I cannot examine here whether what is meant by holism in the philosophy of mind and what is known as holism in quantum physics has a common conceptual content (but see Esfeld, 1998).

These developments in contemporary philosophy of mind are as yet not taken into account when claims about the observer and her mind or consciousness are made in [32] the interpretation of quantum theory. To my knowledge, the only exception is Lockwood (1989), who argues against central features of the current, Anti-Cartesian stream in epistemology (in particular chapters 9 and 16). However, these developments in today's philosophy of mind are pertinent to the interpretation of quantum theory as I shall argue now.

What is the consequence of the option for universal quantum holism as regards our epistemic access to the world? Albert and Loewer (1988), in their many minds interpretation, concede the following consequence: almost all our beliefs about perceptible objects are false (p. 209; see also Albert (1992), pp. 127, 132–33). The option for universal quantum holism has this consequence, because it implies that things do not objectively have the definite properties which we ascribe to them in our perceptual beliefs; their objective states are nothing like the manner in which we conceive them in our perceptual beliefs. Despite this consequence, some philosophers who subscribe to universal quantum holism accommodate *externalism*. Thus, Lockwood (1989) endorses externalism with respect to singular perceptual beliefs as well as general beliefs (pp. 144–45, 310–11). Albert and Loewer (1988) can be seen as intending to make room for externalism: they leave open whether intentional states are correlated merely with states of the brain or with states of the brain plus the environment (pp. 206, 211); the possibility of externalism as a result of this move is hinted at in Butterfield (1995), p. 146.

However, one may wonder whether externalism really fits into a philosophy that takes quantum holism to be universal in the physical realm. What about externalism with respect to singular beliefs? Is the man over there fat? My belief that the man over there is fat is false anyway, because, in fact, the man is in a superposition of, say, being fat and being thin. What is more, his position is not limited to the position indicated by ‘over there’, say, a position in the doorway; rather it is a superposition of being over there in the doorway with, e.g., being in the cellar and many other positions that moreover involve the states of other things including other men. Accordingly, in the region indicated by ‘over there’, there is not one man; instead, a superposition of many things that include, among others, several men extends to this region. Given that as a consequence of a view which considers quantum holism to be universal every object – including common-sense objects – has a state which is entangled with the states of many other objects, what can it mean to say that having a singular belief depends on the existence of the object referred to?

One can of course say that for every singular belief of an observer there is a decomposition of the state description of the universe according to which the object of the belief of the observer exists. That is to say in terms of the notion of a relative state which Everett (1957) introduced: relative to the state of the observer believing that there is a fat man over there, there is a state of the environment in which there is a fat man over there. This consideration is crucial when it comes to explaining how it appears to the observer that there is a fat man over there. However, this consideration is not sufficient to accommodate externalism: the relative state is nothing but a component of an improper mixture. It establishes simply a correlation between the components of the state of mind of the observer (assuming that her state of mind is to be described as an improper mixture) and the components of the state of the physical environment. But this correlation is nothing like giving priority to the physical environment in the sense that the definiteness of the environment contributes to making [33] belief states have a definite content by contributing to individuate the belief states of the observer. This conception therefore does not capture the point of externalism with respect to singular beliefs.

An analogous objection applies to the attempt to combine externalism as regards general beliefs with universal quantum holism. Coming back to the argument of Putnam, assume, as Putnam (1975, p. 223) does when he introduces his thought experiment, that earth and twin-earth coexist in the same universe. In this case, we have to presume that the state of the earth is entangled with the state of the twin-earth. Consequently, water is entangled with twater. Thus, in fact, there is a superposition of H_2O and XYZ. Taking this superposition into account, how can the content of beliefs about the liquid in question depend on being causally related to either H_2O or XYZ? Again, by means of the notion of a relative state, one can establish a correlation between components of the state of mind of the observer and components of the state of the environment. However, again, this correlation is nothing like the environment individuating the beliefs of the observer.

Considering these objections I submit that the outlined externalism in the philosophy of mind is incompatible with the option for universal quantum holism: if one regards quantum holism as universal in the physical realm, one cannot take the individuation and the identity of perceptual beliefs to be dependent on the constitution of the physical environment. *As a result of universal entanglement the physical environment of an observer does not objectively have that definiteness which is a prerequisite for it being able to contribute to the individuation of the observer's intentional states* (since it has to be described in terms of an improper mixture). Hence, the point is not simply that universal quantum holism commits us to regarding more or less all our common sense beliefs as false. There are other metaphysical positions which can be taken to have a similar consequence. For instance, based on relativity physics, one can claim that there are only occurents which have both spatial and temporal parts, but no ordinary things (continuants). However, in this case one sets out to reconstruct the definite properties which we attribute to things in common sense as objective, as definite properties of events or of space–time points. The point is that in the case of universal quantum holism, there is no such reconstruction available.

A similar argument applies to *direct realism*: the option for universal quantum holism cannot go with direct realism as regards the objects of our perceptual beliefs. According to this option, the features which we ascribe to physical things in our perceptual beliefs are relative to the way in which we observe these things by abstracting from entanglement that is objectively there. If one endorses universal quantum holism, one is committed to the position that the objects of our perceptual beliefs—such as cats being always either alive or dead, etc.—are dependent on the conditions of our observation of them, i.e., the abstraction from entanglement. Thus, starting from the option for universal quantum holism, Lehner (1997), in particular pp. 208–13, for instance, sets out an elaborate argument in favour of giving up an observer-independent notion of perceptible reality (see also Landsman (1995)). Lockwood (1989), chapters 9–13, 16, goes as far as endorsing a fully-fledged representationalism: mental representations are the immediate object of our perceptual beliefs; the assumption that there is a physical world is an inference to the best explanation of our representations.

[34] The option for universal quantum holism indeed implies a commitment to representationalism at least in the following sense: there is an epistemic intermediary between our beliefs and the world, namely the appearance of a classical level of the world to observers in perception. The content of our perceptual beliefs consists in this appearance. It is only this representation of physical things relative to an observer that exhibits the features which we take to be characteristic of perceptible things in common sense. In whatever way this relationship of representation is spelled out in detail depending on which option one chooses to square universal quantum holism with our experience, it is, however, nothing like representing physical things as they are in themselves. The commitment to representationalism arises in the case of the option for universal quantum holism just because of the gap between on the one hand the physical world as it is according to this option and on the other hand the properties which we ascribe to physical objects in our perceptual beliefs. Note that interpreting quantum theory in terms of a universal quantum holism contradicts only

a direct realism with respect to perceptible objects including common-sense realism. Nonetheless, this interpretation is a form of scientific realism.

What does this comparison of universal quantum holism with the debate about Cartesianism and its revision in today's philosophy of mind show? If one assumes in the interpretation of quantum theory that all that has to be accounted for is the appearance of a classical level of the world to observers, then one tacitly presupposes a Cartesian philosophy of mind in the sense of what I have described as the epistemic self-sufficiency of intentional states. However, since Cartesianism is called into question in today's philosophy of mind, representationalism cannot be considered to go without saying. As one cannot take traditional assumptions about physics for granted in today's philosophy of mind, so one cannot take a traditional philosophy of mind for granted when it comes to the philosophical significance of quantum theory. *The discussion on Cartesianism and Anti-Cartesianism in current philosophy of mind thus is relevant to the interpretation of quantum physics: taking this discussion into account sharpens up the task for the interpretation of quantum theory*.

We hence face two philosophical packages, so to speak, both of which include the interpretation of quantum physics and the philosophy of mind:

1) On the one hand, one can opt for universal quantum holism in the physical realm. In this case one cannot simply seek to square the ensuing view of physical reality with the appearance of a classical level of the world to observers. One has to take sides in the debate about direct realism and externalism versus representationalism and internalism. One has to counter the arguments against epistemic self-sufficiency of intentional states in contemporary philosophy of mind.
2) On the other hand, if one approves of the arguments for direct realism and externalism, one cannot commit oneself to universal quantum holism in the interpretation of quantum theory. If one countenances these arguments, there is no need to play off common-sense realism against scientific realism. One can endorse scientific realism; but one has to regard the holism which quantum physics exhibits as being limited to more or less the microphysical realm.

These two packages are not exhaustive. For instance, one can conceive quantum holism as being limited to microphysics and favour representationalism when it [35] comes to the philosophy of mind. The point is: *One cannot approve of the revision of Cartesianism in the philosophy of mind and construe quantum holism as concerning the whole physical realm*.

One may raise the following objection against this assessment: if the position that quantum holism is universal in the physical realm is embedded in a philosophy which applies Bohr's notion of complementarity to the relationship between mind and matter (compare the hint in Bohr (1934), p. 24), then a comprehensive holism seems in prospect, namely a holism that includes both the physical and the mental. Such a comprehensive holism is advertised as an attractive replacement for the Cartesian tradition in both the philosophy of nature and the philosophy of mind. Accordingly, universal quantum holism in the physical realm is only one aspect of a holism that concerns the whole of being. For instance, d'Espagnat (1991), chapters 9–10, maintains on the basis of quantum holism that the physical and the mental are two complementary aspects of a holistic reality (see also Kafatos and Nadeau, 1990, in particular chapter 8; Primas, 1993).

As Jonas (1980) has shown, if one regards the mental and the physical as two complementary aspects of being, one is committed to an ontology of psycho-physical parallelism (such as the one which Spinoza developed in his *Ethics*). The proposal of complementarity rules out the positions that the mental is identical with the physical or that the mental supervenes on the physical (without the physical supervening on the mental).[2] This proposal furthermore excludes any account according to which there is interaction between the mental and the physical, because there can be no relation of causation between complementary items. The replacement for interaction which this proposal contains is parallelism in the following sense: the mental and the physical are two aspects of being which are correlated in such a way that they correspond to one another without there being causal relations between them.

Psycho-physical parallelism, however, is a culmination of the Cartesian programme of epistemic self-sufficiency of intentional states: parallelism implies that it is possible to describe and explain every mental state including belief states by referring only to other mental states. Since there is no interaction between physical and mental states, every mental state is solely caused by other mental states. When it comes to accounting for mental states, it is therefore in principle sufficient to refer only to other mental states. This implication is of course a central weakness of psycho-physical parallelism: there is no prospect of a self-contained psychology and epistemology which can do without referring to physical things and events. Physics, by contrast, is self-contained: explanations in physics do not need to have recourse to mental states.

The programme which envisages a comprehensive holism by considering the physical and the mental as complementary aspects of being does hence not constitute an objection against my thesis that endorsing universal quantum holism in the physical realm clashes with the revision of the Cartesian tradition in the philosophy of mind. This programme can give a concrete shape to holism in the philosophy of physics by relying on universal quantum holism. But it fails to give a concrete shape to holism in the philosophy of mind. By conceiving quantum holism in such a way that this holism touches the whole physical realm, this programme is committed to a [36] Cartesian epistemology. Contrary to what is intended, this programme thus in fact implies that there is a gap between the mental and the physical.

V: A Plea For Caution

The scope of quantum holism is a question that cannot be settled by referring to the state of the art of physics. This question enables us to build a bridge between the interpretation of quantum physics and the philosophy of mind. However, as the argument in the last section shows, this bridge does not consist in a simple extension of the notions of quantum physics—and quantum holism in particular—to the philosophy of mind in order to reach a solution to the riddle of consciousness. This bridge consists rather in the fact that paying heed to considerations from today's philosophy of mind (a) sharpens up the task for the interpretation of quantum physics and (b) shows that we face at least two packages so to speak each of which includes both the interpretation of quantum physics and the philosophy of mind.

2 On supervenience in the philosophy of mind, see Kim (1993).

Considering the two packages which I pointed out in the last section, I submit that taking the discussion on Cartesianism and its revision in today's philosophy of mind into account makes out a strong case in favour of the option for limited quantum holism in the interpretation of quantum physics: the mere fact that the option for universal quantum holism commits us to a position in the philosophy of mind which can no longer be considered to go without saying is a weighty argument against this option and supports the option for limited quantum holism. The moral of this paper thus is a plea for caution: if we wish to keep an open mind as regards the debate about Cartesianism and its revision in current epistemology, we should not commit ourselves to an interpretation of quantum physics which takes quantum holism to reach beyond the microphysical realm. To conclude this paper, let me propose three theses:

1) The arguments for a revision of Cartesianism in today's philosophy of mind along the lines of direct realism and externalism are a weighty reason against taking quantum holism to be universal in the physical realm.
2) The clash between taking quantum holism to be universal and pursuing the project of a revision of Cartesianism in the philosophy of mind is a decisive blow to all those who claim in popular literature that quantum theory gives rise not only to a new physics, but also to a new philosophy of mind that amounts to holism and that breaks with the Cartesian tradition in modern thought.
3) Paradoxically enough, if we favour a revision of the Cartesian tradition in both the philosophy of nature and the philosophy of mind, we must not seek direct implications of quantum theory for our view of nature beyond our conception of the microphysical level. Considering quantum holism as being limited to more or less the microphysical level is a prerequisite for an overall revision of the Cartesian tradition in modern thought.

References

Albert, David Z. (1992), *Quantum Mechanics and Experience* (Cambridge, Mass.: Harvard University Press).

Albert, David Z. & Loewer, Barry (1988), "Interpreting the Many Worlds Interpretation", *Synthese*, **77**, pp. 195–213.

[37] Aspect, Alain, Dalibard, Jean & Roger, Gérard (1982), "Experimental Test of Bell's Inequalities Using Time-Varying Analyzers", *Physical Review Letters*, **49**, pp. 1804–07.

Bell, John S. (1964), "On the Einstein–Podolsky–Rosen-Paradox", *Physics*, **1**, pp. 195–200.

Bohm, David (1951), *Quantum Theory* (Englewood Cliffs: Prentice-Hall).

Bohr, Niels (1934), *Atomic Theory and the Description of Nature* (Cambridge: Cambridge University Press).

Busch, Paul, Lahti, Pekka J. & Mittelstaedt, Peter (1996), *The Quantum Theory of Measurement* (Berlin: Springer). Second edition. First edition 1991.

Butterfield, Jeremy N. (1995), "Quantum Theory and the Mind. Worlds, Minds and Quanta", *Proceedings of the Aristotelian Society. Supplementary Volume*, **59**, pp. 113–58.

d'Espagnat, Bernard (1971), *Conceptual Foundations of Quantum Mechanics* (Menlo Park: Benjamin).

d'Espagnat, Bernard (1991), *A la recherche du réel* (Paris: Gauthier-Villars). Third edition.

Davidson, Donald (1995), "The Problem of Objectivity", *Tijdschrift voor Filosofie*, **57**, pp. 203–20.

Descartes, René (1644), *Principles of Philosophy*, English translation in Cottingham, John, Stoothoff, Robert & Murdoch, Dugald (1984–1991), *The Philosophical Writings of Descartes. 3 Volumes*. Cambridge: Cambridge University Press.

Donald, Matthew J. (1997), "On Many-Minds Interpretations of Quantum Theory", *Preprint quant-ph/9703008 Nov. 97.*

Eccles, John C. (1994), *How the Self Controls Its Brain* (Berlin: Springer).

Einstein, Albert (1948), "Quanten–Mechanik und Wirklichkeit", *Dialectica*, **2**, pp. 320–24.

Einstein, Albert, Podolsky, Boris & Rosen, Nathan (1935), "Can Quantum-Mechanical Description of Physical Reality be Considered Complete?", *Physical Review*, **47**, pp. 777–80.

Esfeld, Michael (1998), "Holism and Analytic Philosophy", *Mind*, **107**, pp. 365–80.

Esfeld, Michael (forthcoming), "Holism in Cartesianism and in Today's Philosophy of Physics", forthcoming in *Journal for General Philosophy of Science*, **30** (1999), pp. 17–36.

Evans, Gareth (1982), *The Varities of Reference. Ed. John McDowell* (Oxford: Clarendon Press).

Everett, Hugh (1957), "'Relative State' Formulation of Quantum Mechanics", *Reviews of Modern Physics*, **29**, pp. 454–62. Reprinted in B. S. DeWitt & N. Graham (eds.), The many-worlds interpretation of quantum mechanics (Princeton: Princeton University Press 1973), pp. 141–49.

French, Steven & Redhead, Michael L. G. (1988), "Quantum Physics and the Identity of Indiscernibles", *British Journal for the Philosophy of Science*, **39**, pp. 233–46.

Ghiradi, Giancarlo, Rimini, Alberto & Weber, Tullio (1986), "Unified Dynamics for Microscopic and Macroscopic Systems", *Physical Review*, **D34**, pp. 470–91.

Ghiradi, Giancarlo, Grassi, Renata & Pearle, Philip (1991), "Relativistic Dynamical Reduction Models and Nonlocality", in: P. J. Lahti & P. Mittelstaedt (eds.), *Symposium on the Foundations of Modern Physics 1990. Quantum Theory of Measurement and Related Philosophical Problems* (Singapore: World Scientific), pp. 109–23.

Giulini, Domenico, Joos, Erich, Kiefer, Claus, Kupsch, Joachim, Stamatescu, Ion-Olimpiu & Zeh, H. Dieter (1996), *Decoherence and the Appearance of a Classical World in Quantum Theory* (Berlin: Springer).

Healey, Richard A. (1991), "Holism and Nonseparability", *Journal of Philosophy*, **88**, pp. 393–421.

Howard, Don (1989), "Holism, Separability, and the Metaphysical Implications of the Bell Experiments", in: J. T. Cushing & E. McMullin (eds.), *Philosophical Consequences of Quantum Theory. Reflections on Bell's Theorem* (Notre Dame: University of Notre Dame Press), pp. 224–53.

Jonas, Hans (1980), "Parallelism and Complementarity: The Psycho-Physical Problem in Spinoza and in the Succession of Niels Bohr", in: R. Kennington (ed.), *The Philosophy of Baruch Spinoza* (Washington: The Catholic University of America Press), pp. 121–30.

Kafatos, Menas & Nadeau, Robert (1990), *The Conscious Universe. Part and Whole in Modern Physical Theory* (New York: Springer).

Kim, Jaegwon (1993), *Supervenience and Mind: Selected Philosophical Essays* (Cambridge: Cambridge University Press).

Landsman, Nicholas P. (1995), "Observation and Superselection in Quantum Mechanics", *Studies in the History and Philosophy of Modern Physics*, **26B**, pp. 45–73.

Lehner, Christoph (1997), "What it feels like to be in a Superposition and Why", *Synthese*, **110**, pp. 191–216.

[38] Lockwood, Michael (1989), *Mind, Brain and the Quantum. The Compound 'I'* (Oxford: Blackwell).

Lockwood, Michael (1996), "'Many-Minds' Interpretations of Quantum Mechanics", *British Journal for the Philosophy of Science*, **47**, pp. 159–88.

McCulloch, Gregory (1995), *The Mind and its World* (London: Routledge).

McDowell, John (1994), *Mind and World* (Cambridge, Mass.: Harvard University Press).

McDowell, John (1986), "Singular Thought and the Extent of Inner Space", in: P. Pettit & J. McDowell (eds.), *Subject, Thought, and Context* (Oxford: Oxford University Press), pp. 137–68.

Mittelstaedt, Peter (1998), *The Interpretation of Quantum Mechanics and the Measurement Process* (Cambridge: Cambridge University Press).

Penrose, Roger (1994), *Shadows of the Mind* (Oxford: Oxford University Press).

Primas, Hans (1993), "The Cartesian Cut, the Heisenberg Cut, and Disentangled Observers", in: K. V. Laurikainen & C. Montonen (eds.), *Symposium on the Foundations of Modern Physics 1992. The Copenhagen Interpretation and Wolfgang Pauli* (Singapore: World Scientific), pp. 245–69.

Putnam, Hilary (1975), “The Meaning of ‘Meaning’”, in: H. Putnam (ed.), *Mind, Language and Reality. Philosophical Papers Volume 2* (Cambridge: Cambridge University Press), pp. 215–71.

Scheibe, Erhard (1991), “Substances, Physical Systems, and Quantum Mechanics”, in: G. Schurz & G. J. W. Dorn (eds.), *Advances in Scientific Philosophy. Essays in Honour of Paul Weingartner* (Amsterdam: Rodopi), pp. 215–29.

Schrödinger, Erwin (1935a), “Discussion of Probability Relations between Separated Systems”, *Proceedings of the Cambridge Philosophical Society*, **31**, pp. 555–63.

Schrödinger, Erwin (1935b), “Die gegenwärtige Situation in der Quantenmechanik”, *Naturwissenschaften*, **23**, pp. 807–12, 823–28, 844–49.

Teller, Paul (1986), “Relational Holism and Quantum Mechanics”, *British Journal for the Philosophy of Science*, **37**, pp. 71–81.

von Neumann, Johann (1932), *Mathematische Grundlagen der Quantenmechanik* (Berlin: Springer) (English translation Princeton University Press 1955).