Quantum Mechanics and Intentionality

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Two mysteries – loosely connected?

The Authors who have suggested a deep connection between the solution of the mind-body problem and the understanding of quantum mechanics are too numerous to list. But what exactly would be the alleged structural fit between these two deeply puzzling theoretical issues? Can a genuine philosophical issue - which by its very nature is conceptual in nature - ultimately be resolved by advances in the empirical sciences? The connection is all too often asserted to lie in the subjects confounding natures, but the mere fact that two problems are of equal impenetrability to the human mind does not imply that there is a profound interdependence between the two. There is however an obvious way in which quantum mechanics might have a bearing on the philosophical mind-body problem: if quantum mechanics implies that for some physical events there is no physical cause, then at least the very strong variants of the so-called "principle of causal closure" of the physical realm lose much of their corroborative underpinning in physics as practiced by real physicists as such, and are thus constrained to the speculative physicalism advanced by metaphysicians. However, unless one assumes a strong version of the principle of sufficient reason, which would exclude chance events in principle, even events supposedly not caused by some physical cause are not immediately thereby caused by some *non*-physical cause. Moreover the fact is that not all of the interpretations of quantum mechanics imply indeterministic 'choices' of events: neither the many-worlds interpretation nor a Bohmian hidden variable interpretation assume indeterminism. Even in the most obvious theoretical nexus

between quantum mechanics and philosophy of mind, the theoretical gain is much smaller than initially thought. Our understanding of the ontology at a microphysical level is indeed so limited that just about any position in the philosophy of mind can be construed in such a way that it is in agreement with quantum mechanics, at least in one of its possible understandings. There is, however, one philosophical concept that has quite significant bearing on quite a number (but not all) interpretations of quantum mechanics. It is the concept of intentionality. In this paper it will be argued that the concept of intentionality is the most promising theoretical bridge between the interpretation of quantum mechanics and the philosophy of mind. How quantum mechanics is connected to consciousness is in the end dependent on how we think that consciousness is related to intentionality.

The seemingly incoherent world of quantum mechanics

The common understanding of the problem surrounding quantum mechanics is one of interference: the investigated phenomena are so small that it becomes unavoidable to not change their properties during measurement. The observer is never a passively reporting entity, but always a reality-changing interfering entity. The real problem of quantum mechanics is also not yet fully captured by stating that particles behave like waves when unobserved. While this is true in a very general way, it does not yet encompass the full gravity of the problem that the very nature of the object before measurement is such that we cannot comprehend it. The objects of quantum mechanics do not have the same identity criteria as classical concrete entities. For example, if we have two boxes and two classical objects A and B, the state whereby A is in the left box and B is in the right box is distinct from the state whereby the two objects are switched such that B is in the left box and A is in the right box. In quantum mechanics these supposedly different states are indistinguishable. When not measured, quantum objects are in a strange state that is yet to be fully understood. It is called 'superposition', and dynamics of these states can be

calculated with the robust and well-established 'Schrödinger equation', but understanding what it means to be in this state has proved elusive to such an extent that it might be due to a limitation of human understanding, i.e. a Kantian boundary of reason, as the behavior of particles in this state seems to defy the laws of logic. In a variation of the famous two-slit experiment, it can be shown that particles capable of traveling through exactly two possible pathways in an experimental setup follow neither the first, second, both paths, or no path, yet these are the only possibilities allowed for in classical thinking. That the particles do not take both paths can be shown by interrupting the experiment, which leads to the discovery of the particle in one of the two pathways, but that the particles do not travel through one path only, can be shown by blocking one of the two pathways. This in effect changes the statistical distribution of properties of the particles leaving the apparatus, compared to the original case where both pathways were open. That the particles do not travel via some other route can be demonstrated by blocking both pathways, which results in no particles leaving the apparatus whatsoever.

A detailed description of this experiment was published by David Albert (Albert 1994), but the technical details are at this point not necessary to comprehend the predicament. Some have suggested that we need to revise the laws of logic to make room for the behavior of quantum particles, but even that would not help us in understanding what is going on in this case, as there are other features of quantum behavior that defy human understanding such as non-locality. Particles entangled in a superposition behave somehow as if they were only one thing. Measuring one entangled particle has immediate effects on far removed particles with which it is entangled without any time delay, despite massive distances in between them. While this behavior is certainly not excluded by standard logic, it seems to be inconsistent with the intuition that the world is made up from distinct particulars. The problem with quantum mechanics is thus not simply the interference of the observer with the observed objects but that the very nature of the quantum realm seems bizarre and incomprehensible to us.

Three basic theoretical frameworks have been given to account for these difficulties in grasping the ontology of the quantum world. In order to investigate possible relations to the philosophy of mind, we first have to briefly delineate the logical map of these competing interpretations of quantum mechanics. One way of laying out this logical space is by constructing a trilemma. Here, of three possible claims only two can be mutually consistent, leading to three possible combinatorial solutions. The three claims are:

(I) The dynamics of the system is completely governed by the fundamental Schrödinger equation. There are no additional indeterministic processes.
(II) Our knowledge of the system is essentially complete. There are no hidden variables.
(III) A measurement yields a unique result at the expense of other nomologically possible results. There is no branching of the universe.

From a scientific point of view it is obvious why one would want all three claims to be true: a universe governed by a deterministic equation without random interference is certainly preferable for the sake of making predictions, the idea that we have not missed something of crucial importance is equally attractive, and that the outcome of a measurement is informative only if it happens as exclusive to other possible outcomes. Quantum mechanics forces us, however, to drop one of the three claims.
If (I) the Schrödinger equation is all there is and we have (II) not overlooked something important, then we do not get unique measurement results (not III). The many-worlds or many-minds interpretation bites this bullet and claims that all possible outcomes are realized, each relative to a world or a mind (not III). The standard interpretation of quantum mechanics, however, denies (I). In addition to the process described by the Schrödinger equation there is an indeterministic process by way of which one of the possibilities within the realm given by the

Schrödinger equation is selected. Thus the wave package collapses into one determinate result, what is often referred to as the 'collapse interpretation'. A negation of (II) introduces additional entities and mechanisms, the best-known case of which is arguably Bohm's interpretation of quantum mechanics (Goldstein 2013). There is no collapse in this theory and the wave function does not represent worlds or minds, but is considered to be something like a pilot wave that directs the movements of the particles via the "active information" contained in it.

Each of the three major interpretations offers a strikingly different ontology. Unless future advances in experimental design and theoretical understanding provide a clearer picture of the ontology of the quantum world, the situation will remain one in which philosophers of mind cherry-pick the interpretation that best fits their favorite ontology which is in fact the situation today. Unless it changes, the contribution of quantum mechanics in understanding the mind-body problem will remain limited. Empirical theories function as test cases for metaphysical theories. If the philosophical theory is in obvious disagreement with the empirical facts, it has to give way. But if the empirical facts are but a mathematical formalism which yields reliable predictions but whose ontological implications are completely up for grabs, then it cannot serve well as a something that limits and guides philosophical speculation. This is exactly the predicament in which we find ourselves when we try to establish connections between quantum mechanics and the mind-body problem in philosophy of mind.

The Mind-Body Problem

At first glance the mind-body problem seems to be a bundle of different but related problems in metaphysics. The question of the causal role of the mental in the physical world ('mental causation') and the closely connected question problem of free will are probably the most intuitive and widely known versions of the mind-body problem. Philosophically it seems that the fundamental issues underlying all other aspects of the mind-body problem are intentionality and

phenomenal consciousness. It must be said that these two concepts might be so closely connected that they are ultimately only two sides of one coin, but for the sake of conceptual clarity and to advance the thesis of this paper we must keep them separated. The argumentative thrust of this paper is, after all, that in some interpretations the concept of intentionality will take up a paramount role relevant to the understanding of quantum mechanics, and that consciousness will come into play via a relation to intentionality.

Intentionality needs to be understood as the 'aboutness' of mental content. When we think, we think *about* something, when we make a statement, it contains propositional content, *about* which which this statement is. The contemporary discussion of intentionality probably started with Franz Brentano (1838-1917) who stated that every mental phenomenon includes something as object within itself, i.e. in presentation something is presented while in judgment something is affirmed or denied. The deep philosophical question is how aboutness or intentionality could be possible in a physical world. It seems to be different from physical relations like causation because intentionality can be directed towards possible or non-existent states of affairs. It seems that the connection between the mind and what its represents cannot be captured in physical categories.

The other fundamental version of the mind-body problem is the puzzle how phenomenal experience can arise in a physical world. The so-called 'hard problem of consciousness' (David Chalmers) asks this central question: even when we have explained the performance of all the cognitive and behavioral functions, why is the performance of these functions accompanied by conscious experience? In other words: it seems conceivable that there are other possible worlds which contain creatures that behave just like us, process information just like us, interact with the environment just like us, but don't possess even the faintest internal 'light' of consciousness. They would be perfect humanoid robots or, as philosophers like to call them, 'metaphysical zombies'.

The question of how intentionality and phenomenal consciousness are related is complex and there is significant disagreement among philosophers on this issue. Are all intentional states conscious or at least potentially conscious? Are there intentional states that will never become conscious? For example, medical patients who experience blindsight seem to represent mental content without ever being consciously aware of their own intentional state. There is subliminal processing of symbols and informational content, which never reaches the threshold of conscious experience. Vast arrays of mental operations happen in a subconscious or unconscious realm, but they nevertheless are full of representational content. They thus can be classified as intentional states exhibiting "aboutness" in the relevant sense mentioned above . Relatedly, are all conscious states intentional states? There might be raw feelings that do not represent anything outside of themselves, that is they have no connection with anything outside of the mind itself. For example, in German one distinguishes the raw feeling of "Angst" (anxiety) from the directed feeling of "Furcht" (fear). Angst hast no intentional object while fear has such an object.

Even these few observations make it perfectly clear that the relationship between intentionality and phenomenal consciousness is open to interpretation. Any serious theoretical account of the mind-body problem has to take a stance on this issue of the interdependence of intentionality and phenomenal consciousness. The relevance of quantum mechanics to the mind-body problem is dependent on how one construes this relationship.

The relationship between intentionality and consciousness

Four accounts of this relationship can be distinguished (cf. Siewert 1998).

(1) *Consciousness derived - Intentionalizing consciousness:* Consciousness is explanatorily derived from intentionality. This strategy takes intentionality as basic and construes conscious states from intentional states.

(2) *Consciousness separable - Consciousness as non-intentional raw feeling:* Consciousness is separable from intentionality and cannot be derived from intentionality. Phenomenal states are conceived of with respect to their qualitative content (qualia) and raw feelings are void of intentional aboutness.

(3) *Consciousness inseparable - Phenomenal consciousness is sufficient but not necessary for intentionality:* Consciousness is not derived and inseparable from intentionality. Wherever there is consciousness there is intentionality but not vice versa.

(4) *Consciousness necessary. Strong modal tie between consciousness and intentionality:* Consciousness is not derived from, inseparable from, and essential to intentionality. All intentional states are conscious states.

It is only with these distinctions in mind that we can get a better view on how exactly quantum mechanics might be relevant to philosophy of mind. It seems unlikely and conceptually difficult that quantum mechanics is directly connected with phenomenal consciousness. This is so for broadly Cartesian reasons: it is hard to build a conceptual bridge between something mechanical and phenomenal qualia. Phenomenal content is defined by its intrinsic quality and not by being related to other entities. Intentionality is, however, a relational notion. The chances of being able to connect it somehow to the mechanical structure of the world, that is the causal network, seem higher from the outset. For this reason we will make a crucial decision at this point. We will first try to connect quantum mechanics to intentionality and only then ask the additional question how the gap to phenomenal consciousness might be bridged. The key insight that will be defended here is *that quantum mechanics might give us some help in understanding how intentionality is rooted in physical reality, because quantum mechanics suggests there is some form of representation and information processing built into the very fabric of the universe*. If that is the case, then account (1) and (4) seem to be the most promising for understanding consciousness as well,

while accounts (2) and (3) are less feasible. The reasons for this are obvious: in (2) consciousness is separable from intentionality and as such not representational but a 'raw feeling', whereby quantum mechanics cannot offer much insight into understanding consciousness. In (3) consciousness is sufficient but not necessary for intentionality and all conscious states are intentional, but only some intentional states are conscious, and consciousness can not be derived from intentionality. Here quantum mechanics does not help explain why some intentional states are conscious, and others are not. Account (1) is more promising: if quantum mechanics makes reference to intentionality at the fundamental level of the universe, then the emergence of higher levels of intentionality, and thus consciousness, is less problematic. It could be the case that conscious higher-order intentional states supervene on unconscious lower-level intentional states. A higher order theory of consciousness (HOT) could accommodate this idea. In this case physicalism might be true, if the supervenience relation is strong and intentionality can be construed as bona fide physical (causal?) relation. There are however other non-physicalist versions of (1).

In account (4), i.e. where there is a strong modal tie between consciousness and intentionality, there also seems to be a promising solution. Assuming that quantum mechanics shows that some form of intentionality (representation of informational content) is built into the very fabric of the physical universe, then, if by some form of mutual modal entailment all intentional states are conscious and quantum mechanics cannot be formulated without reference to intentionality, assertions of some kind of panpsychism or pan(proto)psychism might be true.

In short we get the following picture of the four accounts if we construe our interpretation of quantum mechanics in such a way that it locates some form of (proto)intentionality in nature.

(1) *Consciousness derived:* Grounding intentionality in the physical world is a reliable basis to understand the emergence of consciousness as a higher-level intentionality (HOT account of consciousness). Quantum mechanics might be helpful in explaining consciousness.

(2) *Consciousness separable*: Grounding intentionality in the physical world will not help in understanding consciousness if it is a distinct phenomenon, i.e. intrinsic, raw feeling without intentional content. Quantum mechanics is not in an explanatorily relevant sense connected to consciousness.

(3) *Consciousness inseparable*: Even though all phenomenal states are intentional states (inseparable), intentionality does not require consciousness. Neither is understanding intentionality sufficient for understanding consciousness, nor is grounding intentionality in the physical world helpful in understanding consciousness. Quantum mechanics is only accidentally and not in an explanatorily relevant sense connected to consciousness.

(4) *Consciousness necessary*: If consciousness is essential to all intentional states, it follows that: if intentionality is a fundamental feature of nature, then so is consciousness. Grounding intentionality in the physical world results in grounding consciousness in the physical world. Quantum mechanics is essentially connected to consciousness.

It is now time to put our working hypothesis to the test. To this end we will look at the three major interpretations of quantum mechanics as they appear given the denial of one of the three horns of the trilemma above.

Collapse theories and intentionality

Denying (I): It is not the case that the dynamics of the quantum system are completely governed by the fundamental Schrödinger equation. There are no additional indeterministic processes.

Various versions of collapse theories fall under this heading. They introduce an additional indeterministic process or event: the collapse of the wave function. The assumption of a collapse or reduction seems like a crude *ad hoc* assumption to "force ontology to kneel to prejudice" (Stapp 1989, 157). Indeed, the by now classic GRW version of the collapse theory (*G*hirardi, G.C., *R*imini, A., and *W*eber, T., 1985) is ultimately such a brute assumption: each elementary particle is subjected to random and spontaneous localization processes. And even though this can be perfectly described mathematically, there is the inexplicability of mere chance that renders this entire process a somewhat theoretically unsatisfying *ad hoc* construct. Since these spontaneous reductions are not conceptually connected to any mental activity, there is little theoretical gain to be made here for the philosophy of mind. Henry Stapp's version of a collapse theory is quite different (Stapp 2007). For him quantum reality, the superposition, collapses into classical reality if *probed for a specific information* (cf. Heisenberg's Uncertainty Principle). If a question is asked, for example if measured for a specific spin, the system provides specific information in return. From a philosophical perspective the crucial point here is that the measurement process as *asking for a specific information* may be seen as something implying intentionality. In that the quantum system is being represented as specific informational content, a meaningful question posed to the system can thus also be represented. Now, unless these expressions are mere metaphors and the real process is simply nothing other than a random collapse, there is some intentionality built into nature wherever these collapses occur. It is not ultimately relevant at what level of nature these probing actions happen; maybe they happen all the time even at the lowest level, or possibly they require some higher form of mentality. In any case they require something that goes beyond a classical mechanism: that nature answers a question posed to the system requires that a *decision* be made as to what the question will be According to Stapp, in the collapse a big smear of possibilities is being reduced, and this reduction increases knowledge: by becoming more

determinate and realizing possibilities, information is represented in the universe, which in turn can be used to realize new possibilities consistent with what already has happened and what is possible by the laws of nature in the future. The representation of information is thus the key idea in Stapp's theory; for Stapp quantum theory sees the physical world in terms of information. The billiard ball view of classical materialist atomism is replaced by the notion of a holistic and at least partly nonmaterial world consisting of an objective carrier of a growing collection of non-localized bits of information. Representation of information, however, is a form of aboutness, it implies some form of intentionality. The crucial philosophical question is whether such intentionality requires consciousness or experience. If we follow account (1) (consciousness derived from intentionality) then a vast quantity of intentional acts of representation will happen without consciousness, and only some very complex one will be accompanied by a moment of full phenomenal consciousness. Following Whitehead's process metaphysics, Stapp sees the world as dynamically related experiential events. But for Whitehead experience does not necessarily imply consciousness, that is to say that all conscious events are experiences but not all experiences are fully conscious. So, Stapp's view is in principle open to an interpretation in which some form of non-conscious intentionality (Whitehead calls it 'prehension') permeates the universe. Another interpretation might be that the representation of information in a collapse occurs only with respect to fully conscious observers. This would be more in line with account (4), where a strong modal tie between intentionality and consciousness is claimed. Where there is intentionality, there is consciousness. It is not crucially important here to decide this question of interpretation here. What is important is that our hypothesis is corroborated: it is via the notion of intentionality that quantum mechanics becomes relevant for the philosophy of mind.

Michael Epperson's account is another recent philosophical interpretation of quantum mechanics inspired by Whitehead (Epperson 2004). Epperson makes extensive use of the concept of "decoherence" and interprets it as negative selection. The concept of decoherence is more often

used by many-minds or many-worlds views. His theory is thus not a classical collapse account, but nevertheless not a many-minds or many-worlds interpretation. In the process of negative selection the coherent multiplicity of relations is reduced to a set of decoherent and mutually exclusive potential novel integrations. This process guarantees that the history of entities is mutually consistent, and the possible future paths of the universe are consistent with the actual past. At the end of this process, one particular path is chosen from those that are consistent with the actual past. Here Epperson does not take the route of the many-world or many-mind interpretations: only one outcome becomes actual. Thus we have a constant flow from actuality to potentiality to new actuality. But this process requires the *representation* of all possibilities, a calculation of those that are consistent with the past and the states of all other entangled entities. At each moment every physical event at the quantum level brings about its successor by calculating, evaluating and reducing possible future states given the past history of every other event with which it is connected by virtue of quantum entanglement. It is the probability valuation of the mutually exclusive states that governs the actualization of a unique outcome state (Epperson 2004, 102). It is not necessary to venture more deeply into Epperson's fascinating interpretation and how it relates to Whitehead's notion of 'concrescence'. The salient fact is obvious: at the quantum level not only actual events but also merely possible events and their logical relations are represented. Representation of mere potentialities is a paradigm case of intentionality. If representation is happening at the quantum level, then some kind of proto-mentality seems to be built into the very fabric of the universe. Whether consciousness is required for this kind of basic intentionality in the universe is again dependent upon the strategy one favors, that is whether one favors account (1) or account (4). Epperson does not mention consciousness at all; the representation and validation of yet unrealized possibilities seems to be happening without any form of consciousness involved.

Another form of the collapse theory was proposed by Penrose and Hameroff (Penrose, Hameroff 2011). It is an objective collapse theory inspired by quantum gravity theory, whereby the quantum state remains in superposition until the difference of space-time curvature reaches a threshold. This happens all the way down at the minute Planck level of the universe. Larger objects are thus inevitably in a classical state. The thesis of Penrose and Hameroff with regard to the mind-body problem is this: each objective collapse is *identical* with a moment of proto-conscious experience, and larger orchestrated reductions are identical with moments of consciousness. Here conscious experience is simply identical with the collapse of the wave function. This claim articulates a psycho-physical identity theory and in a way leaves no room for further philosophical questions. Identities are brute and rock-bottom and don't allow for "deeper" explanations. Consciousness is not derived from anything else; it is not a higher-level phenomenon. It is built into the Planck level of the universe. This theory certainly entails some kind of panpsychism. According to Penrose, conscious systems are capable of intentional representation in a such way that is not possible for an algorithmic computational system to replicate their representations. Consciousness and at least certain forms of intentionality are closely connected. It seems to be a case of account (4), because it posits a strong modal tie between consciousness and full intentionality. But that is not entirely clear. In order to be more helpful in resolving the mind-body problem the Penrose-Hameroff theory ought to move beyond the claim of brute identities and develop stronger conceptual ties between quantum mechanics and intentionality.

Hidden variable theories and intentionality

Denying (II): It is not the case, that our knowledge of the system is essentially complete. There are hidden variables.

Bohm's ontological interpretation of quantum mechanics (Bohm, Hiley 1993) is the best known example of a hidden variable theory, he in fact used the term in an early paper (Bohm 1952). In addition to the wave function of merely possible states it postulates a pilot wave that exists even when unobserved. At any moment there exists not only a wave function but also a well-defined configuration of the entire universe. The pilot wave guides the particles and informs it about the state of the entire system, ultimately the entire universe. So, for example, in a two-slit experiment, the particle, which passes through one slit, receives information from the pilot wave as to whether or not the other slit is open. Its trajectory is chosen in accordance with this information. Bohm called this kind of information 'active information' because the *content* of the information is what is truly causally relevant for the movement of the particle. Each particle has a rich inner structure that enables it to represent the information provided by the pilot wave and react to it (Bohm, Hiley, 37). "It is thus implied that in some sense a rudimentary mind-like quality is present even at the level of particle physics" (Bohm 1990, 283). An analogy would be a ship that is guided via a GPS-satellite. The information that is received by the ship is actively relevant for its movement. But it is not a physical force or field that is pushing the ship around. In fact, whether the signal comes in with certain signal strength x or a bigger signal strength x+1 makes no difference for the movements of the ship. It is the informational content as such that is causally relevant here, not the strength of the signal. In fact it can be causally strong, even if the signal is weak. This seems indeed like a primitive form of mental causation. Mental causation means that mental content qua content has causal efficacy.

If nature has – even at the quantum level – the capacity to represent mental content and act on the mental content as such, then there is a form of intentionality built into nature. If account (4) above is correct, then Bohm's theory implies a form of panpsychism in which some form of consciousness is ubiquitous in nature. If account (1) is correct, then there is some form of unconscious intentionality even at the very basic levels of nature. Fully developed consciousness

arises from the complex configuration of these basic forms of consciousness. In any case, that Bohm places intentionality into the heart of matter via his theory of active information corroborates the thesis that the concept of intentionality links quantum mechanics to the philosophy of mind.

Many-world and many-minds theories and intentionality

Denial of (III): It is not the case that a measurement yields a unique result at the expense of other nomologically possible results. There is branching of the universe. All results are realized.

The many-worlds and the many-minds interpretation of quantum mechanics stems from the denial of (III). There are no unique results of a measurement because all possible results are realized, with each being relative with respect to a world or to a mind. These theories deny in total the collapse of the wave function. The many-worlds interpretation implies that all possible histories are real, and each one of them represents a "world" or a universe (Everett 1956). The concept of 'decoherence' is used to single out observable classical worlds (ordering of the phase angles) in a quantum superposition. This forking of the world into ever more worlds can be understood without making any reference to minds. In the same way collapse theories can construe the collapse both with or without reference to minds, the many-world theorist need not invoke minds to explain the forking of the world. In this case there is no real connection between this interpretation of quantum mechanics and the philosophy of mind.

But one can also see the forking as a multiplicity of different subject-object states, wherein for each branch there is a mind observing it. As this isolated mind does not know about the other minds observing the other branches, it will be puzzled as to why exactly this particular result (the result this mind observed) occurred. The mind might speculate about a mysterious collapse of the wave function, but in fact there was no collapse. The process of decoherence realizes all possible future states relative to a mind. This many-minds interpretation is a variant of the many-world

interpretation and was first proposed by H.D. Zeh (Zeh 1970). Later David Albert and Barry Loewer developed an influential version of it (Albert, Loewer 1988). Zeh's original idea was quite straightforward, and his goal was to avoid distinct worlds in a decohering universe without necessitating collapses of the wave functions. His idea was that there is a psycho-physical parallelism between decoherent physical states and minds. The metaphysical nature of this parallelism can be spelled out in different ways. It could be that the minds supervene on the physical states, it could also be the case that – in a more interactionist-dualist fashion – the minds actively select the physical states they correspond to. In any case the theory postulates a vast number of minds. No minds are split, they existed all along, far more than the individual minds of human persons in the common sense world. In this many-minds interpretation it is obvious that decoherence exists only in relation to a mind which represents its environment from a certain point of view. Representation by a mind, however, entails some form of intentionality. Here again it is intentionality that connects this interpretation of quantum mechanics to the philosophy of mind. The role consciousness plays in this theory depends – as might be expected by now – on how we construe the relationship between intentionality and consciousness. If we follow account (1), then the minds of the many-minds theory need to be conscious. They do feature intentional, representational states, but these states might be in many cases not complex enough to be classified as conscious because phenomenal consciousness requires some form of higher-order meta-representation. If we follow account (4), then there is a strong modal tie between intentionality and consciousness, and in any of the many minds that represents a decoherent physical state there exists a phenomenal consciousness of some sort. In fact directly following from this, there will be a vast number of conscious minds in the universe, many more than our common sense view takes for granted.

Taking stock

We started out with the observation that the philosophical interpretation of quantum mechanics is far from being a closed issue. The many conflicting theories are, for the time being, consistent with the data and the mathematical calculations, and philosophers of mind tend to cherry-pick the interpretation of quantum mechanics that best fits their philosophical preconceptions. As a result, quantum mechanics cannot provide a compelling case for some possible solution to the mind problem at the expense of philosophical rival theories. In fact, some interpretations of quantum mechanics - like the GRW collapse theory and the many-worlds theory – do not seem to have substantial repercussions in philosophy of mind. Many other interpretations of quantum mechanics are, however, directly relevant for and connected to the philosophy of mind. I have argued above that it is the idea of represented mental content, the idea of aboutness or intentionality that plays the crucial role here. In each of the three main strategies of developing an ontology for the quantum realm there are well-established theories that make heavy use of the idea of mental representation or some (proto-)form of intentionality. The role consciousness plays in these theories is much less clear. I have argued that the nature and scope of consciousness in these theories is (partly) determined by how their proponents see the relationship between intentionality and consciousness: if consciousness is derived from intentionality it will play a less fundamental role and if there is a strong modal tie between intentionality and consciousness, then the phenomenal mind will be present wherever there is intentionality, if only in a simple form. In any case, it is primarily the concept of intentionality that connects many (but not all) interpretations of quantum mechanics to the philosophy of mind.

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ADDENDA

Summary "Quantum Mechanics and Intentionality"

The philosophical interpretation of quantum mechanics is far from being a closed issue. The many conflicting theories are, for the time being, consistent with the data and the mathematical calculations, and philosophers of mind tend to cherry-pick the interpretation of quantum mechanics that best fits their philosophical preconceptions. As a result, quantum mechanics cannot provide a compelling case for some possible solution to the mind problem at the expense of philosophical rival theories. In fact, some interpretations of quantum do not seem to have substantial repercussions in philosophy of mind. Many other interpretations of quantum mechanics are, however, directly relevant for and connected to the philosophy of mind. It is the idea of represented mental content, the idea of aboutness or intentionality that plays the crucial role here. The role consciousness plays in these theories is much less clear. The nature and scope of consciousness in these theories is determined by how their proponents see the relationship between intentionality and consciousness. In any case, it is primarily the concept of intentionality

that connects many (but not all) interpretations of quantum mechanics to the philosophy of mind.

List of names mentioned in Brüntrup: „Quantum Mechanics and Intentionality"

David Bohm

Erwin Schrödinger

Immanuel Kant

David Albert

Sheldon Goldstein

Franz Brentano

David Chalmers

Charles Siewert

Rene Descartes

Giancarlo Ghirardi

Tullio Weber

Alberto Rimini

Henry Stapp

Werner Heisenberg

Alfred North Whitehead

Michael Epperson

Roger Penrose

Stuart Hameroff

Max Planck

Basil Hiley

Hugh Everett

Barry Loewer

Heinz-Dieter Zeh

Jason Holt

Key words in Quantum Mechanics and Intentionality

principle of causal closure

hidden variable

intentionality

interference

measurement

non-locality

superposition

wave package

wave function

collapse

information

consciousness

panpsychism

supervenience

actuality

potentiality

pilot wave