A Neopragmatist Intervention in Science

"As the sciences have developed farther the notion has gained ground that most, perhaps all, of our laws are only approximations..... that no theory is absolutely a transcript of reality, but ... any of them may from some point of view be useful …" [as an instrument.....designed to achieve a purpose—to facilitate action or increase understanding].
(William James *Pragmatism*, 1907)[1]

1. Introduction

From its American source in the work of Charles Peirce and William James, the widening river of pragmatist thought has split into many channels, sometimes reuniting as well as further dividing. One channel led from Peirce to the English Cambridge of Frank Ramsey and Ludwig Wittgenstein, where its sediment fertilised what Huw Price has called Cambridge Pragmatism. Another branch of the river ran through John Dewey to Richard Rorty and then Robert Brandom. The term 'neopragmatism' has been applied recently to a stretch of each of these two streams of thought, despite the turbulence generated at their confluence.[2] I have found ideas borne along by the powerful emerging current most helpful in my own recent scientific as well as philosophical thinking.

With inchoate sympathy for neopragmatist ideas, I came to notice how often their specific applications helped me to make sense of possibly the most successful yet puzzling theory in all of science—quantum theory.[3] Perhaps this is not surprising. Both Peirce and James were scientists before they were philosophers, and Ramsey was also an original mathematician. They all knew that even quite clear scientific concepts remain plastic.

After saying what I mean by neopragmatism in §2 and by quantum theory in §3, I'll explain how, in my neopragmatist view, that theory functions differently from its predecessors in physics. The main difference is that quantum theory is applied through statements of probability. But §4 argues that in these statements probability functions in essentially the same way it always does—to provide good advice, on how strongly to expect each of a set of alternative possible events, to anyone in a situation blocking more direct knowledge of what actually happens.

There is an equation (the Born rule) relating numerical probability statements to a mathematical object representing the quantum state of a system: in simple cases this object is called its *wave-function*, often written ψ. Schrödinger wrote his eponymous equation describing how the wave-function of a system varies from one place to another and how it changes with time. While the wave-function figures in both these key equations, there is still no consensus on whether it specifies features of the system, our knowledge of the system, or something else entirely. I explain my neopragmatist view in §5.

Along with Maxwell's laws of electromagnetism, Newton's laws of motion and gravitation were taken to be fundamental laws of nature prior to the 20th century. But they conflicted with newer experimental results. By successfully accommodating those results and predicting many other observations quantum theory itself came to be called fundamental. A neopragmatist view of laws (§6) shows why the Born rule and the Schrödinger equation may be considered scientific laws although they do not describe the world.

A common objection to such a view is that it would render quantum theory unable to explain the phenomena it predicts. These phenomena include correlations among events violating Bell inequalities that some say manifest "spooky" action at a distance. I respond by sketching neopragmatist views: of explanation in §7 and of causation in §8.

§9 uses a general inferentialist account of content associated with neopragmatism to show how and when a statement about the value of a magnitude like position or momentum acquires meaning. It is a consequence of this account that even a report of measuring such a magnitude has a truth-value only relative to the physical context in which the measurement occurs. By extending Huw Price's neopragmatist view of the function of truth, §10 reconciles this relativity with the objectivity of our evidence for quantum theory.

2. Neopragmatism

'Neopragmatism' is the title of a recent volume of papers (Gert ed. 2023) whose editor takes the word to refer to an approach to various philosophical questions that proceeds from the premise that the human language in which these arise is a naturalistically explicable phenomenon. I will understand neopragmatism even more broadly as an approach to conceptual problems wherever these arise as humans manifest their naturally explicable capacity to deploy concepts, in thought as well as in language, and in science as well as in philosophy.

Neopragmatism rejects any attempt to solve these problems by appeal to something in unconceptualised reality for a concept to represent or a linguistic item to refer to or be made true by. Such a relation would remain metaphysical since we could not specify it without conceptualising reality. One can gesture at unconceptualized reality by calling it the natural world—the world it is the job of natural science (especially physics) to describe and/or represent. But we could never know such a job has been successfully completed, and (I shall argue) this is not the job of the quantum theory that is part of our best current physics.

I join Huw Price (Gert ed. 2023, 28) in taking neopragmatism to be a *subject* naturalist project that addresses conceptual problems we face by beginning not with a metaphysical relation to the natural world but with what science tells us about ourselves as natural creatures, with certain general capacities and needs but subject also to general limitations as to what we can do and know. Collectively (if not always individually) humans have the capacity to form concepts that meet their needs in the changing social as well as natural environments in which they find themselves. These concepts function in the exercise of general capacities for observation, inference, language, mathematics and science. A neopragmatist approaches an understanding of a concept such as possibility, probability, causation, truth or free will by asking what function is served by our deployment of that concept, not only in its linguistic expression but also in our activities, including interpersonal communication but also individual thought and decision.

While the function of many uses of language is not to describe or represent how the world is, many make the default assumption that this is a primary function of a claim made by uttering a declarative sentence. But a neopragmatist rejects what Price (2013, 24) calls *Representationalism* The function of statements is to 'represent' worldly states of affairs and ...true statements succeed in doing so.

This rejection is global in scope. It is not restricted to moral, modal or other statements with distinctive expressive functions that naturalistically-inclined philosophers have found problematic. Even if the statement that it is raining does truly represent the state of the weather, a neopragmatist will not accept this as its function and continue to look elsewhere for a deeper, general account of what social and individual human purpose(s) are served by such statements.

Rejection of Representationalism goes along with a deflationary understanding of truth and reference. Together with a development of Ramsey's redundancy account of truth, this blocks a semantic route to object-naturalistic metaphysics and truth-conditional approaches to meaning. Instead, meaning is to be understood in terms of the uses of language as they have arisen to satisfy practical human needs, both individual and social.

3. Quantum Theory

The general framework of quantum theory emerged about a hundred years ago.[4] This framework has been filled in and extended as the theory has been successfully applied more and more widely in science.

Following the so-called semantic approach, a physical theory is associated with a family of mathematical structures called models. In an application of the theory to a specific physical system, a structure is chosen from the family and used to model the behavior of this system. Proponents of the semantic approach typically assume that the chosen structure is applied by claiming that features of the system and its behavior may be represented by corresponding features of elements of that structure. For example, in a model of Newtonian mechanics the trajectory of a certain projectile may be mathematically represented by a particular parabola together with the moment of time at which the projectile passes through each of its points.

The quantum wave-function in a simple model of a helium atom does not represent the changing locations of each of its two electrons in this way, despite being a function of their positions at each moment of time. Instead, for each pair of regions, the wave-function is used to calculate the probability that a joint measurement of the electrons' positions will locate one electron in one region and another electron in the other region. The calculation proceeds by applying the Born rule to the wave-function of the pair of electrons, which Schrödinger called *entangled* because neither electron can be assigned its own individual wave-function.

This is typical of how a quantum model is applied. Quantum theory is probabilistic because its application to a physical system assigns only *a probability* to each of a set of mutually exclusive and collectively exhaustive possible events, usually described as outcomes of a specified measurement on that system. These include applications in which one possible outcome is assigned probability one while all alternatives are assigned probability zero. There is zero probability for a joint measurement to locate the two electrons in a helium atom in the same place with the same properties as each other.

4. Probability

How should one understand probabilities calculated by applying the Born rule to a wave-function or related mathematical element of a quantum model? Physicists often say that this rule gave the wave-function a *statistical* interpretation, apparently identifying the Born probability of a particular outcome with its relative frequency of occurrence in a large number *N* of repeated trials. But that can't be right: if the probability of this outcome is not zero, then neither is the probability of *any* relative frequency *n/N*, where *n* is any number from 0 to *N*.

This mistaken relative frequency interpretation of quantum probability is an attempt to answer the question "What in a world described by quantum mechanics does the term 'probability' represent?". For a neopragmatist the answer is that 'probability' represents probability, in quantum theory and everywhere else. The answer is no help in understanding Born probability because this was the wrong question to ask. Instead, one should ask for the function of Born probabilities without assuming that it is the function of quantum theory to describe the physical world.

In my pragmatist view, the answer is that Born probabilities have the same general function that objective probabilities have elsewhere, not only in science. This is to offer good advice as to what degree a rational agent should believe each of a set of mutually exclusive and collectively exhaustive possibilities if in a situation that blocks access to more direct knowledge as to which of these is actual. That is, for example, the function of the objective probability that a particular coin lands heads just before the only time it is tossed, by the referee to decide which team may choose the goal their team will attack when a soccer match starts. If the coin and toss are fair, the objective probability is ½ immediately before the toss, but indistinguishable from either 0 or 1 just after it. That would be the case even if the precise path of the coin were determined by the detailed state of the universe immediately before the toss, because no human or other physically instantiated agent could access that state well enough to use it to infer more about how the coin lands.

Born probabilities function as norms. They need not represent any actual agent's degrees of belief and would exist even in a world without agents (including our world prior to the evolution of life). But their values are relative to the physical situation of any actual or merely hypothetical agent with the capacity to apply them. This relativity is a general feature of objective probabilities, as illustrated by the coin-toss example. Recognizing the situation-relativity of Born probabilities is the key to resolving several conceptual problems raised by quantum theory.

5. The Role of a Quantum State

Throughout physics, functions or other mathematical objects are used to represent physical things. In quantum theory, a wave-function ψ is one of many ways of representing what is called the quantum state of a physical system. In Newtonian mechanics, the state of a particle may be represented by its position and momentum (mass times velocity) at each moment: together these determine its energy and all other magnitudes whose values may vary from moment to moment—its so-called dynamical variables. In that sense, the particle's changing position and momentum represent all its dynamical (that is, changeable) properties. While a simple quantum system shares almost the same set of dynamical variables as a corresponding Newtonian system, its quantum state does not determine all of these magnitudes: in the same sense it does not represent all its dynamical properties.

This raises the question of what in the world a quantum state does represent. It is customarily assumed that answering this question is key to understanding the nature of quantum states, but there is still no consensus on the correct answer. The quantum state of a system has been taken to represent some but not all of its dynamical properties; a novel, *sui generis* quantum property of the system; our knowledge of the system; or just an individual agent's credences (coherent degrees of belief) concerning their own possible future experiences when observing the system in various ways.

A neopragmatist should dismiss this question as requiring no nontrivial answer: only a Representationalist would expect anything more substantial. The more important question is "How does a quantum state function in applications of quantum theory?" In my pragmatist view it is its use in the Born rule that provides the basic answer to that question. The primary role of a system's quantum state is to yield probabilities for possible events involving that system in accordance with the Born rule. Because those probabilities are objective yet relative, so too is the quantum state of the system. A system is not *in* a quantum state; it has a quantum state *relative to* the physical situation of any actual or merely hypothetical agent applying quantum theory—relative to what I'll call an *agent-situation*. Agents in relevantly different agent-situations should assign different quantum states to the same system.

6. Scientific Laws

The Schrödinger equation is frequently described as a quantum theoretic replacement for Newton's second law of motion, the basic dynamical law of Newtonian mechanics. The Schrödinger equation implies that a system's quantum state evolves deterministically: as specified by a so-called Hamiltonian operator, the continuous change of its initial state determines a unique subsequent state. This appears to conflict with the frequent description of quantum theory as an indeterministic theory. Since probability enters into quantum theory *via* the Born rule, on the surface the conflict may be removed by supplementing the Schrödinger equation with the Born rule, now taken to specify probabilities not only for alternative possible outcomes of a measurement, but also for how the quantum state changes indeterministically from beginning to end of the measurement. If that strategy worked one could say that quantum theory has a different law describing or even governing the behavior of a system, depending on whether or not the system is measured.

To successfully implement this strategy, one would need to be able to specify in precise physical terms when a system is being measured. If quantum theory is both fundamental and autonomous, that means in terms of quantum theory itself. The notorious quantum measurement problem arises from the provable failure of attempts to do this by providing a quantum model of a measurement as a special type of interaction between a system and an apparatus system. All such attempts over many decades have failed to exhibit a hypothetical interaction that generally leads to a quantum state representing any single determinate outcome of a quantum measurement.

A neopragmatist should be neither surprised nor perturbed by this failure to solve the quantum measurement problem, since the problem arises from the false Representationalist assumption that it is a function of a quantum state to represent physical properties of a system whose state it is (relative to some agent-situation). Whatever a quantum measurement is, it is not a function of a quantum state to represent its single, determinate outcome (still less to explain why that is the outcome). Any legitimate application of quantum theory's Born rule simply assumes that in the circumstances of that application one of the set of mutually exclusive and collectively exhaustive events whose probabilities it specifies actually occurs. I will say later (in §9) how a quantum state may provide advice on whether the circumstances make an application of the Born rule legitimate.

Since neither the Schrödinger equation nor the Born rule describes the physical behavior of the quantum system to whose wave-function it is applied, it may seem inappropriate to call these laws of nature by which quantum theory corrects the basic dynamical law of Newton's mechanics, namely his second law of motion.[5] But from a broad neopragmatist perspective they may be seen to have the same general function in their respective theories. That function is to act as a rule for making reliable inferences when the theory is applied.

Many philosophers have joined Carnap (1966) in identifying scientific laws with statements expressed by a class of general sentences of the form $(x)(Px \supset Qx)$. Ramsey (1929 [1990, 145]) had called these variable hypotheticals. Carnap took such a statement to have truth-conditions, and to express a law only if it is true. But Ramsey (1929) argued that a statement of a variable hypothetical is not a proposition capable of the two cases of truth and falsity—that it is not a judgment but a rule for judging. As he put it ([1990,149]) "Variable hypotheticals or causal laws form the system with which the speaker meets the future". The general function of a scientific law is to act as a reliable guide in modifying one's doxastic state, ultimately in the light of new experience. The modification may involve rejection of old beliefs as well as acceptance of new beliefs. If the law is probabilistic it may involve readjustment of degrees of belief (as in the case of the Born rule).

It is because they serve this epistemic function that both the Schrödinger equation and the Born rule deserve the title of laws, not because they accurately represent or truly describe the behavior of the physical world. But while the Schrödinger equation is a law *of quantum theory* because it holds in all models of the (non-relativistic) theory, the Born rule is not since it functions only in *applications* of quantum models.

7. Explanation

Quantum theory is fundamental to science in part because it explains phenomena that pre-quantum physics was unable to account for. We can use it, for example, to explain why most atoms we encounter are stable while others decay radioactively, and how the sun produces energy through processes of nuclear fusion. But how could quantum theory explain such phenomena if it is not the function of a quantum state to represent what happens? A neopragmatist account of the explanatory function of quantum models can answer that question.

Since any application of a quantum model is *via* the Born rule, the immediate object of a quantum explanation (the *explanandum*) is a probabilistic phenomenon (such as the α-decay of radium). A probabilistic phenomenon is neither an individual event nor a regular pattern of events, but an abstract probabilistic model of such events associated with a low-level theory that offers advice on how strongly to expect events of various types to occur.

We can use quantum theory to explain such a phenomenon by applying the Born rule to the appropriate *quantum* model to show that events of those types have Born probabilities equal to those of the probabilistic phenomenon. Where such a phenomenon is manifested in actual events of types that occur with relative frequencies close to these probabilities, one might say that quantum theory explains these frequencies or even the individual events that constitute them. We can use quantum theory to explain why hydrogen atoms are stable and have discrete energy levels by regarding these facts as limiting cases of probabilistic phenomena and applying the Born rule to demonstrate that each has probability one.

One thing that quantum theory cannot do is to describe a spatiotemporally continuous physical process in which each of many electrons hits a screen after passing through narrow slits in a barrier, resulting in the observed spatial distribution of detections on the screen. This is just one example of a phenomenon of which it can offer no causal explanation describing a spatiotemporally continuous physical process that produces events of the types manifesting that phenomenon. Another thing one cannot expect from quantum theory is an explanation of how or why a measurement of a quantum dynamical variable has a particular outcome, or even any outcome at all. Both these incapacities are simply consequences of the fundamentally probabilistic character of quantum explanations and all other applications of the theory. Neither of them detracts from the explanatory power that helps make quantum theory fundamental in contemporary science.

8. Causation

Einstein famously complained that what he took to be the orthodox view of quantum theory required a kind of "spooky" action at a distance, whereby action on a quantum system in one place can instantaneously change the physical condition of another quantum system arbitrarily far away. Einstein's preferred way of *denying* this was to reject the orthodox view that a system's physical condition is completely described by its quantum state, in which case a change in a system's quantum state need not imply any change in its physical condition. This suggested to him that a more complete description might be possible, perhaps by viewing quantum theory differently.

In a famous co-authored paper (Einstein, Podolsky and Rosen 1935) and elsewhere, Einstein described hypothetical scenarios in which quantum theory predicts correlations between outcomes of certain measurements on each of a pair of systems (S1, S2) to which one assigns an entangled quantum state. He used these to argue against the assumption that quantum theory completely describes the physical conditions of those systems. The conclusion also depended on a "supposition we should, in my opinion, absolutely hold fast: the real factual situation of the system S2 is independent of what is done with the system S1, which is spatially separated from the former" (Einstein 1949, 85). But Bell (1964, [2004]) proved that in a slightly modified scenario quantum theory predicts patterns of probabilistic correlations between outcomes of various measurements on similar pairs of separated systems S1, S2 that are incompatible with Einstein's suggested completion of their quantum state.

Some take subsequent experimental confirmation of these predictions[6] to show that the world is nonlocal—that it manifests instantaneous action at a distance. A neopragmatist avoids that conclusion by denying that a quantum state has the function of describing "the real factual situation" of a quantum system even incompletely, maintaining on the contrary that its function is to specify the objective but situation-relative probabilities of each of a set of mutually exclusive and collectively exhaustive possible events involving that system. The patterns of objective probabilities specified by the joint quantum state of the pairs of systems in Bell's scenario are indeed manifested by relative frequencies in experiments.

Bell (1981 [2004, 151-3]) argued that "certain particular correlations, realizable according to quantum mechanics, are *locally inexplicable*. They cannot be explained, that is to say, without action at a distance." He had in mind correlations realizable in the slight modification of a scenario considered by Einstein that Bell himself used in his 1964 proof. Quantum theory predicts these problematic correlations, and they have been confirmed in experiments realizing that scenario. In the previous section I indicated how, in my neopragmatist view, quantum theory explains them. That explanation appeals to no continuous process propagating from an earlier cause to its later effect, but nor does it appeal to action at a distance. In my view these correlations are explicable by quantum theory—the very theory that predicts them—even though they are not, in Bell's sense, locally explicable.

To say what he means by 'locally explicable', Bell gives a familiar example of a correlation between everyday types of events that occur at the same time but in different places—one here, say, and the other there. In this and similar examples the correlation may be explained just by appeal to causal processes, each of which propagates continuously but independently from some earlier common cause. If there is no direct causal link between the two events, the probability here of what happens there does not depend on what occurs here, given everything that happened earlier.[7] A probabilistic extension of his own 1964 theorem rules out *any* such causal explanation of the problematic correlations, not just one in accord with Einstein's suggested completion of a quantum state.

It is surprising that a familiar style of causal explanation fails here. But this should not perturb a neopragmatist who takes quantum theory to offer a *noncausal* explanation of the problematic correlations, in which the probability of an event there relative to a situation here differs from its probability relative to the situation there at the same time. This explanation shows not only that these correlations were to be expected, but also what each pair of events in their display depends on. It is an effect of the measurements that produced it as well as of whatever preceding events prepared this entangled state of the pair. Had the preparation procedure applied to the pair differed slightly in the right way, so would their quantum state, and consequently also the probability of a pair of events of that type. Had the pair been subjected to slightly different measurements, the probabilities of their results would have differed accordingly. Such manipulations are key to novel technological applications of quantum theory.

9. Meaning

According to most textbooks, quantum theory predicts the Born probabilities of our observations: of alternative outcomes when we measure a dynamical variable. But those textbooks don't say what a measurement is, when it occurs, and whether there has to be someone observing its outcome. This would not be necessary if the outcome simply revealed what value the magnitude had independent of being measured: in that case one could take the Born rule simply to specify the probability of every magnitude claim of the form $M \varepsilon \Delta$ saying that the value of magnitude M on system S is a number in set Δ. But a series of theorems dating back many decades shows that the Born rule cannot be understood consistently to assign probabilities to all magnitude claims of this form.[8] One can restore consistency by licensing applications of the Born rule to statements of the form $M \varepsilon \Delta$, but only in restricted circumstances. The problem is then to say what those circumstances are without reference to an ill-defined notion of measurement.

A neopragmatist can solve this problem by appeal to an inferentialist account of how magnitude claims acquire their conceptual content. Rejecting Representationalism, a neopragmatist foreswears use of referential or truth-conditional semantics as an account of how statements acquire their meanings. "The pragmatist direction of explanation, by contrast, seeks to explain how the use of linguistic expressions, or the functional role of intentional states, confers conceptual content on them." (Brandom 2000, 4) According to inferentialist pragmatism, how much content a claim has is a function of the reliability of inferences to and from that claim. One should apply the Born rule to a magnitude claim only if many such inferences would be very reliable, because only then does the claim have a well-enough defined content.

A model of how interaction with its environment alters the quantum state of a system helps one to gauge inferential reliability: this is known as a model of decoherence. Each magnitude claim $M \varepsilon \Delta$ may be assigned a Born probability if the so-called reduced quantum state of S in environment E is robustly diagonal in a "pointer basis" of eigenstates of the mathematical operator associated with that claim. The Born rule is applicable only to a magnitude claim $M \varepsilon \Delta$ on a system S whose interaction with its environment closely meets that condition: I then call the physical context a *decoherence context* for $M \varepsilon \Delta$. This licensing use of the model is advisory (cautionary): the evolution in the model of the quantum state of system and environment does not represent this as a physical process. In no environment does a model license application of the Born rule to claims about both the precise position and the precise momentum of a system, since such claims are never both meaningful at once. Physical processes involved in measuring magnitudes produce *some* decoherence contexts, in which the outcome of measuring a magnitude *M* is determined by the truth of significant magnitude claims relevant to *M*. In other circumstances decoherence contexts occur naturally, and not because of the measuring activities or even the presence of an agent.

10. Truth & Objectivity

Because the quantum state in a model of decoherence is relative to an agent-situation, so too may be the decoherence contexts determined by application of that model. In most applications of quantum theory one can safely ignore this possibility since relevant variation of agent-situation produces no corresponding variation in decoherence contexts. But there are hypothetical scenarios in which agents in different agent-situations should disagree about what measurements were performed and even on their outcomes. One such scenario was first described by Wigner (1961) in the so-called "paradox of Wigner's friend". Recent no-go theorems based on extensions of this scenario (Bong *et al*. 2020, Schmid *et al*. 2023) show how hard it is to avoid the conclusion that, at least in these scenarios, the outcome of a quantum measurement is merely a relative fact.

A neopragmatist has the resources to make sense of the idea of a relative fact and to explain how relative facts about the outcomes of our quantum measurements provide objective evidence for quantum theory. They are a deflationary account of truth and facts and a non-representational treatment of objectivity.

Pragmatists characteristically deny that truth can be understood as correspondence to the facts. They find the notions of 'fact' and 'correspondence' either too trivial or too obscure to yield understanding. Neopragmatists are happy to accept these deflationary principles:

Truth: A statement that P is true if and only if P.

Fact: A statement states a fact if and only if it is true.

But they seek further understanding not from substantive philosophical analyses of the notions but from an examination of how they function in our thought and speech. One function of the term 'true' is to permit unrestricted generalisations like "Everything John says about what happened that night is true". Huw Price (1988, 2003) goes beyond such minimalism by taking truth-talk to have the important *social* function of stimulating reasoned debate in a speech community, aligning individuals' psychological states and so facilitating action toward individual as well as joint goals.

The key feature of the scenario of Wigner's friend and its extensions is that in them some agents currently occupy different agent-situations between which communication is physically impossible. Successful communication among differently situated agents would require each of them to meet in a newly shared agent-situation in which some could no longer retain memories or records of the outcomes of their own previous measurements. Before meeting, a community of such agents would be physically segmented into sub-communities between which debate would be physically impossible. Applied to magnitude claims expressing the outcomes of their quantum measurements, the notion of truth could no longer serve its normal social function in the whole community.

But a related notion could still serve the same function within a sub-community of agents in essentially the same agent-situation. We can call it *relative* truth, satisfying analogous principles to the notion of truth:

Relative Truth: A statement that P is true-relative to-c if and only if P-relative to-c.

Relative Fact: A statement states a fact-relative to-c if and only if it is true-relative to-c.

Here c is a context relative to which a statement is assessable, not a context in which it is made. A variety of truth-relativism is associated with a class of statements and contexts for which no plain notion of truth and fact is applicable, but only notions of relative truth and relative fact.[9]

A neopragmatist may apply a notion of relative truth to a magnitude claim as assessable relative to the decoherence context of an agent-situation. A magnitude claim lacking significant content in a decoherence context is not assessable for truth relative to that context, so there is no fact about the outcome of a measurement of that magnitude. In the scenario of Wigner's friend, there is a fact about the outcome of his friend's measurement relative to the friend's agent-situation, but not relative to Wigner's. One can even describe extensions of this scenario in which a magnitude claim with well-defined content is assessable as true relative to one decoherence context but as false relative to a different decoherence context.

Most, if not all, of our evidence for quantum theory comes from measurements of dynamical variables on physical systems. In an experiment when a measurement of the same type is repeated many times on similar systems, we take there to be observed relative frequencies of alternative outcomes that match the probabilities quantum theory predicts. But if each measurement outcome is merely a relative fact, then so are the experimental data themselves. If there are no absolute measurement outcomes for observers to agree on, it seems that our experimental data provide no objective evidence for quantum theory.

But naturally occurring interactions modeled by decoherence are extremely difficult to shield against, effectively preventing the kind of isolation assumed in the scenario of Wigner's friend and its recent extensions. No actual experiment will ever realize a scenario in which agents occupy such different agent-situations that the outcomes of their quantum measurements cannot consistently be treated as if they were absolute facts. When scientists communicate the outcomes of their quantum measurements they do so from such similar agent-situations that for each measurement they all share essentially the same decoherence context. Even though the outcome of that measurement remains merely a fact relative to that shared context, it functions as an absolute fact within (as well as outside of) the scientific community.

One can distinguish two conceptions, or senses, of objectivity.

Transcendent objectivity:

A thought or statement expresses an objective truth if and only if its truth depends only on how things are in the world and has nothing to do with any contexts at which it might be assessed as true or as false.

Immanent objectivity:

A thought or statement expresses an objective truth if and only if it expresses a truth relative to all contexts of assessment.

Statements about the outcomes of our quantum measurements can express truths that are objective only in the second sense. They provide the strong immanently objective evidence that now warrants acceptance of quantum theory. Neopragmatists should reject the demand that evidence for a scientific theory be expressed by transcendently objective statements: it is not even intelligible if "the world" is the unconceptualised world of the object naturalist.

Notes

1. Quoted from the Stanford Electronic Encyclopedia of Philosophy entry on *Pragmatism,* section 4.4 (Legg and Hookway, 2008). But note that only the words between the quotation marks actually appear in the text of James (1907), on pages 56-7.

2. *Beware*! Terminology is fluid here. Bunnin and Yu (2004, 467) gave a contrasting definition of neo-pragmatism as "A postmodern version of pragmatism developed by the American philosopher Richard Rorty and drawing inspiration from authors such as Dewey, Heidegger, Sellars, Quine, and Derrida." In her edited volume *New Pragmatists* (Misak 2007, 1) Cheryl Misak says this: "Ian Hacking calls Rorty's view 'neo-pragmatism' to distinguish it from classical pragmatism. I'm happy enough to put up with the infelicity and distinguish Rorty's neo-pragmatism from what I am calling 'new pragmatism'. … Whatever we call it, this kind of position is emerging from a variety of sources—such as the work of Simon Blackburn, Robert Brandom, Donald Davidson, John McDowell, and Crispin Wright." It is worth noting that, after a long period of neglect or even dismissal of pragmatism, philosophers of science and analytic philosophers with realist sympathies (for example Putnam (2017), Kitcher (2012), Woodward (2005), Chang (2022), Mitchell and Anderson *eds*. (2023)) have made use of some, but not other, neopragmatist views.

3. I gave my view in (Healey, 2017). Further thoughts will appear in (Healey, forthcoming).

4. The Schrödinger equation and the Born rule of quantum theory appeared in 1926, the year after Heisenberg's seminal paper.

5. Newton's second law and the Schrödinger equation are often used by philosophers as examples of laws of nature. Maudlin (2007, 11-12) calls them both fundamental laws of temporal evolution.

6. The 2022 Nobel prize was awarded to three physicists for the part they played in these and related experiments.

7. For experts only, I restate this sentence more carefully in the context of a relativistic space-time. Let R_1 and R_2 be compact spacelike-separated regions, with S_1 (S_1') a compact spacetime region in the causal past (causal future) of R_1 but not R_2, and S_2 (S_2') a compact spacetime region in the causal past (causal future) of R_2 but not R_1. Take 'here' to refer to $S_1 \cup R_1 \cup S_1'$, and 'there' to refer to $S_2 \cup R_2 \cup S_2'$. Then S_1 (S_1') specify agent-situations here, and S_2 (S_2') specify agent-situations there. In Bell's familiar example the probability here of an event that may occur there is the same relative to S_1 as it is relative to S_1': but in his quantum scenario these may differ (Bell [2004, 242] Fig. 6 depicts that scenario in spacetime). (For an event to happen earlier is for it to occur to the past of a spacelike hypersurface that crosses the causal pasts of both regions R_1, R_2 where these no longer overlap).

8. These include Gleason (1957), Kochen and Specker (1967), Bell (1966, [2004]).

9. Compare MacFarlane (2014).

References

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