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Objective probability and the mind-body relation

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ABSTRACT

Objective: probability in quantum mechanics is often thought to involve a stochastic process whereby an actual future is selected from a range of possibilities. Everett's seminal idea is that all possible definite futures on the pointer basis exist as components of a macroscopic linear superposition. I demonstrate that these two conceptions of what is involved in quantum processes are linked via two alternative interpretations of the mind-body relation. This leads to a fission, rather than divergence, interpretation of Everettian theory and to a novel explanation of why a principle of indifference does not apply to self-location uncertainty for a post-measurement, pre-observation subject, just as Sebens and Carroll claim. Their *Epistemic Separability Principle* is shown to arise out of this explanation and the derivation of the Born rule for Everettian theory is thereby put on a firmer footing.

> The issue of psycho-physical parallelism is at the heart of the problem of measurement in quantum mechanics.
>
> Harvey Brown (Brown, 1996)

1. Two concepts of objective probability

Since the advent of quantum mechanics it has been widely thought by physicists that there may be two types of probability in the world, objective and subjective. Subjective probability is familiar as 'degree of belief' or 'credence'. It's a tool of everyday life. Objective probability is more problematic. A common term for it is 'chance', the idea of an arbitrary process selecting one possibility from a range of alternatives, but a selection guided by the alternatives' probabilities. A bridled randomness which has come to be known as stochasticity.

It can seem that Hugh Everett (1957) III's 'relative state' formulation of quantum mechanics does without a concept of objective probability. Indeed he changed the title of his thesis to *Wave Mechanics without Probability*. And some Everett theorists concur (Brown, 2011, 6; Groisman, Hallakoun & Vaidman, 2013, 696). My purpose here is to argue that there's scope for retaining a concept of objective probability in Everettian theory via an alternative to the standard stochastic interpretation of probabilistic processes. Furthermore, that alternative arises out of a startling change of perspective on the identity of observers within Everett's multiverse which helps to resolve a problematic aspect of the theory.

I shall begin with a thought experiment which suggests that there's a link between that alternative concept of objective probability and an alternative to a standard interpretation of the mind-body relation. I shall then defend the alternative mind-body relation in detail before going on to use it in an Everettian context.

The thought experiment is to take place in a setting provided by contemporary cosmology, which gives a precise meaning to the term 'parallel universes'. Space may be infinite and contain an infinite number of galaxies but there are only a trillion or two in our local region. Our *observable* universe is finite, and according to quantum mechanics any finite region can only occupy a finite number of possible observable states, so if there are an infinite number of galaxies there may be any number of regions which are exactly like our own, down to the finest observable detail (Tegmark, 2007, 104). Those regions are universes which are parallel to ours. What follows brings a change of perspective on them.

Consider a large ensemble of parallel universes in which stochastic quantum mechanics operates, that is, where a single actual outcome of a probabilistic process is understood to be stochastically selected from a range of possible outcomes. On such a view objective probabilities exist, albeit that their values can only ever be estimated via statistical methods which assume the law of large numbers.

We are to focus attention on an idealised quantum measurement where there are two possible definite outcomes on the

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pointer basis. A pointer on the apparatus moves left for outcome L and right for outcome R. The objective probabilities yielded by the Born rule for these outcomes are pL and pR and we can assume that those values have been statistically confirmed to a high degree of *subjective* probability.

At corresponding positions in each parallel universe we have apparatuses ready to make 'parallel counterpart' measurements. As the results come up the initial set of universes partitions into a subset where the result is L and a subset where the result is R.

Now introduce observers about to make a measurement. There are only two ways of doing this, so far as I know. The usual way is to associate an individual observer with a parallel counterpart organism in each universe. Each observer states, 'For this upcoming quantum measurement there are two possible outcomes and on statistical evidence I assign objective probabilities pL and pR to those outcomes, with subjective probability p(pL, pR)'. That statement is interpreted as being true because it refers to a stochastic process where exclusively one or the other of the outcomes will occur with probabilities pL and pR. The observer is bound to be uncertain to some degree as what the values of the probabilities are but the idea that quantum measurement involves a stochastic process implies that precise probabilities are associated with each outcome. The observers' statements are not strictly true since quantum mechanics allows for many bizarre outcomes with minute probabilities as well as the outcomes L and R, but let that pass.

A less usual way of introducing the observer is to associate a single individual with the set of parallel counterpart organisms. In that case there is just a single utterance of 'For this upcoming quantum measurement there are two possible outcomes and on statistical evidence I assign objective probabilities pL and pR to those outcomes, with subjective probability p(pL, pR)'. The parallel counterpart sonic emissions by the organisms do not each give voice to an utterance. The single utterance is voiced by the set of those sonic emissions. We have a single observer, call her Hydra. She sees a single apparatus before her which is constituted by the set of parallel counterpart apparatuses. That apparatus is going to partition into a subset where the outcome is L and a subset where the outcome is R. As a result, the parallel counterpart organisms are going to be subject to differing stimuli giving rise to cognitive differences and so the fissioning of Hydra into Hydra_{L} who sees a pointer move left and Hydra_{R} who sees a pointer move right.

Ted Sider has provided us with a metaphysics of transtemporal identity which is well suited to this situation (Sider, 2001, 201). He introduces a concept of temporal counterparts analogous to David Lewis's (1968) modal counterparts and identifies continuant objects with momentary stages. Thus single apple resting in a fruit bowl is not the same thing from one moment to the next. Rather, at any given moment an apple bears the relation *will be* to apples which are its future counterparts and the relation *was* to apples which are its past counterparts.

So Hydra can be described as bearing the relation *will be* to each of her future temporal counterparts, Hydra_{L} and Hyrdra_{R}, though she does not bear that relation to the pair of them. Hydra will not become two people. A modal analogy is this: suppose that you were born in Africa, then you might have been born in America (if your mother had moved there whilst pregnant) and you might have been born in Asia; but you could not have been born in America *and* in Asia.

Hydra_{L} and Hydra_{R}, two distinct people, each bear the relation *was* to their past temporal counterpart, Hydra. The leftward pointer and the rightward pointer are sets of parallel counterparts which are future temporal counterparts of the ready pointer. True, Sider's stage theory has the odd consequence that many people have worked on writing these very words but it's arguably not impossibly odd since they are all people who I, now, was. Likewise, there would have been many apples resting in the fruit bowl overnight, though only one apple and one bowl at any given moment.

In the spirit of Donald Davidson's (1973) 'radical interpretation' Hydra can be interpreted as speaking truly when she makes her single utterance of 'For this upcoming quantum measurement there are two possible outcomes and on statistical evidence I assign objective probabilities pL and pR to those outcomes, with subjective probability p(pL, pR)'. What she refers to is an apparatus which will fission into subset apparatuses where L and R occur. What she refers to as possibilities are multiple future actualities which are *causally connected* with her perceived environment, and what she refers to as the objective probabilities of those possibilities are her estimation of the measures of the L and R subsets of her apparatus relative to the set which is the apparatus in the ready state. There will be more on causality in Hydra's environment in the next section.

What this suggests is that a concept of a *non-modal* objective probability is intelligible; a concept of objective probabilities which attach to a range of actualities rather than of possibilities. This may seem to be flirting with absurdity. Before even beginning to seriously entertain the idea it must be established that the alternative 'unitary interpretation of mind' is itself intelligible, which I shall attempt to do in the next section. It is a radical proposal which requires careful scrutiny, but it has long been thought that making sense of a reality underpinning quantum phenomena will require a radical conceptual shift.

2. The unitary interpretation of mind

The idea that 'a plurality of worlds' exists which contains worlds parallel to ours has been around for a long time and it has always seemed natural to think of those parallel worlds as far off in the distance but if we adopt Hydra's perspective they are all right here. In some sense our perceived environment must be a sort of 'superposition' of parallel universes if such exist.

Gottfried Leibniz put these words into the mouth of an interlocutor in a dialogue:

> what is to prevent us from saying that these two persons who are at the same time in these two similar but inexpressibly distant spheres, are not one and the same person? Yet that would be a manifest absurdity.
>
> (Leibniz, 1704, Bk.II, Ch.xxvii, 245).

This expresses exactly the thought in the Hydra scenario. More recently the idea has been discussed in (Zuboff, 1974, 374; Zuboff, 1991, 41-2; Bostrom, 2006, 186-8). A much fuller development is to be found in Tappenden (2011a), Sections 2, 4 and 5 which I shall summarise here.

First of all, it can indeed seem 'manifestly absurd' that parallel counterpart organisms vastly separated in space could be multiple instances of a single mind if it is thought that there must be some sort of causal connection between them. But all that radical interpretation requires is that the organisms and the environments with which they interact should be isomorphic. With that in mind we can approach interpreting Hydra's speech and behaviour.

Hydra says 'I see a single apparatus before me which has a mass of one kilogram'. For this to be interpreted as true she cannot be referring to the aggregate of the parallel counterpart apparatuses since that has a much greater mass, but another type of collective is available, the set of the apparatuses. Usually sets are thought to be abstract but that is not a requirement. Willard Van Orman Quine suggested that some sets could be regarded as concrete when he wrote: