How to Combine Chance and Determinism: Thinking about the Future in an Everett Universe*

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I propose, in the context of Everett interpretations of quantum mechanics, a way of understanding how there can be genuine uncertainty about the future notwithstanding that the universe is governed by known, deterministic dynamical laws, and notwithstanding that there is no ignorance about initial conditions, nor anything in the universe whose evolution is not itself governed by the known dynamical laws. The proposal allows us to draw some lessons about the relationship between chance and determinism, and to dispel one source of the tendency among Everettians to introduce consciousness as a primitive element into physical description.

1. Introduction. How can deterministic dynamical laws, together with complete knowledge of the past, leave room for chancy events? If the universe unfolds in accord with known deterministic physical laws, and you have complete knowledge of your own past, how can there be future events that can be assigned only a probabilistic outcome. This is a problem that advocates of Everett (or Many Worlds) Interpretations of quantum mechanics face in a very stark form: and it is at least partly behind the tendency to import primitive non-physical homunculi into that setting. If the dynamics of the physical universe is completely and correctly described by Schrodinger's equation, it is almost irresistible to think that Born's rule

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must apply to the path of some non-physical what-not—*me* or *my consciousness*—traveling an undetermined path through the branching landscape.

The general question can be separated from the context, and it is only one of the cluster of related problems involved in providing an interpretation for probability in an Everett universe, but it arises in an especially pointed form in that setting. I will recommend an answer that doesn't depend on adding anything non-physical to the universe (that is to say, anything whose evolution isn't completely and correctly described by Schrodinger's Equation), draw some lessons for the relationship between dynamical determinism and predictability, and close by relating the discussion to the broader metaphysical tendency to think of oneself as a transcendent being: a pure, primitive locus of mental life, distinct from brain and body.

2. Introducing the Setting and Separating the Issues. Think of a history as a sequence of results of measurements, or observations, each with N possible outcomes, ordered by time, and think of an Everett Universe as an infinite branching set of histories, represented by a tree-like structure with nodes standing for measurements, and one branch entering, and N branches leaving, each node, in which every possible sequence of results is realized.[1] Providing an interpretation for probability, conceived as a measure over the space of histories, in this setting requires at least the following three things:

1. Finding a canonical method for extracting, from the universal psi-function, an evolving tree-like universe, and doing so in a manner that doesn't make use of a preferred basis,
2. Showing how chance can arise in a deterministic context,
3. Defending Born's Rule as the quantitative method for calculating probabilities.

The problems are related but separable; I adopt the strategy of treating them separately. Progress on 3 has been greatest. 1 is still a matter of heated dispute; there are a number of proposals in the literature.[2] I will be addressing 2 specifically, with some brief words at the end about 1.

The problem arises because if the universe evolves, as a whole, in accordance with Schrodinger's equation, it evolves deterministically, and if it evolves deterministically, there don't exist any genuinely chancy events. Simon Saunders put the problem nicely:

1. This isn't the only way to think of an Everett Universe (see section 9).

2. For an overview, see, Lockwood 1996; also, Saunders 1995, 1993, and Zurek 1992.

> it seems that the concept of probability can only apply to a situation given that only one, say, x, out of a range of alternative possibilities y, z, . . . is true, or is realized, or actually occurs, so as to exclude all the others; [but this is] precisely what Everett denies. (Saunders 1996, 374)

Solving it means finding something in an Everett universe for the Born probabilities to attach to, something for me to be wondering about when, for instance, I'm wondering whether I will find Schrodinger's cat dead or alive, or in general, what the result of a measurement on a quantum system in a superposition of the measured observable will be.

3. A Preliminary Attempt. Consider the little bit of history stretching from the moment just before to the one immediately after a result is obtained in a spin measurement on an electron.[3] Consider, that is to say, what happens, in an Everett Universe, between the moment I feed a particle into a Stern-Gerlach apparatus and that at which a spot appears (or, if you like, is observed) on the photographic plate at the other end. We know that the universe branches, and we know that results distribute themselves across branches in such a way that the probability that an unconstrained choice from the post-measurement worlds will yield one or another outcome corresponds to the Born probability of that outcome obtained from the state of the electron before measurement.[4] Finding something for the Born probabilities to represent means finding something in this stretch of history that we can think of as a 'picking' event, something to whose outcome the Born probabilities can be thought of as assigning expectation values. The difficulty is that, since all results are equally realized, i.e., since all occur at some world, the universe itself doesn't make any choices.

If we could single out one or another branch in the ψ-function, or the world described by one or another branch—e.g., the one that is actual, or the one that is experienced—we could interpret the Born probabilities as the probability of obtaining a given result *in that branch*. The difficulty is that each branch is actual relative to itself, each is experienced by its own inhabitants, and they are related symmetrically to the pre-measurement set-up. There is nothing I could say, from my standpoint before measurement,

3. I distinguish the 'measurement' from its 'outcome,' thinking of the former as everything leading up to, but not including, the moment a result is obtained (remaining vague, for familiar reasons, about when exactly *that* is: e.g., the moment a dot appears on the photographic plate? the moment a conscious observer looks at the plate? the moment she acquires a belief about its position?)

4. There are different ways of doing this, but the differences don't matter for our purposes. We can have a single world for every result with various primitive objective chances of getting picked, or we can have a continuous set of equally probable worlds, under a standard measure, with as many of each type as are needed to get the probabilities right.

to pin my Born probabilities on one of these rather than another; there is nothing that I can use to get a descriptive handle on this one, as opposed to that.[5]

Ask yourself what you are wondering about before measurement when you wonder what the outcome will be. It is tempting to answer is that you are wondering what sort of result *you* will experience, i.e., which of the post-measurement branches of the universe *you* (not any of your externally indistinguishable counterparts, but *you*) will find yourself in, and so many have supposed that what is needed to solve the problem of probability are criteria of personal identity that will allow you to identify one of the branches as *yours,* so that the Born probabilities can be interpreted as pertaining to events in *your* world.[6]

The problem with this, from a physical point of view, is that it gives away the game. It reconciles the determinacy of physical evolution with the need for chancy events only by adding non-physical facts to the universe, where by ‘non-physical facts,’ I mean facts that don’t supervene on the physics of the situation. For if facts about personal identity are to do the work for which they are being evoked, they *cannot* supervene on physical ones because, by hypothesis, the post-measurement me bears all the same physical relations to the pre-measurement me as my *non*-me counterparts. If there is something that unites me with my later stages, something I can use before the measurement is made, to identify the event to whose outcome Born probabilities attach, it *can't* be something physical. The suggestion that we *add* to the Everett picture, a humunculus, or an individual consciousness, traveling a unique path through the branches, making chancy choices at every juncture, and that we interpret the Born probability of an up-result in a spin measurement as the probability that it (i.e., the humunculus) will choose an up branch when it gets there, isn’t very satisfying as physics.[7] Let’s see if we can do better.

4. A Second Pass. Perhaps I needn’t single out a unique trajectory as *mine*—i.e., perhaps I needn’t be able to say beforehand which one of the

5. Save the results themselves, and that is no help, for two reasons; first, there is not in general (at least on some versions of the Many Worlds view, e.g. Lockwood and Deutsch) a unique world at which a given result is obtained, and second, it makes no sense to attach a non-zero probability to any but one result in a world picked out de dicto by outcome. What is needed a way of picking out a world, that allows me to wonder de re of it, what result will be obtained there. It should be noted that Deutsch’s views have changed substantially in recent years. Many thanks to an anonymous reviewer for prompting this mention.

6. For arguments that nothing else will do, see Loewer 1996.

7. Would each of us, and our various counterparts, have our own humunculi? And would the activities of our respective humunculi have to be coordinated so that we follow different paths?

post-measurement observers is *me*—to make out the suggestion that the Born probability of an ∞-result gives the probability that ∞ is what I will *see*. Perhaps it is enough if I can locate the parts of my history (i.e., individual observation events) in the Everettian universe, as they occur, without appealing to any special, non-physical relation that unites them with one another. Here's how to make this out: think of the Born probabilities as giving the probability that the next event in a pre-measurement history of a specified kind is a spin-up-result-observing event. In collapse interpretations, the Born probability of an event is the probability that it is *actual*. In an Everett Universe, the assimilation of 'actual' to 'here' is complete; the Born probability of an up-result in my spin measurement above is the probability of obtaining an up-result *here*, where 'here' picks out a location in one of the post-measurement branches in the universe, and picks out a *different* one in the mouths of each of my post-measurement successors. The Born probabilities tell each how typical her situation is among folks that share her pre-measurement history; they tell her how surprised she should be, given that history, to be seeing what she is seeing.

If this works, it means there is no need for non-supervenient facts about personal identity, it means there is something in the universe (something *already* there, something there before we add supernatural facts constitutive of personal identity, or non-supervenient relations between person stages) on which to pin the Born probabilities. Each post-measurement successor of an experimenter uses Born's Rule to compute the probability of the event at *her* world; the one at w_1 uses it to compute the probability of a spin-up result at w_1, the one at w_2 uses it to compute the probability of a spin-up result at w_2, the one at w_{3009} uses it to compute the probability of a spin-up result at w_{3009}, ... The results themselves differ from world to world, but, since their probabilities only depend on pre-measurement history, they all get the same distribution.

5. Complications. Here is why the matter is so confusing. Worlds don't have names, and the events in question, the ones to which the post-measurement successors attach their respective Born probabilities, can't be identified descriptively *from a pre-measurement perspective*.[8] This means that there has to be an implicitly indexical element in talk of individual measurement results, which isn't by itself a problem, except that, because of the symmetric relations measurement results bear to pre-measurement history, they can't be identified even indexically from a pre-measurement perspective. Indexical reference works by producing linguistic tokens whose objects are particulars that bear the tokens a certain contextual

8. In a way that leaves their outcomes open, i.e., in a way that permits the assignment of a non-zero probability to more than one result.

relation.[9] The problem with referring indexically to measurement results is they bear all the same contextual relations (spatial, temporal, causal) to the events that make up the pre-measurement history, and that means that we can't make identifying reference to them until *after* they have occurred, i.e., until we occupy a context that bears them different relations.

That *is* a peculiarity, but it is a linguistic peculiarity, and the way to see that it is a linguistic peculiarity—i.e., that it underscores the insufficiency of the linguistic resources at my disposal before measurement to *refer* to the events to which Born probabilities attach, without showing that there are none such—is that if worlds had names, or came in different flavors (so that 'the chocolate world' or 'the grape world' were identifying descriptions) there would be no problem about interpreting the Born probabilities. I could use Born's rule to compute the probability of getting one or another result at any world I care to know about.

So, to review; every measurement outcome event at any world, has a fixed probability, given by Born's rule, of coming out this way or that, and the variously situated post-measurement observers of results use Born's rule to compute the probabilities pertaining the events they are, respectively, observing. The probabilities tell each of them how surprised they should be, given their pre-measurement histories (the pre-measurement histories they share), to be seeing what they are respectively seeing. The need for indexicals in identifying the relevant events, and the impossibility of identifying them from a pre-measurement perspective, makes for linguistic awkwardness, but doesn't have the ontological consequence (*viz*., that there *is* nothing for the Born probabilities to attach to) that would undermine the Everett picture. We needn't *add* anything to an Everett universe to say what the Born probabilities apply to; we just have to give names to parts that are already there.

6. Indexicals and World-Locality. A few words about indexicals; the truth conditions of statements containing indexicals can always be expressed in a sufficiently rich non-indexical vocabulary,[10] but that doesn't mean I cannot use indexicals to refer to things that I don't have the vocabulary to pick out in non-indexical terms. I don't need to have a name or description that applies to a thing to refer to it indexically; I only have to be contextually related to it in the right way.[11] That is the beauty of

9. Complexities are needed to deal with all cases, but the characterization is general.

10. Which is not to say that they have the same sense, or that they express the same proposition.

11. I don't, for example, have to have a name or description that applies to my location to refer to it using 'here'; I only have to be, when I produce the token, *at* it. I don't have to have

indexicals, but it is also what gives indexical talk a *local* character; it means that, if we don't have the linguistic resources to refer to the things in question without indexicals, we can only talk about them *from* certain locations in the spatial or temporal landscape. That, I am suggesting, is what is behind the difficulties in interpreting probabilities in the Everett universe; because of the symmetries of such a universe, we cannot make identifying reference to the events to which Born probabilities pertain from a pre-measurement perspective.

7. Global Determinism and Local Chanciness. Let's return to the problem of how a deterministically evolving world can contain chancy events. How do we reconcile the determinism of global evolution with the local chanciness of measurement results? To say the universe evolves deterministically is to say that its global state is uniquely determined by the preceding one. A moment's reflection, however, should convince you that it doesn't follow therefrom that the state of any given *branch* is uniquely determined by *its* history. So long as there are distinguishable branches with the same initial segments, i.e., so long as there are dissimilar down-stream descendents of one and the same pre-measurement world, there *must* be events that are not determined by their histories, namely those that differentiate the branches from one another.[12]

The same will be true in any universe with symmetries of the right sort. Consider a system consisting of a spherically symmetric particle that decays at a pre-ordained moment sending indiscernible particles off in opposing directions. The process might well be deterministic in the sense that the laws prescribe when the thing will decay and the direction in which particles will be emitted, but the path of neither particle will be determined by *its* prehistory. Measurement results in an Everett universe are chancy in the same way as the post-split path of a particle is chancy; nothing in the pre-measurement history of either particle will tell me where it is located after emission. If the particles don't have names, and we don't allow hacceities into our description, conditionalizing on the presplit history of a particle will not tell me its location. And just so, if I forget the outcome of a measurement I carried out yesterday, nothing in the universe right up until I observed the result will tell me what it was. I can use Born's rule to calculate how likely it is to have been one thing rather

a name or description that applies to the present moment to refer to it using 'now'; I only have to be, when I produce the token, in it.

12. Notice the connection with the difficulty encountered above; the only way we could be in a position, before measurement, to descriptively identify worlds at which different results are obtained, would be if there were something that distinguished them before the fact. But this is precisely what is ruled out by their common ancestry.

than another, but no knowledge of the state of the universe *before*hand will tell me more. And this, notwithstanding the fact that the state of the universe as a whole is completely determined by the preceding.[13]

Notice that there is also a kind of epistemological symmetry in the Everett universe that is, in its way, satisfying. On a classical view, if we think of our histories as sets of events, we lose information as we trace them back in time, because records accumulate in the forward direction.[14] In an Everett universe, we lose information in both directions, because our view of the universe as we move forward is increasingly parochial. We get more and more epistemologically isolated, because the information that comes in through the senses concerns only parts of the universe with which we are in causal communication (i.e. our particular branch), and that is an increasingly small portion of the whole. We lose information in the horizontal direction, that is to say, as it accumulates along the vertical.

8. Indeterminism and Unpredictability. Whenever you have a system with the right kinds of symmetries, you will have distinct parts (i.e., particles located in different parts of space, and which may or may not differ intrinsically) with identical histories. You will have distinct parts with the same pre-t history, and whatever distinguishes the parts after t (whether these are intrinsic differences, differences in spatial location[15]) will not be predictable from historic facts. You can predict the global state from global history (complete knowledge of any time-slice of global history will suffice), but you cannot predict the state of every *part* of the system from global history. Observers in an Everett system are interested in predicting the state of a part of the system on the basis of information about its global states at a given time; the structure of the Everett Universe is such that, once an observation has taken place, branches are causally isolated from one another in a way that makes information about what occurs in one branch unavailable to others. The evolution *of each branch* will be indeterministic, in this sense: states after measurements will not in general be predictable on the basis of historic information. The probabilities are epistemic, unpredictability arises not because of indeterministic dynamical evolution, but because the information that one would need in order to use the dynamical laws to predict the result of a measurement in a given branch—*viz*., information about its outcomes in other branches—is

13. This raises a hornet's nest of *really* hard questions concerning the notion of primitive hacceity that eventually have to be faced up to, but which we only note here.

14. It doesn't matter whether you think of this as a metaphysically contingent fact, or you think the forward direction just *is* the direction in which records accumulate.

15. In classical physics, distinct particles are always distinguished at least by spatial location.

unavailable. It arises, that is to say, not because of the way information is spread back to front, but because of the way it is spread side to side. Measurement results are unpredictable in an Everett Universe because they are not determined by the global dynamical laws from the information contained in their own back light cone.

9. Literal Branching or Metaphorical? There are two ways of thinking of the Everett universe; one according to which worlds have common histories and branching is a physical process that occurs when measurements are carried out,[16] and another according to which the universe consists of non-overlapping worlds with *similar* pasts, but no events in common. On the latter way of thinking, branching is a metaphorical way of describing divergence in the post-measurement intrinsic nature of spatio-temporally unrelated worlds. I have been speaking in the first way because the problem of probabilities arises in its most pointed form in that setting, but it is useful to compare the two. On the second way of thinking, every measurement has a unique outcome, which means that it suffices, for the purposes of finding somewhere to pin my Born probabilities, that I can identify the measurement I'm interested in.[17] And there is a great deal less intuitive difficulty with *that* (never mind that there are indiscernible measurements at other worlds) than there is with identifying individual results in a genuinely branching universe: I just feed my electron into my apparatus and say "I wonder what the outcome of *this* measurement will be."

The reason it is easier to get worked up about the problem in a genuinely branching universe is that measurement events in that setting don't (in general) have unique outcomes: a single one has a different result at each post-measurement branch of the universe, and because each is symmetrically related to the event itself, if there is more than one, there is no way *before* branching of singling out any, that we may wonder *of it,* what its outcome will be. I can stand in front of my Stern-Gerlach apparatus, after having fed my electron in, and wonder de dicto whether there will *be* a spin-up result, but I cannot wonder de re, *of a particular outcome,* whether *it* will be spin-up, because I have no independent means at my disposal, from that perspective, of picking it out. It is only by looking back, after the fact, from a location in the universe that bears asymmetric relations to the various results (all equally real, all reflexively actual) that I

16. Never mind, again, the difficult question of what precisely measurements are, or when precisely they can be said to have occurred.

17. Indeed, to identify *any* of the events in my own world, if each event in my world is uniquely (spatiotemporally) related to every other, and none bears spatiotemporal relations to events at other worlds.

can single out those to which a particular set of Born probabilities attach. It is only looking back that I can be surprised by the way things turned out in my branch, because it is only from my post-measurement position that I bear the outcomes of my branch the kinds of asymmetric relations that allow me to make identifying reference to them.

There are two lessons concerning physics:

I. that probabilities in an Everett Universe have an implicit and ineliminable indexical component;[18] this is not a surprise, but it is often supposed that the index has to be a self, or a mind, or something that's not already included in the description of the Everett Universe, and I have argued that that is not necessary, and
II. that there is a kind of *internal* indeterminism that arises in the context of deterministically evolving systems with symmetries of the right sort. There is a local symmetry breaking that goes on in an Everett universe every time a measurement is carried out that gives rise to subsystems with identical histories and distinguishable futures.

There are alternative treatments and they should be noted. I mentioned earlier that Finkelstein's quantum mechanical version of Bernoulli's Theorem establishes a link between Born probabilities and relative frequencies, and if we are willing to refrain from speaking of single-case probability in the Everett universe, we can interpret Born probabilities as limits of relative frequencies in the universe as a whole. Metaphysically the resulting picture is van Fraassen's modal frequency interpretation with the modalities realized physically in disconnected branches of the universe. Alternatively, we can follow Lockwood and Deutsch, allow that there is a plurality of branches in which every physically possible outcome of a measurement is realized, and interpret the Born probability of a given

18. It wouldn't be quite right to describe them as de se, because that makes it sound like they are questions about selves, or minds, and hence that if there were no observers in an Everett universe, there would be nothing for the Born probabilities to attach to. It is true that the questions to which I've suggested the probabilities provide answers can only be raised from within the Everett universe, and it's also true that, if there were no observers in the Everett universe, there would be no one to *raise* the questions to which they provide answers (God, looking on from above, has answers to all of his questions, and there are none he can't raise), but that doesn't make the questions *about* observers. It is also true, after all, that if there were no minds around, there would be no one to raise questions about the feeding habits of sea mollusks, but there is no interesting sense in which questions about the feeding habits of mollusks are questions about observers. It is essential to understanding why no humunculi are needed that the questions to which the Born probabilities provide answers are not essentially questions about what *I* will see after the measurement is carried out, but questions about what things look like from perspectives that can't be identified descriptively before measurement.

outcome as the measure of the set of world-histories extending forward in time from the initial world-time-point in which the outcome in question is realized.[19]

We don't get, in either case, single-case probabilities, we don't get genuine uncertainty, and we don't get to the heart of the intuition that when I'm standing there feeding my particle into my measuring device, or getting ready to open Schrodinger's box, there is genuine suspense, something that I'm waiting to find out something I'm ignorant of, my complete knowledge of how the future of the universe will unfold notwithstanding. It is this powerful intuition that leads one to start talking about consciousnesses, homunculi, or irreducible hacceities; it is this intuition that makes one want to say things like; "look, there is something I'm wondering about, and that I'm using Born's probability to calculate the chance of. It's not any fact about relative frequencies of this or that sort; I know all about those. What I'm wondering is whether *I* will see a dead or live cat when Schrodinger's box is opened, and no amount of objective knowledge is going to alleviate my wondering. There are facts about what happens to *me* that are simply left out of the description of the Schrodinger-evolving physical world, and *they* are the subject matter of the Born probabilities." My suggestion acknowledges the intuition, and, unlike the alternatives, it gets us genuine uncertainty in a deterministic context, and it does so without recognizing non-physical facts.

10. Wondering About the Future. There is another reason for addressing the intuition; it is at least partly behind the persistent appeal of certain recurrent philosophical views of the self. Consider the sequence of events between the birth and death of an observer in an Everett Universe. From the situated perspective of any temporal part of his life, it is determinate what lies in his past, since there is a unique trajectory tracing it back to his birth, but indeterminate what lies in his future. This is not because there is any indeterminacy about the future state of the world, but because "my" in his mouth, fails to pick out a unique future trajectory; his "I"-thoughts fail to bear the asymmetric relations to the future that they would need to in order to get their referential hooks into any *one*.

Not only does the view seem to me coherent from a third person perspective, I can also make psychological sense, from the inside, of living in a world like that. I can imagine *being* one of the experimenters in such a world preparing for a measurement, and then finding myself after the fact, looking at its result at one or another of the post-measurement branches of the world. And when I perform this imaginative feat, I find that it is not

19. A model can be supplied by Giere 1976.

different, in any way I can discern, from what it is actually like in the ordinary world when I perform a measurement with a chancy result and await the outcome. But how can that be? The Everett universe contains no humunculi, no transcendent subjects travelling one or another branch through the universe, no indivisible selves extending into the future for the "I"s of the measurers to refer to, just observers that bear discriminating causal and informational relations to certain past events. Each of them can speak cogently of "my past" because there is a discriminating causal pathway that leads from his present I-thoughts to past I-thoughts that doesn't cut across personal boundaries, but there is no object (no body, no humculus, no transcendent I) to which the various acts of situated self-reference *belong*. There are just the acts, and the discriminating, backward-looking causal relations that at once provide information about, and allow each to make identifying reference to, the causal history of their own states (the memories, beliefs, desires, and attitudes that are the inheritance of the past), but nothing either in those states or in the big, wide world around them that provides them with a referential grip on a particular future I-thoughts.

If *we* do not live in an Everettian universe, and if there is not too much amnesia, fission, or delusional memory in our world,[20] there *are* discriminating causal relations to future as well as past experiences, so the problem of ontological indeterminateness does not arise. But since information only propagates from the past to the future along those links, psychologically and epistemologically, our position is indistinguishable from that of the occupants of the Everett universe. When I use "I" to, e.g., make plans for the future, fear my death, anticipate pleasure, I use the first person pronoun in the same way that they do. And it is almost impossible *not* to conceive of those plans, fears, anticipations as centering on a transcendent object, for the same reason it is hard to resist the idea that the only thing the Everettians could be wondering about, and using Born's rule to calculate, is the post-measurement location of their irreducible *me*-ness.

"My future self," in my mouth, refers to I-know-not-who in the sense that I can't produce an individuating conception or produce criteria of identity. I entrust my beliefs, hopes, wishes, desires, to whomever will inherit them, and I address that person in the first person when I form plans and projects. There are some things I can derive about that person from my knowledge of causal laws (e.g., that she will have the same scars, that there will be a continuous path from my spatiotemporal location to hers, and so on). But no connection to a body, or continuity in content or qualitative character of psychological states plays any role in identification, and none

20. We can resolve the odd case by appeal to non-psychological criteria.

is constitutive of identity over time. For I can *imagine* waking up tomorrow in the body of my sister, or Napolean, or a cockroach, and I can imagine that my thoughts and experiences begin to leap around as wildly as you please, without contradicting myself in ascribing them to me. It is the external, causal relations among my past and future states that make them states of the same self.

This sort of Lockean position I have been sketching is a staple of the literature on personal identity, and it has been developed into a quite psychologically convincing portrait of thought about one's future self,[21] faithful to the phenomenology of first person thought.[22] If it is correct, I am suggesting that it contains an implicit diagnosis of the tendency to think of oneself as a transcendent thing, in the grammatical illusion fostered by the abuse of notation that allows "I" to function like a singular term.[23] There is no mystery about how "I" can be used to identify and reidentify a psychological continuant without application of criteria of identity; all that is required is reflexive identification of the thought in which a token of "I" occurs, coupled with the discriminating, causal relations that places those thoughts with others in a connected stream. But add such a term to a psychological context in which information only propagates from past to future, permit the ordinarily harmless abuse of notation, and it is almost psychologically irresistible to think that when one is wondering about one's future, one must be wondering about a special sort of object, a pure locus of mental life, whose past is known, but whose future is open, unconstrained in any way by the ineluctable goings on in the physical domain. It is the same illusion that encourages the importation of homunculi into an Everett Universe; we get the idea that there has to be something over and above the various acts of situated self-reference that unites them and gives them a common subject matter, some single *thing* that all of our thoughts and wonderings phrased in the first-person to be thoughts and wonderings *about,* some thing in the Everett universe whose future the observers there are uncertain *about*.

This isn't the end of the story; the transcendent picture is too deeply rooted to be traced to any one source. I believe that thinking oneself into an Everett Universe is one way to loosen its grip on the imagination, and we

21. See, in particular, Velleman 1987.

22. If, that is, one lacks-like Hume-any direct intuition of a self distinct from the parade of thoughts, experiences, and acts of situated self-reference that make up one's mental life.

23. The abuse is two-fold; first, the expression itself is not a singular term, but a function from contexts to extensions. Like other indexicals, it can function like a singular term only relative to a fixed context. Second, unlike other indexicals, the extension of "I" isn't an object, since the parts of psychological continuants aren't related by an equivalence relation. That is what is brought out so dramatically by the possibility of fission.

should add it to the repertoire. Quite independently, I hope, I have shown how to get real, single-case probabilities and Born-style uncertainty in a deterministic setting, without adding anything non-physical to the universe.

11. The Preferred Basis Problem. The need to break the objective symmetry between different ways of decomposing the universal psi-function to extract an evolving tree-like universe (1, in the catalogue with which I began), is another source of the tendency to add consciousness to the Everett Universe, so I want to pause to say something about how this might be done if one adopts the recommended treatment of 2. I think the right strategy is to hold that there is no more an objectively preferred basis than there is an objectively preferred moment that orders the parts of time in a succession of incompatible McTaggartian A-series,' a moment whose *preferrability*, that is to say, is itself is non-perspectival in the specific sense that it is invariant under transformations between temporal perspectives, or perhaps, any more than there is an objectively preferred position on your family tree that determines the status of all others (who is mother, who is father, who is cousin, and so on), a position whose preferrability is invariant under transformations between positions.

The way to defend a consistent and thoroughgoing relationalism is not to argue that there is no preferred way of decomposing the psi-function, but to make the preferrability *perspectival*. One lets the situation of a system, characterizable in invariant terms, but indiscernible from the inside[24] supply a suppressed parameter that (in a manner appropriately generalized from the spatial and temporal case) defines its perspective. It is an open question what might serve as the relevant parameter, but so long as there is something in the invariant quantum state of situated systems that can play this role, there is enough structure already in an Everett universe to renounce the demand for a distinguished basis. One holds that for the quantity Q defined by the informational states of a situated system (e.g., a human brain, a measuring instrument), there is a basis whose preference is determined by, and relativized to, Q, on precise analogy with the spatial and temporal cases, but denies that there is any objective preference. This locates the search for a preferred basis where it belongs (in the way Q is situated in Hilbert space, in relation to other observables), and preserves the symmetry of bases on the level of invariant description. It does demand a generalization of the notion of a perspective beyond its ordinary application, but it is one strikes me as entirely appropriate.

24. By definition, as it were, of 'situation', which refers to the *external* relations between an informational state and the objects and events in the objective order, *in virtue of which* the states carries the information that it does.

Simon Saunders has been, if I understand him, an advocate of this kind of view. It is much closer to the spirit of Everett's original paper than the form it took in De Witt's hands.[25] Supplemented with the proposed treatment of 2, it provides a way of making use of structure that is already *in the physics* to account for subjective features of experience and combatting the tendency to introduce non-physical whatnots.

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25. Saunders 1996b, 1993. Saunders has also discussed the analogy with time in Saunders 1996a.