The Costs of Rejecting Quantum Immortality

Proponents of the Many Worlds Interpretation (MWI) of quantum mechanics are divided in their attitudes to the idea of quantum immortality. Some, e.g. Max Tegmark (immortalists), believe one should always expect to experience subjective survival in a quantum suicide thought experiment, because one can only ever be on a branch of the universal wavefunction where one is alive. Others, e.g. Sean Carroll, David Papineau and David Wallace (mortalists), believe that the truth of the MWI has no such consequences and that our situation is analogous to that of an observer in a single, non-branching, stochastically-evolving universe. A related question concerns whether we can take survival of a quantum suicide experiment as evidence confirming the MWI. This paper focuses on the core principles underlying these debates by considering each of these questions in turn for idealised cases of quantum immortality, arguing that while rejecting such applications of the idea of quantum immortality is tenable, to do so requires Everettians to pay various methodological and metaphysical costs that are in tension with the particular strand of austere Everettianism exemplified by Carroll, Papineau and Wallace in particular.

1 Introduction

The famous Schrödinger's Cat thought experiment illustrates the absurdity of the prediction from standard quantum mechanics that a quantum measurement could result in a cat being both alive and dead at the same time. The Many Worlds Interpretation (MWI) of quantum mechanics, pioneered by Hugh Everett III (1957) and popularised by Bryce DeWitt (1972), suggests that it may not be so absurd after all. On the MWI,

every time a quantum measurement is made, all possible outcomes occur, the apparent collapse of the wavefunction and the randomness of the measurement being an artifact of a particular point of view within a deterministically evolving wavefunction, giving rise to what amounts to a constantly branching quantum multiverse. On this view, the universe effectively splits in two, with the cat being alive on one branch, and dead on another.

The concept of Quantum Immortality (QI) considers the implications of this from the perspective of the cat. Euan Squires (1994, pp 72–73) notes that, on the MWI, an observer playing a game of quantum "Russian roulette"[1], where the player is either instantly killed or not depending on the result of a quantum measurement, should always expect to survive. There will be one branch where the observer is dead, and one where the observer is alive. On the assumption that there is no life after death, then instant death cannot be observed, and the only observation possible for the observer is survival. Subjectively, the probability of survival is therefore 1.

Some Everettians, e.g. Max Tegmark (1998), are content to accept the implications of the idea of quantum immortality as significant. However, many prominent Everettians, such as Sean Carroll (2019, pp. 207–209), David Papineau (2003, 2004) and David Wallace (2012, pp. 369–372) disagree, arguing that there is no compelling reason to treat cases of personal survival differently than any other case. Whereas Carroll and Wallace are chiefly interested in why you should not use the idea of quantum immortality to make prospective predictions about your subjective future survival, Papineau (2004) goes further by explicitly denying that it can be applied retrospectively to confirm the MWI.

We have, therefore, two applications of the quantum immortality idea to consider. The prospective case considers whether an Everettian agent should expect to survive a future quantum suicide experiment. The retrospective case considers whether an agent can use quantum immortality to explain its survival of a past quantum suicide experiment, thereby confirming MWI. The goal of this paper is to highlight that rejecting quantum suicide comes at a cost for each case.

By "cost", I mean consequences likely to be unpalatable for certain Everettians, and which should therefore be clearly understood when deciding to reject quantum immortality. The principal target of my argument is the sort of Everettian I take Carroll and Wallace to be (and perhaps Papineau also): the austere Everettian who is a physicalist with reductionist inclinations, accepting a universal wavefunction (or what

[1] This discussion is based on the 2nd edition of the book, the first edition of which was published in 1986.

it describes) into their fundamental ontology and not much else[2]. But it is important to clarify that I do not claim that these "costs" are problematic for all Everettians. Everettians who are open to commitments on essentialist notions of identity, or non-physical value facts may not find them costly at all. Rejecting quantum immortality, I will argue, requires precisely these commitments, commitments explicitly rejected by austere Everettian mortalists. This paper therefore aims to surface unacknowledged tensions within the particular version of Everettianism exemplified by Carroll and Wallace.

Though the targeting of specifically austere Everettianism is a limitation of scope, austere Everettianism is itself an important target. The austere, ontologically minimalist approach is arguably a natural fit for the Everettian program and represents an influential and well-developed strand in contemporary discussions. MWI's primary appeal for many is its parsimony[3]: it purports to solve the measurement problem simply by taking the unitary evolution of the universal wavefunction literally, without adding extra machinery like collapse postulates or hidden variables. This initial commitment to ontological simplicity creates a strong methodological pressure to be austere elsewhere—to derive higher-level phenomena like personal identity and even rational norms from the bare physical state where possible, rather than positing them as additional fundamental entities. My aim, therefore, is to test the internal coherence of this specific, well-motivated research program when combined with mortalism.

To isolate the core philosophical issues concerning identity, value, and observer selection, the scope of this paper will be limited to idealised quantum suicide scenarios. By 'idealised', I mean in particular cases where there is no delay between a branching event and an observer's awareness of their fate. Scenarios such as vacuum decay[4] fall into this category. Because much of the recent philosophical work attempting to ground Everettian probability relies on a 'post-measurement, pre-observation' period of subjective uncertainty (e.g., Vaidman, 2021; Sebens & Carroll, 2018), the stipulation that no such period exists in the cases under consideration allows us to assess arguments against QI on their own terms. As these arguments do not seem to rely on

[2]For a good example of an exploration of the possibilities and advantages of such austere approaches to Everettianism, see Carroll and Singh (2019).

[3]While Everettians may be accused of being extravagantly unparsimonious in their positing of countless universes, they typically respond that parsimony resides in the simplicity of the assumptions being made and not in the number of individuals predicted by those assumptions. By abandoning the assumption that wavefunctions collapse, MWI is arguably parsimonious in its postulates.

[4]It has been known to physicists since at least the seventies (Kobzarev et al, 1974) that the laws of physics upon which our lives depend may be those of a false vacuum, i.e. that a lower energy state for our region of spacetime could be possible. Though it appears to be stable over even extremely long timeframes, it may yet be that a "bubble" of true vacuum could form at any time by a random quantum fluctuation into a lower energy state. This bubble would then expand spherically at the speed of light, almost certainly annihilating all life in its path, in a process termed vacuum decay. Any observers killed could never see the end coming. Death would be unexpected and instantaneous.

the existence of such a delay, a focus on this clean, idealised limit will help to clarify the issues, without conceding anything about more general cases where an appreciable delay might exist. Even on this idealisation, if the rejection of QI incurs significant costs, it represents a profound challenge to the mortalist Everettian position.

I will start by comparing the retrospective case to the attempt to explain the apparent fine-tuning of the physical constants by appeal to a multiverse. I will argue that a consistent approach to these two questions suggests that they come as a package. As such, rejecting retrospective quantum immortalism demands paying the methodological cost of rejecting all anthropic explanations of this form, including those for fine-tuning. Such rejection also requires paying the metaphysical cost of adopting an essentialist account of personal identity.

I will introduce the prospective case by explaining Carroll's intuitive arguments before moving onto a discussion of the technical issues raised by Papineau and endorsed by Wallace. I will argue that these issues reveal that either the austere Everettian must pay one or both of two metaphysical costs relating to identity and value-realism, respectively, or the Everettian must accept that there is no objective fact of the matter on whether prospective QI is true. However, I will present a case for preferring QI even so, by proposing a science-fiction story to illustrate the relative merits of the immortalist account. I aim to show that the immortalist intuitions are more psychologically tenable than Carroll's, and argue that this is a valid criterion by which to choose which attitude to adopt.

2 The retrospective case: anthropic explanations and identity

For Papineau (2004), a quantum suicide experiment is analogous to any other quantum measurement. If I measure spin up, then the MWI guarantees that this should happen to some version of me. And yet this does not confirm the MWI, because there is no guarantee that *I* should be the one to measure spin up rather than spin down. Similarly, when I survive a quantum suicide experiment, I learn not only that there is a survivor, which is guaranteed on MWI, but that *I* am that survivor, which is no more likely on MWI than it is on any other interpretation of quantum mechanics. If this specific evidence is taken into account, MWI is not confirmed.

In this section, I will explain the parallels between Papineau's argument and another hotly contested issue in the literature, implying that endorsing Papineau's argument has implicit methodological and metaphysical costs that may be unpalatable

to many Everettians. That issue is the multiverse explanation of the fine-tuning problem. Philosophers including Alan Olding (1991) and Roger White (2000) have argued against positing a multiverse as an explanation for the apparent fine-tuning of the physical constants. The problem to be addressed is that almost any significant tweak to the physical constants would, it seems, yield a universe inhospitable to life, or indeed any significant complexity. Some (e.g. Carter, 1974; Leslie, 1989; Bostrom, 2002) have sought to explain this by applying what has come to be termed the anthropic principle, or an observer selection effect, positing a vast multiverse wherein these constants vary. If there are enough universes, then they argue that it is no surprise that some such universes are life-permitting by chance, and since we cannot exist in a universe which is not compatible with life, it is no surprise that we happen to find ourselves in one of the rare universes where life is possible. Explanations of this sort, where a vast ensemble of failed trials is posited or observed to explain a rare success under an observer selection effect, I will term anthropic explanations.

The "This Universe" objection to this line of reasoning, particularly as articulated by White, bears a striking resemblance to that of Papineau. White insists that we must take all of the evidence into account when evaluating potential explanations. For White, this means, we cannot take the generic evidence "some universe is fine-tuned for life" to stand in for the more specific "this universe is fine-tuned for life". The former sentence may well be explained by a multiverse, but the latter is not. The existence of a great many other inhospitable universes does nothing to explain why *this* universe in particular is hospitable. It is no more likely to be fine-tuned for life if the multiverse hypothesis is true than if it is not.

The analogy to Papineau's argument could not be clearer. Retrospective QI, like the multiverse explanation for fine-tuning, is an anthropic explanation of an unlikely event, appealing to an observer selection effect and an ensemble of unobservable worlds where the improbable event did not occur. The logical structure of the skeptical responses is also identical. Like White, Papineau accuses his opponents of discarding specific evidence in favour of generic evidence. For Papineau, the error is to discard the evidence that *I* am the survivor in favour of the evidence that there is *some* survivor. For White, the error is to discard the evidence that *this* universe permits life for the evidence that *some* universe does. For both, an appeal to a vast ensemble of failed "experiments" where my existence is prevented cannot do anything to raise the probability of the success of the one where my existence is allowed. This success remains a fluke, and my observation provides no support for the ensemble hypothesis.

This is a problematic parallel for mortalists as there is little consensus that White's argument is correct. Responses to White's argument include those from Manson and Thrush (2003), Epstein (2017) and Ruyant (2025), with notable defences of White including those from Paul Draper (K. Draper et al, 2007; Draper, 2020). Though White's is still very much a tenable position, it is notable that Papineau's argument appears to stand or fall with it.

This is perhaps a problem for Everettian quantum mortalists because White's view is not a comfortable fit with the MWI. Firstly, Everettians are already committed to the existence of a multiverse of some kind, so it is natural for Everettians to explain fine-tuning anthropically. For instance, it may be that the process by which the values of the constants were set was sensitive to quantum fluctuations. If this is so, then the values of the constants of our universe are different across the MWI multiverse, and we will necessarily find ourselves in a branch where our universe is hospitable. Indeed, Wallace (in leaning towards accepting that a theory which predicts life to be improbable is not disconfirmed by the observed existence of life, 2012, p. 384), Carroll (see an interview by Robert Lawrence Kuhn, Closer To Truth, 2022)[5] and Papineau (2005, in response to a question about the possibility that reality extends beyond what we can see) have all indicated that they find anthropic explanations of fine-tuning to be viable. Foreclosing on the possibility of anthropic explanations is a methodological cost that many Everettians may be reluctant to accept. Perhaps it is for this reason that Wallace does not go as far as Papineau in addressing the retrospective question in his otherwise comprehensive book, saying only that the issue of quantum immortality does not bear on the epistemic status of the Everett interpretation for the simple reason that quantum suicide remains a thought experiment only.

All analogies are imperfect, so it is natural to expect mortalists who accept the multiverse response for fine-tuning to seek some key point of disanalogy. Perhaps the most salient may be that QI concerns the diachronic experience of a specific individual before and after the improbable event, while fine-tuning concerns the evidence presented to an observer who only exists at all long afterwards. If I exist before the experiment, I can put my existence into the background knowledge and update by Bayes' rule with the result that the evidence of my unlikely survival is not made more probable by MWI. But this is just how Draper et al. (2007) showed that White's argument worked to defeat the inference to the multiverse. Papineau could reasonably object that the disanalogy excuses putting his existence into the background in

[5] Carroll also thinks that fine-tuning may turn out to be an illusory pseudo-problem requiring no such explanation, because we don't understand well enough whether life really does require such a delicate balancing of the constants.

the QI case but does not excuse Draper or White doing the same for the universe and the fine-tuning case, wherein we only learn of the existence of the universe as a consequence of the improbable success. The problem for Papineau is that his backgrounding move would be no less questionable, in that it rests on assumptions about personal identity which may not be congenial to the austere Everettian.

White's view explicitly relies on a strong notion of essential identity or haecceity, especially of personal identity, in order for his argument to go through[6]. "This Universe" in the "This Universe" objection is intended to pick out a rigidly designated individual α, picked out ostensively by the observers rigidly designated by the pronoun "we". The existence of qualitatively identical universes or observers is no guarantee that "This Universe" or these observers exist ('we do not inhabit these universes, other folks do'). This does not sit very well with austere Everettianism for two reasons. Firstly, austere Everettians are not inclined to embrace an unobservable, empirically inaccessible notion of essential personal identity. Secondly, on the MWI, individuals are constantly splitting into multiple copies as the worlds branch, which poses an obvious problem for how to make sense of the idea of continuous personal identity. If numerical identity is transitive, and I split into two persons, how can I be numerically identical to my future selves unless they are numerically identical to each other, despite leading separate lives from then on? Examination of these questions will illuminate why and how Papineau's argument is as dependent on essential identity as White's.

First, let us compare and contrast an MWI survival case with a classical survival case in order to illustrate the importance of identity. It might be supposed that survival of a quantum suicide experiment at 1% probability is analogous to being among the 1% of people to survive some disaster. In the latter case, I may be appropriately surprised that of all the pre-disaster potential victims, I am the one to survive. This surprise can therefore be explained not just in terms of the intrinsic probability of survival, but in terms of being unusually fortunate relative to some reference class of actual victims. But, in the quantum suicide case, it is not clear if we should think of there being a comparable reference class of pre-measurement potential victims. Different views of diachronic identity in the MWI disagree on this point. As we will see, only the Lewisian account, with its attendant metaphysical costs, allows for such a reference class to exist.

[6]Which exact account of personal identity we adopt is not deemed to be important. White suggests adopting a Kripkean (Kripke, 1980) account of identity as tied to origins, but only as an example. The observer's identity might therefore be dependent on the identity of a specific universe, but then, presumably, that universe itself must have a haecceity. Regardless, the point is just that some account which allows us to treat qualitatively identical individuals as numerically distinct is required.

There are two putative successors of a person who is about to measure the spin of a particle, one who observes spin up, and one who observes spin down. But which successors are genuine continuations of the pre-measurement person? In his analysis of this question, Saunders (1998) identifies three exhaustive possibilities: neither, both or just one of them. These three possibilities can be seen as the respective recommendations of three popular approaches to Everettian personal identity identified by Peter Lewis (2007) as Parfitian (Parfit, 1986), Siderian (Sider, 1996) and Lewisian (Lewis, 1983).

Parfit's work on the fission of persons is often cited in resolving some of the puzzles posed by the MWI (e.g. Saunders, 1998; Wallace, 2002; Greaves, 2004). It is a reductionist approach that concerns itself with psychological continuity rather than haecceities. According to Parfit, there are no further facts about personal identity beyond the physical and psychological facts. As such, for Parfit, when a person appears to split in thought experiments involving split brains or teletransporters, the question of which putative successors are genuine is ill-posed. The same answer can be given for the quantum case, which could be interpreted as making sense of the option that there are no genuine successors. What matters for Parfit is not identity, not whether there are "genuine" successors, but whether there is psychological continuity. For Parfit, all successors with claim to psychological continuity are on an equal footing.

Sider's approach is very similar to Parfit's in many respects. Sider explains that the concept of a non-transitive "I-relation" allows me to say that I will have a genuine successor who measures spin-up, and I will have a genuine successor who measures spin-down. I am not strictly numerically identical to either of them. "I" denotes a time slice, a person-stage, me-at-the-present-moment. But I bear the I-relation to both my successors, while neither of these successors bears the I-relation to the other. Sider therefore answers "both". The distinctions between Parfit and Sider do not matter for present purposes. Indeed, Wallace (2012, pp. 280–287) does not distinguish between them, referring instead to the "stage" view.

If the stage view is correct, then it is difficult to make sense of Papineau's argument. What does it mean to say that you learn not only that there is *some* survivor of the quantum suicide experiment, but that *I* am that survivor? If there are no further facts, and if there are just two branches, one where there is a survivor and one where there isn't, what can *I* denote after the measurement but the survivor? On a Parfitian account, any evidence about my essential identity is inadmissible; I must rely instead on qualitative evidence. It is a tautology that the survivor is the survivor, so without a further fact of essential personal identity, there is nothing learned.

It may be supposed that some sleight of hand has occurred here. Departing from quantum suicide for a moment, it seems hard to deny that I learn something when I observe the spin to be up rather than down. Indeed I do. Following Jenann Ismael (2003), what I learn (via my qualitative evidence) is the indexical fact that I am now on the branch where the spin is up, or that I am now the up-observer. But this is only informative because a genuine alternative existed for my future experience; I could have found myself on the "spin down" branch. In the quantum suicide case, this alternative is foreclosed, at least if my death immediately follows branching. There is no corresponding branch where I oxymoronically experience oblivion, so learning that I am on the survivor branch is learning a tautology. Unlike the quantum suicide case, in an ordinary measurement, *I* can denote either the observer of "up" or of "down". There is no tautology in learning which.

A critic, following the "self-locating uncertainty" strategy (e.g., Sebens & Carroll, 2018; Vaidman 2021), might argue that even in a quantum suicide experiment, there may be an interval of ignorance between branching and observation, making it analogous to a normal measurement. In such a scenario, I may be uncertain, for example, about whether I have been fatally irradiated or not. It seems that under such circumstances, there is no reason for certainty that I have not been irradiated, and thus no guarantee of survival. This is a powerful objection, predicated on the existence of a determinate, post-branching, pre-observation period where an observer is ignorant of their location. However, the existence of such a determinate interval is itself a non-trivial assumption that warrants scrutiny. It may be reasonable to analyse cases of delayed observation as if the observation is itself a quantum measurement, appearing from the observer's viewpoint to collapse an environment (including detectors, other observers, etc) in superposition. If observation is measurement, then there can be no period between observation and measurement. Consider also the idea that a vacuum decay initiated 5 billion light-years away is about to arrive. On one plausible view, where branching is an instantaneous, global event, we have always been on a doomed branch, and are in a situation of self-locating uncertainty between branching and observation. On another equally plausible view, branching is a local event that propagates no faster than the speed of light, and we are not in a position of self-locating uncertainty, finding ourselves instead at a time before branching or measurement. Sophisticated Everettians such as Carroll (Sebens & Carroll, 2018) maintain that there is no fact of the matter as to how to analyse this question, suggesting that it may not always be easy to justify a determinate period between branching and observation. This is not intended as a criticism of self-locating derivations of the Born rule, but it

is problematic to suppose that such derivations imply that questions about whether we are already on a doomed branch have determinate answers. A full analysis of such non-ideal cases is a complex issue that warrants its own investigation. However, the primary claim of this paper concerns idealised QI, which is exemplified by physically realistic scenarios like vacuum decay where observation of one's fate is coincident with the event itself (interpreting branching as local). In these cases, there is no room for a period of ignorance. The arguments against QI addressed here do not seem to depend on the existence of a delay, and so it is in this idealised limit that their costs can be most clearly assessed. If these arguments are valid, then they must be valid even in the idealised case.

The remaining account of identity in MWI is that of David Lewis (1983). On the Lewisian view, there is not one person who splits, but two initially qualitatively identical but numerically distinct people who diverge. Before the measurement, I am already on a branch with a foreordained outcome, though I don't know which branch that is until I measure it. As such, only one of my putative successors is genuine – the other is instead a successor of my qualitatively identical counterpart on another branch. But if there is something that distinguishes me from qualitatively identical counterparts, then there is a further fact of the matter regarding personal identity, i.e. haecceity. Upon measurement, I learn not only something about where I am in the wavefunction, but something about that further fact. I learn who I was all along, the version of me who was destined to observe spin up. As such, this account is perhaps compatible with Papineau's argument (though Peter Lewis may disagree)[7]. Unlike the Parfitian/Siderian accounts, *I* does not simply pick out the bearer of some psychological continuity. It no longer tautologically means the survivor, after the experiment. It rigidly designates *me*, the person with my haecceity. The non-tautological and perhaps surprising fact that *I* am the survivor is no more epistemically likely on the MWI than it would have been on an objective collapse theory, blocking any support my survival would grant to the MWI. Those Everettians who embrace Lewisian identity are therefore relatively justified in rejecting retrospective quantum immortality, but they are not austere Everettians, the primary targets of this paper.

It seems that Papineau's argument requires taking a strong stance that the Lewisian account of identity is not only tenable, not only preferred, and not only determinately the correct one, despite positing empirically inaccessible haecceities, but that these haecceities are admissible as evidence so as to block the confirmation of

[7]Peter Lewis (2007) presents arguments that even in this case there is no genuine, pre-measurement uncertainty and only indexical facts to learn, suggesting that the Lewisian account may also be incompatible with Papineau's argument. The argument leans on the idea that our evidence is qualitative and excludes haecceities.

the MWI by quantum suicide. This is a highly problematic assumption, as haecceities are usually deemed to be causally inert and inadmissible as evidence and are assumed not to exist by austere Everettians. Sean Carroll, for example, states in an Ask Me Anything episode of his Mindscape podcast (Carroll, 2024, 1:33:32–1:33:48):

> "I absolutely stick by my opinion that what matters to personhood is continuity of psychological experiences, not some mystical essence that floats from our body from moment to moment."

While in *Something Deeply Hidden* (2019), in his discussion of quantum immortality (pp. 207–209), Carroll states:

> "Any one individual can trace their lives backward in a unique person, but going forward in time we will branch into multiple people. There is not one future self that is picked out as "really you," and it's equally true that there is no one person constituted by all of those future individuals."

Elsewhere in the book (p. 139), discussing identity in general, Carroll cites Parfit as providing an account to show how we should think about our future successors. Papineau (1996) also cites the Parfitian account favourably, albeit in this case as a suggestion for how to resolve a problem not with the MWI exactly but with Lockwood's (1996) formulation of the related Many Minds Interpretation. Wallace compares the Lewisian view to the stage view and tentatively concludes (2012, p. 286) that there may be no fact of the matter, amounting to a denial of haecceity.

To sum up, while Papineau's position on the retrospective case is tenable, it seems to commit him to taking positions on various other questions that he and many other austere Everettians may find unattractive. Firstly, it seems to suggest that coincidences such as fine-tuning cannot be explained anthropically or by observer selection effects, a methodological cost. Secondly, it requires that we must adopt an essentialist notion of personal identity of exactly the kind that austere Everettians such as Carroll (and likely Papineau) disavow and Wallace disfavours, a metaphysical cost for them (if not for Lewisians). As such, it may be preferable for many Everettians to concede that the idea of quantum immortality can be applied retrospectively to confirm MWI. It may yet be that it fails in the prospective case. That is, it may yet be that quantum immortality gives you no reason to expect to survive a future quantum suicide experiment. Let us examine this question next.

3 The prospective case: technical considerations and a sci-fi scenario

In his popular discussion of the MWI, *Something Deeply Hidden*, Sean Carroll (2019, pp. 207–209) explains his skepticism regarding QI. Carroll's view depends on the fact that sudden oblivion is a prospect that many of us find upsetting in its own right, regardless of the grief and suffering our deaths might cause to the bereaved. When coupled to the standard MWI attitude that all branches of the wavefunction stemming from the present one are equally real, we should not discount the branches where oblivion awaits us. That dispreferred outcome is just as much in our future as survival, and so we should avoid playing quantum Russian roulette. A further argument from Carroll suggests that we have little reason to be happy about a situation where we lose one dollar in an even bet on this branch of the wavefunction just because we win a million dollars in another branch. Once branching happens, our two future selves are no longer the same person, and the losses of one self are not compensated for by the gains of another. In the same way, the fact that there exist branches where you survive does not compensate the versions of you that die, from their perspective.

At the heart of more technical Everettian objections to QI lies the Born rule, the rule by which the complex-number-valued amplitudes of the observables of a system in superposition are translated to subjective probabilities as wavefunctions appear to collapse. In an Everettian context, the Born rule, which is simply to square the magnitude of amplitude, can be thought of as an intensity rule, by which some branches of the wavefunction are deemed to be more "intense" than others, corresponding to how they appear to be more subjectively probable. Wallace (2012, Ch. 5) makes a detailed and compelling decision-theoretic derivation of why the Born rule determines how rational agents should form expectations. While being (with David Deutsch, 1999) the architect of the decision-theoretic framework underwriting much of the austere Everettian antipathy to QI, surprisingly Wallace (2012, p. 371) himself does not claim to have any knock-down arguments against prospective quantum immortalism (referred to by Wallace as sensationalism, with mortalism termed deflationism). He explains his dislike for QI by briefly sketching a reductio ad absurdum that if QI amounts to the observation that we cannot experience oblivion, then even in a classical case we should not expect death[8]. Perhaps so, in a certain sense: we can expect our experience to end, but not to experience death itself. Unfortunately, this argument fails to fully engage with QI as it appears to miss the point that only on MWI should we expect to experience

[8] Papineau (2003) makes a similar point in the section "hedonistic values".

survival somewhere, which on a Parfitian view of identity implies that psychological continuity is unbroken and there is no such end in quantum suicide, only a failure to fission. Wallace also endorses Papineau's (2003) argument, which we will discuss next.

Papineau's reply (2003) to Peter Lewis (2000) critiques various reasons to think immortalism is correct[9], two of which critiques are salient here. He sets up the overall question in terms of a comparison of two alternative premisses about what rational agents should value, one congenial to immortalism and the other to mortalism.

The immortalist premiss (per Papineau): rational agents should consider utility for their (living) successors.

The mortalist premiss: rational agents should consider utility across all future branches.

Papineau finds no reason to prefer the immortalist premiss to the mortalist one. On the contrary, he argues that the mortalist one is preferable because it aligns more with conventional thinking, i.e. what we should expect regardless of the truth of the MWI. I concede that Papineau's premiss more closely matches conventional thinking. I disagree that this is a significant advantage, because it is far from clear that we should expect the truth of MWI to make no difference to our decisions. If anything, it is surprising that such a radical reframing as MWI makes as little difference as it does. The intuition that it is reasonable to care about what one will experience, and that one will be certain to experience something on some branch, may well be more persuasive to some. This leaves us with no objective basis on which to make a choice.

Papineau then proceeds to set up and critique various reasons one might have for preferring the immortalist premiss. The first of these he refers to as the issue of hedonistic values. Like Wallace, Papineau rejects the idea that only experiences are valenced and that we should be indifferent to oblivion. While I agree with Papineau that this is not a plausible motivation for immortalism, because otherwise immortalism would not depend on MWI, one point here should be clarified. Papineau asserts that it is not irrational to care about things one cannot experience, giving the example of worrying about what will happen to his garden after his death. This succeeds in showing that the immortalist premiss as he has presented it is implausible. However, his presentation is not quite right. The immortalist only applies this premiss when considering what we should expect to experience, or considerations that derive valence

[9] Again, strictly speaking, these papers concern the Many Minds Interpretation, which is a slightly different gloss on Everettianism than MWI, but the differences need not concern us here.

from personal experience, setting aside issues one might care about regardless of being able to experience them (especially the bereavement of loved ones).

The immortalist premiss (amended): rational agents should consider only their (living) successors when assessing utility derived from personal experience.

The second of these critiques is what Papineau calls "premature renormalisation". The idea is that Peter Lewis's approach incorrectly translates the survivor's 100% chance of survival, as judged by the survivor after the experiment, backwards in time to the subject's chance of survival before the experiment. If survival has intensity 50%, then Papineau argues that the pre-experiment subject objectively has only a 50% probability of survival, and subjective probabilities should ideally track objective probabilities. The problem here is that it assumes that there are objective probabilities in the first place, and on MWI there are not, as, objectively, all allowed outcomes happen with no indeterminacy whatsoever. Instead, there are intensities, and how these become epistemic probabilities as might be deployed by a rational agent to make decisions is exactly the point of contention. Papineau's argument could instead be rescued by suggesting that the agent is already on a branch which leads to one outcome or another even before the experiment, in which case there really would be pre-experiment self-locating probabilities. But this, again, is Lewisian identity, relying on haecceities and so disfavoured by austere Everettians.

More broadly, in his reply to David Lewis (2004), Papineau (2004) characterises the immortalist position (or at least Lewis's) as requiring an unmotivated modification of the intensity rule. I disagree, on the basis that this assumes that there is no ambiguity in the question that the intensity rule is deployed to answer. As implied by the two premisses Papineau identified in his reply to Peter Lewis, there are at least two subtly different ways to interpret the question "What should I expect?".

The Objective Question: What should I expect to happen in the future?
The Subjective Question: In which future(s) should I expect to find myself?

These are different questions, and both questions could be asked regardless of stance on QI more broadly. An immortalist concerned about surviving for the sake of her loved ones may be more interested in the objective question. An immortalist only concerned with the egocentric experience of quantum suicide may be more interested

in the subjective. By appreciating that these are different questions, and that QI concerns the latter, we can see that there is no genuine conflict between immortalism and the Born rule, and that no strange metaphysics are being proposed. The Born rule is assuredly the correct rule for answering all objective questions about what should be expected to happen, including in questions of personal survival. But the subjective question is not a question about what will objectively happen. It is a question about subjective experience that can be thought of as conditional: given that I will have actual successors somewhere in the wavefunction, what should such a successor expect to experience? Only branches where successors exist are relevant. Though of course other branches yet exist, they are discarded from consideration (note: not assigned a utility of zero; discarded altogether) as irrelevant to the conditional question about where my successors should expect to find themselves. Compare with a question like: "Should I have a child, what sort of home environment could I provide?". Having a child might influence where I choose to live or how much income I earn. But where I live and what I earn on childless branches is irrelevant to the question. Only branches where such a child exists are relevant to questions about what the child will experience. I do not weight the income and location differently on those branches. I exclude them from consideration as irrelevant. No metaphysical strangeness is required, and no genuine deviation from the Born rule is proposed. The same is true for QI. It may seem that "What should I expect?" is an innocuous, determinate question with a well-defined answer that all rational people should agree upon, but this is false. The difference between mortalists and immortalists therefore concerns not metaphysics, but how to interpret this question and which interpretation it is rational to care about. Conflation of these interpretations causes much of the debate to go awry.

If, as Wallace admits, there are no knock-down arguments against the immortalist premiss for egocentric utility, I concede that it is yet open to the mortalist to assert that the only rational utility functions are those that consider all future branches. On such a view, it is objectively irrational for me only to care about branches where I exist. Conditional questions such as the subjective question may be asked, but no such question is a valid basis of value. While it is often assumed or argued by decision-theoretic analyses of the MWI (e.g. Wallace, 2012; Deutsch, 1999) that a rational agent must employ a utility function which considers utility across all successor branches, weighted according to the intensity rule, these approaches do not typically consider quantum immortality specifically. This explains Wallace's lack of knock-down arguments, despite his very strong derivation of the Born rule for ordinary measurements. When experiencing successors and successor branches come apart, it is not clear on

what objective basis we should rule out utility functions that take as their scope the former. Therefore, the Deutsch-Wallace decision-theoretic proof, for all its formal power, cannot resolve this dispute. It is a machine for deriving rational preferences given a set of possible rewards. The immortalist's core claim is an axiological one that occurs a step prior: that outcomes of oblivion are not valid candidates for inclusion in a purely egocentric utility calculation in the first place. The formal proof begins too late to adjudicate this fundamental conflict of values.

Perhaps one might propose that an objectively pragmatic measure of rationality looks at how often an agent manages to succeed at achieving its goals. If an agent's goals include or imply survival, as they often do, then from an objective third-person perspective, immortalist agents are less rational than mortalist ones, being more inclined to risk sacrificing themselves for trivial expected gains. It seems that this line of argument again begs the question, however, by presupposing that what agents value is objective survival across all branches rather than subjective survival somewhere. Perhaps the only avenue for the mortalist is therefore to take this as an axiomatic brute fact. It is true that Wallace's derivation of the Born rule requires the assumption of certain axioms of rationality, but austere Everettians nevertheless should prefer to keep the number of such axioms to a minimum. Axioms about the rationality of differently-scoped utility functions are unnecessary to derive the Born rule, have no empirical motivation, and are hence perhaps too arbitrary, adding a layer of non-physical, normative reality to an ontology that MWI is often praised for simplifying.

This need to avoid arbitrary axioms is especially important as they could significantly exacerbate a potential weakness of Wallace's derivation, as the existing axioms are not uncontroversial. Tim Maudlin (2014) suggests that Wallace's axioms do not correctly capture how an Everettian who has preferences about other branches (as opposed to just the current branch) should reason. Maudlin's strongest example concerns an Everettian student who wants to study both physics and history full-time and decides to achieve this goal by flipping a quantum coin so that physics is studied on one branch and history on another. However, it seems implausible that a conventionally rational student thirsty to pursue both history and physics should be satisfied by a course of action where each successor will only experience one and miss out on the other. As Carroll notes, one successor's losses are not compensated for by another successor's gains; after the split, they are different people. An axiom adopted purely to defeat immortalism would be much harder to support, as there are concrete examples of prominent Everettians such as Max Tegmark who claim that immortalism is

rational. If we are unwilling to pay the cost of adding such an axiom, then it seems we may be at an impasse.

The difference between mortalists and immortalists in the prospective case therefore arguably amounts to a subjective preference, leaning on intuitions perhaps more clearly emphasised by Carroll (2019) than by Wallace or Papineau. Even so, we may find good reasons for such preferences if we compare them carefully. To that end, let us consider a thought experiment. This thought experiment is structurally analogous to the usual quantum suicide "Russian roulette" thought experiment discussed by Squires and Tegmark, though, as suggested by Daniel Dennett (2013), it can be informative to 'turn the knobs' on an intuition pump to test what is doing the work and so examine whether Carroll's intuitions are robust.

Twenty years from now, a breakthrough reveals a radically new technology for harnessing energy from nuclear fusion cheaply and cleanly. Neo-fusion technology is developed and rolled out as soon as possible and, by forty years from now, it is ubiquitous, responsible for almost all of humanity's energy production.

New observations of particle collisions inspire new theoretical proposals to unite quantum mechanics and gravity, explaining dark matter and energy to boot. The new theoretical paradigm survives every test, and by sixty years from now it is universally accepted and fundamental physics appears to be complete.

However, team of theoretical physicists learns that, according to this new paradigm, our nuclear fusion reactors should be creating bubbles of true vacuum at an extremely alarming rate, such that we should all expect to be destroyed in the next five minutes by vacuum decay, despite the fact that the reactors have been in use at this point for over twenty years. This is difficult to accept, and so there is much debate. Arguments such as Tegmark's (1998) are put forth to attribute our survival to the truth of the MWI and quantum immortality. Arguments such as Papineau's (2004) retrospective argument are marshalled against this, and suggest that there must be something wrong with our theoretical understanding. Eventually, when no better theoretical explanations are forthcoming, and perhaps due to considerations such as those I outline in my response to Papineau's retrospective argument, Tegmark's retrospective view wins the day, and a scientific consensus emerges that the MWI is true, that our technology is destroying us constantly, that it has been doing so for over twenty years, and that we only experience subjective survival due to retrospective quantum immortality. This does not settle the prospective case, however.

The mortalists are at first extremely upset, but a state of constant terror is not sustainable for very long. The world has all the appearance of a stable utopia. Though

intellectually they know they should expect to die any moment, they struggle to feel this intuitively. Some mortalists revert to their base emotional states relatively quickly. Others continue to feel a persistent, nagging anxiety that won't go away. All mortalists agree that it is quite clear that the reactors must be stopped.

Unfortunately, this is not so easy. There is little agreement on what to do. Most laypeople are skeptical of the scientific consensus for anthropogenic vacuum decay, a truth that is a little too inconvenient to be readily believed. The experience of survival at such long odds has convinced many mortalists to convert to immortalism. Even among the remaining mortalists, there are those who argue for a slow, planned phase-out of neo-fusion technology and those who argue for immediately pulling the plug. The immediatists are accused of irresponsibility. Given our dependence on this technology, any immediate closure of the reactors would certainly lead to scarcity, economic collapse, famine and war. The gradualists are accused of holding an inconsistent position: as bad as the consequences of pulling the plug might be, they are better than the almost certain destruction of not only the earth but ultimately of everything within our future light cone with every hour we allow our reactors to run.

Without a consensus to act, nothing is done. The scientific consensus is only consolidated, and becomes more and more accepted by the public. As time passes, any sense of urgency diminishes. Immediatism becomes less attractive. Gradualism remains inconsistent. For these reasons, even many mortalists become resigned to the status quo, developing the view that we should expect to die but be unconcerned about it. But more people become immortalists, particularly a new generation exposed to these ideas from a young age. Over time, "concerned mortalism" becomes a fringe position, with concerned mortalists regarded as fanatics. Immortalism wins out not by having a better argument, but for economic, social and psychological reasons. We have finally accommodated to anthropogenic vacuum decay.

The following "knobs" have been turned on our intuition pump to depict as ideal a QI scenario as possible.

1. Quantum suicide is no longer an insanely nihilistic experiment motivated merely by a desire to confirm MWI, but an unintended consequence of a technology of enormous societal benefit (on the rare branches where society is not destroyed).
2. There is no longer any lingering concern for the bereaved, or even those who have to clean up the mess.

3. The odds of survival are much lower. The experiment has been going on for much longer, and at a greater frequency, so that regarding survival as merely lucky is no longer tempting.
4. Related to the above, there is no longer any doubt that MWI is true.
5. The experiment is not performed at discrete intervals, any one of which we can consider opting out of, but is ongoing and continuous, with death predicted to come at any time in the very near future.
6. It is no longer so easy to stop participating in the experiment; the experiment can only be halted with enormous collective effort over time, at least without the disastrous, apocalyptic consequences that would ensue if we simply turned the reactors off without a plan.
7. Death is instantaneous, with the bubble of true vacuum expanding at the speed of light; there is never issue of whether one is already on a doomed branch (assuming branching is local).

If Carroll's argument is right, then the appropriate response for our protagonists would seem to be terror, insofar as one is predisposed to feel terror at the prospect of rapidly approaching death. Some initial terror seems plausible. But it is not plausible that it continues indefinitely. This is not the situation of a terminal patient, anticipating a death that approaches ever closer. This is a situation where death is expected to be imminent, but sustained over decades. Even the intellectual belief that we should expect to die immediately seems difficult to sustain when faced with the lived experience of a safe, stable environment. We are by nature inductive reasoners. We expect the future to be like the past.

The psychological impact on the protagonists in our story is relevant not least because one of the axioms of rationality Wallace (2012, Ch. 5) uses to derive the Born rule is that of diachronic consistency. This axiom requires that the preferences of a rational agent must be consistent over time. Those mortalists who change their mind on experiencing quantum immortality are therefore arguably irrational by this standard. However, there is a problem for this line of argument. It could be argued that the immortalist successors of an erstwhile mortalist are in the minority – the vast majority are dead, and have no preferences at all. The correct interpretation of this axiom in this case is therefore indeterminate in cases of survival. If anything, this issue is illustrative of the problematic nature of naively attempting to apply Wallace's derivation of the Born rule directly to Ql.

If there is no objective truth, no uniquely rational attitude, then applying diachronic consistency to the survivors may yet be grounds for taking one attitude to be more fitting in some sense. Regard this as a case of speculative thought-experimental philosophy, in the spirit of experimental philosophy, in that it takes seriously what ordinary people would think (albeit in a situation we cannot practically put them in). If my speculations are correct, then prospective quantum immortalism is the better account, better capturing what humans care about and how humans actually would reason in such cases upon reaching a psychological equilibrium (i.e., after recovering from any initial shock and working through the issues) and eliminating any potential confounders (e.g. lingering worries about the bereaved). Carroll's views are considerably less likely than he himself to survive a protracted and repeated quantum suicide experiment like anthropogenic vacuum decay, and if so they are neither diachronically consistent nor reflective of the preferences such an experiment might reveal.

It may be asked: are not our protagonists merely freak observers, in an epistemically tragic situation, unable to form true beliefs because of the freakish nature of their evidence? Consider instead that perhaps our situation is the more epistemically tragic one, limited as we are to forming beliefs about quantum suicide despite never having experienced it. Or perhaps talk of epistemic tragedy is wrongheaded. If we wish to avoid paying the requisite metaphysical costs of Lewisian identity or brute facts about which utility functions are rational, then prospective QI is indeterminate. If there is no fact of the matter, then there are no epistemically tragic situations, because there is no objective truth to be had. Immortalists might instead argue that we should be suspicious of the reasoning of our protagonists, as they are subject to known cognitive biases such as normalcy bias. This is a fair observation of the psychological mechanisms that may be in play, but it does not invalidate the conclusion. We need not regard these psychological tendencies as mere cognitive bias; rather, they can be seen as a form of revealed preference, a practical test that uncovers which framework is actually livable. In a situation where the standard tools of objective, third-person rationality are inadequate, the question of which framework is diachronically consistent, pragmatically coherent and stable under sustained, first-person experience remains a salient, non-arbitrary criterion for an agent to adopt.

There is certainly room to doubt these speculations, but in the absence of proof either way, they should serve to at least make the case that quantum immortality should not be dismissed too easily by austere Everettians such as Carroll.

4 Conclusion

I have identified two distinct applications of the idea of quantum immortality: a retrospective case and a prospective case. The retrospective case applies quantum immortality to confirm MWI after a quantum suicide experiment. The prospective case applies quantum immortality to anticipate survival of a future quantum suicide experiment. I have shown that there is room to reject quantum immortality in both cases, but only by incurring methodological and metaphysical costs which may not be palatable to austere Everettians of a reductionist mindset.

Because Papineau's argument against retrospective quantum immortality relies on the same logical structure as the "This Universe" critique of anthropic reasoning, it incurs the methodological cost of also rejecting all anthropic explanations, in particular anthropic explanations of the fine-tuning of the physical constants. Furthermore, it incurs the metaphysical cost of accepting a non-reductionist, essentialist account of personal identity, both costs in contradiction of the stated views of prominent Everettian quantum mortalists such as Carroll and Wallace and of the assumed views of the target of this paper: austere Everettianism.

I argued that Papineau's arguments against rejecting prospective quantum immortality either mischaracterise or fail to identify any objective mistake in the reasoning of quantum immortalists. Arguments against prospective quantum immortality as determinately irrational or incorrect seem to demand paying one or both of two metaphysical costs. Mortalists may once again pay the cost of accepting Lewisian essentialist personal identity, or they may pay the cost of accepting value realism with respect to a specific account of which sorts of utility functions a rational agent must adopt. I argued that if, on the other hand, mortalists accept that there is no fact of the matter on prospective QI but instead reject it as merely an implausible account of what humans in fact do value, then the question becomes an in-principle-empirical one concerning human psychology. Since practical experiments to investigate this matter are anything but, I proposed an alternative thought experiment which aims to make plausible that immortalism is the more psychologically tenable of the two prospective stances to quantum suicide, arguing that in the absence of a unique determinately rational attitude, diachronically consistent psychological tenability emerges as a salient, non-arbitrary criterion.

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