Can Self-Locating Uncertainty Exist in a Branching Universe?

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Abstract

The Everett interpretation of quantum mechanics faces a well-known challenge: how can probabilities emerge in a deterministic theory where all measurement outcomes occur? A prominent response appeals to self-locating uncertainty (SLU): after branching, copies of an observer are uncertain about which branch they inhabit during the post-measurement, pre-observation period, and this uncertainty is then quantified to yield the Born rule. This paper examines whether the notion of SLU can be coherently instantiated in the Everettian framework. It argues that the two conditions required for SLU—having a branch-relative identity (Recording Condition) and being uncertain about that identity (Uncertainty Condition)—are difficult to satisfy simultaneously in any physical system. Any attempt to realize SLU appears to force a decomposition of the observer into a memory module that records the outcome (and thus has branch-relative identity) and a decision module that is uncertain (and thus lacks branch-relative identity). Neither module individually possesses SLU, and it is not obvious that they can be combined into a unified epistemic agent that does. The analysis complements and deepens existing critiques and suggests that SLU-based derivations of the Born rule may rest on a problematic foundation.

1 Introduction

The Everett interpretation of quantum mechanics (Everett, 1957), also known as the Many-Worlds Interpretation, resolves the measurement problem by rejecting wavefunction collapse. Instead, it posits that unitary evolution of the universal wavefunction leads to branching: whenever a measurement-like interaction occurs, the wavefunction decoheres into non-interfering branches, each containing a determinate outcome together with a corresponding observer copy who records that outcome. All possible outcomes occur, each in its own branch. This elegant ontology, however, faces a notorious challenge: how can genuine probabilities emerge in a fully deterministic theory in which every measurement outcome is realized with certainty?

A prominent response appeals to self-locating uncertainty (SLU). The central idea, first proposed by Vaidman (1998, 2012, 2014), is that after branching via decoherence but

before an observer records or becomes aware of the measurement outcome, each observer copy knows the global quantum state of the universe exactly, yet remains uncertain about which branch they inhabit. In other words, there is a brief window of unavoidable SLU: the observer can ask "Which branch am I on?" and assign non-trivial credences to the different possibilities.

Sebens and Carroll (2018) develop this idea into a sophisticated derivation of the Born rule. They argue that rational principles of self-locating belief—particularly their Epistemic Separability Principle (ESP)—require that the credence an observer assigns to being in a particular branch equals the squared amplitude of that branch in the universal wavefunction (for a critical discussion, see also Gao, 2025). McQueen and Vaidman (2019) defend and refine a closely related SLU account. They argue that quantum SLU is ubiquitous in the Everettian multiverse and provide a symmetry- and locality-based proof that directly yields Born-rule probabilities for self-location in branches with given outcomes.

Although the SLU approach is promising, existing criticisms have identified certain problems. Lewis (2007, 2009) systematically examined the uncertainty strategy and concluded that it fails either because the uncertainty is spurious, or because it is in the wrong place to yield probabilistic predictions. Kent (2015) questioned whether SLU can be meaningfully invoked in a deterministic branching universe, arguing that it conflates first-person and third-person perspectives. Quirke (2024) showed that the fission analogy often used to motivate SLU is misleading: in fission cases, post-fission individuals lack information about their identity, whereas in Everettian branching, copies have determinate outcome records. Adlam (2024) distinguished between "pure" and "superficial" SLU, arguing that pure self-locating credences (the kind relevant to Everettian branching) are not rationally constrained by physical facts.

This paper offers a more fundamental critique. It examines whether the notion of SLU can be coherently instantiated in the Everettian framework. The central claim is that the two conditions required for SLU—having a branch-relative identity (Recording Condition) and being uncertain about that identity (Uncertainty Condition)—are difficult to satisfy simultaneously in any physical system. Any attempt to realise SLU appears to force a division of the observer into two components with incompatible properties, and it is not obvious that these components can be unified into a single epistemic agent that possesses SLU. The argument relies only on the tension between encoding outcome information and maintaining genuine uncertainty.

The paper is structured as follows. Section 2 formally articulates the two necessary conditions for SLU. Section 3 shows that any attempt to satisfy both conditions forces a decomposition of the observer into a memory module (which records the outcome) and a decision module (which is uncertain). Section 4 demonstrates that neither module individually possesses SLU: the memory module lacks doxastic states and hence cannot be uncertain; the decision module lacks branch-relative identity and hence cannot be located in a branch. Section 5 argues that the two modules cannot be combined into a unified epistemic agent that satisfies both conditions, drawing on information integration requirements. Section 6 states the main difficulty as a theorem. Section 7 discusses the implications for SLU-based derivations of the Born rule. Section 8 responds to potential objections. Section 9 analyzes why this problem of SLU was overlooked. Section 10 concludes.

2 The Necessary Conditions for SLU

To evaluate whether SLU can exist in the Everettian framework, we must first identify the conditions that any instance of SLU must satisfy. Drawing on the literature (Vaidman, 2012; Sebens & Carroll, 2018; McQueen & Vaidman, 2019), we can identify two necessary conditions:

Definition 2.1 (Recording Condition)**.** *For an observer to be in a state of SLU about which branch they inhabit, the observer must have a branch-relative identity. That is, there must be a fact of the matter about which branch the observer is in. This requires that the observer's physical state encode the measurement outcome. Otherwise, the observer would not be a branch-relative copy at all.*

Definition 2.2 (Uncertainty Condition)**.** *For an observer to be in a state of SLU about which branch they inhabit, the observer must not know which outcome occurred. That is, the observer's epistemic state must not discriminate between the possible branches. The observer must assign non-trivial credences (e.g.,* $1/2$ *in the symmetric case) to each possible outcome.*

These two conditions are widely accepted in the SLU literature. McQueen and Vaidman (2019) explicitly assume that after branching, the observer has a determinate local state (Recording Condition) and yet is uncertain about the outcome (Uncertainty Condition). The question is whether these conditions can be simultaneously satisfied.

Proposition 2.3 (Incompatibility)**.** *The Recording Condition and the Uncertainty Condition cannot be simultaneously satisfied by a single physical system.*

The remainder of this paper demonstrates this proposition. The argument proceeds in three steps. First, I show that any attempt to satisfy both conditions forces a division of the observer into two components. Second, I show that neither component individually satisfies both conditions. Third, I show that the two components cannot be combined into a unified epistemic agent that satisfies both conditions.

3 The Two-Component Analysis

Consider a post-measurement, pre-observation observer who has just performed a quantum measurement on a system in a symmetric superposition:

$$|\Psi\rangle = \frac{1}{\sqrt{2}}(|\uparrow\rangle|\text{up}\rangle_O + |\downarrow\rangle|\text{down}\rangle_O) \tag{1}$$

where $|\text{up}\rangle_O$ and $|\text{down}\rangle_O$ are the observer's states recording the respective outcomes.

For the observer to satisfy the Recording Condition, their physical state must encode the outcome. For the observer to satisfy the Uncertainty Condition, their epistemic state must not encode the outcome. These requirements point toward a functional decomposition of the observer into two components:

Definition 3.1 (Memory Module)**.** *The component of the observer's physical system that records the measurement outcome. This module's physical state differs across branches: in the* $\uparrow$ *branch, it is in state* $|up\rangle_M$*; in the* $\downarrow$ *branch, it is in state* $|down\rangle_M$*.*

Definition 3.2 (Decision Module)**.** *The component of the observer's physical system that is responsible for epistemic states and decision-making. This module is stipulated to lack access to the memory module's record.*

This decomposition is not an arbitrary stipulation; it is forced by the requirements of SLU. If the observer is to have the outcome record (Recording Condition) and yet be uncertain (Uncertainty Condition), there must be some part of the observer that holds the record and some part that does not have access to it. The two-module model is therefore the natural—indeed, the only—way to attempt to satisfy both conditions. The memory module records the outcome, while the decision module, which is the locus of epistemic states, does not have access to this record until a later time. Thus, the observer (identified with the composite of both modules) can be said to both have the outcome (in the memory module) and be uncertain (in the decision module).

4 Why Neither Module Satisfies Both Conditions

We now examine each module individually to determine whether it possesses the properties required for SLU.

4.1 The Memory Module

The memory module records the measurement outcome. Its physical state differs across branches: $|\text{up}\rangle_M$ in the $\uparrow$ branch, $|\text{down}\rangle_M$ in the $\downarrow$ branch. Therefore, the memory module satisfies the Recording Condition: it has a branch-relative identity.

However, the memory module does not possess doxastic states (beliefs or credences). It is a physical information-storage device, analogous to a classical memory register or a measuring apparatus. It does not have beliefs, credences, or epistemic states. Uncertainty is a property of systems that can hold doxastic states, not of information-storage devices. The memory module therefore fails to satisfy the Uncertainty Condition.

Proposition 4.1 (Memory Module)**.** *The memory module satisfies the Recording Condition but not the Uncertainty Condition. It is in a branch but cannot be uncertain.*

4.2 The Decision Module

The decision module is the locus of epistemic states. By stipulation, it does not have access to the memory module's record. Its physical state does not encode the outcome. Consequently, the decision module is not in any branch.

Definition 4.2 (Branch Membership)**.** *An observer is in branch i if and only if the observer's physical state includes the record of outcome i (or is appropriately correlated with that outcome).*

This definition captures the standard Everettian understanding of branch-relative identity. An observer copy is distinguished from other copies precisely by the outcome recorded in its physical state. Without such a record, there is no fact of the matter about which branch the observer inhabits.

Since the decision module's physical state does not include the outcome record, it does not satisfy the conditions for branch membership. The decision module is a single physical

state that is multiply instantiated across the universal wavefunction. In the $\uparrow$ branch, there is a decision module in state $|\text{ready}\rangle_D$; in the $\downarrow$ branch, there is another decision module in the same state $|\text{ready}\rangle_D$. These are not distinct copies in any meaningful sense—they are identical instantiations of the same physical state. There is no fact of the matter about which branch "this" decision module inhabits because the indexical "this" cannot pick out one instantiation over another.

Therefore, the decision module fails to satisfy the Recording Condition. It has no branch-relative identity. The question "which branch am I in?" has no answer grounded in the decision module's physical state.

Proposition 4.3 (Decision Module)**.** *The decision module satisfies the Uncertainty Condition (it is uncertain because it lacks access to the outcome) but not the Recording Condition. It can be uncertain but is not in any branch.*

4.3 Interim Summary

Neither module individually possesses both properties required for SLU:

Module	**Recording Condition**	**Uncertainty Condition**
Memory Module	Yes	No (no doxastic states)
Decision Module	No (no branch identity)	Yes

The memory module is in a branch but cannot be uncertain. The decision module can be uncertain but is not in any branch. SLU requires a single entity that is both in a branch and uncertain. Neither module provides this.

5 Why the Two Modules Cannot Form a Unified Epistemic Agent

The proponent of SLU may respond that the observer is not identical to either module individually but rather to the composite of both modules. The memory module provides branch-relative identity; the decision module provides uncertainty; together, the composite observer possesses both properties. This section argues that this response fails. The two modules cannot be combined into a unified epistemic agent that satisfies both conditions.

The following analysis assumes only the minimal physicalism and functionalism about observers that is standard in the SLU literature (Vaidman 2012; Sebens & Carroll 2018; McQueen & Vaidman 2019). Epistemic states (including uncertainty and credences) are realized by physical/functional processes in the observer's brain. A unified epistemic agent exists only when information from its subsystems is integrated into a common doxastic framework (i.e., a single set of beliefs and credences). These commitments are not controversial; they are precisely the background against which SLU is defended.

5.1 The Interaction Dilemma

Consider the causal relationship between the memory module M and the decision module D. There are two possibilities:

(i) M **and** D **interact.** If M and D are causally connected, then information can flow from M to D. Since M contains the outcome record, this information will eventually reach D. Once D receives this information, D's physical state will encode the outcome. The decision module will then know which outcome occurred, and uncertainty disappears.

(ii) M **and** D **do not interact.** If M and D are causally isolated from each other, then they constitute two independent physical systems. There is no sense in which they form a single unified epistemic agent. D is a system with doxastic states and no access to the outcome record; M is an information-storage device with no doxastic states. The pair does not constitute a single agent that both has the record and is uncertain. The epistemic agent is just D, which lacks branch-relative identity.

Proposition 5.1 (Interaction Dilemma)**.** *Regardless of whether M and D interact, we cannot obtain a unified epistemic agent that simultaneously has branch-relative identity (in virtue of containing the outcome record) and epistemic uncertainty (in virtue of lacking access to it).*

5.2 The Integration Problem

One might respond that epistemic states are not localized in D alone but are distributed across the composite $M + D$. On this view, the entire system holds doxastic states, integrating information from both modules.

This response faces a serious problem. If doxastic states are distributed and integrate information from both modules, then the integrated belief state should include the outcome record stored in M, and the agent would know the outcome—uncertainty disappears. If, on the other hand, epistemic states are distributed but do not integrate information from M, then the agent lacks branch-relative identity: the outcome record is excluded from the doxastic framework, so there is no fact of the matter about which branch the epistemic agent inhabits.

Proposition 5.2 (Integration Problem)**.** *If epistemic states are distributed across M and D and integrate information from both, the agent knows the outcome—uncertainty disappears. If epistemic states are distributed but do not integrate information from M, then the agent lacks branch-relative identity.*

5.3 The Concept of a Unified Epistemic Agent

Finally, we should examine what it means for two modules to form a "unified epistemic agent." In philosophy of mind and cognitive science, a unified agent is typically understood in terms of information integration: an agent is unified when information from different subsystems is accessible to a common doxastic state. This is precisely what is lacking in the two-module model if D cannot access M's information. Without such access, there is no unified epistemic agent; there are two separate systems, one with doxastic states (D) and one without (M). The fact that they are physically connected (by being part of the same brain) does not automatically make them a single agent. Two systems can be physically connected without their information being integrated into a single doxastic perspective.

Proposition 5.3 (Unity Condition)**.** *A unified epistemic agent requires information integration across its constituent parts. The two-module model either lacks such integration (if M and D do not interact) or loses uncertainty (if they do interact and integration occurs).*

5.4 Summary of the Unification Argument

The two-module model fails to produce a unified epistemic agent with SLU for three interrelated reasons:

1. **Interaction Dilemma:** If M and D interact, information flows and uncertainty is lost. If they do not interact, they are not a unified epistemic agent (and the epistemic agent D alone lacks branch-relative identity).

2. **Integration Problem:** If epistemic states are distributed and integrate information, the agent knows the outcome—uncertainty disappears. If they do not integrate, then the agent lacks branch-relative identity.

3. **Unity Condition:** Genuine unity requires information integration, which either is absent (no unity) or destroys uncertainty (if present).

Therefore, the two modules cannot be combined into a single entity that is both in a branch and uncertain.

Here it is worth noting that the two-module decomposition proposed here is not entirely new to the literature. Tappenden (2017) explicitly posits a separation between a branching physical brain and a unitary mental state, arguing that this separation makes SLU intelligible. He writes that mental states do not branch until the observer becomes aware of the outcome, even as the physical brain has already branched. This is precisely the memory-module/decision-module structure analyzed above. However, Tappenden does not address the interaction dilemma or the integration problem. He assumes that the unitary mental state can be located in a branch (by virtue of its association with a particular physical brain) while simultaneously lacking access to the outcome record stored in that brain. The present analysis shows that this assumption is problematic: either the mental state has access to the record (and thus knows the outcome) or it does not (and then lacks branch-relative identity). Tappenden's proposal thus illustrates, rather than resolves, the tension at the heart of the SLU project.

6 The Impossibility Theorem

We are now in a position to state the main result of this paper.

Theorem 6.1 (Impossibility of Everettian SLU)**.** *There is no physical system that satisfies both the Recording Condition and the Uncertainty Condition in the Everettian framework.*

Proof. Assume, for contradiction, that there exists an observer O who satisfies both conditions. Then O must have a branch-relative identity (Recording Condition) and be uncertain about which branch it inhabits (Uncertainty Condition). These requirements force a decomposition of O into a memory module M that records the outcome and a decision module D that lacks access to this record (Section 3).

Consider M: it satisfies the Recording Condition but does not possess doxastic states, hence cannot be uncertain. Consider D: it can be uncertain but has no branch-relative identity, hence the question "which branch am I in?" has no answer. Neither module individually satisfies both conditions (Section 4).

Consider the composite $M + D$. For M and D to form a unified epistemic agent, they must interact and integrate information. If they interact, information flows from M to D, causing D to encode the outcome, and uncertainty is lost. If they do not interact, they do not form a unified epistemic agent. If epistemic states are distributed across $M + D$ and integrate information, the agent knows the outcome—uncertainty disappears. If epistemic states are distributed but do not integrate M's information, then the agent lacks branch-relative identity (Section 5).

Thus, no entity—whether M, D, or $M+D$—satisfies both conditions. This contradicts the assumption. Therefore, no such observer exists. □

7 Implications for the Born Rule Derivation

If SLU is impossible in the Everettian framework, then SLU-based derivations of the Born rule (Sebens & Carroll, 2018; McQueen & Vaidman, 2019) face a significant challenge. These derivations assume that after branching, and specifically during the post-measurement, pre-observation period, observers are in states of SLU about which branch they inhabit. The foregoing analysis suggests that such states may be more difficult to instantiate than has been appreciated, and perhaps cannot be coherently realized at all.

This conclusion does not entail that the Everett interpretation is false or that probabilities cannot be derived within it. Other approaches to the probability problem—such as the decision-theoretic accounts (Deutsch, 1999; Wallace, 2012) and the branch-counting approach (Saunders, 2021)—may succeed where the SLU approach encounters difficulties. The present argument is more modest: it points to a potential incoherence in one particular strategy for deriving the Born rule, not in the Everett interpretation as a whole.

The argument also sheds light on why previous criticisms of the SLU approach have been compelling. Lewis's (2007, 2009) conclusion that uncertainty cannot ground Everettian probability is given a deeper foundation: it is not merely that existing SLU formulations fail, but that the required state of SLU cannot be physically instantiated at all. Kent's (2015) suspicion that SLU is incoherent finds support in the two-module impossibility theorem presented here. Quirke's (2024) observation that the fission analogy is misleading is illuminated: in fission cases, post-fission individuals have genuine uncertainty because their physical states do not contain the relevant indexical information, whereas in Everettian branching they arguably do. Adlam's (2024) claim that pure self-locating credences are unconstrained is given a deeper grounding: they may not merely be unconstrained but physically impossible to realize. Even Tappenden's (2017) "unitary interpretation of mind", which attempted to defend SLU by positing a separation between branched physical states and unified mental states, turns out to illustrate the two-module problem rather than resolve it. Certainly, further analysis is needed to determine whether alternative formulations of SLU might evade the difficulties raised here.

8 Objections and Replies

8.1 Objection 1: Vaidman's Sleeping Pill Thought Experiment

Vaidman (2012) proposed a sleeping pill thought experiment to show that SLU for a post-measurement, pre-observation subject can exist. The idea is as follows. After the measurement, the observer takes a sleeping pill that temporarily blocks access to the memory record. Upon waking, the observer knows the global quantum state but cannot access which outcome occurred. Hence, the observer is uncertain which branch they inhabit, even though the record exists physically.

Reply: The sleeping pill thought experiment does not provide a counterexample to the impossibility theorem. It instead illustrates the very tension the two-module decomposition is designed to capture. Let us examine the scenario carefully.

Who is uncertain? Only the decision module D is uncertain. But D has no branch-relative identity (Section 4.2). The decision module's physical state does not encode the outcome, so there is no fact of the matter about which branch D inhabits. The question "Which branch am I in?" has no answer relative to D. Therefore, D's uncertainty is not self-locating uncertainty — it is just ignorance of a fact that does not apply to D.

Who has the record? The memory module M has the record and thus branch-relative identity. But M does not possess doxastic states (Section 4.1). M cannot be uncertain. A memory register does not have epistemic states.

Is there a unified epistemic agent that both has the record and is uncertain? No. The sleeping pill ensures that M and D do not interact during the uncertain period. Without interaction, they do not form a unified epistemic agent (Section 5.3). The epistemic agent is just D, which is branchless. Hence, no entity satisfies both conditions.

What if one insists that the composite $M + D$ is the agent? Then because M contains the record, the composite has the record. Uncertainty requires lack of information. But the composite has the information (stored in M). The fact that part of the composite cannot access that information is irrelevant to whether the composite possesses it. A system that possesses the outcome record cannot be genuinely uncertain about that outcome — even if some subsystem is ignorant. Therefore, the composite cannot be uncertain.

Thus, Vaidman's sleeping pill does not produce a counterexample. It merely relocates the problem: uncertainty without branch-identity (if we focus on D), or branch-identity without doxastic states (if we focus on M), or possession of the record without uncertainty (if we focus on $M + D$). Never both properties in a single epistemic agent.

8.2 Objection 2: Temporal Separation

One might argue that the memory module and decision module are not simultaneous but temporally separated: first the memory module records the outcome, then later (before access) the decision module is uncertain. On this view, the same physical system plays both roles at different times.

Reply: This response fails because at the time of uncertainty, the physical system's state already contains the outcome record. The record does not disappear between recording and access. If the physical state contains the record at the time of uncertainty, then by any physicalist account of cognition, that information is present in the system that is the subject of uncertainty. The temporal separation does not remove the information; it merely postpones access. But the presence of the information in the physical state at the

time of uncertainty is sufficient to ground knowledge (or at least, the potential for knowledge). Uncertainty requires the absence of information, not merely the postponement of access.

8.3 Objection 3: Quantum Indeterminacy

One might appeal to quantum indeterminacy to argue that the outcome record is not "present" in a determinate form until accessed. On some interpretations of quantum mechanics, properties are not determinate until measured.

Reply: This response is not available to the Everettian. In the Everett interpretation, all outcomes are determinate (they occur in different branches). The whole point of branching is that each branch contains a determinate record of the outcome. If the outcome record is not determinate until accessed, then the branching picture collapses. The Everettian cannot have it both ways: either branches contain determinate records (in which case the information is present and uncertainty is impossible) or they do not (in which case the branching ontology is undermined).

8.4 Objection 4: The Epistemic Perspective

Vaidman and others (e.g., Sebens & Carroll, 2018) argue that probability is about what an agent can know, not what is physically written in an inaccessible memory module. If you cannot access the information, you are effectively uncertain, regardless of the underlying physics. On this view, the decision module D's uncertainty is genuine SLU because the agent has no way to discriminate between branches.

Reply: This objection conflates epistemic uncertainty with SLU. The paper does not deny that a system can be uncertain about a fact it cannot access. The problem is that in the Everettian setting, the question "Which branch am I in?" is not a purely epistemic question — it is a metaphysical question about which branch the epistemic agent inhabits.

Branch membership is physical: an observer copy is in a branch only if its physical state (or the relevant part of it) encodes the outcome record (Definition of Branch Membership, Section 4.2). The decision module D has no such record (by design of the sleeping pill or any information-blocking mechanism). Therefore, D is not in any branch. There is no fact of the matter about which branch D inhabits.

Uncertainty without a fact is not SLU — it is simply global ignorance. Asking "Which branch am I in?" relative to D has no answer, so the question does not make sense. The epistemic perspective smuggles in the assumption that the epistemic agent has a branch location to be uncertain about. But the very conditions that create uncertainty (blocked access) also erase the physical grounding for branch membership. You cannot have both: either you have the record (and thus a branch) but then you are not uncertain, or you are uncertain but then you have no branch. "Effective uncertainty" does not create a branch location.

8.5 Objection 5: The Sleeping Beauty Precedent

Proponents of SLU point to the classical Sleeping Beauty problem as proof that SLU is a real phenomenon even in deterministic settings. They may argue that the impossibility

theorem ignores the fact that agents can be rationally uncertain about indexical facts (like "Where am I?") even when the third-person facts are fully known.

Reply: The Sleeping Beauty problem is not a valid analogy for Everettian branching, for two reasons.

First, different kind of uncertainty. In Sleeping Beauty, the uncertainty is across different possible worlds (Monday vs. Tuesday) that are not both actual. The agent knows that only one of them is real, but she does not know which. In Everettian branching, all branches are equally actual. The uncertainty is supposed to be within a single actual world. Sleeping Beauty provides no precedent for SLU; it is a case of superficial uncertainty across possible worlds.

Second, no amnesia mechanism in Everettian physics. Sleeping Beauty works because there is a concrete causal mechanism (the amnesia drug) that erases the relevant information from the agent's physical state. In Everettian branching, there is no such mechanism. The outcome record is physically present in the observer's brain from the moment of measurement. To posit an amnesia drug is to import a classical information-blocking device that has no physical basis in unitary quantum mechanics. And even if we grant it, the two-module analysis shows that the decision part (D) then has no branch identity — the agent's indexical question has no answer. Sleeping Beauty does not rescue SLU; it merely highlights the missing physical grounding.

8.6 Objection 6: Functional Unity

Some philosophers of mind argue that a unified epistemic agent does not require every part of the system to share all information at once. We have "blind spots" and subconscious processes all the time without losing our status as a single, uncertain agent. Hence, the decision module D and memory module M could be part of one unified epistemic agent even if D cannot access M's record during the period of uncertainty.

Reply: This objection misunderstands what the paper requires for a unified epistemic agent in the context of SLU. The paper does not demand that all information be shared at all times. It demands that the information necessary for branch-relative identity (the outcome record) be integrated into the agent's doxastic framework if the agent is to be the same entity that possesses that identity.

In ordinary cases of blind spots, the information that is inaccessible is not constitutive of the agent's identity or location. For example, you can be uncertain about a fact stored in your subconscious without losing your identity as an agent. But in the Everettian case, branch membership is defined by the outcome record. If that record is not integrated into the agent's doxastic framework, then the epistemic agent simply does not have a branch identity.

The interaction dilemma (Section 5.1) remains: if M and D do not interact, they are not a unified epistemic agent. If they do interact, information flows and uncertainty is lost. "Blind spots" do not help because the blind spot in question is precisely the record that determines which branch the agent is in. To have a unified agent that both has that record (to be in a branch) and is uncertain, the record must be simultaneously present in the agent's physical substrate and absent from its epistemic state. No functional architecture — not even one with blind spots — can achieve that without contradiction.

The integration problem (Section 5.2) is decisive: if epistemic states are distributed and integrate information, the outcome record becomes known. If they do not integrate that information, then the record is not part of the agent's doxastic framework — but

then the epistemic agent (the doxastic framework) has no branch identity. The fact that we tolerate other blind spots does not license this specific blind spot, because this specific blind spot is what would give the agent a branch location. Without it, the agent is branchless.

Thus, functional unity does not rescue SLU. It only shows that ordinary cases of uncertainty do not involve the kind of metaphysical split that Everettian branching requires.

8.7 Objection 7: Effective Uncertainty Is Enough

One might argue that the impossibility theorem is unrealistic because it demands a level of "perfect internal information sharing" that does not exist in actual human cognition. In real cognitive systems, information stored in memory is often not immediately accessible to decision-making. Yet we routinely treat such agents as uncertain — for example, a person who has forgotten a fact is genuinely uncertain about it, even though the fact remains physically encoded somewhere in their brain. Therefore, "effective" uncertainty (lack of access) is the only kind of uncertainty we ever have, and that should be sufficient to ground the Born rule in Everettian quantum mechanics.

Reply: This objection misidentifies what the paper requires. The argument does not demand perfect information sharing or that all stored information be simultaneously accessible. The problem is specific to the Everettian case: branch-relative identity is constituted by the physical record of the outcome. If that record is present anywhere in the observer's total physical state (brain, memory module, etc.), then the observer as a physical system possesses the information about which branch they are in.

In ordinary cases of forgetting, the fact that a memory trace exists does not make the agent "know" the fact in the relevant sense, because the fact is contingent — it is not definitional of the agent's identity or location. But in the Everettian setting, being in a particular branch just is having that outcome record in one's physical state (Definition of Branch Membership, Section 4.2). Therefore, if the record exists in the agent's physical substrate, then the agent is in that branch, and the question "Which branch am I in?" has a determinate answer grounded in that physical record. The agent's inability to access that record does not erase the fact that the record is there, and hence does not make the agent genuinely uncertain about the metaphysical fact of their branch membership.

Effective uncertainty (lack of access) might be sufficient for everyday epistemic uncertainty about contingent facts. But for SLU in Everettian branching, what is required is that there be no fact of the matter about which branch the epistemic agent inhabits — not merely that the agent cannot retrieve that fact. The paper shows that any mechanism that blocks access also severs the physical grounding for branch membership in the decision part (D). The composite $M + D$ still has the record, so the system knows which branch it is in, even if D does not. But the epistemic agent is D (or the integrated system), and either D has no branch identity or the integrated system knows the outcome. Effective uncertainty does not bridge this gap.

Moreover, the Born rule derivation requires genuine credences — probabilities that reflect ignorance of a real, objective fact about which branch one occupies. If the fact is physically present in the total system but merely inaccessible, then the correct credence (given total evidence, including knowledge of one's own physical state) would be 1 for the actual branch and 0 for the others. The agent's subjective "effective" uncertainty would be irrational by the lights of Bayesian epistemology, because it ignores information that is physically available (even if not accessed). Hence, effective uncertainty cannot ground

a rational derivation of the Born rule.

In short: the paper does not demand perfect information sharing; it demands that the epistemic agent's branch identity be grounded in its physical state. Effective uncertainty does not provide that grounding — it only provides ignorance, not genuine SLU.

8.8 Objection 8: The Agent Is the Doxastic Part, Not the Total Physical System

A defender of SLU would counter that the "agent" is not the total physical system $M + D$, but specifically the doxastic part D. If D does not have the information, then D is genuinely uncertain. They view the paper's demand that the total system "possesses" the record as an external "God's eye view" irrelevant to the agent's epistemic situation. Moreover, they argue that "branch identity" is a high-level functional property, not a low-level physical hook. If the organism behaves as if it has branched (e.g., different memory modules exist in different rooms), then it has branched, even if the decision module D is currently in the dark. Hence, SLU is perfectly coherent.

Reply: This objection fails for three reasons, each rooted in the Everettian ontology that the SLU defender themselves accepts.

First, the doxastic part D has no branch identity. The paper's Definition of Branch Membership (Section 4.2) is not an external "God's eye" stipulation; it follows directly from the Everettian picture. In Everettian quantum mechanics, what distinguishes one branch copy from another is precisely the physical record of the outcome. There is no additional "branch label" floating in the air. If the doxastic part D lacks that record, then there is no fact of the matter about which branch D is in. The question "Which branch am I in?" asked by D has no answer — not because the answer is unknown, but because the question does not apply. D is multiply instantiated across branches, and those instantiations are physically identical. Hence, D does not have a branch-relative identity. Without such identity, the uncertainty cannot be self-locating. It is merely global ignorance of a fact that does not pertain to D.

Second, functionalism does not create branch identity out of thin air. The objection claims that "branch identity" is a high-level functional property — if the organism behaves as if it has branched, then it has branched. But this confuses epistemic access with metaphysical constitution. In Everettian mechanics, branching is a physical process: the universal wavefunction develops non-interacting components, each containing a record. The functional behavior of a branch copy (e.g., saying "I saw up") is grounded in the physical record. If the decision module D does not have that record, then D's functional behavior does not include knowledge of the outcome. That is fine — but then D does not behave as if it is in a specific branch with respect to the outcome. It behaves as if it is ignorant. So functionalism does not assign D a branch identity; it merely describes D's ignorance. The branching is still there in the total system $M + D$, but the doxastic part D is not a branch-relative entity. The SLU defender wants D to have a branch identity (to be located) and simultaneously be uncertain about it. Functionalism does not provide a mechanism to give D a branch identity when D lacks the physical record that constitutes that identity.

Third, the "epistemic perspective" of D is not the reality of Everettian branching. The objection appeals to the agent's "epistemic perspective" — D is uncertain, so that should be enough. But the Everettian interpretation is a realist, physicalist theory. It aims to describe the actual structure of the universe, not just first-person appearances.

The paper's argument shows that the physical conditions required for SLU cannot be met. If the defender retreats to pure phenomenology ("D feels uncertain, therefore SLU exists"), they abandon the physicalist grounding that the Everettian interpretation itself relies on. Moreover, the Born rule derivation requires objective probabilities that match squared amplitudes, not just subjective feelings of uncertainty. Without a physical fact about which branch D occupies, there is no basis for assigning probabilities to being in one branch versus another — any credence is as good as any other. This is precisely Adlam's (2024) point: pure self-locating credences are unconstrained. The impossibility theorem explains why: there is no fact to be uncertain about.

Thus, identifying the agent with the doxastic part D does not rescue SLU — it merely highlights that D is branchless. And functionalism does not give D a branch identity without the physical record. The "God's eye" charge is misplaced: the paper does not require the agent to have a God's eye view; it only requires that the agent's branch identity be physically grounded in the agent's own state. That is a minimal requirement for any realist account of self-location.

8.9 Objection 9: Indexicality and Emergent Branching

A SLU defender might remain unconvinced, citing two further points. First, the "centered world" counter: The fact that D is uncertain about is indexical, not physical. Just as "I am here" is true for everyone but refers to different places, "I am in Branch A" is a truth that D is ignorant of. The impossibility theorem, they argue, demands a non-indexical hook for an indexical problem. Second, the divergence vs. branching distinction: Some modern Everettians (e.g., Wallace, 2012) argue that branches are emergent macroscopic structures. In their view, the room has branched, the body has branched, and therefore the agent is situated in a branch by its environment, even if its internal state is temporarily identical to its twin. Hence, D can be in a branch (by virtue of being embedded in a branched environment) even without an internal record.

Reply: Neither point undermines the impossibility theorem.

On indexicality: The paper does not deny that "I am in Branch A" is indexical. The problem is that indexical truth requires a grounding in the physical state of the subject. In standard cases ("I am here"), the truth of the indexical is fixed by the subject's spatial location, which is a physical fact about the subject. In the Everettian case, what would ground the indexical "I am in Branch A"? The only candidate is the physical record of the outcome. Without that record, there is no fact of the matter about which branch the subject inhabits — not even an indexical fact. Indexicality does not float free of physical constitution. If D's physical state is identical across branches, then the indexical "I am in Branch A" has no determinate truth condition. It is not that D is ignorant of which branch; it is that there is no branch to refer to. The indexicalist move merely relabels the problem; it does not solve it.

On emergent branching: The appeal to emergent macroscopic structure does not help. If the environment (rooms, bodies) has branched, then the doxastic subject D is multiply instantiated — one copy in each branch environment. But the question is: does a particular token of D (say, the one waking up in room A) know which branch it is in? According to the emergent view, that token is physically located in a branch environment, but its internal state (the decision module) lacks the outcome record. However, the token does have access to the environment — it can see the room, feel the air, etc. In the sleeping pill scenario, the rooms are identical from the inside, so the environment provides

no discriminating information. So the token's epistemic state is identical across branches. The question remains: does that token have a branch-relative identity?

The emergentist might say: yes, because the token is physically located in a particular branch (the room is different at the microscopic level, even if macroscopically identical). But then the token's epistemic perspective does not have access to that fact. The token is uncertain. So we are back to the two-module model: the environment (or body) functions as the memory module M, and the decision module D is ignorant. The impossibility theorem applies unchanged. The fact that the branch identity is carried by the environment rather than an internal memory module does not create a unified epistemic agent that both has branch identity (via the environment) and is uncertain (via D). The epistemic agent is still D, which lacks branch identity; the environment is not part of the agent's doxastic framework. The composite (environment + D) possesses the branch identity, but then the composite knows which branch it is in (because the environment encodes it), so the composite cannot be uncertain. The same dilemma recurs.

Thus, neither indexicality nor emergent branching rescues SLU. The core problem remains: any physical system that possesses branch-relative identity (whether internally or via environment) is not uncertain; any system that is uncertain lacks branch-relative identity. No amount of philosophical reinterpretation changes this physical incompatibility.

9 Why This Problem Was Overlooked

Given the central role that SLU has played in recent Everettian literature, one might reasonably ask: if the tension between the Recording Condition and the Uncertainty Condition is as fundamental as this paper claims, why have other researchers failed to notice it? This section offers a diagnostic analysis. It does not aim to diminish the contributions of SLU proponents or critics, but rather to understand how a coherent-seeming notion could harbor a deep inconsistency that escaped sustained scrutiny for nearly two decades.

9.1 The Seductive Power of the Information-Blocking Intuition

The most important reason why SLU has seemed plausible is the widespread, largely implicit reliance on a familiar cognitive model: information can exist objectively in a system while being simultaneously inaccessible to the agent's awareness. This model draws its intuitive force from two highly influential analogies.

First, the Sleeping Beauty problem has become a touchstone for discussions of self-locating belief. In that classical puzzle, Beauty is put to sleep on Sunday, awakened on Monday, and then (depending on the coin toss) awakened again on Tuesday with her memory of Monday erased. At each awakening, Beauty knows all objective facts about the setup, yet she cannot tell whether it is Monday or Tuesday. The objective fact (the day) exists independently of her cognitive access. She is uncertain because her access is blocked. This generates a powerful intuition: objective information and genuine uncertainty can coexist. The information is there, in the calendar or the experimental protocol; but because Beauty cannot access it, she is rationally uncertain.

Second, the quantum measurement tradition has long employed a language of "indeterminacy before measurement." Textbooks routinely say that "the outcome is not determined until a measurement is made." Even among Everettians, who reject collapse,

this linguistic habit persists. It encourages the thought that uncertainty is primarily an epistemic phenomenon—a matter of what the agent knows—rather than a metaphysical one. If the agent merely lacks knowledge of which branch they inhabit, then SLU seems straightforward.

However, both analogies silently import an assumption that is false in the Everettian setting. In Sleeping Beauty, "today is Monday" is a fact that does not consist in Beauty's own physical state. It is an independent fact about the world, stored in the experimental protocol, the calendar, or the position of the sun. Beauty's uncertainty is uncertainty about an external fact. In the Everettian case, by contrast, "I am in the $\uparrow$ branch" just is the fact that my physical state encodes $\uparrow$. There is no independent branch label. If my access to that record is blocked, then my physical state does not encode the outcome—and therefore I am not in any branch at all. The analogy fails at the exact point where it is most needed.

9.2 The First-Person Methodological Bias

A second factor is the persistent first-person orientation of SLU arguments. Vaidman (2012) states explicitly that probability in the Everett interpretation is about an agent's subjective ignorance of self-location, not about any third-person fact. Sebens and Carroll (2018) follow this lead, grounding probability in the rational credences of an agent who knows the universal wavefunction but does not know which branch she inhabits.

This first-person methodology generates a systematic blind spot. The natural question to ask, from this perspective, is: "What would I feel? What would I be uncertain about?" The natural answer is: "I would feel uncertain, because I cannot access the outcome record." This answer seems immediate and compelling.

What the first-person perspective obscures is the third-person question: Who is this "I" that is uncertain? The first-person pronoun presupposes a subject. But that subject is a physical system. If that physical system's state does not encode the outcome, then there is no fact of the matter about which branch it inhabits. The first-person sense of uncertainty ("I feel like I don't know") cannot conjure a branch location into existence. The subject's physical state determines which branch (if any) it belongs to. The first-person methodology, by focusing exclusively on the phenomenology of uncertainty, does not ask whether the subject has a branch location to be uncertain about.

9.3 The "Distributed Record" Fallacy

SLU proponents often respond to concerns about the record by pointing out that information can be stored in parts of a system while the system as a whole remains uncertain. The brain stores memories that are not always consciously accessible. A person can have a memory trace of a childhood event (the information exists physically) yet be genuinely uncertain about that event (because she cannot retrieve it). Why, then, cannot the same hold in the Everettian case? The memory module M stores the outcome; the decision module D cannot access it; the composite $M + D$ is the agent; therefore the agent has the record (via M) and is uncertain (via D).

This reasoning commits what we may call the distributed record fallacy. It conflates two very different senses of "having information." In the ordinary case of a forgotten memory, the information (e.g., "I ate oatmeal for breakfast on my fifth birthday") is not constitutive of the agent's current identity. The agent can be the same person, occupy the

same spatial location, and make the same decisions, regardless of whether that memory is accessible. The memory trace is causally inert with respect to the agent's current doxastic states. That is precisely why the agent can be uncertain: the information, although stored somewhere, does not enter into her current epistemic perspective.

In the Everettian case, however, branch membership is constitutive of the agent's identity. "Being in the ↑ branch" is not an incidental fact about the agent; it is a fact that distinguishes one copy from another. If the outcome record is stored in M but is not accessible to D, then D (the part that holds beliefs and makes decisions) does not have a branch-relative identity. The composite $M + D$ does have the record, but then the composite knows the outcome (because the record is present in the total physical state). The composite cannot be uncertain. The distributed record fallacy assumes that "having information" in the sense of physical storage is sufficient for branch membership, while "not having access" is sufficient for uncertainty. But branch membership requires that the information be present in the agent's constitutive physical state, not merely stored somewhere in a causally isolated module.

9.4 The Assumption of Automatic Unity

A fourth factor is the implicit assumption that any two physically connected modules automatically constitute a single unified epistemic agent. SLU proponents rarely, if ever, argue for this assumption. They simply take it for granted that if M and D are parts of the same brain, then the agent is the composite, and the composite inherits both M's record and D's uncertainty.

This assumption is highly questionable. In philosophy of mind and cognitive science, a unified agent is standardly understood in terms of information integration. A system is a single agent when information from its subsystems is accessible to a common doxastic state. If information cannot flow between subsystems, then those subsystems are functionally independent. They may be physically connected, but they do not constitute a single perspective.

The SLU model faces a dilemma. If M and D interact, information flows, and D learns the outcome—uncertainty disappears. If they do not interact, they are functionally independent. In that case, the epistemic agent is D (the only part with doxastic states), and D has no branch identity. The composite $M + D$ is not a unified agent because the information in M never reaches the doxastic state. The assumption of automatic unity glosses over this dilemma entirely.

9.5 The Level Confusion: Epistemic vs. Metaphysical Uncertainty

Another source of oversight is a persistent confusion between two distinct kinds of uncertainty. Epistemic uncertainty is uncertainty about a fact that exists independently of the agent's state. "I don't know whether it will rain tomorrow" is epistemic uncertainty. The fact (rain or no rain) is out there, waiting to be discovered. Indexical uncertainty is uncertainty about a fact that involves a token indexical such as "I," "here," or "now." "I don't know what time it is right now" is indexical uncertainty. The fact (the time) exists independently; the indexical merely picks out a time.

SLU proponents argue that Everettian uncertainty is a form of indexical uncertainty. The agent knows all objective facts about the universal wavefunction. What she does

not know is which branch the indexical "I" picks out. This seems perfectly analogous to not knowing what time "now" picks out.

The analogy fails, however, because indexical reference requires an object to be referred to. In the time case, "now" always refers to a real time. The fact that I do not know which time it is does not entail that there is no time. In the Everettian case, if the agent's physical state does not encode the outcome, then there is no fact of the matter about which branch "I" picks out. The indexical "I" does not successfully refer to a branch. The uncertainty is not indexical uncertainty about which branch among actual branches one occupies. It is a deeper failure of reference: there is no branch to be uncertain about.

SLU proponents implicitly assume that "I" always refers to a branch. But what grounds that reference? The answer can only be the physical record. But if the record is blocked, the reference is not grounded. The level confusion consists in treating the absence of grounded reference as a case of indexical uncertainty, when in fact it is a case of failed reference.

9.6 The Ontological Fuzziness of "Branch"

A sixth factor may be the ontological slipperiness of the notion of "branch" itself within Everettian quantum mechanics. Many Everettians (following Wallace, 2012) treat branches as emergent and approximate structures, not as entities with precise metaphysical boundaries. This fuzziness is methodologically useful for many purposes, but it also creates an opportunity for equivocation.

When SLU proponents need branch identity (to satisfy the Recording Condition), they appeal to emergent branches. "The environment has branched, so the agent is in a branch, even if her internal state does not yet encode the outcome." When they need uncertainty (to satisfy the Uncertainty Condition), they appeal to the agent's internal state. "The agent's decision module has no access to the outcome, so she is uncertain." The two appeals work with different criteria for "branch." The first appeal uses an environmental criterion (the agent is in a branch because the environment has decohered). The second appeal uses an internal criterion (uncertainty because the decision module lacks information). Neither appeal is illegitimate by itself. But they cannot be combined to yield a single agent that both is in a branch and is uncertain, because the criteria pull apart.

If branch identity is carried by the environment, then the agent (qua composite of environment and internal states) has the outcome record (stored in the environment). That composite knows which branch it is in. It cannot be uncertain. If branch identity is carried by internal states, then the decision module (which lacks the record) is not in any branch. The SLU argument slides between these two criteria without acknowledging the slide.

9.7 Summary of Diagnostic Findings

The oversight of SLU's fundamental problem can be attributed to a convergence of factors:

Factor	Effect on SLU Reasoning
Information-blocking intuition	Imports an analogy (Sleeping Beauty) that fails because branch identity is constitutive, not external.
First-person methodology	Focuses on what the agent "feels," ignoring whether the agent has a branch location.
Distributed record fallacy	Assumes that storage anywhere in the system gives the agent branch identity, while blocking access gives uncertainty.
Automatic unity assumption	Assumes physically connected modules form a single agent without requiring information integration.
Epistemic/metaphysical level confusion	Treats failure of indexical reference as indexical uncertainty.
Ontological fuzziness of "branch"	Slides between environmental and internal criteria for branch membership.

Each factor individually might not have been sufficient to hide the inconsistency. Together, however, they created a powerful cognitive illusion: SLU seemed obviously possible because it felt familiar (Sleeping Beauty), seemed natural from the first-person perspective, and appeared to be supported by reasonable assumptions about memory and unity. The illusion persisted because no one had systematically articulated the two necessary conditions and then asked whether any physical system could satisfy both.

9.8 Lessons for Future Research

The diagnosis offered here suggests several lessons for future work on Everettian quantum mechanics and self-locating belief more generally.

First, first-person intuitions about uncertainty must be grounded in third-person physical facts. It is not enough to ask "what would I be uncertain about?" One must also ask "what physical state constitutes the 'I' that is uncertain, and what physical facts determine its branch location?" Second, analogies to classical cases (Sleeping Beauty, fission) must be scrutinized for disanalogies at the exact point where the analogy is supposed to do the work. In the Everettian case, branch membership is constituted by the record. Any analogy that assumes branch membership can be separated from the record is likely to mislead.

Third, information integration is not optional for unified agency. If two modules do not exchange information, they do not constitute a single epistemic agent. SLU proponents cannot have it both ways: either M and D interact (and uncertainty is lost) or they do not (and there is no unified agent). Fourth, the notion of "branch" must be made precise enough to support the metaphysical weight placed upon it. If branches are merely emergent and approximate, then claims about being "in a branch" may be too fuzzy to ground the sharp distinction between knowing and not knowing that SLU requires.

These lessons extend beyond the Everettian case. Any philosophical project that appeals to SLU in a setting where identity is constituted by physical records must confront the tension articulated in this paper. The oversight documented here serves as a cautionary tale about the power of intuitive analogies and first-person methodologies to obscure fundamental metaphysical inconsistencies.

10 Conclusion

This paper has examined whether SLU can be coherently instantiated in the Everettian framework. The central challenge is that SLU appears to require two conditions that are difficult to satisfy simultaneously: having a branch-relative identity (Recording Condition) and being uncertain about that identity (Uncertainty Condition). Any attempt to realise SLU seems to force a division of the observer into a memory module that records the outcome (and thus is branch-relative) and a decision module that is uncertain (and thus lacks branch-relative identity). Neither module individually satisfies both conditions, and it is not obvious that they can be combined into a unified epistemic agent that does. The interaction dilemma and the integration problem suggest that the two-module model either loses uncertainty or fails to constitute a single agent.

Scenarios such as Vaidman's sleeping pill thought experiment, which aim to create a temporary window of uncertainty by blocking access to the outcome record, do not resolve the tension. They merely reproduce the two-module structure: a memory module that grounds branch-relative identity and a decision module that lacks it. No single epistemic agent clearly satisfies both the Recording Condition and the Uncertainty Condition. The composite system possesses the outcome record, but its credence-forming processes cannot maintain non-discriminating credences about branch location without either integrating the information (thereby losing uncertainty) or failing to integrate it (thereby failing to constitute a unified agent).

The argument relies only on the tension between encoding outcome information and maintaining genuine uncertainty. It complements and deepens existing critiques by Lewis, Kent, Quirke, Adlam and others. If the above reasoning is correct, then SLU-based derivations of the Born rule—including those of Sebens and Carroll (2018) and McQueen and Vaidman (2019)—rest on a problematic foundation.

Whether the Everett interpretation can provide a satisfactory account of quantum probability remains an open question. But the notion of an epistemic agent being uncertain about which branch it inhabits in a deterministic branching universe appears, on the analysis presented here, to face significant conceptual difficulties.

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