Quantum Superposition and the Mind: A Cognitive Filtering Hypothesis

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Abstract: This paper proposes a paradigm shift in the interpretation of quantum mechanics, reframing wavefunction collapse as cognitive selection. Prevailing interpretations of quantum mechanics—such as the Copenhagen interpretation, Many-Worlds, and objective collapse theories—assume that quantum superpositions resolve into singular outcomes via measurement or branching realities. This paper posits an alternative hypothesis: quantum superpositions exist within a single universe, but our perception filters and stabilizes a single outcome. To test this hypothesis, a modified delayed-choice quantum eraser experiment is proposed, introducing observer delusions to determine whether wavefunction collapse is influenced by an observer's belief about which-path information, rather than its mere physical recording. This framework bridges quantum mechanics, neuroscience, and artificial intelligence, offering a falsifiable alternative to existing interpretations. If validated, this hypothesis would expand our understanding of the observer's role in quantum mechanics.

1. Reevaluating Observer-Dependent Reality

Humans and animals inhabit the same physical world but experience it through different perceptual mechanisms. For instance, cats can detect ultraviolet light, a spectrum invisible to the human eye. Such variations suggest that objective reality extends beyond our cognitive constraints. Building on this principle, this paper proposes that quantum superposition persists within a single universe, but perception functions as a probabilistic filter rather than a passive observer. Unlike the Copenhagen Interpretation, which asserts that measurement causes wavefunction collapse, or the Many-Worlds Interpretation, which assumes that all possible states materialize in parallel universes, this model suggests that the brain selects a single reality to experience among many coexisting quantum states.

Just as the brain resolves conflicting sensory inputs—such as in binocular rivalry, where each eye receives different visual information but only one version reaches conscious awareness (Blake & Logothetis, 2002)—it may similarly filter quantum ambiguities into a single stable experience. Similarly, the McGurk Effect, where mismatched auditory and visual speech cues create an illusory perception (McGurk & MacDonald, 1976), demonstrates that perception isn't passive but actively constructs reality by integrating probabilistic inputs.

A study by Proietti et al. (2019) provides empirical support for the idea that quantum measurement is observer-relative, reinforcing the hypothesis that cognitive processing actively shapes the experienced reality. Their experiment extends Wigner's Friend paradox, effectively creating a nested Schrödinger's box scenario where different observers can hold contradictory accounts of quantum reality. In the experiment, an inner observer (Wigner's Friend) measured a quantum system inside an isolated lab and recorded a definite outcome. Meanwhile, an outside observer (Wigner) remained external to the lab and still described the entire system—including the inner observer and their measurement—as being in a superposition state. This setup tested whether wavefunction collapse is an absolute event or if it remains observer-dependent. The results showed that, from the outside observer's viewpoint, interference persisted even when the inner observer had already registered a definite outcome, suggesting that wavefunction collapse may not be universally definite. The implications of these studies compel a reconsideration of the classical assumption that our reality is the absolute reality.

Additionally, empirical research in quantum cognition suggests that human decision-making aligns more closely with quantum probability rules than classical logic. Unlike classical models, which assume fixed probabilities, quantum cognitive models allow for the superposition of cognitive states and interference effects, mirroring quantum systems where potential outcomes evolve probabilistically before selection (Busemeyer & Bruza, 2012; Pothos & Busemeyer, 2009). Studies comparing quantum Bayesian models to classical Bayesian models in predicting decision-making under uncertainty (Busemeyer & Trueblood, 2009; Busemeyer et al., 2011; Moreira & Wichert, 2016) have demonstrated that quantum models more accurately capture paradoxical decision-making behaviors, such as violations of the Sure Thing Principle and dynamic inconsistency. The ability of quantum cognitive models to account for decision-making interference effects further strengthens the argument that the mind computes probabilities in a manner analogous to quantum state evolution.

2. Cognitive Filtering Hypothesis

This hypothesis suggests our experience of classical reality emerges from the brain interpreting uncertain or ambiguous quantum information into a simplified construct. By linking quantum probability to cognitive resolution, this perspective bridges neuroscience and quantum mechanics, recontextualizing how the brain's mechanisms shape our physical reality.

This model posits a multi-layered reality:

Universal Reality Layer: The quantum state where all possible outcomes exist.

Filtering Reality Layer: The cognitive process where the brain probabilistically resolves ambiguous sensory information into a coherent perception

Experienced Reality Layer: The world we perceive, structured by the resolved quantum-consistent interpretation

3. Traditional Quantum Interpretations

The Copenhagen Interpretation asserts that wavefunction collapse occurs upon measurement. Many-Worlds (Everett, 1957) assumes that all possible realities exist in parallel universes, but the observer's experience is constrained to a single branch, with other branches becoming effectively inaccessible due to macroscopic decoherence (Zurek, 2003). The cognitive filtering hypothesis acknowledges decoherence while proposing that certain quantum correlations—such as residual entanglement effects or weak measurement influences—may persist across what are typically considered separate realities.

Like Wigner's Consciousness Collapse, the cognitive filtering hypothesis asserts that the observer plays an active role in shaping experienced reality. However, unlike Wigner's claim that consciousness itself collapses the wavefunction (a view he later reconsidered due to concerns about solipsism), this hypothesis does not suggest that reality is solely dependent on individual consciousness. Instead, it proposes that all observers share the same underlying quantum reality, but perception acts as a filter, determining which structured aspects of that reality become accessible to the senses. In other words, the observer navigates a landscape of quantum possibilities through a cognitive interface that selects and stabilizes lived experience.

This hypothesis parallels Thaheld's (2005) proposal that biophysical processes in the eye contribute to quantum state selection. Thaheld's model suggests that quantum state selection may begin at the sensory level, shaping the information that reaches conscious awareness. The cognitive filtering hypothesis expands this idea beyond sensory input, proposing that quantum principles also influence cognitive processing in the brain. This distinction is significant, as it suggests that quantum effects may operate across multiple levels of cognition, from perception to higher-order processes such as thought construction and decision-making. This reframing could have profound implications for AI models designed to emulate human-like cognition by integrating quantum-inspired probabilistic reasoning. It may also provide insights into whether quantum effects play a role in emotions, creativity, and problem-solving.

4. Modified Delayed-Choice Quantum Eraser Experiment

A modified delayed-choice quantum eraser experiment is proposed to investigate whether subjective awareness—independent of machine measurement—plays a role in wavefunction collapse. Building upon the foundational setup of Kim et al. (2000), this experiment introduces a key modification: observer delusions to test whether a false belief about which-path information can influence quantum state resolution.

In Kim et al.'s experiment, entangled photon pairs were used to determine whether wavefunction collapse depends on the availability of which-path information. A signal photon passed through a double-slit apparatus, while its entangled idler photon traveled toward detectors capable of determining its path. The results showed that an interference pattern appeared only when which-path information was erased, whereas a two-band particle pattern emerged when which-path data was recorded. This suggests that quantum state selection depends not on direct physical interaction but on whether which-path information remains accessible.

The proposed experiment follows a similar structure but introduces an additional variable: the observer's belief about which-path information, even when that belief is false. In this setup, entangled photon pairs are generated: the signal photon passes through a double-slit apparatus and reaches a detection screen. The idler photon travels toward a which-path detection system. Instead of immediately recording or erasing the which-path information, the experiment introduces a Quantum Memory Storage Unit, where the which-path data is temporarily stored but remains inaccessible.

A Quantum Random Number Generator (QRNG) determines whether the stored which-path information is preserved or erased before any observer has the opportunity to access it. In Condition A, the which-path information exists but is never accessed—the idler photon's which-path data is recorded and stored, yet no observer ever retrieves or views the data. In Condition B, the which-path information is permanently deleted before any observer can access it, ensuring that no record of the which-path information remains. This distinction allows us to determine whether wavefunction collapse depends on the mere existence of information or requires an observer's conscious awareness of that information.

The key innovation in this experiment is the introduction of observer delusions—systematically manipulating the observer's expectation about whether which-path information exists. In the False Positive Condition, the observer is led to believe that which-path data exists, even when it has already been deleted. In the False Negative Condition, the observer is led to believe that which-path data has been erased, even when it actually remains stored but inaccessible.

If wavefunction collapse depends on cognitive recognition rather than physical measurement, then the interference pattern should persist or collapse based on what the observer expects to be true, rather than the actual physical state of the which-path data. However, if standard quantum mechanics holds, then the physical recording of which-path data alone should determine the outcome, regardless of what the observer believes. If the traditional view is correct, observer delusions should have no measurable effect on the interference pattern. Regardless of the outcome, this experiment could deepen our understanding of the relationship between information, perception, and quantum mechanics.

5. Conclusion

This paper proposes a reinterpretation of quantum mechanics, reframing wavefunction collapse as a process influenced by cognitive selection, rather than being strictly dictated by physical measurement alone. While collapse models suggest that measurement finalizes reality, the cognitive filtering hypothesis posits that observation does not create reality but determines which quantum possibilities become accessible. Unlike the Many-Worlds Interpretation, which remains experimentally challenging to verify due to the effects of decoherence obscuring alternate branches, the cognitive filtering hypothesis can offer testable predictions by examining whether cognitive processes exhibit quantum-like selection effects under ambiguous conditions. This can be explored through weak measurements, neural studies on perception under quantum uncertainty, and AI models that integrate quantum probability-based decision-making frameworks.

Inspired by the Copernican Revolution's shift away from an egocentric view of the cosmos, this perspective suggests that nature's operations extend beyond human perceptual constraints, challenging the assumption that reality exists in a singular, observer-independent form. Beyond its implications for quantum mechanics, cognitive science, and computational modeling, validating this hypothesis could contribute to ongoing discussions in quantum information theory and the role of entropy in measurement.

If cognition selectively resolves uncertainty while interpreting relativistic effects within its own frame of reference, then observed reality may be more dependent on the observer's constraints than traditionally assumed. Exploring how Heisenberg's Uncertainty Principle and Einstein's Relativity interact through cognitive filtering may provide new insights into how perceptual constraints influence our experience of reality. Understanding this interaction may refine our grasp of how consciousness and physics intertwine, potentially unveiling hidden dimensions of quantum reality in our immediate world.

Funding Declaration: No funding.

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