Why Coherent Histories?

The Selection Problem in Informational and Branching Ontologies

Federico Batori
Working paper draft — programmatic/foundational note; no new quantum dynamics claimed

---

Abstract

Many ontologies of quantum reality and information share an under-formulated difficulty: they describe how facts, records, branches, or simulations may exist, but do not clearly explain why observer-coherent, law-like histories dominate over arbitrary continuations. This paper calls that difficulty the **selection problem**. The problem arises in different forms across Everettian branching, Relational Quantum Mechanics, Quantum Darwinism, and simulation-style informational ontologies. Everettian quantum mechanics allows branching but does not by itself provide a general criterion for why quasi-classical observer-histories dominate over white-rabbit continuations. Relational Quantum Mechanics makes facts relative to systems but does not, by itself, specify which long-run chains of relative facts remain admissible and stable. Quantum Darwinism explains how records become objective once stable structures exist, but presupposes a substrate in which such regularities are already robust enough to be redundantly broadcast. Simulation-style or computational ontologies say that reality may be generated informationally, but they do not automatically supply a principle that suppresses incoherent or arbitrary observer-histories. The present paper argues that these approaches leave a common problem insufficiently isolated. It then sketches a partial BCT Level-3 response: a record-chain framework in which coherent continuations receive higher weight under an Occam-like measure filtered by coherence constraints. The proposal is not a full solution. Its current formal status is explicitly partial: generic glitches can be exponentially suppressed under stated assumptions, while simple-glitch cases still depend on additional rigidity conditions. The claim of the paper is therefore modest but significant: the selection problem should be named, separated, and treated as a foundational issue in its own right, and BCT Level-3 offers a disciplined partial framework for doing so.

---

1. Introduction

Interpretations and ontologies of quantum reality often focus on a familiar set of problems: measurement, collapse, branching, objectivity, relationality, classicality, and probability. These are genuine problems. But there is another question that is less often isolated explicitly:

> Why do coherent, law-like histories dominate over arbitrary continuations?

Not merely: why does one outcome occur rather than another?
Not merely: how do records become objective?
Not merely: how are states relative to systems?
Rather:

> Why do observer-accessible histories exhibit stable regularities rather than rampant anomaly, inconsistency, or white-rabbit behavior?

This paper calls that question the **selection problem**.

The selection problem is especially pressing in ontologies that permit large multiplicity, informational generation, relationally defined facts, or observer-relative structures. Such ontologies often allow a rich space of possible continuations. But unless they include a principled criterion for why coherent histories dominate, they risk leaving law-likeness unexplained.

The present paper has two aims.

First, it argues that several major frameworks share this under-formulated problem. The frameworks considered here are:

1. Everettian branching;
2. Relational Quantum Mechanics;
3. Quantum Darwinism / Spectrum Broadcast Structures;
4. simulation-style or computational informational ontologies.

Second, it sketches a partial BCT Level-3 response. In that framework, subjects are modeled as record-chains; continuations are weighted by an Occam-like measure filtered by coherence constraints; and arbitrary glitches can be partially suppressed. The current result is not a full theorem of law-likeness. It is a partial framework with explicit proof obligations and limits.

This is not a paper claiming final victory. Its narrower thesis is:

> the selection problem should be treated as a foundational issue in its own right, and BCT Level-3 offers a nontrivial partial candidate framework for it.

---

2. The Selection Problem

The selection problem can be stated informally as follows:

> Given a space of possible continuations, why do observer-histories with stable, coherent, law-like structure dominate over arbitrary, incoherent, or white-rabbit continuations?

The problem has several components.

2.1 Multiplicity

Many ontologies allow or imply multiplicity: multiple branches, multiple relative facts, multiple computational realizations, or large informational spaces. Multiplicity itself is not the problem. The problem is the absence of a principle that discriminates among continuations at the level relevant to observers or histories.

2.2 Coherence

Observers do not seem to inhabit wildly inconsistent continuations. They inhabit histories in which records, expectations, and laws are sufficiently stable to support science, memory, and action. Why those continuations, rather than pathological ones?

2.3 White rabbits

The term “white rabbit” is useful as shorthand for arbitrary, low-regularity, law-violating or observer-incoherent continuations. The issue is not merely miracle events. It is the broader question of why experience is not dominated by unconstrained anomaly if the underlying ontology is large enough to permit many continuations.

2.4 Selection versus description

The selection problem is not solved merely by redescribing coherent histories after the fact. The point is not to say, retrospectively, “we observe stable laws.” The point is to ask what, in the ontology or formalism, privileges such histories over arbitrary ones.

Thus, the selection problem is distinct from the measurement problem, the probability problem, and the problem of classical objectivity, even though it is related to all of them.

---

3. Everettian Branching and the Selection Problem

Everettian quantum mechanics is often presented as a natural target for the selection problem. If all outcomes occur in branching structure, why do observers find themselves in quasi-classical, law-like histories rather than in bizarre or unstable ones?

To be precise, Everettianism does have resources: decoherence, emergent branch structure, quasi-classicality, and decision-theoretic approaches to probability. These should not be ignored. In particular, sophisticated Everettian work argues that quasi-classical structure is not an extra miracle layered onto the theory, but an emergent consequence of decoherence and the high-level structure of macroscopic dynamics.

That reply is significant, but it does not fully eliminate the selection problem.

The reason is that decoherence and quasi-classical emergence explain why certain structures are dynamically robust once the relevant dynamical architecture is in place. They do not automatically answer the stronger question at issue here:

> why should observer-histories be dominated by coherent continuations rather than by arbitrary, low-regularity, or white-rabbit continuations in the first place?

Put differently, decoherence can explain the stability of certain branch structures relative to a given dynamics, but the selection problem asks why the ontology available to observers should be dominated by such stable law-like branch-histories rather than by pathological continuations. If the answer is simply “because the equations generate quasi-classicality,” then the burden shifts to why those equations, or histories governed by them, dominate in the relevant informational or branching ontology.

This is why the selection problem is not identical to the ordinary Everettian problem of deriving quasi-classical branches from decoherence. It is a higher-order question about why coherent observer-histories are the dominant continuations at all.

A related issue appears in branch-counting and observer-counting. If branch multiplicity is large, and if world or observer individuation remains approximate, then the theory still needs some account of which continuations deserve ontological or phenomenological weight. This is especially visible when branch structure is treated as emergent and approximate rather than fundamentally countable.

The selection problem in the Everettian setting is therefore:

> Branching may exist, and decoherence may explain quasi-classical stability, but why do coherent quasi-classical observer-histories dominate over arbitrary continuations?

---

4. Relational Quantum Mechanics and the Selection Problem

Relational Quantum Mechanics denies that systems possess observer-independent absolute states. Facts are relative to systems. This is a powerful move against naïve absolutist ontology.

However, relationality alone does not settle the selection problem.

A natural RQM-style reply would be that there is no further admissibility problem: every interaction produces a relative fact, and the lawfulness of those facts is already encoded in the quantum dynamics. On that view, it is misguided to ask for an additional selection principle “over” the evolution, because the equations already determine the relevant structure.

This reply is important, but it does not fully remove the pressure. The selection problem is not a request for a second dynamics layered on top of the first. It is a request for an account of why long-run chains of relative facts form coherent, observer-stable histories rather than merely being locally well-defined interactions.

In other words, the existence of lawful equations is not yet the same as an account of why observer-accessible histories are dominated by admissible, record-coherent continuations. RQM tells us that facts are relative to systems. It does not, by itself, specify which chains of such facts remain coherent, stable, and observer-compatible over extended histories.

The selection problem in the relational setting is therefore:

> If facts are relative, what explains the dominance of coherent chains of relative facts over arbitrary or observer-incoherent continuations?

To be clear, the pressure is weaker here than in explicitly large-multiplicity ontologies such as Everettian branching or broad computational generation. A relational ontology need not posit a vast space of simultaneously realized observer-histories in the same way. But even in the relational case, one may still ask what makes extended chains of relative facts observer-stable, law-like, and mutually admissible rather than merely locally well-defined at each interaction.

This question does not deny the RQM formalism. It asks for a supplementary account of long-run admissibility in a relational ontology.

---

5. Quantum Darwinism and the Selection Problem

Quantum Darwinism and Spectrum Broadcast Structures explain how objective classical information can arise from quantum dynamics. Records become redundantly encoded in environmental fragments; multiple observers can access the same information; objectivity becomes an emergent structural feature.

This is a major achievement. But it addresses a different problem from the selection problem.

Quantum Darwinism explains how stable records, once available, become public and objective. What it largely presupposes is that the substrate already contains stable enough law-like structures for such records to be redundantly encoded and broadcast.

Thus, Quantum Darwinism may be said to answer:

> How does objectivity emerge from stable record-formation?

But the selection problem asks:

> Why are there stable record-forming histories rather than observer-incoherent or arbitrary continuations?

These questions are complementary, not rival. Quantum Darwinism is not threatened by the selection problem. It simply does not, by itself, answer it.

The selection problem in the Darwinian setting is therefore:

> Given that objectivity requires stable records, why are stable record-histories dominant in the first place?

---

6. Simulation and Computational Ontologies

Simulation-style or computational ontologies often suggest that reality may be generated by a substrate more primitive than ordinary physics. Whether framed as digital physics, exhaustive computation, simulation, or informational generation, such pictures raise the selection problem in an acute form.

If reality emerges from a broad computational or informational space, then why is the resulting observer-accessible domain so regular, law-like, and coherent?

The problem is not whether computation can generate worlds. The problem is:

> what suppresses arbitrary generated histories?

Without a selection principle, computational ontologies risk allowing observer-histories that are too unconstrained. A large computational space can generate orderly histories, but also disordered, white-rabbit, or unstable ones. Why should observers typically inhabit the orderly region?

This is one of the central conceptual pressures on simulation-style metaphysics.

The selection problem in the computational setting is therefore:

> Why does informational generation yield coherent law-like histories rather than arbitrary observer-incoherent outputs?

---

7. Why Existing Frameworks Do Not Fully Eliminate the Problem

The point of the previous sections is not to diminish the achievements of Everettianism, RQM, Quantum Darwinism, or computational ontologies. Each illuminates something important.

- Everettianism: branching without collapse;
- RQM: relational facthood rather than absolute states;
- Quantum Darwinism: objectivity through redundant records;
- computational ontologies: deep informational or generative substrate.

But none of these, by itself, gives a general selection principle over histories.

They tend to do one or more of the following:

1. **describe multiplicity**, without fully selecting among continuations;
2. **relativize facts**, without fully constraining coherent chains of facts;
3. **explain objective records**, given stable structures, without fully explaining why stable structures dominate;
4. **posit informational generation**, without a principled suppression of pathological outputs.

This is why the selection problem should be named explicitly. Without naming it, discussions drift between measurement, probability, objectivity, and branching while leaving the deeper issue partly implicit.

---

8. A BCT Level-3 Candidate Framework

BCT Level-3 is relevant because it does not merely redescribe observer histories. It attempts to provide a candidate selection framework.

At its most general, the Level-3 idea is this:

1. subjects are modeled as record-chains rather than as primitive egos;
2. continuations are evaluated under coherence constraints rather than left unrestricted;
3. histories are weighted by an Occam-like measure rather than counted indiscriminately;
4. incoherent continuations should lose weight by complexity, coherence penalty, or defeat.

This does not yet produce a complete theory of law-like selection. But it gives a disciplined architecture:

record-chain continuity + coherence filtering + Occam-like weighting.

The philosophical importance of this architecture is that it directly addresses the selection problem. It does not start by assuming that law-like histories dominate. It asks what could make them dominate.

The core thought is not mystical. It is structural:

> observer-histories that preserve coherent records and remain describable by low-complexity, stable continuation rules should be favored over arbitrary continuations.

This candidate framework is not purely verbal. In the current Level-3 technical draft, a partial suppression theorem is obtained for generic single-step white-rabbit deviations under explicit assumptions. In schematic form, the result yields an exponential suppression ratio of the form

> $m(S_{WR}) / m(S_{law}) \leq 2^{[-nH_2(\varepsilon) + nH_2(\theta_{step}) + c \log(nT)]}$

for generic glitches satisfying the stated regularity conditions. The details and assumptions matter, and the result is not universal. But it is enough to show that the framework is more than an unstructured appeal to coherence. It already contains a partial mathematical mechanism for suppressing arbitrary continuations.

Whether that mechanism can be extended to the full selection problem remains open. But the existence of even a partial suppression result is precisely what distinguishes a research program from a slogan.

---

9. Partial Formal Status: What Is Actually Claimed

The present paper must be explicit about the current status of the Level-3 framework.

It is **not** claimed that the selection problem has been solved in full generality. What is claimed is more limited:

1. the problem has been isolated explicitly;
2. a candidate formal architecture has been proposed;
3. a nontrivial partial suppression result has been obtained;
4. the remaining proof obligations are openly stated.

In particular, Level-3 currently supports a generic-glitch suppression result under explicit assumptions. Roughly speaking, high-complexity or incoherent deviations can be exponentially suppressed under an Occam-weighted, coherence-filtered measure when local regularity conditions hold.

But this is not enough for a complete solution. Known open issues remain:

- simple-glitch cases;
- predictor rigidity;
- aggregation over large deviation families;
- reference-machine robustness;
- computable proxies for uncomputable complexity measures;
- average-to-local bridges.

This is important. A serious foundational program should state its limits before critics do.

The proper claim is therefore:

> BCT Level-3 offers a disciplined partial framework for the selection problem, not a complete derivation of law-like reality.

---

10. Why the Partial Result Still Matters

A critic may reply: if the result is only partial, why is it significant?

The answer is that foundational progress often begins by making a neglected problem explicit and attaching even a partial formal structure to it.

The contribution is significant for three reasons.

10.1 Problem isolation

The selection problem is often smuggled into other debates. By isolating it, one can ask more precise questions and compare frameworks more cleanly.

10.2 Architectural advance

BCT Level-3 does not merely state "coherent histories are better." It supplies an architecture in which coherence, record-continuity, and Occam-like weighting interact. This is already more structured than many informal appeals to typicality or classicality.

10.3 Explicit proof obligations

The framework does not hide its weaknesses. Predictor rigidity, simple-glitch closure, and entropy-gap issues are named as open tasks. This turns the project into a falsifiable research program rather than a vague metaphysics.

Thus, the partial result matters not because it ends the debate, but because it turns an under-formulated worry into a structured agenda.

---

11. Relation to Record-Based Approaches

The selection problem connects naturally with record-based approaches to subjectivity, definiteness, and observer-history. If subjects are modeled as record-chains, if definiteness is treated as record-integrated difference, and if operational relevance depends on accessible persistent records for finite agents, then the question of why coherent histories dominate becomes unavoidable.

The present paper does not presuppose that the reader has accepted any larger system. Its narrower point is simply this:

> once records, continuations, and observer-histories are taken seriously, a further question arises about admissibility and weighting over histories.

The BCT Level-3 framework is introduced here only as one explicit candidate response to that question. It matters because it attempts to connect record-chain continuity, coherence constraints, and weighting over continuations within a single framework.

Thus, the current paper should be read as a problem-setting and problem-linking note. It isolates the selection problem and identifies record-based continuity as one plausible route toward a solution.

---

12. Objection: Decoherence Already Selects the Relevant Histories

One might object that decoherence already explains why quasi-classical histories dominate. Why introduce a separate selection problem?

Decoherence is indeed crucial. It explains why interference between certain structures becomes negligible and why pointer-like stability emerges. But decoherence alone does not settle every selection question.

In particular, decoherence does not automatically explain:

- why coherent observer-histories dominate over arbitrary low-regularity continuations in large informational ontologies;
- why record-chains remain admissible over long timescales;
- why white-rabbit continuations are suppressed rather than merely not described.

Thus, decoherence may be part of the answer, but the selection problem remains a distinct question about admissibility and weighting over histories.

---

13. Objection: Typicality Already Handles This

Another objection is that many frameworks already rely on typicality. Perhaps coherent histories dominate simply because they are typical under the relevant measure.

But this only relocates the problem.

Typicality is not self-explanatory. It depends on a measure. The selection problem asks precisely which measure, weighting principle, or admissibility criterion privileges coherent histories.

An appeal to typicality is therefore not yet an answer unless the typicality structure itself is justified. BCT Level-3 is relevant here because it proposes a concrete candidate: coherence-filtered Occam weighting.

The candidate may fail. But it is more informative than a bare appeal to typicality without structure.

---

14. What This Paper Does Not Claim

This paper does not claim that Everettianism, RQM, Quantum Darwinism, or simulation-style ontologies are simply inadequate. It does not claim that BCT Level-3 is already a complete theory. It does not claim a new physical dynamics.

Its claims are narrower:

1. there is a genuine selection problem in informational and branching ontologies;
2. that problem is not fully eliminated by current leading frameworks;
3. BCT Level-3 offers a disciplined partial framework for addressing it;
4. the current formal result is partial and comes with explicit open obligations.

This is enough to justify taking the problem seriously.

---

15. Conclusion

Many foundational frameworks explain how branching, relative facts, objective records, or informational generation may be possible. Fewer explain why observer-coherent, law-like histories dominate over arbitrary continuations.

This paper has argued that the latter issue deserves explicit recognition as the **selection problem**.

The selection problem is not identical to the measurement problem, the probability problem, or the emergence of classicality, though it touches all of them. It is the question of why coherent histories dominate at all.

BCT Level-3 does not yet solve this problem completely. But it offers something rare and valuable: a disciplined partial framework in which record-chain continuity, coherence constraints, and Occam-like weighting are brought together to suppress arbitrary continuations and identify explicit remaining proof obligations.

The final claim is therefore modest but sharp:

> the selection problem should be named and treated as a foundational problem in its own right, and BCT Level-3 is a serious partial attempt to address it.

References — provisional

Everett, H. (1957). “Relative State” formulation of quantum mechanics. *Reviews of Modern Physics*, 29, 454–462.

Horodecki, R., Korbicz, J. K., and Horodecki, P. (2015). Quantum origins of objectivity. *Physical Review A*, 91, 032122.

Korbicz, J. K. (2021). Roads to objectivity: Quantum Darwinism, Spectrum Broadcast Structures, and Strong Quantum Darwinism — a review. *Quantum*, 5, 571.

Laudisa, F., and Rovelli, C. (2021). Relational quantum mechanics. *Stanford Encyclopedia of Philosophy*.

Rovelli, C. (1996). Relational quantum mechanics. *International Journal of Theoretical Physics*, 35, 1637–1678.

Saunders, S., Barrett, J., Kent, A., and Wallace, D. (eds.) (2010). *Many Worlds? Everett, Quantum Theory, and Reality*. Oxford University Press.

Saunders, S. (2021). Branch-counting in the Everett interpretation of quantum mechanics. *Proceedings of the Royal Society A*, 477, 20210600.

Wallace, D. (2012). *The Emergent Multiverse: Quantum Theory according to the Everett Interpretation*. Oxford University Press.

Zurek, W. H. (2003). Decoherence, einselection, and the quantum origins of the classical. *Reviews of Modern Physics*, 75, 715–775.

Zurek, W. H. (2009). Quantum Darwinism. *Nature Physics*, 5, 181–188.

Author note — optional

This paper is part of a broader project on record-based subjectivity, quantum definiteness, and selection principles for coherent histories. It is a programmatic/foundational note and does not propose a modification of quantum mechanics. AI tools were used for drafting assistance, critical review, and editing; the author takes responsibility for all claims, sources, and final wording.