

Observational Coherence and Immutable Temporal History: Reconciling COE and the Theory of Global Time

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Abstract

This paper examines the relation between Coherent Observational Epistemology (COE) and the Theory of Global Time (TGT). At first glance the two frameworks appear to impose conflicting constraints. COE allows reconstruction and alignment of observational sequences originating from independent localities, while TGT postulates the immutability of reconstructed temporal history.

We show that this apparent tension arises from a confusion of epistemic and ontological levels. COE operates at the level of observational integration, establishing conditions under which heterogeneous observational sequences may be treated as jointly evidential. TGT, in contrast, governs the ontological structure of temporal history reconstructed from reception events.

Once this distinction is made explicit, the two frameworks become complementary rather than conflicting. Based on this clarification, we introduce an additional structural principle—the Temporal Reconstruction Constraint—which extends the Global Observational Postulates of COE by incorporating the immutability requirement of TGT.

Keywords: observational coherence; canonical order; global time; epistemology; temporal reconstruction.

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1 Introduction

Modern scientific practice relies increasingly on the integration of observations produced by distributed infrastructures: astronomical networks, detector arrays, climate observatories, and large-scale sensor systems. The epistemic architecture enabling such integration has become a subject of growing philosophical interest.

Two frameworks addressing this architecture have been proposed in recent work. Coherent Observational Epistemology (COE) [1] provides structural conditions under which independent observational sequences may support unified scientific inference. The Theory of Global Time (TGT) [2] develops a physical framework in which temporal structure arises from the canonical ordering of observer-registered events.

At first glance these frameworks appear to impose conflicting constraints. COE allows retrospective reconstruction and alignment of observational sequences, while TGT asserts that once temporal history has been reconstructed it cannot be retroactively modified.

The present paper argues that this tension is only apparent. The two frameworks address different structural layers of scientific reasoning: COE operates at the epistemological level of observational integration, whereas TGT governs the ontological structure of temporal history itself.

Distributed observational systems raise a structural problem that is often left implicit. Observational integration frequently involves retrospective reconstruction of relations between data produced by independent localities. Such reconstruction may alter our understanding of how events relate to one another.

At the same time, physical theories of time typically assume that temporal history, once established, is not subject to retroactive revision. This raises a conceptual question: how can retrospective observational reconstruction coexist with the immutability of temporal history?

The present paper resolves this tension by distinguishing two layers of analysis: epistemic reconstruction and temporal ontology.

2 Observational Integration in COE

COE investigates the structural conditions under which observations produced by independent localities may be integrated into a single evidential structure.

Let

$$L_1, L_2, \dots, L_n$$

denote observational localities producing sequences

$$S_1, S_2, \dots, S_n.$$

Definition 2.1 (Inter-local coherence). *Observational sequences are coherent if ordering relations, transformations, and operational semantics admit a non-contradictory mapping across localities.*

Under appropriate conditions COE allows construction of global observational structures enabling cross-local inference.

Importantly, these constructions operate at the level of observational data and their epistemic alignment. They do not assert the existence of an ontologically real global structure independent of observational practice.

3 Canonical Temporal History in TGT

The Theory of Global Time begins from a different premise. Temporal structure is not treated as a pre-existing coordinate but as a relation reconstructed from observer-side events.

Let E_r denote the set of reception events available within an observational domain.

Definition 3.1 (Canonical temporal structure). *The canonical temporal structure is the ordered pair*

$$(E_r, \prec),$$

where \prec denotes the canonical order relation constructed from reception sequences.

Temporal history corresponds to chains within this ordered structure.

Axiom 3.1 (History Immutability). *Once a segment of canonical temporal history has been reconstructed, its order cannot be retroactively modified.*

This axiom ensures that temporal order functions as a stable carrier of causality and coordination.

4 Epistemic Reconstruction vs Ontological History

The apparent conflict between COE and TGT arises from a failure to distinguish between two types of reconstruction.

COE permits retrospective reconstruction of relationships between observational sequences. This process concerns the alignment of observational representations.

TGT, however, constrains the ontological structure of temporal history. It states that once a canonical ordering has been established, it cannot be revised.

The distinction can therefore be summarized as follows:

COE	Epistemic alignment of observations
TGT	Ontological structure of temporal history

Once this separation is made explicit, the two frameworks become mutually consistent.

Central Distinction

Epistemic reconstruction \neq Temporal ontology

Reconstruction of observational relations concerns the epistemic alignment of observational records. Temporal ontology concerns the canonical order of events that constitute reconstructed history.

Observational coherence may expand or refine epistemic access to events, but it cannot alter the canonical temporal order of already reconstructed history.

5 Temporal Reconstruction Constraint

The integration of COE and TGT motivates an additional structural principle.

Postulate 5.1 (Temporal Reconstruction Constraint). *Observational reconstruction procedures may refine or extend the set of accessible events but must preserve the canonical order of any previously reconstructed temporal history.*

This constraint expresses the compatibility condition between epistemic reconstruction and ontological temporal order.

Corollary 5.1. *Observational alignment may reveal previously unknown relations between events but cannot invert the established canonical order of those events.*

Postulate 5.2 (GOP6: Temporal Consistency Postulate). *Let H denote a canonical temporal history reconstructed from a set of observer-registered events.*

Any observational reconstruction procedure that integrates additional data, observational localities, or alignment transformations must satisfy the following constraint:

Previously established canonical order relations within H must remain invariant.

Formally, if

$$H = \langle e_1, e_2, \dots, e_k \rangle$$

is a reconstructed history and a reconstruction procedure produces an extended sequence

$$H' = \langle e_1, e_2, \dots, e_k, e_{k+1}, \dots \rangle,$$

then for all $i < j \leq k$

$$e_i \prec e_j \quad \Rightarrow \quad e_i \prec' e_j.$$

No admissible observational reconstruction may invert or modify previously established temporal order.

5.1 Illustrative Example

Consider three observational localities monitoring a periodic astrophysical source.

Each locality records a sequence of reception events:

$$S_1 = \{e_1, e_2, e_3, e_4\}, \quad S_2 = \{e_1, e_3, e_4\}, \quad S_3 = \{e_2, e_3, e_4\}.$$

Initially, the observational base may be incomplete, and different localities may provide only partial sequences.

COE alignment procedures may later reconstruct correspondences between these sequences and reveal that the global canonical order is

$$e_1 \prec e_2 \prec e_3 \prec e_4.$$

Additional observational data may extend this history by revealing new events such as e_5 . However, once the canonical order $e_1 \prec e_2 \prec e_3 \prec e_4$ has been established, no admissible reconstruction can invert these relations.

Theorem 5.1 (COE–TGT Compatibility Theorem). *Let L_1, \dots, L_n be observational localities producing sequences S_1, \dots, S_n .*

Assume that these sequences satisfy the structural compatibility conditions of COE (ordering mappability, transformational coherence, and semantic commensurability).

Let H denote a canonical temporal history constructed according to the TGT canonical ordering relation.

Then observational reconstruction procedures permitted by COE cannot produce temporal histories that violate the TGT immutability axiom.

Proof. COE reconstruction procedures operate by establishing order-preserving mappings between observational sequences. These mappings may reveal previously unknown correspondences between events but do not modify the internal ordering of the underlying sequences.

Canonical temporal history in TGT is defined exclusively through the order of reception events.

Since COE transformations preserve the order relations within each observational sequence, the canonical order relation defining H remains invariant.

Therefore no admissible COE reconstruction can retroactively modify canonical temporal order. \square

Theorem 5.2 (Prefix Invariance under Observational Extension). *Let*

$$H = \langle e_1, e_2, \dots, e_k \rangle$$

be a canonical temporal history reconstructed from a set of observational localities

$$L = \{L_1, \dots, L_n\}.$$

Let

$$L' = L \cup \{L_{n+1}, \dots, L_{n+m}\}$$

be an observationally extended system obtained by adding further localities, additional data, or new alignment mappings.

Assume that reconstruction over L' is admissible under the COE structural constraints and satisfies GOP6.

Then the reconstructed history

$$H' = \langle e'_1, e'_2, \dots, e'_k, \dots \rangle$$

contains H as an order-preserving prefix. This establishes the structural irreversibility of reconstructed temporal history. In particular, for all $1 \leq i < j \leq k$,

$$e_i \prec e_j \Rightarrow e'_i \prec' e'_j,$$

and the ordering relations already established in H remain invariant.

Therefore, observational extension may enlarge the reconstructed history, but cannot retroactively revise its canonical prefix.

Proof. By COE, observational extension consists in adding new localities, new observational sequences, or new admissible mappings between sequences. Such an extension may increase evidential coverage and reveal previously unavailable relations, but it does not authorize arbitrary replacement of already established structural correspondences.

By GOP6, any admissible reconstruction procedure must preserve previously established canonical order relations. Hence, when the observational base is extended from L to L' , the reconstruction may add new events or new comparabilities only outside the already established canonical prefix.

By the TGT immutability axiom, once a segment of canonical temporal history has been reconstructed, it cannot be retroactively modified. Therefore the portion

$$\langle e_1, e_2, \dots, e_k \rangle$$

must remain invariant under all admissible observational extensions.

It follows that H is preserved as an order-preserving prefix of H' . Thus, observational growth produces extension, not revision. \square

Theorem 5.3 (Temporal Non-Reversibility Theorem). *Let H be a canonical temporal history constructed from observer-registered reception events.*

Assume that observational reconstruction procedures satisfy the COE structural constraints and the Temporal Consistency Postulate (GOP6).

Then no admissible observational reconstruction can produce a temporal history in which the canonical order of previously reconstructed events is reversed.

In particular, if

$$e_i \prec e_j$$

holds in the reconstructed history H , then no admissible reconstruction may yield

$$e_j \prec e_i.$$

Proof. Canonical temporal order in TGT is defined exclusively through the ordering of reception events.

By the immutability axiom of TGT, once a segment of canonical temporal history has been reconstructed, its order cannot be retroactively modified.

Observational reconstruction procedures permitted by COE may introduce additional data, establish new correspondences between observational sequences, or reveal previously inaccessible events.

However, by GOP6 such procedures must preserve all previously established canonical order relations.

Therefore any admissible reconstruction may extend the history or refine its epistemic accessibility, but it cannot reverse the temporal order of already reconstructed events. □

Corollary 5.2 (Irreversibility of Reconstructed History). *Once a canonical temporal relation between two events has been established, it remains invariant under all admissible extensions of the observational base.*

Corollary 5.3 (No Retroactive Temporal Revision). *No admissible enlargement of the observational base can transform a previously reconstructed temporal history into a different history with a conflicting canonical order on its established segment.*

Proof. Immediate from the Prefix Invariance theorem. □

Corollary 5.4 (Epistemic Growth without Ontological Reversal). *Increases in observational coherence may improve temporal accessibility, resolution, and coverage, but they cannot produce ontological reversal of reconstructed temporal order.*

6 Layered Structure of Observational Inference

Scientific inference in distributed observational environments exhibits a layered structure.

At the lowest level, independent observational localities produce ordered sequences of recorded events.

The COE framework establishes the structural conditions under which these sequences may be aligned and interpreted jointly.

Once observational alignment becomes possible, canonical temporal order can be constructed from reception events.

The Theory of Global Time then governs the ontological structure of the resulting temporal history.

This layered architecture ensures that epistemic reconstruction procedures operate within constraints imposed by temporal ontology.

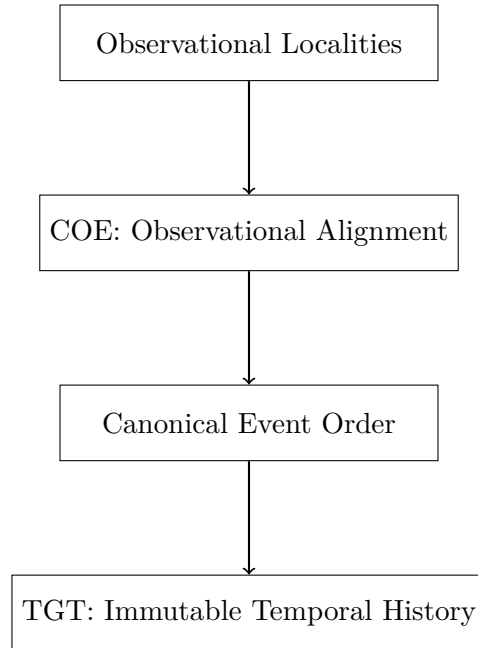


Figure 1: Layered architecture of observational inference and temporal structure. COE governs epistemic alignment of observations, while TGT governs the ontological structure of temporal history.

7 Implications

The combined framework yields a layered architecture of scientific inference.

1. Observational localities generate independent sequences of records.
2. COE establishes structural conditions for cross-local integration.
3. TGT governs the temporal structure of reconstructed history.
4. The Temporal Reconstruction Constraint ensures compatibility between epistemic reconstruction and temporal ontology.

This layered structure clarifies the relationship between observational practice and the physical structure of time.

8 Scope and Clarifications

The present work should not be read as a restricted or merely local compatibility claim. Its argument is structural.

First, canonical temporal order is not treated as a rare or fragile construction available only under ideal observational conditions. Within the present framework, canonical order is in principle always constructible from observer-accessible regularities of registration. The problem is not whether order can exist, but which observational basis is used to stabilize and reconstruct it.

Second, the paper does not distinguish between an allegedly “purely epistemic” reconstruction and some separate temporal reality given independently of observation. What is reconstructed is not an arbitrary representation but the accessible order of history itself.

Third, the argument does not presuppose any independent notion of metric time. Temporal structure is grounded in canonical order, and all further parametrizations are secondary to that order rather than ontologically prior to it.

Accordingly, the relation established here between COE and TGT should be understood not as a compromise between two partially valid models, but as a clarification of their place within a single structural architecture: observational coherence governs admissible reconstruction, while immutable canonical order governs the temporal structure of history.

9 Conclusion

The apparent tension between Coherent Observational Epistemology and the Theory of Global Time arises from a conflation of epistemic and ontological levels of analysis.

COE addresses the conditions under which observational sequences may be integrated into coherent evidential structures. TGT governs the ontological structure of temporal history reconstructed from observation.

Once these levels are distinguished, the frameworks become complementary. The Temporal Reconstruction Constraint introduced here provides an explicit link between them and extends the Global Observational Postulates of COE.

The compatibility established here suggests that the epistemology of observation and the ontology of time should not be treated as independent problems. Rather, they form a hierarchical structure in which observational coherence constrains the construction of temporal order, while temporal immutability constrains admissible forms of observational reconstruction.

Observational extension temporal revision.

References

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