

# A CONDITIONAL CASE AGAINST NON-TRIVIAL BACKWARD TIME TRAVEL

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**ABSTRACT:** This paper advances a conditional rationalist argument against the metaphysical possibility of backward time travel. It proceeds from the assumption, accepted by some but not all modal rationalists, that metaphysical possibility is constrained by intelligibility, where intelligibility requires non-circular explanation and justification. Under this assumption, worlds that violate either the Strong Principle of Sufficient Reason (Strong-PSR) or anti-circular epistemic norms fail to meet the constitutive standards of metaphysical admissibility. The paper formalises this link through a Bridge Principle, showing that any non-trivial backward time travel on a single timeline inevitably generates either causal loops (self-grounding contingent totalities) or epistemic loops (self-justifying knowledge states). Both forms of circularity undermine explanatory and justificatory structure at the global level. While logically consistent and physically modelable, such worlds collapse under the rationalist requirement that intelligibility is non-circular. The conclusion is conditional: if one accepts Strong-PSR or an equivalent acyclicity constraint on grounding and knowledge, then non-trivial backward time travel is metaphysically impossible.

**KEYWORDS:** time travel, closed timelike curves, causal loops, Principle of Sufficient Reason, epistemic circularity, modal rationalism

## 1. Introduction

Time travel has long posed a distinctive philosophical challenge, lying at the intersection of physics and metaphysics. General relativity admits solutions such as Gödel's universe that contain closed timelike curves, suggesting the physical permissibility of time travel. Philosophically, however, backward time travel appears to generate paradoxes that test our metaphysical principles. Lewis' classic 1976 paper set the agenda by arguing that such paradoxes do not entail inconsistency: closed causal loops are, he maintained, metaphysically coherent provided the overall history remains self-consistent (Lewis 1976).

Lewis held that time travellers could retain ordinary abilities and that self-causing events, such as objects being their own ultimate cause, involve no outright contradiction. His influential stance treats logical consistency as sufficient for metaphysical possibility: if the worldline is self-consistent, then time travel is metaphysically coherent. The present paper targets exactly this sufficiency claim:

consistency constrains but does not constitute metaphysical possibility, because metaphysical possibility also demands groundedness and non-circular justification.

This view has shaped subsequent debate, with later authors appealing to consistency constraints such as Novikov's principle (Friedman et al. 1990) or branching timelines to sidestep paradoxes, while implicitly accepting that the possibility of time travel depends entirely on the absence of contradiction.

By contrast, I argue that logical consistency is not a sufficient condition for metaphysical possibility: scenarios that undermine explanatory or epistemic norms fail to count as metaphysically possible, even if they are logically coherent.

**Bridge Principle (BP):** Conditional on a strong rationalist background, if metaphysical admissibility requires (i) non-circular grounding for contingent totalities (Strong-PSR) and (ii) non-circular justification for knowledge, then any scenario that violates (i) or (ii) is metaphysically impossible, even if logically consistent (Melamed and Lin 2023; Pruss 2006).

I do not claim that BP follows from modal rationalism per se or that it is widely accepted; rather, it articulates an exceptionally demanding rationalist constraint endorsed by a minority of contemporary PSR-based modal rationalists (e.g. Pruss, Della Rocca, Dasgupta) and rejected by most others. BP is therefore not entailed by a mere commitment to modal rationalism; it arises only when one combines modal rationalism with Strong-PSR and anti-circular epistemic norms.

The subsequent sections show that backward time travel would violate (i) via causal loops and (ii) via epistemic loops; hence, conditional on BP, it is metaphysically impossible.

### 1.1 Why accept BP?

The guiding thought is a strong form of modal rationalism: metaphysical possibility is constrained by intelligibility, where a world is intelligible just in case its contingent facts can in principle be fitted into a non-circular explanatory and justificatory structure under idealised rational norms (Della Rocca 2010; Melamed and Lin 2023; Pruss 2006). Intelligibility here is therefore a normative notion: it is not a matter of psychological familiarity, but of there being, in principle, a non-circular pattern of grounding and justification that could make the relevant facts and beliefs fully answerable to reason. Many philosophers (Schaffer 2009; R. L. Bliss 2013; Bennett 2017; Lange 2013), especially localists about explanation, would deny that intelligibility requires this kind of non-circular global structure and are prepared to count ungrounded or self-containing chains as intelligible; the present argument proceeds explicitly from the more demanding rationalist conception.

On this view, Strong-PSR codifies an anti-brutalism about contingent totalities; anti-circularity in epistemology codifies the requirement that warrant not depend on its own future uptake. I do not assume that every modal rationalist must accept this package. Many are content with weaker PSR principles or with a looser link between explanation and modality. The claim is rather conditional: for those who take intelligibility in this demanding sense to be constitutive of metaphysical possibility, violation of Strong-PSR or of anti-circular epistemic norms is not merely an oddity but a defeater of modal admissibility. BP then records this bridge from norm failure to modal failure: where explanation bottoms out in self-grounding, or justification collapses into a closed loop, such scenarios fail to qualify as fully intelligible worlds and are excluded on rationalist grounds. Consistency may prevent contradiction; it does not restore intelligibility.

### 1.2 The Bridge Principle Clarified.

The BP can be formalised as a modal constraint linking norm failure to impossibility:

$$(BP\text{-Formal}) \forall \varphi [(Viol\ Norm(\varphi)) \rightarrow \neg \diamond \varphi].$$

Its motivation stems from modal rationalism: if metaphysical possibility coincides with conceivability under ideal rational norms, then any scenario violating those norms is inconceivable in principle and hence impossible (Della Rocca 2010). The principle thus plays a constitutive, not heuristic, role in modal assessment. Similar bridges appear in Della Rocca's "PSR-based modal rationalism" and Pruss's attempt to ground modal facts in the PSR (Pruss 2006; Della Rocca 2010). By contrast, a merely heuristic BP would render norm-violation evidence of improbability rather than impossibility, a weaker reading the present argument explicitly sets aside. The principle is therefore best seen as belonging to a sub-class of rationalist views on which explanation and intelligibility stand in a constitutive relation: on such views, explanatory and epistemic norms are not just good guides to possibility but help fix the space of admissible worlds.

In what follows I take BP in this constitutive sense: scenarios that systematically violate the relevant explanatory and epistemic norms are thereby excluded from the space of metaphysical possibilities, not merely downgraded in credence.

The implications of BP become clear when we examine how its two domains of application, explanation and justification, are challenged by time-travel scenarios.

The argument has two strands. First, epistemic instability: if information can travel backwards, agents may acquire true beliefs from the future without justification, breaking the temporal asymmetry on which standard epistemic

practices rely. Such loops generate self-fulfilling prophecy structures that undermine the very possibility of knowledge (Rennick 2021). Second, ontological incoherence: closed causal loops give rise to facts or entities without external origin, violating the strong PSR. Strong PSR requires that not only each link in a causal chain but also the entire chain have an explanation (Pruss 2006). I will argue that for those who accept Strong-PSR, rejecting it to preserve time travel carries severe costs, since it forces acceptance of brute existents precisely where explanatory demands are strongest. Bootstrap scenarios meet only weak PSR; strong PSR is breached precisely at the level where explanation is most needed. For readers who accept Strong PSR, the preceding considerations amount to a conditional defence against the Lewisian consensus (Hanley 2004; Meyer 2012; Smith 1997). Together, these strands yield a shared modal point: conditional on the explanatory and epistemic norms stated below, scenarios that permit brute facts and ungrounded beliefs are not merely puzzling but metaphysically impossible.

The remainder of the paper proceeds in four stages. Section 2 situates the debate within competing metaphysical theories of time, drawing on classic A- and B-theoretic distinctions (Bourne 2006; Daniels 2012). Section 3 develops the ontological argument, offering a precise characterisation of causal loops and arguing that they violate both the PSR and basic standards of ontological coherence. Section 4 turns to temporal epistemology, examining how the transfer of information from future to past undermines stable belief formation. Drawing on recent work by Rennick, Sayan and Cagatay, I argue that such scenarios generate epistemic circularity and threaten the intelligibility of knowledge itself. Section 5 integrates these strands and considers prominent replies, including Novikov's self-consistency principle, Lewis' personal-time framework, and presentist fact-based causation, arguing that these strategies fail to address the underlying explanatory and epistemic deficits (Zhuang 2022). The conclusion reflects on the broader metaphysical and epistemological implications and explores whether weakening PSR or revising epistemic norms could render time travel coherent.

Throughout, I adopt a broadly eternalist, or block universe, framework for the sake of concreteness, as the argument is sharpest when directed against the dominant four-dimensional model in which time travel is typically theorised. That said, I also highlight implications for presentist views, which already face well-known difficulties in accommodating backward causation (Zhuang 2022). I contend that the metaphysical and epistemological challenges posed by time travel, especially concerning explanation and justification, have not been adequately synthesised or addressed in their combined force within existing literature. This cumulative case, I argue, offers a decisive reason to reject the coherence of time travel altogether.

### 1.3 Principles and Terminology.

For clarity, I use the following working notions throughout.

**Weak-PSR (distributive PSR).** Every contingent fact has some explanation or sufficient reason, but there is no requirement that *totalities* of facts be grounded in anything beyond their members. On this view, explanation may be entirely local.

**Strong-PSR (holistic PSR).** Every contingent fact and every contingent *totality* has a non-circular ground. Explanatory chains may be long, but they cannot be self-supporting or brute at the level of wholes. This is the rationalist principle associated with Leibniz (1934), and explicitly defended in different forms by Pruss (2006) and Della Rocca (2010).

**Localism about explanation.** Localists (e.g. Hanley, Smith, and more recent defenders of non-foundational or network-based grounding) hold that once each event in a structure has a sufficient proximate cause or ground, no further explanation of the structure as a whole is metaphysically required (Hanley 2004; Smith 1997; Lange 2013; R. L. Bliss 2013; Bennett 2017; R. Bliss and Priest 2018; Schaffer 2016).

**Causal loop.** A closed chain of events in which an event is (directly or indirectly) among its own causes, often yielding ‘originless’ objects or facts (Lewis 1976, 1976; Hanley 2004; Meyer 2012; Smith 1997; Ismael 2003; A Lossev and I D Novikov 1992).

**Epistemic loop.** A closed justificatory structure in which an agent’s belief is ultimately warranted only by that very belief (or its future acceptance), rather than by evidentially prior states. Rennick (2021) calls these “epistemic loops” and models them as the epistemic analogue of bootstrap paradoxes.

These definitions fix the dialectical space. The conditional argument in what follows is addressed to readers who accept either Strong-PSR itself or, at minimum, some anti-circular constraint on explanation and justification.

## 2. The Metaphysical Landscape of Time Travel

Philosophical accounts of time distinguish both the ontology of temporal reality and the nature of temporal passage. Eternalism treats past, present, and future as equally real within a four-dimensional block universe; presentism holds that only the present exists, and ‘growing block’ views take the past and present as real but not the future. Time travel is typically analysed within an eternalist framework, where moving to another temporal location is geometrically unproblematic (Gödel 1949), while presentism faces *prima facie* obstacles because past and future times lack ontological status (Hales 2010). These debates matter for whether time travel can be

modelled at all, but my argument does not depend on any specific theory of temporal ontology.

Within an eternalist framework, closed timelike curves are often deemed coherent so long as global consistency is preserved (Lewis 1976; Richmond 2022). Even if no outright contradiction arises, however, backward time travel can still violate other metaphysical principles. The claim I develop is independent of one's preferred ontology of time: presentism faces its own hurdles, and eternalism, where time travel is geometrically straightforward, nonetheless inherits the explanatory and epistemic deficits at the heart of this paper. I assume the standard Lewisian definition (divergence between personal and external time) only for definiteness; the arguments target what follows if one can travel to the past. With that in place, we can turn to the central structural feature that enables time travel: causal loops.

### **3. Causal Loops and Strong-PSR**

A defining feature of most backward time-travel scenarios is the presence of causal loops, sometimes called bootstrap or ontological paradoxes. A causal loop arises when an event is among its own causes, creating a closed causal chain (Lewis 1976). While my examples are framed within an eternalist setting, the problems of ungroundedness arise in any metaphysical framework (compare the presentist 'fact-based' strategy (Zhuang 2022).

Consider the familiar case of a time traveller who discovers blueprints for a time machine, travels to the past, and hands them to an inventor, who then builds the very machine from those plans. The blueprints have no external origin; they exist in a self-sustaining cycle. Analogous paradoxes appear in cases of self-parentage or information loops, where effects influence their own causes without any independent explanatory ground (Ismael 2003).

Causal loops are often described as involving brute facts: entities or states of affairs whose existence originates "from nowhere". A familiar example is the clock handed from a future self to a younger self, thereby lacking any independent origin. Such objects, sometimes called "Jinn" (A Lossev and I D Novikov 1992), are physically lawful yet ontologically unexplained. Krasnikov observes that while loops need not violate physical laws, they exhibit anomalous self-sustaining dynamics (Krasnikov 2002). Philosophically, the issue is best captured by PSR, according to which every contingent fact has an explanation or ground. Weak PSR requires that each link in a causal chain be explained; strong PSR additionally demands an explanation for the existence of the chain as a whole (Hanley 2004; Meyer 2012; Smith 1997). Bootstrap scenarios may satisfy weak PSR, every event is caused by

another, but they violate strong PSR, since the loop as a whole has no external ground.

This distinction matters: weak PSR is compatible with brute existents, whereas strong PSR reflects a deeper explanatory ideal, articulated by Leibniz and defended in recent metaphysics, that refuses to treat entire causal structures as unexplained primitives. Hanley (Hanley 2004) and Smith (Smith 1997) offer two of the most sophisticated contemporary treatments of causal loops. Both question whether loops really violate explanatory norms if one adopts a local conception of explanation. Hanley argues that each event on a loop can be adequately explained by other events within the loop, and that the demand for a further 'global' explanation stems from a controversial metaphysical commitment to strong PSR rather than from anything intrinsic to the structure of the loop itself. Smith develops this line by defending the idea that causal explanation is essentially local: as long as each event has its own sufficient cause, the loop as a whole need not be grounded in anything outside itself. On this view, bootstrap cases are not metaphysically defective but simply illustrate an unfamiliar causal topology.

### 3.1 Strong PSR: Dialectical Role and Costs of Rejection

A key point of contention in the literature concerns whether the strong form of the Principle of Sufficient Reason is metaphysically mandatory. Classical rationalists such as Leibniz, and more recent defenders like Pruss (2006), Della Rocca (2010), and Dasgupta (2016), endorse versions of Strong-PSR or closely related rationalist principles on which every contingent totality must have a non-circular explanation. Others are sympathetic to weaker, local principles, or sceptical of PSR altogether. I do not attempt a full defence of Strong-PSR here; instead, the argument is explicitly conditional: it targets readers who either accept Strong-PSR, or accept at least an acyclicity constraint on grounding that rules out self-supporting totalities. Nothing in what follows is meant to show that every modal rationalist must adopt Strong-PSR, only that those who do are committed to excluding time-travel loops. On the localist view, loop cases are explanatorily adequate so long as each node has a sufficient local cause; any demand for a ground of the whole is optional.

Dialectically, several considerations speak against localism for those who accept Strong-PSR. Localists such as Hanley and Smith argue that explanatory adequacy is exhausted by local causal closure (Hanley 2004; Smith 1997), but this view misconstrues the role of explanation in modal evaluation. Strong-PSR articulates not merely a demand for sufficient causes but for non-self-dependence of totalities: explanation must terminate in an external ground. Rejecting this ideal collapses the distinction between the intelligible and the merely consistent. The

localist's sufficiency claim therefore mistakes logical coherence for metaphysical adequacy. As Della Rocca (2010) and Melamed and Lin (2023) observe, explanation and intelligibility are internally related; a structure lacking external ground is ipso facto unintelligible. Consequently, the choice is stark: either sustain Strong-PSR or accept brute self-grounding as metaphysically benign, a price most rationalists will find unacceptable.

Second, rejecting strong PSR undermines modal rationalism, the view that metaphysical possibility is constrained by the availability of intelligible explanations (Pruss 2006). Weak PSR licenses worlds where large-scale structures are unexplained, even if locally determined. This is precisely what Lewis' acceptance of causal loops entails: the loop exists "because it exists," with no deeper reason (Lewis 1976). If such brute structures are permitted, then almost any logically coherent structure, however ontologically baroque, qualifies as metaphysically possible. This collapses the distinction between the merely logically possible and the metaphysically intelligible, the latter being precisely what strong PSR aims to demarcate.

Third, causal loops differ crucially from infinite regresses. As Meyer (2012) observes, even an infinite regress allows for a direction of explanation: each event is explained by its predecessor, and the regress can, at least in principle, be embedded within broader cosmological frameworks. Loops, by contrast, eliminate explanatory direction entirely. The structure is closed, and the explanatory demand targets the whole loop, not its parts. Accepting weak PSR here is not a mere weakening of an ideal but a qualitative shift: it amounts to accepting self-grounding as metaphysically benign. For many metaphysicians, this is precisely what strong PSR rules out (Della Rocca 2010; Pruss 2006).

Finally, it is worth noting that the burden of proof lies with localists. Strong PSR has been defended as a methodological postulate of metaphysics since Leibniz (Leibniz, 1934). It is the rejection of this principle, not its endorsement, that demands special justification. Hanley and Smith's localism offers no positive account of why global explanation can be dispensed with, beyond the observation that loops are logically consistent. But logical consistency is not metaphysical sufficiency: a structure can be coherent without being intelligible.

If metaphysical possibility is tied to intelligibility, as many rationalist and explanatory approaches hold, then weak PSR is inadequate. Recent defenders of local or minimal explanatory sufficiency extend this line of resistance beyond Hanley and Smith. Lange (2013) and Bliss (2013) argue that explanation may legitimately terminate locally (or need not bottom out in global foundations), while Bennett (2017) and Bliss & Priest (2018) develop anti-foundational or non-well-

founded pictures on which circular or self-contained structures need not be defectively explanatory. Lange emphasises that explanatory dependence is often domain-relative and contextually bounded; Bliss argues that the demand for total explanation amounts to metaphysical overreach; and Bennett likewise treats building relations as plural and not necessarily constrained by global foundations.

Similarly, Schaffer's grounding framework, developed first in *On What Grounds What* (2009) and later refined in *Grounding in the Image of Causation*, (2016) rejects any demand for a single, global foundation. His model conceives metaphysical dependence as a structural analogue of causation, allowing locally acyclic networks of dependence without presupposing an ultimate ground. Explanation, on this picture, concerns what grounds what rather than what explains everything, thereby denying Strong-PSR and supporting a localist conception of sufficiency.

These localist strategies thereby generalise Hanley's view: causal self-containment is not a defect but a permissible limit-case of explanatory closure. Yet, as Della Rocca (2010) and Pruss (2006) observe, this position effectively trades metaphysical intelligibility for descriptive adequacy, treating explanation as pragmatic rather than constitutive. The cost is that modal assessment becomes empirically bounded: what is physically self-consistent is deemed metaphysically sufficient, eroding the very normative bridge that grounds PSR-based modal reasoning.

Accordingly, conditional on Strong-PSR, causal loops that lack an external ground are metaphysically impossible; those who reject Strong-PSR owe an alternative principle that blocks self-grounding structures without collapsing intelligibility. The recent literature on localist explanation, though sophisticated, ultimately confirms this point.

Smith's (1997) program treats loop cases as explanatorily adequate so long as each node has a sufficient local cause; any demand for a ground of the whole is, on his view, optional. The conditional result here shows why that stance cannot be a free lunch. If Strong-PSR is in force, Smith's localism fails because the loop as a totality lacks an external ground; if Strong-PSR is rejected, the price is explicit: admit brute, self-sustaining structures or offer an alternative anti-circularity principle that rules them out without covertly reinstating Strong-PSR. Either way, the dialectical pressure remains. Moreover, even granting local causal sufficiency, Smith's view is silent on epistemic loops: closed justificatory circuits generate knowledge-like states without independent warrant, and local causal adequacy does nothing to repair that epistemic deficit.

### 3.2 Causal Loops as Violations of the PSR

The relevant principle here is Strong-PSR: not only must each link have an explanation, but the totality of contingent facts must be non-circularly grounded (Leibniz 1934; Melamed and Lin 2023; Pruss 2006). Leibniz's dictum, 'a full reason why there should be any world rather than none', explicitly targets total explanation (Leibniz 1934) (p 31–32). For clarity, I'll reserve Weak-PSR for the distributive claim that each fact in a chain has an explanation; Strong-PSR adds the holistic, anti-circular requirement. While the PSR is subject to controversy, especially in its strongest forms, it remains a foundational metaphysical ideal and underpins many philosophical arguments against the acceptance of brute facts.

Causal loops challenge PSR by yielding facts whose origins lie solely within the loop. Imagine a time-traveller who hands blueprints to an earlier inventor; the plans exist only because they already exist later. Or consider self-parentage. The loop offers an internal story, A causes B, B causes C, C causes A, but nothing outside the loop explains why any of it obtains. This is precisely the kind of self-grounding Strong-PSR forbids: the totality lacks an external ground even if each local segment has a cause. The result is not merely counterintuitive; it is a structural failure of explanation under any framework that rejects circular grounding (Leibniz 1934; Melamed and Lin 2023; Meyer 2012).

Leibniz anticipated the problem of infinite causal regresses: even if each link is explained by its predecessor, the chain as a whole remains unexplained. His famous example of endlessly copied geometry books illustrates that explanation cannot be fully internal to the series (Leibniz 1934). An infinite regress defers dependence without foundation; a loop closes dependence on itself. On standard views, explanation/grounding is irreflexive and acyclic; no fact is explained in virtue of itself even via mediation. Loops thus preclude an external ground, whereas regresses merely defer it (Meyer 2012). There is no external explanatory standpoint from which to answer "Why does this loop exist at all?" As Meyer (2012) and Hanley (2004) emphasise, accepting loops requires abandoning Strong-PSR entirely. For Strong-PSR proponents, that price is prohibitive: it undercuts the very explanatory ideals that motivate PSR and would license brute causal structures wherever convenient; critics who reject Strong-PSR owe an alternative anti-circularity norm.

A natural reply is that a sufficiently rich initial state X, together with the laws, might already fix the existence of the loop: why not say that X explains the loop and thereby satisfies Strong-PSR? On the strong rationalist reading, this manoeuvre simply relocates the problem. If there are nomically admissible solutions with and without loops, then Strong-PSR demands a reason why this X-solution, containing a self-sustaining structure, obtains rather than a nearby solution without it. If,

instead, there is only one physically admissible X-solution and it contains a loop, then the explanatory deficit reappears at the level of laws and initial conditions: why must reality instantiate exactly this law-state package, rather than another that avoids self-grounding structures? Invoking X therefore either (i) leaves the loop explanatorily brute relative to alternative admissible solutions, or (ii) pushes the bruteness up a level. In either case, the strongly PSR-driven explanatory demand is not met.

### 3.3 Lewis on bootstrap cases

Lewis's (1976) classic defense of time travel explicitly embraces bootstrap cases as "strange but not impossible" so long as they are logically consistent. His discussion of the self-existing information or artefact is paradigmatic: the book, or set of blueprints, has no external origin but is taken to be metaphysically permissible because each local stage has a cause and no contradiction arises. On the localist picture, this is enough; no further explanation of why that loop exists, rather than no loop, is required.

From the standpoint of Strong-PSR, Lewis's verdict is precisely what is at issue. Bootstrap cases neatly satisfy Weak-PSR, every event has a cause, but they flout the holistic, anti-circular demand that totalities be grounded. If Strong-PSR (or even a more modest acyclicity constraint on grounding) is taken as constitutive of metaphysical adequacy, then Lewis's permissive treatment of bootstrap objects is not a neutral data point but an argument *against* time travel: his cases vividly illustrate the very kind of self-sustaining structure that Strong-PSR rules out. The conditional conclusion of this section can thus be stated succinctly: for those who share Lewis's localist scruples about PSR, bootstrap cases are admissible; for those who accept Strong-PSR, they are precisely what disqualify time-travel worlds.

Besides PSR, causal loops also contravene intuitive notions of ontological coherence (R. Wasserman 2018, 50). In ordinary causal relations, objects come into existence through prior causes, such as birth or creation events, and their identity is grounded in these origins. In a causal loop, however, this foundational basis disappears. For example, consider the time-travelling watch that is never manufactured but instead endlessly recycled through time. This situation exemplifies a circular ontology: the watch exists solely by virtue of its own future instantiation, lacking any originating cause. Similarly, in the paradox of self-parentage, a person exists solely by virtue of their own existence. This ontological circularity is deeply counterintuitive, challenging our basic notions of identity, persistence, and what it means for something to exist 'in virtue of' something else. If Alice is her own great-grandparent, does she constitute a single individual occupying

multiple generational roles, or multiple distinct individuals? While theorists like Lewis argue that identity conditions may be stipulated, under his four-dimensionalist framework (Zhuang 2022), to maintain Alice as one individual, the deeper metaphysical concern persists: there is no external explanation for why that individual exists at all. This lack of an independent grounding challenges fundamental metaphysical intuitions about existence and identity.

One might object that causal loops are no more mysterious than an infinite causal regress. Yet an infinite regress at least offers a direction of explanation, however incomplete. A loop has none: its structure is closed, lacking any external anchor. Physical consistency principles such as Novikov's ensure logical coherence but do not supply metaphysical explanation (Visser 1997). Even if physics allows loops, PSR-based considerations remain: why does the loop exist at all? As Meyer (2012) emphasises, explaining one loop-event by another merely relocates the deficit; and Hanley (2004) argues that if an external ground is demanded, local explanations within the loop can never supply it.

I conclude that any permissible causal loop must contain at least one brute fact, an event or object lacking explanation external to the loop itself. This stands in clear tension with a robust formulation of the PSR and conflicts with our ordinary explanatory expectations. For those who find the PSR compelling, as Leibniz, Spinoza, and many others did, this tension alone may suffice to reject the metaphysical coherence of time-travel loops.<sup>41</sup> Yet the problem extends further, as such loops also generate epistemic anomalies, to which I now turn.

#### 4. Temporal Epistemology and Backward Knowledge

Epistemic loops mirror the ontological loops considered above: they involve belief states whose justificatory basis lies entirely within a closed temporal circuit. Standard epistemic practices rely on a temporal asymmetry: justification flows from earlier evidence to later belief. Backward knowledge transmission disrupts this structure, allowing agents to acquire true beliefs whose justification originates from nowhere. Rennick (2021) calls these "epistemic loops", arguing that they represent self-sustaining justification structures analogous to bootstrap paradoxes. In such cases, no agent is epistemically responsible for the belief's content; the justificatory chain is circular and temporally closed.

Consider a simple case. In 2100, a scientist discovers a new mathematical theorem and sends the proof back to a colleague in 2050 via time travel. In 2100, a

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<sup>41</sup> Lewis (1986) was skeptical of the PSR as a universal constraint, suggesting that not every truth must have a cause or explanation. However, even if PSR is not inviolable, rejecting it in cases of time travel introduces significant metaphysical costs that many find unacceptable.

mathematician later finds the same proof in the historical archives, credited to that colleague's 2050 publication, and travels back to 2049 to deliver it to them. The colleague learns the theorem from the delivered proof and publishes it in 2050. No one actually discovers the theorem: its presence in 2050 depends on its existence in 2100, and its existence in 2100 depends on its publication in 2050. The justificatory structure is temporally closed. The colleague's belief in the theorem is true, but it lacks any evidential basis: it is accepted solely because it is already assumed true in the future. This is a paradigmatic epistemic bootstrap paradox, structurally analogous to ontological Jinn cases. It violates the temporal asymmetry that epistemic practices normally rely upon and breaches anti-circularity norms, which require that justificatory chains either terminate in non-inferential grounds or connect reliably to truth-makers. Here, neither condition is met. Allowing such cases would force us to count beliefs as knowledge despite their complete lack of independent justification, thereby destabilising the concept of knowledge itself.

Many philosophers have noted that the backward transmission of true beliefs generates distinctive epistemic paradoxes. Rennick (2021) develops the notion of self-fulfilling prophecy (SFP) loops to describe cases in which future beliefs bring about their own past realization. Consider Alice, who travels to 2050 and learns that she will invent a time machine in 2070. Returning to 2040, she acts on this information and ensures that she does indeed invent the machine in 2070. The belief justifies itself: Alice has no independent reason to trust the prophecy, since it cannot be empirically confirmed outside the loop, yet her actions are predicated upon it. Rennick (2021, p. 9) emphasises that such loops are an underexplored form of causal loop. She argues that 'at worst, SFP loops are as inexplicable and improbable as the more familiar causal loops,' though in fact they may be easier to bring about.

Epistemically, these cases invert the usual temporal order of justification: the warrant for belief depends on its future acceptance, not present evidence. Allowing such self-justifying beliefs as knowledge would require abandoning justification as a temporal precondition for knowledge or accepting closed justificatory circuits, both of which are deeply revisionary.

A natural response is to appeal to the reliability of the future source. The mathematician, for instance, might claim that her belief is justified because she trusts the proof sent by her older self or by a reputable colleague from the future. Yet this move merely displaces the problem. In a loop, the reliability of the source is itself fixed by the loop: her future self is reliable because of information received from the past, and the past self's justification rests on the future self's reliability, and so on. The justificatory chain circles endlessly without ever reaching an independent epistemic ground. In ordinary testimonial cases, justification ultimately terminates

in non-testimonial sources such as perception or inference; this structural feature underwrites their ability to transmit knowledge. Time-travel loops violate this requirement. Invoking reliability in such cases either generates an infinite regress, each appeal to trustworthiness requiring further justification, or collapses into circularity, since the reliability is explained by the very belief it is meant to justify. Either way, the epistemic basis fails: there is no termination point at which justification originates.

This circularity breaches a fundamental epistemic requirement: beliefs must be grounded in evidential states that temporally precede them, not in their own future truth. Standard epistemic practices presuppose a directional flow from past or present evidence to later belief. This temporal asymmetry underwrites our ordinary understanding of justification, ensuring that beliefs are tethered to independent sources of epistemic warrant. Epistemic loops invert this structure. The warrant for a belief depends on its future acceptance, not on prior evidence, producing a justificatory architecture that is temporally closed and self-sustaining rather than evidentially anchored.

Sayan and Cagatay (2019) make a parallel point in their discussion of infallible foreknowledge. They note that if a perfectly reliable oracle reveals your future actions, one faces a puzzle analogous to time travel: why is the oracle's information true in the first place? The content of the revelation seems to lack any independent epistemic ground. They conclude that perfect foreknowledge is, in principle, impossible, precisely because it would require truth without prior justification. Time-travel epistemic loops exhibit the same structural defect. When information is transmitted backwards, the resulting beliefs derive their 'justification' from future acceptance rather than past evidence, thereby violating the temporal asymmetry on which epistemic practices depend.

Knowledge-first and reliabilist frameworks, despite their differences, reinforce rather than weaken this verdict. On Williamson's (2000) account, knowledge is primitive and not decomposable into belief plus justification; yet the very possibility of knowledge presupposes an independent truth-maker.

In an epistemic loop, that independence is for-feited: the belief's truth depends upon its own future acceptance, violating Williamson's anti-luminosity and safety constraints. For example, the belief in the loop is not "safe" because in nearby possible worlds, the belief would still be held even if the truth-maker (its future self-acceptance) were absent, which undermines the core requirement of counterfactual sensitivity. Likewise, Sosa's (1999) virtue epistemology requires that a belief be apt, true through the reliable exercise of intellectual competence. Temporal closure

destroys such competence, for accuracy derives from self-referential stability rather than epistemic virtue.

It is important to distinguish this claim from familiar sceptical scenarios. Traditional sceptical worlds, evil demons, brains in vats, fake barn counties, undermine *our* knowledge that things are as they seem, but they need not involve any violation of epistemic norms *in those worlds themselves*: there may still be non-circular justificatory structures available there, even if their occupants are systematically misled. By contrast, time-travel epistemic loops make non-circular justification structurally unavailable: any candidate knowledge-state depends, in part, on its own future uptake. The conditional claim here is therefore targeted: worlds whose epistemology is dominated by such loops fail the rationalist intelligibility test, whereas worlds that are merely hostile to our evidence need not.

Even Bayesian models presuppose a temporal asymmetry. Updating on evidence requires that the evidence be independent of (and prior to) the posterior it helps fix. In a loop, the “evidence” for P is just future certainty of P; assigning P probability 1 because it will be assigned 1 is circular. Conditionalisation cannot distinguish justified learning from self-sustaining certainty under backward information flow. If one claims that P is already certain because it will be certain, the posterior is fixed by the very posterior it is meant to generate. Bayesian updating thus fails to model rational belief revision under backward information flow: the temporal asymmetry built into probabilistic confirmation theory collapses, leaving no principled way to distinguish justified belief from self-sustaining certainty.

Backward knowledge transfer exposes a structural vulnerability in standard epistemic models. Traditional belief formation presupposes an epistemic arrow of time: justification flows from past and present evidential states towards future beliefs (Wolpert and Kipper 2024). This temporal ordering enables epistemic practices to anchor beliefs in evidence that is both temporally and explanatorily prior. Backward information flow inverts this structure. The justificatory basis of a belief lies in its future acceptance rather than in independent evidential grounds, thereby severing the usual connection between belief and temporally antecedent warrant.

Rennick highlights this disruption by distinguishing between third-person and first-person foreknowledge. Third-person cases, where an agent learns about another’s future actions, already generate explanatory gaps. First-person foreknowledge, however, is particularly prone to closed justificatory loops: an agent learns a proposition about their own future, comes to believe it, and then acts to ensure its truth. In both cases, the justificatory chain is trapped within the loop (Rennick 2021). What distinguishes first-person loops is their self-fulfilling structure, which makes the justificatory circularity especially transparent. Backward

time travel thus allows agents to bypass the normal evidential routes through which knowledge is acquired, destabilising the temporal architecture upon which epistemic justification depends.

It is important to be clear on what follows from this. The claim is *not* that whenever a possible world makes our epistemic situation bad or sceptical, that world is thereby impossible. Standard sceptical scenarios (brains in vats, Cartesian demons, global illusions) may leave the underlying justificatory norms intact even while making them hard or impossible for us to satisfy. The existence of such sceptical worlds does not necessitate the abandonment of epistemic norms; rather, they explore the difficulty of fulfilling them. By contrast, in the time-travel cases at issue, the problem is structural: the only available routes to belief formation run through closed epistemic loops in which warrant depends on future acceptance.

By contrast, in the time-travel cases at issue, the problem is structural: the only available routes to belief formation run through closed epistemic loops in which warrant depends on future acceptance. Under the rationalist conception of intelligibility I am assuming, such worlds fail not because agents inside them cannot tell how things are, but because there is no non-circular justificatory structure available in principle. This is why the Bridge Principle, read constitutively, licenses a modal verdict: worlds in which justificatory norms cannot even be instantiated are excluded, whereas merely sceptical worlds in which those norms can in principle be met are not.

The scientific method, in particular, relies on the temporal accumulation of evidence and its role in hypothesis confirmation. Backward information flow would render this structure circular: experimental findings might themselves depend on future acceptance, undermining their status as evidence. Analogously, inferential and mnemonic processes would lose their justificatory force if their content might have been injected retrocausally. The situation superficially resembles self-fulfilling prophecies in ordinary contexts, but differs in a crucial respect: loop-generated beliefs originate acausally, without grounding in past events. As Rennick and others note, such epistemic loops are not isolated curiosities but present systematic challenges on a par with causal loop paradoxes.

Allowing the backward transfer of beliefs or information entails a distinctive form of epistemic circularity. True beliefs can arise without independent justification, sustained solely by their future acceptance, and agents may act on these beliefs not because of antecedent evidence but because the loop itself guarantees their content. This undermines the link between belief and justification that structures epistemic practices, collapsing the distinction between warranted knowledge and self-sustaining certainty.

These are not isolated curiosities but structural features of any scenario in which information flows backwards through time. In such worlds, epistemic norms lose their explanatory and justificatory function. In the next section, I integrate these epistemic difficulties with the ontological problems generated by causal loops to show that, taken together, they provide a powerful cumulative argument against the metaphysical possibility of non-trivial time travel.

## 5. A Cumulative Case Against Time Travel: Integration and Replies

### 5.1 The Master Argument: Norm Violation and Modal Impossibility

The foregoing sections have examined two distinct but convergent lines of critique. The first concerns explanatory adequacy: causal loops violate the strong PSR by producing entities and facts without external grounds. The second concerns epistemic stability: backward information transfer enables agents to acquire true beliefs through closed justificatory circuits, severing the link between evidence and belief. Taken together, these problems yield a cumulative argument: any non-trivial time-travel scenario either involves unexplained causal loops or unjustified beliefs, and typically both.

Having established the formal case, we may now illustrate it through concrete examples, originless artifacts and Bayesian loops, which make the ontological and epistemic costs of abandoning Strong-PSR vividly apparent.

### 5.2 Originless Artifacts and Bayesian Loops

Originless artifacts illustrate the ontological cost of abandoning Strong-PSR. Objects such as the self-existing time-travelling watch or blueprint possess lawful trajectories yet lack creation events, exemplifying *nommic self-containment*. Such cases can be formalised as fixed-point solutions to causal equations  $E = f(E)$ , which yield existence without origination (Horwich 1987). Bayesian analogues arise in epistemic space: justification loops in which a posterior probability  $P_{\square}$  depends solely on its own future certainty ( $P_{\square} = P_{\square+\square}$ ). These constitute epistemic fixed points rather than rational updates, collapsing evidential independence. Both structures satisfy internal consistency yet violate the irreflexivity of grounding, precisely the norm captured by Strong-PSR and anti-circular epistemology.

Even when such loops are physically coherent or nomically necessary, they remain metaphysically defective precisely because they collapse grounding and justification into self-dependence.

This diagnosis aligns with insights drawn from the physics of closed timelike curves. Deutsch (1991) shows that quantum systems on CTCs can achieve internal

consistency without paradox, while Thorne and Novikov treat CTCs as geometrically permissible yet causally degenerate solutions to Einstein's equations (Friedman et al. 1990). Price (1996) and Earman (1995) observe that such models secure nomic coherence at the cost of explanatory vacuity: the equations admit self-consistent histories but furnish no reason for their obtaining. Visser (1997) and Arntzenius (2006) add that CTC spacetimes lack well-posed initial-data surfaces, eroding the asymmetry on which ordinary causal explanation depends. The resulting worlds are lawfully self-contained but ontologically under-determined. Accordingly, even if general relativity permits CTCs, the metaphysical question remains unresolved: physical admissibility does not entail intelligible existence. Conditional on Strong-PSR, the very feature that renders CTCs consistent, their self-containment, renders them metaphysically inadmissible.

To consolidate the foregoing results and clarify what follows as a matter of metaphysical (not merely logical) possibility, I now turn from these physical considerations to the standing assumptions that underwrite the conditional argument.

Scope and neutrality. I do not presuppose Strong-PSR as a substantive commitment; rather, I prove a conditional: on a single-history model, if Strong-PSR and anti-circular epistemic norms are in force (together with the bridge from norm-violation to modal impossibility), then backward time travel is ruled out.

With these in view, I set out a Master Argument and a brief formal derivation that together display the cumulative force of the explanatory and epistemic objections.

Assumptions for the conditional result:

**A1 Single-timeline:** Backward travel, if any, occurs within a single history (no branching/many-worlds), so closed loops are in principle available.<sup>42</sup>

**A2 Strong-PSR (necessity):** The strong PSR holds necessarily: no contingent totality is circularly grounded.<sup>43</sup>

**A3 Anti-circular Epistemology (necessity):** Knowledge requires non-circular justification; on externalist views the process must track truth independently of the

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<sup>42</sup> On branching/many-worlds models, one can often avoid closed loops by relocating causal effects to a distinct branch; the present argument targets single-history models in which the traveller re-enters our past.

<sup>43</sup> I do not presuppose Strong-PSR as a substantive commitment. The main result is conditional on A2 and A3 together with A4. Readers who reject A2 may instead adopt a weaker Acyclic Grounding constraint (grounding/explanation is irreflexive and acyclic) and recover an analogous no-loops result for single-history models when combined with the epistemic anti-circularity and the bridge principle. The same formal template then yields  $\neg\Diamond B$  for single-timeline cases.

## A Conditional Case Against Non-Trivial Backward Time Travel

belief's future acceptance.

**A4 Bridge Principle:** Any scenario that violates A2 or A3 is metaphysically impossible (read “impossible  $\phi$ ” as  $\neg\Diamond\phi$ ).

**A5 Modal background:**  $\Box$  = metaphysical necessity;  $\Diamond$  = metaphysical possibility; standard normal modal logic (K + Necessitation) suffices.

**A6 Scope:** The claim targets metaphysical (not merely logical or physical) possibility; logical consistency alone is insufficient.

### 5.1 Master Argument

Given A1–A6, the following argument shows that if (1)–(6) hold, then non-trivial backward time travel is metaphysically impossible.

To make the inferential role of the Bridge Principle explicit, we now include it as an independent premise within the formal schema.

(1) **Strong-PSR:** Any contingent totality must be non-circularly grounded (no explanatory self-dependence) (Leibniz 1934; Melamed and Lin 2023; Pruss 2006).

(2) **Anti-circular Epistemology:** Knowledge requires non-circular justification; on externalist views, the belief-forming process must be truth-tracking independently of the belief's future acceptance.

(3) **Loop Generation:** Non-trivial backward time travel (on a single timeline, given A1) yields either (a) a causal loop (an originless contingent structure) or (b) an epistemic loop (self-grounding information), or both (Lewis 1976; Meyer 2012; Rennick 2021).<sup>44</sup>

(4) **Bridge Principle:** Worlds violating explanatory or epistemic norms (1–2) are metaphysically impossible. (formally:  $\Box(V \rightarrow \perp)$ , i.e.,  $\Box\neg V$ ).

(5) From (3) and (1–2): any world with backward time travel involves such violations.

$\therefore$  Therefore, non-trivial backward time travel is metaphysically impossible.

A few clarifications about premise (1) are needed. First, the claim that  $\Box(B \rightarrow (C \vee K))$  is restricted to non-trivial backward travel on a single timeline: cases in which the traveller appears in an empty region, leaves no trace, interacts with no agents, and generates no records are bracketed as metaphysically idle. The intended reading is that backward time travel **B** entails **B**<sub>non-trivial</sub>, a worldline intersecting an

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<sup>44</sup> Clarification: The necessity operator in  $\Box(B \rightarrow (CVK))$  reflects a non-degeneracy constraint already built into A1: on a single history, any backward visit that is not causally and epistemically inert (no interaction, no records, no testimony) inevitably generates either an object/event loop (C) or an information/belief loop (K). Trivial ‘no-interaction’ travel is bracketed as irrelevant to metaphysical admissibility; once non-trivial interaction occurs, loop-closure follows

earlier external time where the traveller’s presence results in causal or epistemic interaction. Given the single-timeline constraint (A1), any such non-inert interaction necessarily closes into a dependence loop (C  $\vee$  K). Once the traveller or their artefacts interact with the past, by leaving an object, altering a causal chain, creating a record, or transmitting information to another agent, either a causal or an epistemic loop is unavoidable. If the traveller’s actions help bring about the very conditions that enable their later departure, we obtain a causal loop of the familiar bootstrap kind; if instead the traveller conveys novel information with no independent past source, we obtain an epistemic loop in which acceptance of a proposition depends wholly on its future acceptance. In both cases, the single-timeline constraint ensures closure: there is no independent branch on which the relevant object or item of information is first introduced.<sup>45</sup>

Formally, the core reasoning may be expressed as follows; it is deductively valid and, given the principles defended in §§3–4, also sound.

Let:

B = Backward time travel (single-timeline) occurs.

C = A causal loop exists.

K = An epistemic loop exists.

V = A world violates explanatory or epistemic norms (i.e. violates PSR or Anti-Circularity).

Modal operators:  $\Box$  = necessarily

$\Diamond$  = possibly.

**Then:**

Here the Bridge Principle is introduced as an independent modal premise (line 3), not merely as commentary. It transfers norm-violation (V) into impossibility ( $\Box\neg V$ ). When combined with  $\Box(B \rightarrow V)$ , it yields  $\Box\neg B$  and, by duality,  $\neg\Diamond B$ .

1.  $\Box(B \rightarrow (C \vee K))$  (Loop generation)

2.  $\Box((C \vee K) \rightarrow V)$  (from the PSR and epistemic principles: causal or epistemic loops constitute norm-violation)

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<sup>45</sup> One might object that a traveller could simply reappear a short time earlier but in a causally isolated region, “a billion light years away and a second ago”, and then live out an ordinary life, with no loops. My claim is that such scenarios are either trivial (if no interaction with the original history ever occurs) or else fall under the causal-loop case once they do interact. If the traveller later causally reconnects to the original history, then her earlier presence forms part of the antecedent conditions that explain that very reconnection; given single-history, this yields a loop at the level of the total causal structure.

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3.  $\Box(V \rightarrow \perp)$  (Bridge Principle: norm violation entails impossibility)  
4.  $\therefore \Box(B \rightarrow V)$  (from 1, 2, by propositional composition inside  $\Box$ )  
5.  $\therefore \Box(B \rightarrow \perp)$  (from 3, 4, by propositional reasoning inside  $\Box$ )  
6.  $\therefore \Box\neg B$  (since  $(B \rightarrow \perp) \equiv \neg B$ , a tautology, and by necessitation + K)  
7.  $\therefore \neg\Diamond B$ . (by duality)
- $\therefore$  Non-trivial backward time travel (in a single-timeline world) is metaphysically impossible.

Such scenarios therefore conflict simultaneously with two foundational metaphysical and epistemological principles. This dual failure is not remedied by imposing consistency constraints or adopting alternative temporal frameworks; these measures may preserve logical coherence but leave explanatory and justificatory deficits untouched. The remainder of this section develops this cumulative argument explicitly and considers the main strategies by which defenders of time travel, most notably those inspired by Lewis and Novikov, might attempt to resist it.

To make the structure of the cumulative argument clear, consider a generic closed timelike curve scenario within an eternalist framework. Let an event  $E$  occur at a future time  $t_2$  and be transported to an earlier time  $t_1$ , where it either directly causes itself or initiates a chain that culminates in  $E$  at  $t_2$ . Two schematic possibilities capture the cases we have considered.

(i) **Ontological case.** If  $E$  concerns a physical object or event, the resulting loop yields an entity without independent origin: its existence is explained entirely in terms of its own future stages, violating Strong-PSR at the level of the totality (Hanley 2004; Melamed and Lin 2023; Meyer 2012). Weak-PSR may be satisfied, since each local segment has a cause, but the loop as a whole lacks an external ground.

(ii) **Epistemic case.** If  $E$  concerns information or belief, an agent at  $t_1$  believes  $P$  solely because they have been informed of  $P$  at  $t_2$ , and that later belief in turn depends on the earlier acceptance. The justificatory structure is closed: warrant is supplied by the loop itself rather than by evidentially prior states. In both cases, some element of the world becomes self-sustaining without external explanation or justification. This is not a contingent feature of particular examples but a structural feature of any temporally closed system: whether the loop carries objects or propositional content, the explanatory or epistemic architecture becomes circular.

This is precisely where my approach diverges from Hanley's and Smith's localist accounts. They argue that once local causal explanations are in place, no further global grounding is metaphysically required; strong PSR is treated as an

optional principle (Hanley 2004; Smith 1997). On the Strong-PSR reading, localism fails: the explanatory demand arises precisely at the global level, since loops, taken as a whole, lack any external ground. Strong PSR articulates this requirement. Alternatively, rejecting Strong PSR amounts to accepting localism at the cost of brute structures. My claim is conditional: either accept Strong PSR (and rule out loops), or reject it and bear the corresponding explanatory costs.

One possible response seeks to avoid epistemic loops by restricting the transfer of information rather than the movement of persons or objects. On this view, agents are simply prohibited from learning about their own future. Yet this strategy is unstable: if backward time travel allows the transmission of physical objects, records, or testimony, then epistemic transfer will inevitably occur. As Rennick (2021) observes, even apparently simple cases of foreknowledge generate loops in an agent's belief states: once a novel proposition is accepted on the basis of information from the future, its justificatory structure closes on itself.

As a diagnostic, I distinguish two kinds of information-transfer:

**Case B (Backward testimony, no loop):** If a traveller conveys someone else's discovery with an original source, the case reduces to ordinary testimony (albeit temporally exotic) and does not threaten knowledge.

**Case A (Closed epistemic loop):** Where acceptance stems only from future acceptance (no original source), justification collapses.

The paper's claim concerns Case A.

The only way to avoid this consequence would be to impose a blanket prohibition on epistemic transfer, forbidding time travellers from speaking, writing, or bringing records. Such a model is physically *ad hoc* and metaphysically unmotivated. It insulates time travel from epistemic anomalies only by fiat, not by appealing to any independent principle. As a result, attempts to defuse the epistemic objection through informational restrictions ultimately fail: epistemic feedback is either inevitable or artificially excluded.

A second defensive strategy appeals to global consistency conditions, most famously Novikov's self-consistency principle (Novikov 1992). On this view, the only physically possible histories are those in which all events are globally consistent; time travellers may bring about the past but cannot alter it. This principle ensures that closed timelike curves do not generate logical contradictions within the overall history.

However, consistency is neither explanation nor justification. Novikov's principle constrains what histories can occur, but it does not explain why any particular loop exists. A self-consistent causal loop may be logically possible yet still lack an external ground, thereby violating strong PSR. As Meyer stresses, explaining

one loop-event by another relocates rather than resolves the global deficit (Meyer 2012). In this respect, Novikov's principle not only fails to answer the explanatory objection but highlights it, by stipulating that such loops occur without contradiction, it implicitly accepts their brute existence.

Nor does consistency address the epistemic problem. An agent who receives information from her future and acts on it can inhabit a perfectly self-consistent history, yet the justificatory structure of her beliefs remains circular. Global consistency ensures coherence at the level of events but is silent about the provenance of reasons or evidence. Hence, Novikov-style constraints may preserve logical possibility, but they do nothing to secure metaphysical intelligibility.

A further response invokes Lewis' distinction between personal and external time. Lewis (1976) argued that a time traveller's personal time, the sequence of experiences along her worldline, can diverge from external, or coordinate, time. On this view, backward time travel simply involves following a continuous personal timeline that intersects earlier external times. Some have suggested that this reframing dissolves paradoxes by treating time travel as an ordinary, if oddly ordered, sequence of events from the traveller's perspective.

Yet personal time is a descriptive device, not an explanatory mechanism. Reordering events along a traveller's worldline does not supply any new causal or justificatory origins for the objects or information involved. From the standpoint of external time, the loop persists: an event, object, or piece of information still closes back on itself. The PSR and epistemic problems are frame-independent. If information from a traveller's future appears in her past, invoking personal time merely relocates the anomaly within the traveller's timeline; it does not explain it away. Lewis' framework clarifies how loops can be experienced without contradiction, but it does nothing to ground their existence or justify the beliefs they generate. As such, it leaves the core metaphysical difficulties untouched.

A final line of response comes from sophisticated presentists such as Zhuang (2022), who seek to reconcile time travel with presentism by reformulating causation in terms of facts rather than events. Since past and future events do not exist on strict presentism, Zhuang proposes that causal relata are present-tense facts about those events. Instead of saying "Event A at 2100 causes Event B at 2000", the presentist can say "The fact that A will occur in 2100 causes the fact that B occurred in 2000", treating both as present facts. This manoeuvre allows presentists to model backward causation without positing non-present entities.

While ingenious, this reformulation merely redescribes the relata; it does not resolve the grounding problem. The relevant facts mutually support each other within a closed structure: the fact that B occurred depends on the fact that A will

occur, and vice versa. No external explanation is provided for why this network of facts obtains. Strong PSR is therefore violated just as in standard loop cases, only now the loop consists of facts rather than events. The metaphysical challenge remains: why do these facts hold at all?

The epistemic problem persists as well. An agent's belief about these facts still originates entirely within the loop, lacking any justificatory source outside the fact-structure. No new evidence or causal origin is introduced by the shift to present-tense facts. Zhuang's strategy may preserve logical compatibility for presentists, but it leaves the explanatory and epistemic deficits untouched.

None of the standard strategies succeeds in defusing the cumulative argument. Consistency principles such as Novikov's eliminate logical contradictions but leave explanatory and justificatory gaps entirely untouched. Lewis' personal-time framework reorders events from the traveller's perspective but supplies no new grounds for their occurrence. Presentist fact-based causation redescribes the relata without altering their circular dependence.

In every case, the underlying structure remains the same: loops persist without external explanation or epistemic origin. Logical coherence is preserved, but metaphysical intelligibility collapses. The cumulative force of the PSR and epistemic objections therefore remains intact. Any world that permits backward time travel would necessarily contain ungrounded facts or unjustified beliefs, or both. Such worlds fail to meet basic standards of metaphysical possibility.

The conditional result also extends to branching or multi-history models. Where histories diverge, each branch either contains a loop or terminates in an unexplained divergence event whose ground lies outside its own history; the explanatory deficit merely relocates. Novikov-style consistency conditions restrict physical evolution but remain silent on metaphysical grounding. Thus, even if every branch is self-consistent, the total system either violates Strong-PSR globally or collapses into brute modal segregation. The argument's force therefore persists across single- and multi-history frameworks.

Taken together, these considerations show that any theory that accommodates non0-trivial backward time travel must either reject strong-PSR or abandon standard accounts of epistemic justification. Logical consistency alone cannot secure metaphysical possibility. Allowing time travel would collapse the distinction between brute and derived facts, and between justified and unjustified beliefs, thereby undermining core explanatory and epistemic principles. This constitutes a decisive reason to reject its metaphysical coherence.

## 6. Objections and Replies

Several standard responses are insufficient against this cumulative argument:

**1. Consistency constraints (Novikov):** It is often said that Novikov's self-consistency principle removes contradiction and thereby saves the possibility of backward travel. True: Novikov guarantees logical coherence. But coherence is not explanation. The principle explicitly permits exactly the kind of originless loops, "Jinn" objects and information, that Strong-PSR forbids (A Lossev and I D Novikov 1992). Novikov's physics precludes paradox only by accepting brute coincidences, such as chance alignments preventing alteration of the past. These are precisely the brute contingencies that explanatory rationalism excludes (Pruss 2006; Della Rocca 2010). As Visser notes, Novikov's rule restores only logical bookkeeping, not intelligibility (Visser 1997). The epistemic problem also remains: a perfectly self-consistent prophecy loop still provides circular justification (Rennick 2021). Thus, Novikov-style replies concede logical possibility (which is not denied here) while ignoring the explanatory and epistemic deficits. Consistency alone cannot countenance intelligible worlds.

**2. Localist PSR defences.** Hanley, Smith, and Schaffer contend that causal loops meet a local sufficiency requirement: each event has a proximate cause, and that should exhaust explanation (Hanley 2004; Meyer 2012; Smith 1997). On this localist reading, the demand for an external ground is optional. The Bridge Principle, however, embeds Strong-PSR as a constitutive rather than heuristic norm. It marks the boundary between the intelligible and the merely consistent. Local closure within a loop may yield causal adequacy, but it abandons metaphysical adequacy by accepting self-grounding totalities. For those who reject Strong-PSR, the conditional force of the argument is transparent: they may keep time travel only by relinquishing the very explanatory ideal that distinguishes metaphysical from logical possibility (Melamed and Lin 2023; Pruss 2006).

**3. Personal-time re-description:** Lewis's (Lewis 1976) appeal to personal time re-orders events along the traveller's worldline but does not provide new grounds for them. From any temporal frame, the loop's contents remain self-dependent. The Bridge Principle is viewpoint-neutral: norm-violations persist regardless of whose **clock** ticks. Re-labelling a sequence as "ordinary causation from the traveller's perspective" adds description, not explanation (Ryan Wasserman 2018).

**4. Branching/multiverse strategies:** If backward travel initiates a new branch, one might think the loop dissolves. Yet either the branching event itself is brute, or the traveller imports ungrounded entities into a new history, generating inter-branch loops. Unless an external mechanism grounds why that branch and its contents exist, Strong-PSR remains globally violated. Many-worlds models preserve

local consistency but not global intelligibility; they replicate the problem rather than resolve it (Deutsch 1991; Price 1996; Arntzenius 2006).

**5. Presentist fact-based causation: Presentists** sometimes redescribe past-directed causation as relations among present facts, “the fact that A will occur causes the fact that B occurred.” This manoeuvre changes ontology, not **dependence**. If those facts mutually determine one another, the explanatory circularity persists. A world of closed facts is no more intelligible than a world of closed events; both breach Strong-PSR and anti-circular epistemic norms (Bourne 2006; Zhuang 2022).

**6. Grounding non-causally (nomic necessity):** Could the loop’s contents be fixed by law rather than cause? If so, their existence would be nomologically necessary but explanatorily brute: the law would dictate the loop without reason **for** that law or that solution. This merely promotes the brute fact from contingent to law-like status, contravening the spirit of PSR-based rationalism (Della Rocca 2010; Lange 2013). Physical necessity cannot substitute for intelligible grounding (Pruss 2006).

**7. Epistemic circularity and knowledge-first replies.** A reliabilist or knowledge-first theorist might claim that if the loop guarantees truth, the resulting belief could still count as knowledge. Yet reliability within a loop is reflexive, not truth-tracking: the belief ensures its own truth by construction. Williamson’s (2000) and Sosa’s (1999) accounts both require counterfactual stability that collapses in a looped system. Hence, even the most generous epistemic theories cannot rehabilitate backward justification without abandoning independence from the very belief to be explained (Rennick 2021; Pritchard 2005).

**8. Constitutive status of the Bridge Principle.** Finally, one might worry that BP simply restates a rationalist preference rather than yields a genuine modal constraint. However, as clarified in § 1.2, BP functions constitutively: worlds violating explanatory or epistemic norms are unintelligible by definition of metaphysical possibility (Pruss 2006; Della Rocca 2010). To reject that link is not to refute the argument but to adopt a different modality altogether.

None of these replies restores explanation or justification. They preserve physical or logical coherence at the cost of intelligibility. Accordingly, unless one weakens the constitutive reading of the Bridge Principle, abandons Strong-PSR, or accepts epistemic circularity as benign, the obstacles remain.

## 7. Conclusion

Time travel has long intrigued philosophers and physicists. This paper has argued that, given non-circular explanatory and epistemic standards (and a modest bridge from norm-violation to modal impossibility), non-trivial backward time travel is

metaphysically impossible. The argument proceeds on two fronts. First, causal loops violate the strong PSR by generating entities and facts without external origin. Second, epistemic loops allow agents to acquire true beliefs from the future without justification, undermining the temporal asymmetry on which knowledge depends. These are two manifestations of a single underlying problem: certain facts and beliefs become self-sustaining within loops, lacking any independent ground.

This cumulative argument challenges the prevailing view that logical consistency is sufficient for metaphysical possibility. Even models that satisfy Novikov-style constraints or adopt Lewisian personal-time frameworks leave these explanatory and justificatory gaps untouched. Given the requirements **that** facts be grounded and beliefs justified (and the bridge from norm violation to modal impossibility), the metaphysical possibility of time travel cannot be sustained. Logical coherence is not enough; metaphysical intelligibility fails. Accordingly, non-trivial backward time travel is metaphysically impossible given minimally plausible explanatory and epistemic norms.

The implications extend beyond the time travel debate. If time travel is ruled out on these grounds, this reinforces central metaphysical principles and clarifies the limits of acceptable models in physics. It underscores the continuing relevance of PSR-style explanatory demands and epistemic norms to our understanding of rational worlds. Conceptual analysis thus complements technical physical arguments against closed timelike curves by showing that their very possibility would undermine basic principles of intelligibility.

Future research might instead explore whether there are coherent ways of weakening PSR or revising epistemic norms that intentionally accept Lewis-style brute loops and yet preserve a recognisable rationalist structure. The present conditional argument shows what is lost on that path: once Strong-PSR and anti-circularity are relaxed, time travel may be admissible, but only at the cost of treating self-sustaining structures as metaphysically benign.

In sum, backward time travel fails to meet the fundamental standards by which metaphysical possibility is assessed. Logical consistency alone cannot rescue it. The cumulative explanatory and epistemic deficits identified here provide decisive reason to reject its metaphysical coherence.

The Bridge Principle thus serves as the conceptual hinge: once explanatory or epistemic norms fail, metaphysical possibility itself is withdrawn.

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