

The Rigor Laws of Peer Review: A Core Mechanic Treatise for Restoring Epistemic Boundaries in Scientific Practice

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These laws define the epistemic backbone that science and peer review must enforce to prevent linguistic drift, measurement drift, proxy substitution, narrative inflation, and mechanism-free claims. They are not stylistic guidelines; they are non-negotiable invariants required for scientific validity.

Each law includes a Nuance Clause, because scientific reality contains gradients, not binaries.

Law Zero. The Premise Gate

A study may not proceed unless its foundational premise is mechanistically plausible, empirically grounded, causally coherent, environmentally realistic, linguistically precise, and free of unbounded proxy substitution.

Nuance Clause: Proxies may be used when direct measurement is unavailable, provided their limitations are explicit and conclusions remain within the proxy's load-bearing capacity.

1. Universal Definition of Evidence

Evidence must be a direct empirical measurement of the phenomenon under investigation, collected under conditions that preserve the mechanism being studied.

Nuance Clause: Indirect evidence may be used only when the causal link to the target phenomenon is validated and bounded.

2. Universal Definition of Mechanism

A mechanism is a physically plausible, causally continuous chain connecting cause to effect without gaps, substitutions, or narrative leaps.

Nuance Clause: Mechanistic uncertainty is allowed, but mechanistic impossibility is not.

3. Requirement for Causal Coherence

All claims must align with known physical, chemical, biological, or computational constraints. No step may contradict established causal structure.

Nuance Clause: Novel mechanisms must demonstrate compatibility with existing causal laws or explicitly define the conditions under which they diverge.

4. Rule of Empirical Load-Bearing

Every major claim must be supported by measurements that carry the causal weight of the conclusion.

Nuance Clause: Supporting measurements may be distributed across multiple datasets, but the causal load must be traceable and justified.

5. Standard for Environmental Realism

Experiments and measurements must reflect the real environmental conditions of the system being studied, or deviations must be explicitly justified.

Nuance Clause: Artificial environments may be used for mechanistic isolation, but not for ecological generalization.

6. Prohibition on Proxy Substitution

A proxy may not replace a measurement unless its causal relationship to the target variable is empirically validated, bounded, and explicitly stated.

Nuance Clause: Proxies are acceptable tools; they are unacceptable stand-ins for phenomena.

7. Requirement of Study Necessity

A study must address a real causal uncertainty, fill a mechanistic gap, or resolve an empirical ambiguity. Studies that do not add scientific value should not proceed.

Nuance Clause: Replication is necessary when it tests robustness, not when it repeats narrative.

8. Law of Scope

The scope of the conclusion must match the scope of the measurements, mechanism, and environment. No extrapolation beyond causal justification is permitted.

Nuance Clause: Scope may expand only when supported by mechanistic universality or cross-environmental invariance.

9. Law of Uncertainty Propagation and Load-Bearing Transparency

Every quantitative or semi-quantitative claim must explicitly propagate all sources of uncertainty, measurement, proxy, environmental, mechanistic, through to the final conclusion. The conclusion may not exceed the propagated uncertainty band.

Nuance Clause: Zero uncertainty is impossible. The requirement is traceable, bounded uncertainty that reviewers can independently verify. If the uncertainty band swallows the claimed effect, the claim fails load-bearing.

10. Law of Archival and Reproducibility Invariance

All data, code, raw measurements, and environmental metadata that carry causal load must be archived in a form that permits independent forensic reconstruction at any future time, under the same epistemic standards applied to the original study. Claims dependent on non-archived or non-reproducible elements are disallowed.

Nuance Clause: Proprietary or ethically restricted data are acceptable only if a fully documented synthetic or redacted surrogate dataset is provided that preserves the mechanistic and uncertainty structure

How these laws function in peer review

A rigor-based peer review system must operate as a constitutional filter rather than a mere formatting checklist. The process begins with the Premise Gate: if the foundational premise fails any of the required criteria, the study is rejected before methods or results are even examined.

Next, mechanistic plausibility is evaluated before any narrative is considered. Load-bearing empirical measurements must exist and be traceable before interpretation is allowed. Scope is checked before any generalization is entertained. Proxies are accepted only when explicitly bounded rather than substituted. Study necessity is verified to ensure the work adds genuine mechanistic or empirical value. Finally, full uncertainty propagation is required for any quantitative claim, and archival invariance serves as the ultimate gatekeeper, ensuring that future forensic reconstruction remains possible.

Only studies that pass all ten invariants advance. This sequence prevents drift at the architectural level rather than attempting to patch it after the fact.

How Science Forensics Revealed the Need for Rigor Laws in Peer Review

Science Forensics did not begin as an attempt to reform peer review. It began as a diagnostic tool, a way to trace scientific contradictions back to their mechanistic roots. But as the forensic method was applied across hydrology, exposure science, environmental modeling, and ecological inference, a pattern emerged: The contradictions were not emerging from the data but from faulty premises, thin-slice or non-representative data, and mis-attributed evidence. None of which peer review is structurally equipped to detect because it lacks a mechanism-level coherence check.

Science Forensics repeatedly uncovered the same structural failure:

- linguistic categories that no longer matched the phenomena

- measurement categories that drifted away from mechanism
- proxies treated as phenomena
- models treated as evidence
- artificial environments treated as natural
- causal chains with missing or impossible steps
- conclusions that exceeded the load-bearing capacity of the data

These were not isolated errors. They were symptoms of a deeper architectural void.

Science Forensics and the Discovery of the Epistemic Void

Science Forensics began as a diagnostic tool, not a reform agenda. Its purpose was straightforward: trace scientific contradictions back to their core mechanistic roots. But as the method was applied across hydrology, exposure science, environmental modeling, and ecological inference, a deeper pattern emerged. The contradictions were not coming from the data. They were coming from the architecture of scientific reasoning itself. Peer review was operating without the epistemic boundaries required to evaluate whether a study's premise was valid, whether its measurements carried causal weight, or whether its conclusions remained within the limits of mechanism and environment

Across every field examined, the same structural void appeared. There was no universal definition of evidence. No definition of mechanism. No requirement that causal chains align with physical, chemical, or biological constraints. No rule ensuring that measurements carried the inferential load of the claims built upon them. No standard for environmental realism. No prohibition on proxy substitution. No law of scope. No requirement that a study be necessary. And critically, there was no gate that validated the premise before the study proceeded. Peer review was not failing because reviewers were careless. It was failing because no constitutional framework existed to guide them. Without epistemic boundaries, peer review could enforce format, not scientific validity.

As Science Forensics reconstructed contradiction after contradiction, a universal drift pattern emerged, it was predictable, repeatable, and structurally inevitable in a system without boundaries. Definitions froze while the systems they described continued to evolve. Measurements froze while environmental conditions changed around them. Proxies expanded beyond their causal justification, gradually transforming from tools into stand-ins for the phenomena themselves. Models inflated into evidence; their outputs treated as empirical observations rather than

computational artifacts. Artificial environments were quietly reinterpreted as natural ones. Local observations were generalized into global claims. And narratives filled the gaps left by missing mechanisms, creating the illusion of causal coherence where none existed.

This drift was not random. It was the architectural consequence of operating without mechanistic, empirical, and environmental constraints. Once definitions, measurements, and proxies were allowed to drift away from mechanism, the entire scientific structure became vulnerable to narrative inflation and causal distortion. Peer review, lacking the tools to detect these shifts, approved studies whose premises violated physical constraints, whose measurements could not support their conclusions, and whose causal chains contained missing or impossible steps.

Science Forensics revealed that the failures were not anomalies or disciplinary quirks. They were the predictable outcome of a system that had lost the structural context required to keep scientific claims anchored to mechanism, measurement, and reality. The absence of epistemic boundaries created the conditions for drift; the drift produced the contradictions; and peer review, lacking a constitutional framework, could not detect or prevent either.

The laws emerged as the only viable repair

The Rigor Laws were not invented, nor were they discovered in the sense of being new. They are the natural invariants of sound scientific reasoning; the causal, empirical, and mechanistic boundaries that science has always required. What Science Forensics uncovered was not the laws themselves, but the fact that modern scientific practice had drifted away from them. Through repeated forensic reconstruction of scientific contradictions, it became clear that every failure traced back to violations of these long-standing scientific necessities: a faulty premise, a missing mechanism, a proxy treated as a phenomenon, a model treated as evidence, an unrealistic environment, a conclusion that exceeded the load-bearing capacity of the data, or a study that answered no causal question. The laws formalize the structure that should have been present from the beginning, the structure that scientific practice gradually lost as definitions, measurements, and proxies drifted away from mechanism.

The pattern was so consistent that the repair became unavoidable. If science was to remain anchored to mechanism, measurement, and reality, it needed a constitutional framework; one that defined evidence, defined mechanism, enforced causal coherence, bounded proxies, constrained scope, required environmental

realism, demanded empirical load bearing, and validated the premise before any study proceeded. The Rigor Laws emerged as the only viable repair because they addressed the root causes of drift rather than its symptoms.

Science Forensics proves the mechanisms; the Core Mechanic laws provide the structure

Science Forensics and the Rigor Laws form a complementary system. Science Forensics is the diagnostic engine. It reveals where drift has occurred, how it propagated, and which architectural elements failed. It reconstructs causal chains, identifies missing steps, and exposes contradictions that narrative-based peer review cannot detect.

The Rigor Laws are the core mechanic that provides the structural repair. They define the boundaries that prevent drift from occurring in the first place. They ensure that premises are mechanistically plausible, that evidence is empirical and load-bearing, that proxies remain bounded, that environments are realistic, and that conclusions remain within the limits of mechanism and measurement. Together, the diagnostic mechanism and the constitutional structure form a complete system: Science Forensics detects drift; the Rigor Laws prevent it.

Synthesis: The Architectural Meaning of the Rigor Laws

Science Forensics revealed a pattern that was impossible to ignore: the contradictions appearing across fields were not anomalies, not disciplinary quirks, and not the result of individual error. They were the predictable outcome of a system operating without the epistemic architecture required to keep scientific claims anchored to mechanism, measurement, and reality. The drift patterns, the frozen definitions, the proxy expansions, the model inflations, the environmental mismatches, and the narrative substitutions all pointed to the same conclusion: science had gradually lost the structural context that once constrained its claims.

The Rigor Laws exist because that context must be restored. They are not new principles, nor are they inventions. They are the natural invariants of sound scientific reasoning, the boundaries that have always been required for causal claims to remain coherent. What Science Forensics uncovered was not the laws themselves, but the fact that modern scientific practice had drifted away from them. The laws formalize the structure that should have been present from the

beginning, the structure that scientific practice slowly lost as its categories, measurements, and proxies drifted away from mechanism.

Seen through this lens, the Rigor Laws are not a reform. They are a restoration. They re-establish the definitional, mechanistic, environmental, and inferential context that scientific claims must sit on. They provide the constitutional architecture that peer review never had, the architecture required to evaluate whether a premise is valid, whether evidence is empirical and load-bearing, whether proxies are bounded, whether mechanisms are continuous, and whether conclusions remain within the limits of the data and the environment.

This synthesis is the pivot point of the treatise. Everything that follows; the case-agnostic demonstrations, the architectural analysis of peer review, and the application of Science Forensics across domains, rests on the understanding that the Rigor Laws are not an overlay on science. They are the structure that makes science possible. The drift documented in earlier sections is the consequence of their absence. The coherence that follows is the consequence of their return.

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