

Trust Formation in Heterogeneous Relational Trajectories: A Discussion of Evidence Access and Retrospective Recognition

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Abstract

This paper investigates how heterogeneous relational events can change the conditions under which previously formed trajectories become observable, interpretable, and available for trust assessment. The research object is a structural opportunity: a new participant, event, or cross-context coupling may create an evidence path for an observer who previously had limited access to a contribution history. Such a pathway can support independent scrutiny, preserve uncertainty, or expose evidence warranting a less favorable assessment. The proposed analysis distinguishes revisable relational-history representations, observer-relative event heterogeneity, distributional entropy, realized surprisal, diagnostic information, accessibility of evidence, actual examination, and warranted trust. It develops conditional structural hypotheses and a comparative agenda for temporal networks and other locally specified relational representations, with preliminary attention to power-conditioned observability. A historically situated extension investigates the uneven development of knowledge-producing capacities and the institutions mediating the visibility of existing scholarly records, drawing on comparative bibliometric coverage and documented 2026 indexing and classification changes. These examples establish changes in recorded coverage and representation; their consequences for independent examination and warranted trust remain empirical questions. The paper reserves detailed human cognitive mechanisms, systematic power theory, and the circulation of relational warrants for companion investigations. The ten-section manuscript synthesizes historical evidence access, observer-relative novelty, independent testimony, pathway robustness, and research identification. It reports no original empirical findings or validated general law.

Keywords: relational trajectories; structural heterogeneity; observer-relative surprisal; epistemic trust; evidence pathways; retrospective recognition

Discussion Paper Note

This second paper of a coordinated research programme examines how structurally heterogeneous relational events may alter the accessibility and interpretation of existing trajectories. Its proposed mechanisms concern evidence pathways and observer-relative opportunities for warranted assessment. The analysis distinguishes an opportunity to observe from actual examination and distinguishes examination from warranted trust. Neither structural novelty nor cross-community affiliation is presumed to establish trust.

The document is an exploratory scholarly draft. It comprises a revised ten-section draft, including structural and information-theoretic models, illustrative counterfactuals, historically situated examples of bibliographic infrastructure, and prospective empirical designs. The reported indexing and classification changes are descriptive observations of services rather than findings of increased epistemic trust. Its provisional title and theoretical hypotheses remain subject to author review, independent scholarly critique, and empirical investigation. The source-verification ledger records bibliographic checks and limitations. The representations are conditional and remain open to conceptual revision.

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Notices

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1 Introduction

The formation of epistemic trust depends partly on the routes through which accounts of prior contributions become available for examination. A contribution can be documented and assessed within one community yet remain difficult to encounter or interpret elsewhere. A subsequent encounter, participant, or institutional connection can open a pathway to that history without changing the preserved contribution itself. This paper investigates how such relational transformations expand, restrict, or rearrange opportunities for warranted assessment. Its immediate object is the structure of evidence access; detailed cognitive interpretation and the endogenous formation of institutional authority remain subjects of companion investigations.

An archived record and an epistemically usable record are different achievements. Discoverability, permissions, representational compatibility, contextual materials, and the resources needed for examination condition whether an observer can use preserved evidence. An accessible record may be difficult to interpret without provenance or relevant expertise. A comprehensible account may nonetheless offer little reliable information about a person’s competence, integrity, or conduct. The analysis therefore distinguishes the persistence of documentary evidence, its observer-specific accessibility, contextual legibility, substantive examination, and the assessment that the evidence warrants.

The historically specific motivation for this inquiry concerns the relation between expanding capacities for knowledge production and the organization of the infrastructures through which their products become socially visible. Scientific instruments, computational systems, digital repositories, research labor, and collaboration networks jointly sustain the production and preservation of intellectual work. Yet the procedures that determine whether its records appear in indexes, can be retrieved, can be translated, or qualify for institutional evaluation have distinct costs and institutional histories. Marx’s account of the reciprocal relation between productive forces and historically specific relations of production provides a methodological point of departure for asking how material capacities and social arrangements condition one another [23]. This paper draws on that orientation as a problem-setting method. It does not infer from a general historical schema that a particular platform arrangement must be exploitative, that every access restriction is illegitimate, or that knowledge infrastructures follow a necessary sequence of development.

The immediate empirical setting illustrates why the distinction matters. An observational study of 41.3 million papers across the natural sciences reported that researchers engaging in AI-augmented research published 3.02 times as many papers and received 4.84 times as many citations as comparison researchers, while the collective distribution of investigated topics contracted by 4.63% and measured engagement among scientists was lower by 22% [14]. These quantities refer to the study’s particular measurements and comparisons; they do not establish a causal effect of generative language models, nor do they measure the rates at which previously produced work becomes independently examined. They demonstrate a relevant contemporary tension: changes in research capacities and individual output indicators may coexist with changes in collective attention and the organization of inquiry. The present paper addresses the narrower question of how relational and infrastructural conditions mediate access to a given historical contribution.

Evidence of uneven knowledge visibility also comes from bibliographic comparison. Van Bellen, Alperin, and Larivière compared publisher representation in Dimensions and Web of Science for 1980–2021 and recovered approximately 55 million articles in the former against 42 million in the latter, a reported difference of 32% [3]. The datasets employ different inclusion rules, coverage arrangements, and data processing procedures. Their difference is evidence of database-conditioned representation, rather than evidence that one database holds an authoritative and complete inventory of scholarship. For a study of observability, this distinction is valuable: what appears to be the distribution of published contributions can depend substantially on the infrastructural route by which the distribution is constructed. UNESCO’s global open-science assessment likewise identifies uneven access to funding, skills, and tools despite the wider adoption of open-science practices [32]. These observations support investigation of historically situated access conditions; they do not establish the epistemic quality of an omitted or newly

51 included contribution.

52 A more direct development occurred in October 2026, when OpenAlex reported increasing coverage
53 of active Open Journal Systems journals from 44,464 to 52,927 and associated article records from 14.6
54 million to 18.8 million [25]. The provider attributed the change principally to expanded harvesting
55 directly from journal feeds. Such figures concern records in a particular index, measured under the
56 provider’s specified journal reference list. They should not be interpreted as the number of articles newly
57 written during the expansion, or as demonstrated increases in scrutiny, citation, or trust. Their immediate
58 analytical significance is narrower and more precise: changing relations among journals, harvesting
59 protocols, metadata, and an index can make older records retrievable through an additional institutional
60 interface without altering their underlying publication histories. Sections 5 and 9 develop the resulting
61 retrospective-access mechanism and a feasible research design.

62 Within historical materialism, the resulting research problem concerns the socially organized repro-
63 duction of collective inquiry. Production, preservation, discovery, scrutiny, and reuse are connected
64 forms of labor and technical operation, yet their development need not proceed at the same pace or under
65 the same rights and resource arrangements. A publicly funded research result may be broadly readable
66 and still be difficult to discover in a dominant index. Conversely, improved retrieval can generate reputa-
67 tional attention without providing an independent verification of its content. The proposed contradiction
68 is therefore conditional: where productive capacities expand more rapidly than the institutions and labor
69 sustaining equitable observability, socially valuable contributions may remain difficult to examine. This
70 paper develops a structural representation of that possibility; an empirical demonstration of its magnitude,
71 causes, and normative consequences remains an open task.

72 In the coordinated research programme of which this paper forms a part, the preceding investigation
73 examines the recognition problems that can accompany AI-mediated expansion of intellectual produc-
74 tion. Its analysis distinguishes output volume, artifact quality, evidential attribution, recognition, and
75 material resource return. The present inquiry begins at a different point in that analytical chain. Its
76 object is the possibility that a change in relational structure permits an already existing history to be en-
77 countered under different evidential circumstances. AI-mediated research supplies one relevant context,
78 because the number and diversity of artifacts and potential interactions may change; the proposed struc-
79 tural framework, however, is not restricted to artificial intelligence or to scientific careers. Comparable
80 questions can arise wherever actors participate in partially connected contexts and their histories become
81 visible through contingent encounters. This wider scope is a proposal for comparative analysis, not an
82 assertion that the same causal mechanism operates identically in each domain.

83 Prior work on delayed scientific recognition already establishes that contributions can receive sus-
84 tained attention long after publication. Van Raan’s account of “sleeping beauties” and a subsequent
85 multidisciplinary study of delayed citation trajectories document the phenomenon using bibliometric cri-
86 teria [27, 19]. The present investigation therefore makes no priority claim for the occurrence of delayed
87 recognition. Citation awakening, increased discoverability, assessment of documentary provenance, and
88 justified revision of a target proposition are different outcomes. What the present paper proposes to add
89 is an explicitly conditional and potentially testable account of how changes in relational access and repre-
90 sentation could help generate some of those outcomes, while permitting prestige, audience change, and
91 shifts in scientific relevance as competing explanations.

92 The network perspective supplies an important starting point. Work on the strength of weak ties
93 considers how relations linking otherwise separated social contexts can facilitate the diffusion of infor-
94 mation and opportunities [13]. Research on brokerage across structural holes likewise examines the
95 association between bridging positions, access to different ideas, and the evaluation of ideas in particular
96 organizational settings [7]. These arguments demonstrate the relevance of cross-context relations while
97 leaving open the question pursued here: how a particular relational event, provisionally individuated for
98 analysis, changes the routes by which evidence about an *earlier relational trajectory* becomes available
99 to a particular observer. A bridge through which information can circulate does not by itself establish
100 that the transmitted information is reliable, that the receiver will examine it, or that any change in trust
101 would be warranted. The analytic extension proposed in this paper concerns the event-conditioned trans-

formation of evidence-access possibilities, together with the conditions under which those possibilities remain unexercised or prove misleading.

Temporal network research provides a second foundation. A representation of actors connected by static edges can obscure the temporal ordering of contacts, periods of activity, and the sequencing conditions of potential paths. The temporal-network literature demonstrates why event timing and the order in which connections become active can matter for network processes [18]. For the present question, a trajectory must preserve enough ordering and provenance to distinguish an earlier contribution from the later event that makes it newly inspectable. The relevant ordering may be partial: different activities can coexist, records can be revised, and the reconstruction of an event history may itself be incomplete. An indexed sequence will sometimes be a useful analytical approximation. Such indexing should not be taken to establish a complete ontology of past, present, and future, nor to imply that all relevant relations admit a unique global chronology.

A *relational trajectory* will provisionally mean an ordered or partially ordered representation of events, interactions, contributions, and relevant changes in relations, together with the provenance and conditions of access needed to interpret the record. The word *representation* is important. A recorded history may omit unobserved events, inherit errors, privilege certain forms of activity, or conceal the circumstances under which it was assembled. Two archives can represent the same course of activity differently without rendering either archive a complete description of the underlying history. The paper will therefore distinguish an underlying target history, when such a distinction can be operationalized, from available traces and from an observer's reconstruction of those traces. The model will not presume that an observer can consult a perfect chronological account.

The term *heterogeneous event* also requires a relational and comparative specification. An event may be assessed as unusual relative to a specified representation, participating relations, domain of activity, or reference distribution. The criteria used to individuate events and describe their features are themselves provisional. A newly appearing actor, the event in which that actor participates, and a new connection between existing domains are different analytical objects. Their effects on evidence pathways may differ, even when ordinary language describes each as a new acquaintance or encounter. A change that is rare within a narrow professional trajectory may be familiar across a broader population. An event that appears structurally exceptional to one observer may fit another observer's established expectations. Accordingly, claims of novelty must specify the relevant history, provisional descriptive features, observation conditions, and reference distribution. Heterogeneity cannot be inferred solely from high node degree or the presence of a newly added edge.

Information theory offers a potentially useful but carefully limited vocabulary for this problem. Shannon's entropy concerns a distribution of possible outcomes and its associated uncertainty; it is analytically distinct from the surprise assigned to one realized outcome [29]. The surprisal of a realized event depends on the probability attributed to that event under a specified distribution. A further distinction concerns the information an observation supplies about a particular target, such as the reliability of an attestation or the authenticity of a contribution. Divergence measures developed in statistical information theory can quantify differences between probability distributions, provided the relevant distributions and their supports have been specified [21]. These concepts should not be collapsed into a single magnitude called *novelty*. Entropy characterizes uncertainty in a candidate event distribution; realized surprisal characterizes how unexpected an event is under that distribution; diagnostic information concerns what the event or associated evidence permits an observer to learn about the target of assessment.

The distinctions matter because a surprising event may be entirely irrelevant to the competence or trustworthiness of a person. A rare encounter can draw attention while conveying almost no diagnostic evidence. A familiar and unsurprising verification procedure can provide unusually strong evidence about an earlier contribution. A highly visible event may also change the available selection of records without changing their evidential strength. The proposed relationship between event surprisal and attention therefore remains a conditional hypothesis rather than a general law. Attention may rise, saturate, or fall as an event becomes harder to interpret; an ordinary event may attract examination because the observer has a direct task-related reason to attend. Moreover, the probability of observing an event may

differ from its probability of occurring. The empirical meaning of surprise depends on whether it is defined over an underlying event-generating process, an observer's accessible observations, or an explicitly modeled expectation conditional on previously available information.

The central distinction of the paper is between an alteration in structural opportunity and an alteration in trust. A new connection can open a path to a record, but the observer may decline to follow it. The observer may inspect the record and remain uncertain. The inspected material may reveal that an apparently independent endorsement rests on repeated circulation of one unverified assertion. It may also disclose previously unavailable evidence of careful work, reproducible results, or principled correction. The same sort of cross-context encounter is therefore compatible with more favorable assessment, stable assessment, and less favorable assessment. The present paper treats the opening of an evidence pathway as a candidate enabling condition, while leaving the sign and magnitude of a subsequent trust judgment dependent on the content, provenance, independence, and interpretation of the evidence.

Questions of epistemic dependence are particularly relevant here. Scientific and practical inquiry commonly require reliance on knowledge whose production or verification exceeds the direct capacities of a single observer; the philosophical discussion of epistemic dependence establishes the importance of analyzing that reliance [15]. This dependence should not be understood as permission to regard every endorsement or social connection as evidence of competence. A witness's statement may be directly informed by an independent assessment, indirectly derived from another statement, conditioned by an institutional role, or compromised by uncertainty about what was actually observed. Multiple attestations need not provide multiple independent pieces of evidence. In the model envisaged here, the appearance of a new witness changes the available information only to the extent that their testimony, provenance, and dependence relations have some relevant evidential content. The full analysis of how individual human observers process this content belongs to the companion investigation on cognition; the present inquiry concentrates on what information can structurally reach them and the conditions under which that information could be diagnostic.

Consider a hypothetical contributor who has created and preserved a series of technically inspectable artifacts within a narrowly connected context. These records have identifiable provenance and permit direct verification, but their existence is known to relatively few prospective evaluators. A later collaboration makes the contributor's activities visible to a different community. The event may introduce an additional route from that community to the unchanged records. One possible response is independent examination that confirms particular claims. Another is a prestige-based update driven mainly by the affiliation newly attached to the contributor. A third is a decision to disregard the material because the evaluator lacks the time, domain expertise, or authorization required for inspection. A fourth is a more critical reconstruction in which previously unnoticed gaps become apparent. These outcomes share a change in the opportunity structure yet differ in their evidential justification and practical consequences. The example remains deliberately non-identifying; no specific organization, membership, appointment, or professional decision is implied.

The example also shows why retrospective recognition must be treated carefully. A later event may lead an observer to reclassify an earlier contribution, although the underlying contribution and its chronological position remain unchanged. Such revision can be justified when the observer gains access to genuine new evidence about the earlier record. A revision driven only by an unrelated affiliation may be a status response with weak diagnostic grounds. A more unfavorable assessment can be warranted if the new evidence documents earlier error or misattribution. A formal comparison will therefore hold the earlier target record fixed while varying the later relational event or the evidence made available through it. This comparison isolates an analytically tractable form of retrospective reinterpretation without assuming that historical facts themselves change when their recognition changes. In empirical applications, the investigator must further distinguish the effects of new observation pathways from contemporaneous changes in competence, activity, and available material.

This retrospective aspect differentiates the inquiry from a theory concerned solely with the dissemination of newly created information. A record can become newly visible long after its initial production, and the meaning attached to its contents can depend on which associated traces have become inspectable.

The event producing access may be substantively unrelated to the original work: its causal role could consist in changing who can find, obtain, and understand the relevant evidence. In another case the later event may itself provide diagnostic testimony by creating a genuinely new occasion to demonstrate a competence. The formal framework must distinguish these situations. A pathway that makes existing records accessible is not equivalent to a newly produced demonstration, even when an observer experiences both as a fresh impression of the same contributor.

A second source of complexity arises from competing representations of a trajectory. A contributor may possess a detailed sequence of records, while an evaluator sees only a brief summary. Another observer may receive a selectively assembled portfolio; a further observer may have permission to inspect underlying methods and revisions. Differences among these representations can affect the space of defensible conclusions. Summary length, documentation quality, technical vocabulary, access rights, and the relation between evidence and its provenance should therefore be treated as properties of the observation interface. A more complete archive does not guarantee better understanding, and greater visibility of a compressed representation does not imply greater visibility of the underlying trajectory. By distinguishing reachability, accessibility, legibility, and examination, the research can locate where a structurally promising connection ceases to function as an epistemic opportunity.

This inquiry necessarily encounters power, even though its primary research object is structural heterogeneity. Actors and institutions may regulate disclosure permissions, search visibility, admissibility of evidence, or opportunities for participation in an evaluative encounter. These capacities can affect which events occur as well as which events reach particular observers. Their significance cannot be reduced to a numerical prestige score or assumed to arise only after an encounter has taken place. The present paper will introduce power-conditioned observability as a preliminary qualification on event-generating and observation processes. A separate companion paper will investigate the forms, reproduction, contestation, and normative consequences of power over trust and its evidential infrastructures. Maintaining this boundary allows the present analysis to test whether a proposed structural pathway actually creates an additional opportunity for examination before introducing a comprehensive theory of institutional authority.

A further boundary concerns the distinction between the conditions of possible assessment and the cognitive act of making that assessment. Human observers may rely on heuristics, schemas, selective attention, bounded memory, and prior experience. These processes matter for actual judgments, but introducing a complete cognitive architecture here would risk treating a structural problem as though it could be explained by one observer model. The present research will use only minimal observer-relative variables sufficient to index the accessible evidence and, when necessary, the opportunity for examination. The companion paper on human recognition will provide a more detailed treatment of inferential processing and cognitive bias. The distinction has methodological consequences: an experiment demonstrating increased discoverability need not establish increased trust; an experiment finding increased trust need not establish that the observer used the intended evidence pathway.

A corresponding separation applies to circulation. A representation of an earlier contribution can be copied, cited, attested, summarized, or introduced to another person. The movement of such representations is a process through which new observers may gain access. However, the contextual conversion of references, endorsements, credentials, and related relational warrants into further opportunities constitutes an additional research object. The programme's fifth paper will investigate these circulation and conversion interfaces under the provisional concept of relational currency. The present paper will consider the existence and diagnostic quality of pathways, leaving questions about exchange, transferability, recognition as a transferable warrant, and resource conversion to that later analysis. This division also avoids presuming that trust can be freely transferred from one observer to another like an interchangeable unit.

Within these boundaries, the paper advances five conjectural directions. First, particular cross-context events may increase the reachable set of observers or the set of evidence paths available to them. Second, a new observation pathway may permit retrospective reinterpretation of an unchanged historical contribution. Third, realized surprisal may affect the probability of examination under conditions

mediated by relevance, processing cost, and visibility, with no assumed monotonic response. Fourth, an additional witness can strengthen a justified assessment when the witness contributes sufficiently reliable and independent diagnostic evidence; a nominal increase in witness count may have little effect when testimony is strongly dependent. Fifth, cross-context contact may expose conflicting evidence, misattribution, or representational incompatibility, producing uncertainty or less favorable warranted judgments. Each conjecture admits counterexamples and requires distinct operational definitions before it could be tested.

The strongest empirical test would separate event novelty, evidence accessibility, actual examination, and the resulting assessment. An experimental design could manipulate a hypothetical contributor's event history and access pathways while holding underlying contributions constant. Different arms could vary whether a cross-community encounter changes only the presence of a link, offers a genuinely verifiable record, or adds a purported witness whose informational independence differs. Evaluators could then be asked separately whether they noticed the evidence, which records they chose to inspect, how they interpreted the evidence, and which claims they regarded as justified. Alternative designs could investigate real-world changes in archival visibility or cross-community collaboration, although such observations would raise selection and confounding problems. A measurable change in network connectivity would be evidence of a structural change; its interpretation as an epistemic improvement would require further evidence concerning what observers actually acquired and learned.

The design must also allow findings that contradict the proposed mechanisms. A new cross-context event might leave the accessible evidence set unchanged. An additional observation path might be redundant with existing access. Unexpected events may attract less examination when their meaning is obscure or the available evaluation budget is limited. Increased visibility might result in a more negative justified assessment. Observers might respond favorably to a socially prestigious association without inspecting a contribution at all. These possibilities are substantively different outcomes rather than exceptions that the model should explain away. A theory of structural trust opportunities becomes informative when it specifies the circumstances in which an observed change should count as a new evidence pathway, and the circumstances in which a superficially similar change is better explained by prestige, content differences, selective observation, or unrelated institutional incentives.

The methodological contribution sought by this paper is correspondingly bounded. It proposes a representation-sensitive and observer-relative account of heterogeneous events capable of separating a historical trajectory from the mechanisms that make its representations available. It connects temporal relational structure to distinctions drawn from information theory without equating statistical uncertainty with social value or trustworthy conduct. It then proposes discriminable hypotheses about cross-context evidence access, retrospective recognition, dependence among witnesses, and potential negative trust updates. The present stage is conceptual. Neither a particular graph representation nor a chosen information measure has been established as uniquely appropriate for all social relations. The intended formalism is an analytical instrument for comparing hypotheses and specifying observable consequences, not a claim about the ultimate constitution of social reality.

The ten sections proceed from the representation of evolving relational trajectories (Section 2) and observer-relative heterogeneity (Section 3) to surprisal and evidence observability (Section 4). Sections 5 and 6 examine cross-context access, retrospective assessment, and dependent testimony. Section 7 identifies institutional and material conditions on observability; Section 8 compares graph-based and higher-order models. Section 9 develops empirical identification strategies, and Section 10 synthesizes the results and limitations. Together these analyses treat historical production, infrastructural access, and warranted assessment as related but distinguishable research objects.

2 Relational Trajectories in Evolving Representations

A theory of heterogeneous relational change requires an explicit account of how trajectories are represented and how their records may be revised. Prescribing an exhaustive catalogue of event kinds would pre-empt questions about event boundaries, participating relations, and changes in significance. This

section develops provisional event individuation, documentary provenance, dependency relations, and transformations of representation. These constructions support comparisons in which a wider relational configuration changes access to evidence about a preserved contribution. They are modeling choices, not an ontology of social entities or universal time. Section 3 subsequently specifies the conditions for comparisons of heterogeneity.

2.1 Event Individuation under Relational Change

A relational event can provisionally be regarded as a distinguishable configuration of change, interaction, or differentiation within a chosen domain of inquiry. The qualification is substantial. Distinguishability depends on the analytical resolution, available traces, questions under investigation, and relations through which a putative event is identified. A technical demonstration, for example, may appear as one occurrence in an institutional announcement, as several coordinated operations in a procedural log, and as a heterogeneous set of contributions in a reconstruction of its production conditions. These descriptions need not be mutually exclusive, even when they support different inferences. The apparent unity of an event at one resolution may correspond to an internally differentiated process at another. The term *event* therefore serves initially as a representational designation whose individuation can be revised.

The concern is especially relevant to the separation between an actor, an event involving an actor, and the formation of a relation. A new participant may appear in an observation system because an encounter occurs, because an existing relation becomes discoverable, or because previously separate identifiers become linked to the same subject. These alternatives have different implications for the reconstruction of history. An added database node may represent a newly involved subject, a renamed subject, an improved record, or a changed convention of indexing. Similarly, an apparent new relation may express an actual additional interaction or the exposure of an existing interaction to a different observer. Treating every new record element as evidence of an additional event would conflate documentary change with the relational change under investigation.

Event boundaries are also sensitive to the observer's practical and epistemic commitments. A collaboration can be individuated by a formal agreement, a sequence of exchanges, joint production of a technical result, or a continuing dependency among contributors. None of these criteria is adequate for every inquiry. They select different aspects of an extended and potentially overlapping set of relations. Where an event definition is required for measurement, the proposed criterion should therefore be reported together with its scope and plausible alternatives. The methodological aim is to make individuation reproducible and contestable without asserting that the resulting units exhaust the relational world.

A related difficulty concerns compositionality. Several distinguishable interactions can participate in a larger event, and one interaction may belong to several analytically defined processes. The simple picture of a trajectory as a chain of nonoverlapping, indivisible events is accordingly an optional approximation. One may instead use a nested description, a relational hyperstructure, an incidence system, or another formal representation that makes such overlap expressible. This proposal does not require that every application use a high-dimensional topology or a hypergraph. It requires that the limitations of the chosen representation remain identifiable. Temporal-network analysis illustrates the value of describing when contacts and interactions become available while also revealing why static connectivity can obscure interaction order [18]. Relational-event models likewise offer operational tools for observed social actions; their use of discrete interaction records is a modeling decision suited to particular data and mechanisms, rather than an ontological result concerning every social event [8].

The present paper therefore avoids defining heterogeneity as the mere occurrence of events belonging to different preassigned categories. Event descriptors may be useful when they are derived from the particular inquiry, for example to distinguish a direct verification procedure from an informal report, or a cross-domain interaction from a recurring within-domain encounter. Their usefulness lies in identifiable analytical differences, including differences in evidential dependence, accessibility, and the ways relations are reconfigured. A classification becomes problematic when its categories are treated

as exhaustive, mutually exclusive, or stable without justification. The question subsequently addressed in Section 3 is how heterogeneous configurations can be compared while allowing the very descriptions used in comparison to be historically and observer dependent.

A minimal modeling object can make these commitments explicit. Let ρ designate an analytical resolution and representational convention, including criteria for distinguishing subjects, interactions, and traces. A finite or otherwise delimited relational-history representation may be written as Equation 1.

$$H_\rho = (U_\rho, \mathcal{I}_\rho, D_\rho, \triangleleft_\rho, P_\rho). \quad (1)$$

Here U_ρ is a collection of provisionally distinguished units, which may include participants, contributions, interaction complexes, or other units defined for the task; $\mathcal{I}_\rho$ describes the relational incidence among those units; D_ρ is a collection of available documentary traces or claims; $\triangleleft_\rho$ represents dependencies that the inquiry can justify; and P_ρ records provenance and related qualifications of the traces. The notation is a *representation schema*, not an empirical assertion that history consists of five independently given components. In particular, a subject may be an active participant in the evolving history and in its observation, and an event may be a composite element of U_ρ rather than a primitive atom. The incidence object can express relationships among more than two units where the research question warrants them. The dependency relation is partial by default and need not assign a universal clock coordinate.

Two remarks delimit this schema. First, the status of a record within D_ρ differs from the occurrence or validity of the event that it purports to describe. A record may be authenticated, inaccurate, incomplete, or contested. Second, the schema is neither unique nor necessarily information preserving: changing ρ can change what counts as a unit and which relations are visible. As a consequence, two representations of a trajectory should not be assumed to be interchangeable merely because they concern an overlapping historical domain. A meaningful comparison requires an explicit account of the possible correspondences and information losses between them.

2.2 Historical Records, Provenance, and Representation

The distinction between a relational history and a record concerning that history is central to the paper's account of trust. An archived contribution may be encountered through a full technical artifact, a summary, a citation, a credential, a testimony, or a metadata entry. Such representations differ in the claims they make, their conditions of production, their granularity, and the evidence they preserve. A repository entry may identify a result without displaying its underlying methods. A derived account may accurately summarize one dimension of a contribution while omitting the collaboration through which it became possible. A certificate may attest that a procedure occurred without establishing the quality of every conclusion subsequently drawn from it. The ability to obtain a record is therefore distinct from the ability to determine what that record warrants.

Provenance supplies one partial remedy. At a minimum, an evidential claim should be situated in relation to its source, the operation by which it was recorded or transformed, the dependencies on which it rests, and the limits of the claim's scope. This does not require every source to disclose an exhaustive history of its own creation. It calls for information sufficient to distinguish, where possible, original observation from copying, independent verification from repetition, and an assertion about an artifact from an assertion about its author. The W3C PROV-O specification provides an established vocabulary involving entities, activities, agents, derivation, and attribution [34]. Those categories can serve as interoperable recordkeeping instruments. Their technical utility does not entail adopting them as a complete ontology of the entities and events under investigation.

The provenance of a statement is not identical to the truth of the statement. An independently authenticated account can faithfully record an error. Conversely, an incomplete provenance chain does not logically establish that a substantive claim is false. Provenance changes the evidential situation by informing an observer about the circumstances, dependency structure, and possible routes of verification. The observer must still decide, using domain-appropriate standards, what those circumstances support. This distinction is particularly important when a later relational event connects two contexts. The newly

accessible representation may preserve a reliable path back to an inspectable artifact, or it may merely reproduce a reputation claim whose evidential origin is unclear.

We can distinguish at least four questions about a record: whether it exists within the available archive, whether a particular observer can reach it, whether its content and origin can be interpreted, and whether it supports the proposition under consideration. The answers may differ. An accessible record can lack relevant content. A verified contribution may be preserved in a technically incompatible format. An apparently authoritative endorsement can be copied from several downstream sources that all depend on one initial assertion. A full analysis of evidential dependence belongs to Section 6; the present concern is to ensure that dependency information can in principle be represented and traced.

Recordkeeping can also alter the subject matter it documents. A correction notice may change which earlier claim remains current. A newly introduced archive may make a previously dispersed series of contributions appear to constitute a coherent programme. A refusal of access may prevent observers from seeing information that participants otherwise regard as essential. In such cases, representation is an activity within the relational environment, with participants, resources, permissions, and consequences. Accordingly, the proposed distinction between the recorded object and the recording process remains analytical. Their histories may interact causally; it would be misleading to assume an external, passive observer or a perfectly transparent repository.

Representation changes require explicit treatment when the analysis compares descriptions at different resolutions. Let ρ and σ denote representational conventions. An attempted translation between their history descriptions is expressed in Equation 2.

$$T_{\rho \rightarrow \sigma} : H_{\rho} \rightharpoonup H_{\sigma}. \quad (2)$$

The partial-map notation indicates that some units, relations, or claims may have no adequate translation under the available evidence and conventions. It is not a claim that the map is an objectively existing function between two fixed worlds. In one direction, an individual exchange might be incorporated into an aggregate account of collaboration; in another, an aggregate statement might fail to disclose the exchanges required to reconstruct its production. A translation can preserve particular evidential properties while losing others. It may also introduce uncertainty when terms, roles, or thresholds have different meanings in the respective settings.

For the purposes of this paper, an adequate translation should identify which propositions remain supported and where the transformation weakens, strengthens, or alters the evidential claim. Stronger evidential support should not be inferred from a more prestigious presentation format alone. A summary can improve intelligibility and widen access while simultaneously reducing the detail available for independent examination. The relation between legibility and fidelity is consequently a matter for analysis. The present schema permits an investigator to record failures of translation, which may be as informative as successful mappings when studying cross-context encounters.

Retrospective recognition becomes possible against this background. Suppose a set of contribution records has remained substantively unchanged within a chosen archival comparison. A new encounter, index, translation, or verified communication may make those records accessible to an observer who lacked a usable path to them. The new event can therefore change the *evidential environment* surrounding an unchanged set of records. The phrase *unchanged historical contribution* is a disciplined counterfactual restriction, not a thesis that the total relational history is frozen. The encounter and any resulting interpretation are themselves further relations within the evolving system. Furthermore, the counterfactual must allow for the possibility that the allegedly unchanged records were incomplete, misattributed, or wrongly interpreted from the outset. A better-informed later assessment may thus become more favorable, less favorable, or remain undecided.

2.3 Partial Ordering and Relational Dependencies

An inquiry into trajectory formation requires relational ordering, yet such ordering need not be a universal succession of events. At least three distinct relations should be kept apart: dependencies asserted

within a model, orderings documented by a specific recording system, and causal claims warranted by independent evidence. A date stamp may help determine an archive’s registration order; it cannot by itself establish a substantive causal relation between recorded contributions. Likewise, an account stating that one verification procedure used the output of another establishes a proposed dependency that must be checked against the relevant traces. The model should preserve these distinctions rather than treating every relation as a point on one globally given timeline.

A partial order is useful where some dependencies or precedence relations are established while other pairs of events remain incomparable. The ordering idea has a well-known operational precedent in distributed systems, where Lamport’s event-order relation is defined through local sequences and message-mediated dependence, without assuming a perfectly shared physical clock [22]. The applicability of a comparable device to social and epistemic relations is limited and must be argued rather than presumed: human interactions may contain negotiated meanings, mutually constitutive processes, uncertain records, and dependencies that cannot be reduced to message transmission. Nevertheless, a partially ordered representation provides a disciplined way to avoid inventing a total sequence where the evidence supplies none.

Within Equation 1, the relation $\triangleleft_\rho$ is therefore to be understood as a selected and justified ordering relation on the relevant elements of U_ρ or D_ρ . If the analysis uses a strict partial order, irreflexivity and transitivity must be established for the chosen interpretation. Reciprocal influence or cyclic feedback may call for a different relation, a change in resolution, or a representation that explicitly accommodates cycles. One should not force every evolving relational system into a directed acyclic graph merely because such a graph is computationally convenient. Similarly, the absence of a represented order between two events means only that the chosen formal account does not supply the specified relation; it is no proof of causal independence, simultaneity, or unrelatedness.

There are at least four ways an ordering claim can become uncertain. The documentary sources may disagree. An interaction may extend across several recorded operations with no clear indivisible boundary. A purported causal dependence may be inferred from narrative rather than direct evidence. Or a coarser representation may erase distinctions preserved in a more detailed account. Each situation calls for a different response. Conflicting records should carry their provenance and disagreement; composite interactions should permit multiple resolutions; causal inferences should display their assumptions; and transformations across resolutions should record lost detail. Assigning an arbitrary numerical ordering may be defensible for a particular algorithm, but it should be identified as a convention and its sensitivity examined.

These cautions directly affect evidence paths. Consider a claim that one actor’s work was independently verified by a second observer. An evidential reconstruction may need to determine whether the supposed verification drew on the original artifact, on a derivative report, or on a statement already dependent on the first actor’s testimony. A list of event dates is insufficient to distinguish these possibilities. One needs relations describing what information each activity used, which attestations derived from others, and what constraints governed access. This is the structural beginning of the independent-witness problem developed in Section 6. It also explains why a newly connected observer can appear to receive several confirmations while actually receiving repeated versions of one account.

The temporal-network framework [18] can describe time-sensitive opportunities for contact, but the admissibility of an evidential path requires additional semantics. A communication link may be active while the target record is unavailable. A record may arrive without authentication material. A valid verification may be technically accessible while lying outside the observer’s expertise. The term *pathway* will therefore refer to a possibility of transmission or access defined relative to stated relational, documentary, and institutional constraints. Its existence must not be confused with actual transmission, interpretation, or a justified revision of trust.

Finally, an emphasis on ordered records should not imply a privileged ontological *now*. The present paper can compare a recorded evidential configuration and a counterfactual configuration containing a specified additional relation. Such a comparison describes dependence between model states under an intervention, even where the complete world is not representable through a single external time coordi-

nate. The expressions *earlier record* and *new event* will ordinarily refer to the specified documentary or intervention ordering relevant to the research design. Where those expressions are ambiguous, the ordering relation should be stated. This discipline matters because the paper’s claims concern historical reinterpretation while maintaining ontological suspension concerning the ultimate structure of time.

2.4 Representational Transformation under Heterogeneous Events

The formal problem can now be posed without assuming an inventory of elementary event kinds. A proposed heterogeneous event is understood as a candidate transformation whose structural implications are assessed relative to an explicit representation, reference configuration, and observer. It may involve a participant previously outside an observer’s accessible network, a coupling among formerly separated evidence repositories, a reinterpretation of an established relation, or a change in the procedures through which a claim is made inspectable. These descriptions characterize possible differences relevant to a question of evidence access. They do not purport to enumerate every possible event or to decide in advance which configuration is genuinely novel.

Let e denote the represented intervention under consideration and let $\Phi_{e,\rho}$ be a transformation defined only where the selected representation can accommodate it. Let o designate an observer situated within a relational environment, and let $\Gamma_{o,\rho}$ collect the practical conditions governing access, such as permissions, available records, interfaces, and supported forms of translation. The accessible evidential traces in one modeled configuration can be represented by the set-valued operator in Equation 3.

$$\mathcal{A}_{o,\rho}(\mathbf{H}_\rho; \Gamma_{o,\rho}) \subseteq D_\rho. \quad (3)$$

Accessibility in this expression is always relative to the specified observer and conditions. It is not an invariant property of the historical record. Changes of access conditions, the creation of a new evidential link, or a change in representation may alter $\mathcal{A}_{o,\rho}$ even when particular records remain fixed. The operator records structural possibility; it does not encode the observer’s decision to examine a record or the reliability of the inferences drawn from it. Detailed observer behavior and power over $\Gamma_{o,\rho}$ are reserved for the companion papers concerned with cognition and authority.

For a comparison between configurations, the investigator may hold fixed an explicitly delimited *target core* $D^* \subseteq D_\rho$ and examine how access to this core changes when the wider representation is transformed. The paired-access contrast is specified in Equation 4.

$$\begin{aligned} A_0 &= \mathcal{A}_{o,\rho}(\mathbf{H}_\rho; \Gamma_{o,\rho}) \cap D^*, \\ A_e &= \mathcal{A}_{o,\rho}(\Phi_{e,\rho}(\mathbf{H}_\rho); \Gamma'_{o,\rho}) \cap D^*. \end{aligned} \quad (4)$$

The comparison is informative only if the target records remain identifiable across the two modeled conditions, and if the analyst specifies whether $\Gamma'_{o,\rho}$ differs because of the event, an accompanying policy change, or a separate intervention. A larger A_e indicates access to more members of the chosen record core, conditional on the operational definition of access. It establishes neither a larger quantity of independent evidence nor an improvement in justified trust. A smaller set may indicate restriction or loss of a path. Two equal sets may conceal changes in provenance quality, redundancy, or the conditions under which the same evidence is reached. Such differences motivate the richer pathway model in Section 5.

Table 1 summarizes the analytical distinctions that should accompany a relational-history reconstruction. They allow a new connection to be investigated without presupposing that connectivity itself carries a favorable epistemic meaning. They also allow the research to register a change in documentation or indexing as such, rather than counting it automatically as a change in the underlying relational processes. This is particularly useful where evidence crosses institutional, technical, linguistic, or disciplinary boundaries and the act of translation itself changes what an observer can understand.

A hypothetical configuration illustrates the point. A contributor maintains inspectable records in one technical setting. An observer in another setting has no usable route to those records. A new joint encounter may add a link that carries a repository identifier, translates the relevant technical vocabulary, and supplies provenance sufficient to make direct inspection possible. The access set in Equation 4 may

Table 1: Analytical distinctions in relational-history reconstruction. Each row states a modeling question rather than an ontological category of event.

Analytical question	Object held explicit	Risk when conflated
What is individuated?	Resolution, boundary, composite relations	Treating descriptive units as natural event atoms
What is recorded?	Claims, traces, source provenance, omissions	Equating documentation with occurrence or truth
What is dependent?	Justified relational or evidential ordering	Mistaking index order for causation
What is accessible?	Observer, access conditions, usable pathway	Equating reachability with examination
What can be inferred?	Diagnostic relevance and evidential dependence	Equating visibility with warranted trust

then expand while the target artifacts remain unchanged. Alternatively, the encounter may provide only a prestige-bearing description and no inspectable path. It may also reveal contradictory accounts that weaken the case for the contribution's authorship or reliability. In each alternative the configuration of relations changes, but the evidential implications depend on which traces become available, how they were produced, and what they justify. This example is hypothetical and introduces no specific professional or institutional outcome.

An additional possibility is that the new encounter changes the investigator's model of the historical domain itself. A supposed individual event may be reinterpreted as a composite process. A presumed independent attestation may be shown to derive from another source. An observer previously treated as external to the trajectory may emerge as a participant who influenced the documents being evaluated. These changes should be recorded as revisions to the representation and its evidential dependencies. They need not imply that the earlier model was wholly useless. A provisional model can support valid local inferences while remaining vulnerable to revision under a broadened comparison class. In this sense, relational change can reorganize not only the paths to an already specified body of evidence, but also the distinctions by which that evidence is assembled.

The present construction has clear limits. Equation 1 is a schematic representation, not a unique or complete mathematical theory of relational formation. Equation 2 provides no guarantee that translations exist or preserve evidential properties. Equations 3 and 4 express conditional access contrasts rather than a validated causal mechanism for trust. None supplies an empirical probability of surprise, a behavioral model of attention, or a normative criterion for warranted belief. These matters require further assumptions and the research designs developed in Sections 3–9. The framework is useful insofar as it keeps event individuation, documentary change, structural connection, and epistemic assessment analytically separable and makes their possible interactions explicit.

The representational distinctions established here support two subsequent analyses. Section 3 evaluates heterogeneity relative to declared comparison domains and revisable descriptors; Section 4 distinguishes event surprise from diagnostic evidence. Section 5 then examines which preserved records a changed relation makes available. The common analytical question is how a transformation changes *conditional epistemic possibilities* while leaving the direction of any warranted trust revision open.

3 Structural Heterogeneity and Observer-Relative Novelty

Relational configurations can appear unfamiliar or discontinuous only relative to a basis for comparison. Building on Section 2, this section specifies reference domains, provisional descriptors, conditional distributions, and structural contrasts for investigating heterogeneity without presupposing a universal event taxonomy. It also examines how institutional indexes and classification systems alter observed reference populations. These comparisons establish the premises for the information-theoretic analysis in Section 4; structural difference alone provides neither a diagnostic statement about a contributor nor a prediction of trust.

3.1 Reference Domains and Provisional Descriptive Features

A claim that an event is heterogeneous or novel is incomplete until it identifies what the event is being compared with. The comparison might concern relations among previously separated contributors, dependencies among evidential records, access routes between institutional settings, or a change in the composition of a collaboration. The same configuration may be typical with respect to one question and unusual with respect to another. A transfer of documentation between two established partners, for example, can be routine as a communication act while introducing an unfamiliar provenance relation into the evidential system used by a particular observer. Treating novelty as an intrinsic label on the transfer would conceal this divergence.

The selected reference domain also matters. A connection between two technical areas might be common in a broad interdisciplinary archive but nearly absent in the local records available to a particular research group. An interaction with an unfamiliar institutional representative may be unprecedented within one participant’s documented relations yet ordinary within the relevant institution. In either case the difference is meaningful only relative to the comparison class, the observation conditions, and the grounds on which a configuration was counted as comparable. These requirements do not eliminate novelty. They specify what an empirical assertion of novelty must mean before it can be evaluated.

Let ρ denote a representation and κ the analytical question and resolution under which comparisons are made. Let $\mathcal{C}_{o,\rho,\kappa}$ denote an explicitly selected collection of reference configurations accessible to, or reconstructed for, observer o . The collection need not be a complete history, a set of independent observations, or a probability sample. Its construction is itself a claim about comparability, and that claim must be reported. Let $Z_{\rho,\kappa}$ be a potentially partial descriptor mapping a configuration to a comparison space $\mathcal{X}_{\rho,\kappa}$. The descriptor may register incidence patterns, dependencies, path configurations, coupling structure, or other features relevant to the declared question. It is not a function assigning each event to an ontologically fixed kind.

Equation 5 records the dependence of a comparison on its components.

$$\mathfrak{C}_{o,\rho,\kappa} = (\mathcal{C}_{o,\rho,\kappa}, Z_{\rho,\kappa}, \sim_{\rho,\kappa}, \mathcal{I}_{o,\rho,\kappa}). \quad (5)$$

Here $\sim_{\rho,\kappa}$ is a declared comparability relation, and $\mathcal{I}_{o,\rho,\kappa}$ describes information available to the observer or analyst under the baseline configuration. Comparability may be restricted or uncertain. It can depend on a common documentation protocol, a translation between repositories, or an explicit decision to examine analogous relational positions. Requiring $\sim_{\rho,\kappa}$ to be an equivalence relation would be unnecessarily strong for many applications. In particular, pairwise comparability across two repositories need not extend to arbitrary third repositories. A record that cannot be translated into the comparison space should be reported as outside its domain rather than silently coded as maximally different.

The descriptor $Z_{\rho,\kappa}$ can also change as the representation improves. Suppose a dataset initially records only whether two participants are connected. Subsequent inspection reveals that some connections convey primary records while others carry only secondhand summaries. A descriptor based on binary connectivity can then be refined to preserve evidential dependencies. The refinement can reverse an initial interpretation of heterogeneity: what appeared to be several diverse sources may become one shared source distributed through different channels. Such revision is a feature of the research process rather than evidence that an observer failed to identify a uniquely correct initial classification.

Provisional descriptions are nevertheless necessary when comparing cases. An insistence that all features remain open at every stage would make measurement impossible. The methodological compromise is to state the selected domain, the scope of each descriptor, the record transformations used to derive it, and known consequences of the discarded information. An indicator of cross-context coupling, for example, may be useful when domains are defined through institutional affiliation; its sensitivity to overlapping affiliations and administrative boundaries should also be examined. The objective is a publicly contestable specification, with no claim that the selected descriptors capture the entirety of relational change.

This caution has analogues in existing research without being derived from any single similarity theory. Tversky’s feature-based analysis demonstrates that similarity judgments may depend on com-

mon and distinctive features and on context [31]. That work concerns psychological similarity, and the present framework does not import its cognitive mechanism as a model of trust. It provides a bounded methodological reminder that feature selection and comparison conditions materially affect similarity claims. Research on atypical combinations in scientific work likewise operationalizes unusual associations through a particular bibliometric comparison class [33]. Such an operationalization can support empirical investigation within its own domain; the bibliometric association between combination patterns and scientific impact does not establish that an unusual social event is epistemically informative or that it improves trust.

3.2 Conditional Distributions of Relational Configurations

A reference collection becomes a basis for statistical novelty claims only when a defensible distribution over comparable observations is available. Frequency in a collection is not automatically the probability of a configuration under the process that produced it. Records may be missing because access is restricted, because some encounters leave fewer traces, or because observers preferentially preserve certain interactions. An observed distribution may consequently describe an archive's selection process at least as strongly as it describes the relational processes of interest. This issue is particularly acute for heterogeneous connections, whose traces may be systematically easier or harder to document than familiar local interactions.

For a declared comparison system $\mathfrak{C}_{o,\rho,\kappa}$, introduce a conditional predictive distribution $Q_{o,\rho,\kappa}$ over those descriptions on which it is defined. Equation 6 expresses a schematic probability assignment to measurable sets B of comparable configurations.

$$Q_{o,\rho,\kappa}(B \mid \mathfrak{C}_{o,\rho,\kappa}) = \Pr\{Z_{\rho,\kappa}(E) \in B \mid \mathfrak{C}_{o,\rho,\kappa}\}. \quad (6)$$

The random variable E in Equation 6 represents a hypothetical draw under a specified sampling or predictive model. It is not the claim that the world produces independently sampled event atoms. The equation requires a probability space, a chosen sampling frame or stochastic model, a measurable descriptor, and a conditioned body of information. Without those objects, the numerical distribution is undefined. In empirical applications, Q might be estimated from multiple documented configurations, elicited as a bounded predictive judgment, or supplied by a mechanistic simulation. These routes answer different questions and should not be treated as interchangeable measures of objective rarity.

The information set in Equation 5 prevents a related inferential error. A probability assigned using records that became available through the candidate event is not necessarily an adequate estimate of how surprising that event would have been relative to the selected baseline. The baseline information restriction is a feature of the counterfactual research design. It makes no commitment to a metaphysically privileged present or a globally synchronized time axis. If a reliable documentary or intervention order can be established, the analyst can condition on the information permitted at the specified comparison state. If the ordering is uncertain, the resulting range of admissible baselines should be reported rather than arbitrarily collapsed.

Reference distributions may also differ across observers while both remain locally well justified. An archive custodian with access to many institutional exchanges may assign high baseline probability to a cross-context transfer. A participant observing only one narrow research community may assign a much lower value. Such a disagreement is not necessarily an error by either observer. It may reflect a difference in information and admissible comparison records. When one baseline is believed to be better calibrated for a specified prediction task, that claim calls for external validation. The fact that an observer finds an occurrence unexpected does not by itself establish that the occurrence is objectively rare within a larger relational environment.

There is a further distinction between a structural descriptor and its distribution. A transformation may change a relation's local connectivity while producing a descriptor frequently observed in the selected population. Conversely, a trivial administrative change may receive a rare code because a document format is obsolete. These cases show why the support and granularity of Z must be examined

independently of the frequency of its values. If a representation assigns a novel event to an unrecognized or out-of-domain descriptor, setting its estimated probability to zero may simply expose the inadequacy of the model’s support. A reported zero should carry its empirical and representational interpretation, rather than being interpreted automatically as an event of infinite significance.

Shannon’s theory supplies the mathematical basis for distinguishing probability distributions from informational quantities [29], and Kullback and Leibler provide a formal basis for comparing probability distributions under appropriate conditions [21]. The present section uses those references only to motivate disciplined distributional specification. Section 4 will formulate realized surprisal, entropy, and diagnostic information, including conditions under which distribution comparison is meaningful. No trust measure can be obtained from Equation 6 without additional evidence about the target proposition, evidential reliability, and the observer’s assessment task.

An especially important empirical danger is endogeneity of the sampling frame. A new relational event can alter the records an observer can access, thereby changing the reference collection used to judge how unusual that very event is. An event may initially appear exceptional and later appear ordinary when a repository is connected and many analogous cases become available. Such change in estimated rarity need not entail any correction to the target event’s occurrence. It may reflect enlargement of the comparison population. Accordingly, studies of heterogeneous events should report whether reference populations are fixed for a counterfactual comparison or re-estimated as access changes. Both designs are legitimate for different questions, but conflating them can manufacture an apparent novelty effect.

3.3 Structural Discontinuity and Relational Neighborhoods

Distributional rarity is only one possible sense in which a relational event can be described as different. Another concerns the organization of the surrounding configuration. An event may open a route between separated records, alter dependency paths, connect previously weakly related communities, or introduce a newly inspectable evidential interface. These effects may be important even when interactions of the same broad descriptive kind occur frequently elsewhere. Conversely, an unusual event description may leave the relevant relational pathways unchanged. Structural discontinuity therefore requires a comparison between configurations with respect to the structural properties selected by the research question.

Let $\Phi_{e,\rho}(\mathbf{H}_\rho)$ be a candidate transformation of the baseline representation described in Section 2. For a declared collection of structural observables $\mathcal{F}_{\rho,\kappa}$, a scoped discontinuity score can be introduced through Equation 7.

$$\Delta_{\rho,\kappa}(e; \mathbf{H}_\rho) = d_{\rho,\kappa}(\mathcal{F}_{\rho,\kappa}(\mathbf{H}_\rho), \mathcal{F}_{\rho,\kappa}(\Phi_{e,\rho}(\mathbf{H}_\rho))) . \quad (7)$$

The function $d_{\rho,\kappa}$ represents a locally justified dissimilarity or comparison rule. It need not be a metric, and neither the domain nor its value need remain meaningful under arbitrary changes of representation. The symbol $\mathcal{F}_{\rho,\kappa}$ may stand for path reachability, incidence patterns, evidential dependency relations, or a vector of several explicitly weighted observables. A large value of $\Delta_{\rho,\kappa}$ says that the selected observables differ appreciably under the specified comparison rule. It does not prove that the event is rare, epistemically valuable, or normatively desirable.

The role of relational neighborhoods can be made more precise. A neighborhood need not be defined by geographic distance or a fixed graph radius. It may comprise the records and participants connected through an admissible sequence of documentary transfers, verification dependencies, or locally specified interactions. A short path in a social graph may be unusable as a path for evidence if the intermediary cannot release the necessary records or lacks a way to preserve their provenance. Inversely, a publicly inspectable archive may establish a reliable route for evidence without a social tie to the observer. For this reason the graph-theoretic notion of reachability and the epistemic notion of usable access must remain separate, even when one is used to approximate the other.

The classic weak-tie and structural-hole literatures provide reasons to investigate the consequences of connections across otherwise separated positions [13, 7]. These sources concern network structure, diffusion, and brokerage in bounded settings. Their findings do not imply that any bridge supplies independent testimony, removes institutional restrictions, or guarantees more favorable judgments. What

Table 2: Comparison-sensitive aspects of relational heterogeneity. These dimensions are provisional analytical descriptors, not event kinds or an exhaustive taxonomy.

Comparison focus	Possible operational evidence	Important limitation
Descriptive departure	Feature contrasts under a declared reference rule	Feature choices and translation losses affect the result
Distributional rarity	Conditional frequency or predictive probability	Sampling bias, sparse support, and reference drift
Relational reconfiguration	Changes in incidences, dependencies, or paths	Social reachability need not transmit inspectable evidence
Evidential access	Changes in the accessible target-record set	Access does not establish examination or reliability
Cross-representation stability	Agreement under justified changes of resolution	General invariance may fail or remain undefined

they motivate here is a question about the possible formation of new pathways. The pathway’s documentary integrity, informational redundancy, and admissibility require additional investigation, undertaken in Sections 5 and 6.

Table 2 separates several quantities often folded into the single label *novelty*. The table is a guide to model specification. Whether a quantity can be reliably estimated depends on records, access, comparison conventions, and the distributional assumptions adopted. No row licenses the conclusion that novelty itself improves trust.

A hypothetical contrast illustrates these differences. Suppose two repositories already contain many similar contribution records, but an observer in one setting cannot inspect records held in the other. A new cross-context connection may carry a stable identifier and an authenticated route to a target document. The connection may be ordinary among repository maintainers, giving it little distributional rarity within that reference domain, while changing the observer’s accessible record set substantially. Conversely, a first-of-its-kind public announcement may be highly unusual within a particular archive while creating no new path to the primary records. The examples differ in the extent to which novelty of description, structural change, and epistemic access align.

A structural comparison may also be unstable under changes of analytical resolution. At a coarse level an event may appear to connect two separate communities; at a finer level an undisclosed chain of intermediaries may already connect them. Alternatively, a coarse representation may treat a record as accessible because its repository is public, while a fine representation reveals missing metadata needed to verify authorship. These results are not contradictions when the difference in resolution is made explicit. They become inferential errors when a coarse structural property is asserted to survive every finer description without proof.

Where translations between representations are available, one can test a restricted form of comparison stability. For example, suppose an investigator can translate selected observables from a detailed representation into a coarser one while preserving relevant access-path identities. A finding that the candidate event changes connectivity at both resolutions is stronger than a result apparent only under one arbitrary coding convention. Yet such agreement may be unavailable when the representations express distinct relations or when aggregation destroys precisely the evidential distinctions at issue. The appropriate conclusion in those cases is local sensitivity rather than a universal invariant measure of structural novelty.

Finally, a structurally consequential event may impose costs. A new link can increase exposure to scrutiny while allowing irrelevant or misleading claims to circulate. It can concentrate evidence access in one intermediary, making the pathway fragile. Or it can change institutional permissions in ways that constrain some observers while assisting others. These effects motivate the robustness and evidence-dependence analyses in Sections 5–7. The present account confines its contribution to showing which structural changes are being compared, which access conditions they may alter, and where their epistemic significance remains undetermined.

3.4 Historically Changing Reference Infrastructures

A reference population is constructed through historical institutions as well as through statistical choices. A bibliography compiled from a selectively indexed collection does not sample the same documentary universe as a corpus assembled from repository deposits, multilingual journal catalogues, or community-held archives. Moreover, a change in the available index can shift the measured rarity of an unchanged contribution. If a reference distribution originally lacks a set of publications and subsequently includes them, apparent distances among subjects, disciplines, and topics can change even when earlier records and the represented contributors have not undertaken new work. This is a problem of reference construction and representation change, with implications for any claim that an event is unusual or that a trajectory occupies a rare position.

The bibliometric comparison by van Bellen and colleagues provides a historically concrete illustration. The authors report approximately 55 million articles in Dimensions and 42 million in Web of Science during 1980–2021, with important disparities in the representation of smaller publishers and disciplinary and geographical publication patterns [3]. Those counts belong to database-specific retrieval procedures rather than to a known population of all contributions. In a study that estimates the novelty of an academic encounter, the inclusion of smaller or previously underrepresented publishing contexts could modify both the underlying comparison set and the apparent relative distance between participants. It might also improve the visibility of legitimate contributions; whether this produces better substantive assessment is a separate question.

The October 2026 OpenAlex topic-classifier revision illustrates a second, distinct mechanism. The provider retained a nominal hierarchy of 4,516 topics while changing how works are assigned to those topics [26]. In the provider’s reported evaluation, the primary-topic agreement for non-English works rose from 9% to 72%, where comparison labels were selected by two AI readers from document titles and abstracts and scored on the defined agreement subset. That is a provider-reported metric with a particular evaluation protocol, and should not be treated as an independently validated measure of truth or as evidence that all non-English work experienced equal benefits. Its structural implication is nevertheless clear: classifications and search-mediated descriptions can change around a document whose title, publication history, and content remain fixed. A defensible heterogeneity measure must therefore report the classifier version, language-dependent coverage, missing metadata, and the reference distribution from which a comparison was calculated.

This suggests a test of *reference-instability sensitivity*: apply two documented indexing or classification regimes to an unchanged historical corpus, recompute reference-conditioned heterogeneity measures, and compare which apparent anomalies survive. Where the regimes produce different results, the analyst should distinguish changes in the represented population from transformations of the events represented within it. A useful research result may consist in showing that a purportedly extraordinary interaction becomes ordinary under a broader, better-documented comparison set. This would not discredit contextual measures of heterogeneity; it would establish the conditions under which those measures remain interpretable.

3.5 Alternative Explanations and Observer Dependence

There are several reasons a relational event may appear unusually heterogeneous. One is a substantial change in a relevant relational configuration. Another is the emergence of previously hidden documentation. A third is a change in the observer’s reference population or descriptive vocabulary. A fourth is an artifact of the recording procedure, such as duplicate identities being reconciled or a repository adopting a new index. These explanations may coexist. The purpose of methodological comparison is to distinguish them sufficiently for an interpretable claim about structural novelty.

Observer dependence should accordingly be specified in more than one sense. First, observers can possess different admissible information and reference collections. Second, they may have different legitimate evidential tasks, so that they select different structural observables. Third, their practical conditions for reaching the same records may differ. Fourth, the act of recording or investigating a configuration

may itself affect how subsequent interactions are organized. These are structural and methodological differences. The psychological processes through which an individual notices, remembers, and evaluates unfamiliar information are addressed in the companion paper on cognitive recognition rather than presumed by the present formalism.

An observer-relative assessment can be compared across specified information conditions without treating either observer as an external spectator. For observers o and o' , the same candidate transformation may be evaluated through different comparison systems $\mathfrak{C}_{o,\rho,\kappa}$ and $\mathfrak{C}_{o',\rho,\kappa}$. Even if the structural contrast in Equation 7 is fixed by an investigator's representation, the conditional distribution in Equation 6 may differ across observers. The corresponding assessment of rarity may diverge while the represented transformation is unchanged. Alternatively, the same baseline distribution may be shared but the observers' admissible evidence paths may differ as in Equation 4. This two-way separation of comparison and access is essential for identifying what a putative novelty effect actually describes.

Hypothesis 3.1 (Reference-conditioned assessment of relational novelty). For a fixed candidate relational transformation and an explicitly held target record core, estimated novelty may change across admissible observer-specific reference collections and representation resolutions. Such variation can occur without any change to the target records or their authorship, and it need not predict the direction of warranted trust revision.

Hypothesis 3.1 is a methodological and empirical conjecture, not an assertion that observer perspectives are interchangeable or equally calibrated. It could be tested by presenting the same underlying relational configuration under experimentally varied access to background cases, while holding target artifacts fixed and recording the comparability criteria used. A suitable test would need to identify when a participant's assessment follows the controlled reference information, when it reflects mistaken inference, and when the chosen structural descriptors genuinely change. Those distinctions set up, but do not replace, the human cognitive inquiry of Paper III.

A separate family of explanations concerns selection. An observer may encounter mostly unusual events because ordinary events remain undocumented or because the discovery mechanism preferentially surfaces outliers. Apparent heterogeneity could then be a consequence of the observation process. A newly connected archive may increase both the number of events observed and the representation of previously invisible routine activity. A naive comparison of frequencies before and after that connection might suggest that the surrounding relational world became less heterogeneous, when the change actually concerned selection into the recorded sample. This problem becomes especially serious where actors can influence the disclosure and circulation of evidence. The present manuscript treats those effects as restrictions and sampling mechanisms; Paper IV will develop the endogenous power relations involved.

A further issue concerns changes in the grounds of comparison themselves. An encounter may introduce a distinction the analyst's earlier vocabulary could not express, such as an unfamiliar procedure for authenticating records or a collaborative practice that cuts across conventional institutional affiliations. A meaningful revision might require extending $\mathcal{X}_{\rho,\kappa}$ rather than simply locating the encounter farther from an existing cluster. The extension should preserve the limitations of comparisons made under the earlier representation. It would be misleading to claim that a numerical rarity score computed before and after such an extension represents one stable quantity unless a justified translation between the descriptive spaces has been supplied.

The resulting account supports a disciplined but open-ended research program. Structural heterogeneity is an assessment of difference under stated relational descriptions; novelty is an assessment with respect to a selected reference domain and, where justified, a predictive distribution. Neither is identical with the introduction of a new social actor, the appearance of a new database record, the creation of a genuinely independent evidential path, or the trustworthiness of the target subject. The most consequential empirical work will therefore contrast cases where these aspects coincide with cases where they diverge. The design should distinguish a substantive relational transformation from improved discoverability, from changed coding practices, and from the observer's revised baseline information.

The comparison system in Equation 5, the conditional law in Equation 6, and the structural contrast in Equation 7 formalize three distinct analytical choices. Their sensitivity to reference domains matters

especially when the documentary population changes through indexing or reclassification. Section 4 evaluates the separate informational question of whether an observed event bears on a trust-relevant proposition. Section 5 examines changes in access to preserved records. Neither step infers evidential significance from rarity alone.

4 Informational Surprise and Trajectory Observability

Section 3 specifies when an event can be described as unusual under a declared comparison. This section asks what that event permits an observer to learn about an existing trajectory. It separates distributional entropy, realized surprisal, and diagnostic evidence, then models the conditions under which evidence becomes accessible and receives examination. The variables, reference distribution, and assessed proposition are explicitly specified. The resulting vocabulary concerns informational opportunities under an observation scheme; human attention and trust behavior require additional models.

4.1 Distributional Entropy and Realized Surprisal

A statement that an event is surprising involves a comparison with possible alternatives. The distribution employed in that comparison may derive from a model of relational interactions, a selected documentary archive, or the predictive information available to a specified observer. Each route has distinct validity requirements. Section 3 introduced a reference-conditioned probability law $Q_{o,\rho,\kappa}$ over provisional relational descriptions. The same law may be used to calculate information-theoretic quantities when the underlying sample space, probability assignments, and descriptive resolution support those operations. The law is a model object. Its use does not establish that relational reality consists of independently sampled, naturally categorized events.

For a discrete, finite comparison space with distribution Q and declared conditioning information $\mathcal{I}$, Shannon entropy summarizes uncertainty over the possible descriptions. Equation 8 gives the conventional definition, with the logarithm base fixed throughout a particular analysis [29].

$$H_Q(Z \mid \mathcal{I}) = - \sum_{z \in \mathcal{X}} Q(z \mid \mathcal{I}) \log Q(z \mid \mathcal{I}). \quad (8)$$

Terms of zero probability contribute zero by convention. Entropy in Equation 8 describes the uncertainty of a specified distribution, not the significance of a particular realized encounter. It is sensitive to the description space and reference conditions. Refining a relational descriptor to distinguish primary evidence from secondhand summaries, for example, can alter the distribution even when the underlying records are held fixed. Moreover, the entropy of the distribution of recorded events can reflect an archive's selection and documentation procedures. High entropy in that archive need not imply that the processes producing the recorded events are equally unpredictable.

For a realized candidate event e with admissible discrete descriptor $z_e = Z_{\rho,\kappa}(e)$, Equation 9 defines realized surprisal when the predictive probability is positive.

$$s_Q(e \mid \mathcal{I}) = - \log Q(z_e \mid \mathcal{I}), \quad Q(z_e \mid \mathcal{I}) > 0. \quad (9)$$

Entropy averages over the possible outcomes, whereas surprisal is evaluated for one realized description. A low-probability event may therefore have high surprisal even when the reference distribution has low entropy. Conversely, a high-entropy distribution may generate many realized events that carry little surprisal relative to its own probability assignments. These mathematical differences matter for any argument that invokes unusual cross-context encounters as sources of attention. The relevant quantity must be named and justified rather than inferred from the generic adjective *unexpected*.

The model conditions for Equation 9 are substantial. If the relevant descriptions have continuous support, the probability of a precisely specified realization may be zero; a pointwise expression based on probability mass is then inappropriate. A density-based log score requires an explicit reference measure

and changes under reparameterization. A study may instead select a declared measurable neighborhood or resolution and report the probability assigned to that region. If the candidate event demands a descriptive feature unavailable in the baseline representation, the researcher must specify a defensible extension or translation before calculating a cross-representation surprisal contrast. A zero estimated probability can also indicate limited data, model misspecification, or an inadmissible description, rather than an event that is literally impossible.

The conditioned information $\mathcal{I}$ must be controlled with similar care. A researcher assessing the prospective rarity of a heterogeneous connection should avoid computing its likelihood using documentary facts disclosed only through that connection, unless the analytical target expressly concerns retrospective reconstruction. This is a restriction on inference and study design, not a commitment to an ontologically preferred present or a universal temporal ordering. Where multiple dependency-compatible baselines exist, the analysis should disclose their range. Different observers may reasonably obtain different surprisal scores because their warranted reference distributions differ, even while a common relational representation holds the event itself fixed.

An additional distinction concerns novelty relative to a subject's own trajectory and novelty relative to a wider field. A cross-disciplinary encounter may be unprecedented within one documented career but frequent among participants in the broader research area. The former quantity can be informative for explaining a local change in available relationships; the latter can be useful for assessing distributional rarity in a wider population. Neither score establishes that new reliable evidence has been obtained. Indeed, a conventional administrative transfer can expose previously unavailable primary records while a highly surprising public encounter can leave all relevant documentation inaccessible. The informational analysis therefore needs a separate target proposition and a separate account of what evidence reaches the observer.

4.2 Diagnostic Information and Posterior Change

Trust-related assessment concerns propositions about a subject, contribution, or relationship under specified criteria. A proposition might concern the correctness of an independently testable result, the authenticity of an authorship record, or the reliability of a documented commitment. The resulting assessment is domain-specific: evidence supporting technical competence does not automatically establish reliability in an unrelated institutional or ethical role. For analytic convenience, let $\Theta \in \{0, 1\}$ designate one explicitly stated target proposition and let Y denote evidential content actually examined by an observer. Binary Θ is an illustrative restriction for transparent analysis. Neither the model nor the research program requires all trust-relevant questions to have binary answers.

Suppose that the observer's admissible information is $\mathcal{I}$ and that an event $E = e$ has been identified. The event can itself be informative about Θ ; consequently, evidence arriving through the event must be evaluated relative to the prior already conditioned on e where that conditioning is warranted. Equation 10 states the standard posterior-odds decomposition for positive conditioning probabilities and defined likelihoods.

$$\log \frac{\Pr(\Theta = 1 \mid y, e, \mathcal{I})}{\Pr(\Theta = 0 \mid y, e, \mathcal{I})} = \log \frac{\Pr(\Theta = 1 \mid e, \mathcal{I})}{\Pr(\Theta = 0 \mid e, \mathcal{I})} + \log \frac{p(y \mid \Theta = 1, e, \mathcal{I})}{p(y \mid \Theta = 0, e, \mathcal{I})}. \quad (10)$$

The final term is a log-likelihood ratio for the observed evidence under the chosen statistical model. It can be positive, negative, or zero. An event with high surprisal under Equation 9 need not yield a nonzero likelihood ratio for evidence about Θ . This is the central separation in the present section: the marginal unpredictability of a relational occurrence and the diagnostic content of evidence associated with it are different formal questions. An unusual introduction may create a route to an authenticated research record, yet the evidential force comes from the record and its provenance under the target question. A rare ceremonial encounter, by contrast, may leave the likelihood ratio at zero if the encounter and associated observations do not discriminate among relevant propositions.

Equation 10 also demonstrates why better information is compatible with an unfavorable assessment. If previously inaccessible records reveal a falsified claim or a failed replication under a defensible proto-

col, the newly observed evidence can reduce posterior support for the target proposition. Such a reduction may constitute successful assessment. It should not be treated as an epistemic failure merely because it does not produce favorable recognition. Likewise, an independently verified correction may increase confidence in integrity while decreasing confidence in the correctness of a particular earlier result. A multi-dimensional target would represent this distinction more faithfully than a single undifferentiated trust score.

The likelihoods in Equation 10 require more than mathematical notation. They depend on evidence-generation mechanisms, a justified association between examined records and the target proposition, and an account of error and source dependence. Two documents with matching claims may be two observations of one underlying report rather than independent tests. Likewise, a prominent intermediary’s endorsement and a repository summary may share the same primary source. Naive multiplication of their likelihood ratios would overstate their combined evidential force. The general problem of conditional independence has a substantial statistical literature [9]; the relevant dependence structure for historical testimony is an object of empirical investigation, with its closer examination reserved for Section 6.

Information gain can also be characterized without presupposing the direction of a belief update. Let $P(\Theta, Y \mid e, \mathcal{I})$ be a well-defined conditional joint distribution associated with a specified observation arrangement. Conditional mutual information measures the expected reduction in Shannon uncertainty about the proposition when Y is observed, under the stipulated probability model. The observed information need not be available to every observer in the access model. Equation 11 expresses it for discrete variables; the divergence formulation generalizes to appropriate probability spaces [29, 21].

$$I(\Theta; Y \mid E = e, \mathcal{I}) = \mathbb{E}_{Y \mid e, \mathcal{I}}[D_{\text{KL}}(P(\Theta \mid Y, e, \mathcal{I}) \parallel P(\Theta \mid e, \mathcal{I}))]. \quad (11)$$

The quantity in Equation 11 is an expectation across possible observations under a fixed model. A realized posterior shift, a positive expected divergence, and increased confidence in a favorable proposition are three distinct properties. The divergence is nonnegative under its standard conditions, although particular observations may move posterior probabilities in either direction. An observer who receives a highly informative negative result may revise confidence downward. Equally, a new accessible document may be redundant with records already examined, yielding little additional information despite an expanded archive.

There is another methodological distinction between *information about a proposition* and *information useful for a decision*. Different decisions may attach different consequences to false acceptance, false rejection, delayed judgment, and additional verification. Conditional mutual information alone does not specify those consequences or an appropriate decision rule. Trust may also involve normative criteria extending beyond probabilistic estimates of task competence. The present model therefore uses information-theoretic quantities to delimit what can be learned under declared assumptions, while leaving substantive trust judgments to specified evaluative standards. This prevents a change in descriptive uncertainty from being promoted into an unqualified claim about trustworthiness.

4.3 Observation Kernels and Evidence Legibility

The possibility of acquiring evidence is not identical with evidence acquisition. An observer may have a nominal path to an archive but lack permission to retrieve records; the retrieved records may lack sufficient identifiers; the observer may not examine them; or examination may fail to yield interpretable evidence. Section 2 introduced a set-based contrast in potentially accessible historical records. A stochastic representation provides a complementary account of variation and uncertainty across these stages. It is particularly useful when a pathway is available only intermittently or when competing observers encounter different documentation and selection mechanisms.

Fix a representation ρ , a historical target core h_0 , an observer o , and relevant institutional or technical conditions c . Let a denote an admissible access action, such as querying a repository or requesting documentation through an intermediary. A representation-specific observation kernel $K_{o, \rho}$ assigns a distribution to possible retrieved record bundles X , including an explicit null outcome $\emptyset$ for retrieval

failure. Equation 12 defines the modeled access mechanism under a candidate event e .

$$K_{o,\rho}(B \mid h_0, e, a, c) = \Pr(X \in B \mid h_0, e, a, c, o, \rho), \quad B \in \mathcal{B}(\mathcal{X}_{\text{rec}}). \quad (12)$$

In Equation 12, $\mathcal{X}_{\text{rec}}$ is a measurable space of possible record bundles and $\mathcal{B}$ an appropriate collection of measurable subsets. Holding h_0 fixed isolates one counterfactual component: a new event may modify the observer’s evidence-access distribution without modifying the content or authorship of the historical target core. The kernel is conditioned on representation, observer, access action, and operating conditions. These components may themselves be part of the evolving relational system, and the counterfactual need not suppose that the observer exists outside it. The ceteris-paribus comparison is a specified analytical intervention, not a universal statement about how histories evolve.

A retrieved bundle X is not yet evidential content Y . A record may be written in an unfamiliar notation, lack provenance, refer ambiguously to its subject, or require specialized verification. An extraction or assessment process $G_{o,\rho}$ can map retrieved bundles and relevant context into outcomes comprising examined content, unresolved ambiguity, or examination failure. The resulting evidential observation law is the composition of $K_{o,\rho}$ with an explicitly described examination process. This distinction allows an evaluation of whether improved retrieval alone creates epistemic improvement. A repository may become publicly searchable while its records remain impossible to authenticate; its access probability rises but the quality of evidence derived from examination may remain unchanged.

Actual examination is a further selection event. Let $M = 1$ indicate that an observer undertakes a defined examination of a retrieved bundle. For the same event and conditions, the probability of an examined evidential outcome can be decomposed through retrieval and subsequent examination, as indicated in Equation 13.

$$\begin{aligned} &\Pr(M = 1, X \neq \emptyset \mid e, h_0, a, c, o, \rho) \\ &= \Pr(X \neq \emptyset \mid e, h_0, a, c, o, \rho) \\ &\quad \times \Pr(M = 1 \mid X \neq \emptyset, e, h_0, a, c, o, \rho). \end{aligned} \quad (13)$$

Equation 13 is a probability identity, not an empirical law asserting that an event increases either factor. Its interpretation requires an examination rule and a clear distinction between the observer’s opportunity to encounter records and the observer’s decision or capacity to inspect them. The latter may vary with workload, professional responsibilities, incentives, costs, or institutional policy. This paper models those variations as externally specified mechanisms. Their detailed psychological explanations belong to Paper III and the endogenous structures of power and authority to Paper IV.

Table 3 summarizes the informational and observational objects. Its separation of stages also identifies different kinds of research evidence. A frequency table can describe relative prevalence in a selected archive; access logs can document retrieval attempts; examination protocols can register whether records were scrutinized; and independent validity assessments can help evaluate the informational content of resulting evidence. Each observation answers a different question. The table does not imply that every case passes through a common sequence of socially given stages, and it does not treat observations as independent merely because they are differently labeled.

An important caution concerns conditioning on successful examination. If the candidate event changes which records are retrieved, or which records receive attention, the distribution of Y among examined cases may change even when the underlying historical target is held fixed. An apparent change in average evidential quality could then reflect selection into the observed sample. Claims about the causal effect of the event on trust should distinguish an access effect, a selection effect, and any change in information quality conditional on a common examination protocol. Experimental designs can hold the records and examiner instructions constant while varying relational access paths. Observational designs need an account of missing data, access restrictions, and the conditions under which pathways become available. These identification questions are developed further in Section 9.

Information accessibility should also be distinguished from evidential robustness. Two observers may both be able to retrieve the same historical record, while one depends on a single brokered summary and the other can inspect the primary source, verify its signature, and compare it with independent

Table 3: Information-theoretic and observational distinctions under specified representations.

Object	Analytical question	Principal limitation
Distributional entropy	How uncertain is the reference distribution over possible descriptions?	Depends on descriptor, sampling, distribution and conditioning information.
Realized surprisal	How improbable is the event’s description under that reference distribution?	Does not establish diagnostic relevance to the target proposition.
Evidential information	How strongly can examined evidence discriminate among target propositions?	Requires defensible likelihoods, source dependence and target definition.
Potential evidence access	What records can an observer retrieve through the available relational configuration?	Retrieval can yield unavailable, ambiguous or inauthentic records.
Actual examination	Are accessible records substantively inspected under a stated procedure?	Selection may reflect resources, incentives or institutional restrictions.
Warranted assessment	What judgment follows under declared evidential and normative criteria?	Positive, null and negative updates are all possible.

records. Their access probabilities alone conceal differences in provenance, possible corruption, and contestability. Conversely, making multiple copies of an identical summary accessible through several channels can increase the number of retrieval paths without introducing additional independent evidence. Sections 5 and 6 will examine the reconstruction and witness-dependence questions that arise once such pathways are created.

4.4 Attention Opportunity and the Limits of Informational Inference

The central account of this paper concerns changes in epistemic opportunity produced by evolving relational configurations. A heterogeneous connection may make an existing trajectory discoverable to a new observer, change what the observer can retrieve, or supply a route by which previously distant records can be compared. In such cases the event can matter even when it is familiar under the reference distribution. Conversely, a surprising encounter may fail to change access or examination conditions at all. The informational mechanisms therefore need to be described at the level of their actual contribution to evidence, with a separate account of the observer’s behavior.

For a fixed historical core and a common evaluative question, consider two hypothetical observation arrangements indexed by e_0 and e_1 . The first represents an admissible baseline; the second represents a candidate relational transformation. Each arrangement induces its own retrieval kernel and, if the examination procedures are specified, its own evidential observation law. A comparison may show that the second arrangement improves the probability of obtaining a particular authenticated record. That result establishes an access opportunity for that record under the model. It does not by itself establish that the observer will examine the record, update a belief, or make a more favorable decision. Additional assumptions and observations would be required at each stage.

A stronger ordering is sometimes possible under declared probability models. Suppose two evidential observation channels Y_1 and Y_2 are compared for the same target Θ , event condition, and baseline information. If Y_2 is generated by applying a further random transformation to Y_1 that is conditionally independent of Θ given Y_1 and the fixed context, then the second channel is a garbling of the first. The following restricted statement is a standard consequence of the data-processing principle and is related to the statistical comparison of experiments [5, 9].

Proposition 4.1 (Information loss under admissible garbling). *Fix an event condition e , admissible information $\mathcal{I}$, and a finite target space. If the conditional distribution of (Θ, Y_1, Y_2) obeys the Markov condition $\Theta \perp Y_2 \mid (Y_1, E = e, \mathcal{I})$, then*

$$I(\Theta; Y_2 \mid E = e, \mathcal{I}) \leq I(\Theta; Y_1 \mid E = e, \mathcal{I}). \quad (14)$$

For the probability spaces in the proposition, the result follows from the chain rule for mutual information and nonnegativity of conditional mutual information. Equation 14 does not imply that every new bridge creates a more informative evidential channel. The required garbling relation between the channels must be demonstrated, and the comparison must hold the target and conditioning context consistent. Two observation channels can also be incomparable: one may reveal provenance more clearly while the other reveals substantive technical details. The formal ordering does not turn accessibility, review intensity, or credibility into one universal scalar measure. A higher-capacity channel may be unused, or used through a decision rule whose purposes differ from the specified target.

A decision-theoretic qualification is important. Under a common prior, fixed decision problem and preferences, correctly specified channels, and the ability to ignore an additional signal without cost, the more Blackwell-informative experiment weakly improves optimal expected decision performance. This result concerns the value of an opportunity under those assumptions; it does not require the posterior probability of a favorable proposition to rise for each realized observation. The data-processing inequality alone is weaker than a full comparison of every possible decision problem. When examination consumes time, changes incentives, shifts admissible actions, or is allocated selectively, the free-disposal premise can fail and a more accessible channel need not generate higher realized welfare. The novelty of the present application therefore lies in linking access mechanisms to observable assessment stages, rather than in claiming a new information-ordering theorem.

Hypothesis 4.2 (Conditional evidence-opportunity transformation). For an explicitly held historical target core, heterogeneous relational transformations may change observer-specific retrieval and examination opportunities without a corresponding change in the target records. Where the transformation supplies newly retrievable, reliable, and diagnostically relevant evidence, it can enable warranted revision of an assessment. The direction of that revision depends on the evidence and the relevant standards rather than on the event's distributional surprisal alone.

Hypothesis 4.2 expresses a conditional structural possibility, not an empirical estimate of the frequency or typical sign of trust revision. It would be supported in a suitably controlled setting if altering a relational access pathway while holding historical artifacts fixed changed the rate at which independently assessable records became available, with corresponding examination outcomes observed separately. Stronger tests would vary the pathway's authentication and dependence properties while keeping its nominal accessibility comparable. Null outcomes would be important: they could indicate that other access routes already existed, that the new materials were redundant, that observers did not examine them, or that the records offered no diagnostic content. A negative warranted trust update would remain consistent with the hypothesis where the disclosed evidence gave reason to revise the target assessment downward.

One can formulate several competing explanations for an apparent association between event surprisal and subsequent recognition. A highly surprising event may be deliberately publicized, increasing discoverability through publicity rather than through its relational heterogeneity. Observers may encounter surprising cases because recording systems preferentially surface outliers. Cross-context connections may be common among already well-resourced institutions, making resource access a confounder. Some apparently new links may only reveal relations that were present but undocumented. Finally, an observer's increased confidence may derive from the authority of an intermediary rather than the independent content of the historical record. The present section identifies such possibilities as methodological alternatives; their detailed cognitive and political explanations fall beyond its scope.

A trust study should also avoid imposing a universal ordering of the underlying historical process merely to fit an information model. The counterfactual arrangements e_0 and e_1 describe analytically specified conditions of access and observation. Where historical dependency is only partially ordered, claims about baseline and transformed configurations should follow the documented dependency structure. Versions of a record may be independently generated, partially translated, or mutually dependent; their representations may change without a unique global account of succession. An information-theoretic comparison is legitimate only for the objects that its model renders jointly comparable. This restriction

is especially relevant when heterogeneous events require extending the representational vocabulary used to characterize an existing trajectory.

A relational event may change access to a preserved contribution, while the event’s novelty remains separate from the evidential content subsequently examined. The resulting assessment may become favorable, unfavorable, or unchanged. Section 5 identifies the relational pathways enabling such retrospective examination, and Section 6 evaluates whether the sources they carry are independent, credible, or redundant.

5 Cross-Context Access and Retrospective Recognition

Section 4 distinguishes statistical surprise from diagnostic information. Here the question becomes concrete: under what conditions does a new relation let an observer examine an existing contribution without altering its preserved documentary content? The section separates nominal cross-context connections from authenticated access pathways, defines the documentary target held fixed in a comparison, and analyzes retrospective assessment and contestation. Positive, null, and negative examples establish that access alone does not endorse a contributor or determine the direction of a warranted judgment.

5.1 Relational Bridges and Evidence-Access Pathways

A relational bridge may connect actors, communities, repositories, practices, or institutional settings that were weakly connected under a selected representation. Research on weak ties and structural brokerage gives established reasons to study access across relatively separated social contexts [13, 7]. These approaches illuminate possible transmission and exposure mechanisms. The inference required here is more restricted. The presence of a connection in a represented network does not demonstrate that a particular record is available to a particular observer, that the record can be examined, or that its content supports an assessment of its subject. A link may support conversation while excluding document exchange; a broker may transmit a reputation without providing a record; and a new public reference may point to material that remains inaccessible.

For the present purpose, a *context* is a provisional region of relationships, constraints, interpretive practices, and documentary interfaces relevant to an inquiry. Contexts are not presumed to be mutually exclusive communities or naturally bounded social containers. A technical repository, a professional review setting, and a collaborative work arrangement may overlap in participants while organizing access to evidence differently. A heterogeneous event can modify relations across such arrangements without being assigned to any fixed event type. The effect depends on which operations and evidentiary pathways it changes.

An *evidence-access pathway* is a modeled sequence or higher-order configuration of admissible operations by which a specified observer can locate, request, retrieve, and, where necessary, authenticate a specified record. Its description may involve participants, record identifiers, permissions, transformation steps, and institutional conditions. The pathway is therefore more demanding than graph-theoretic reachability. If a record is publicly indexed but its underlying file is corrupted, a nominal discovery route exists while substantive access fails. If a trusted intermediary can provide a document only under confidentiality restrictions, the pathway may be available to some observers but inadmissible to others. If a broker offers a summary, access to the summary does not automatically establish access to its evidentiary source.

A useful pathway description should distinguish at least four questions. First, does an observer possess a usable route to a claimed record? Second, does that route preserve record identity and relevant provenance? Third, under which conditions can the observer complete the required operation? Fourth, what evidentiary content, if any, can be obtained and examined as a result? These questions may require different data sources. A graph may identify a potential route, a permission system may establish authorization, a repository log may show retrieval, and a review record may establish that substantive

examination occurred. Treating these observations as interchangeable would overstate what structural evidence alone demonstrates.

An analytical access contrast can be defined using the observation kernel of Equation 12. Fix the represented historical core h_0 , observer o , representation ρ , admissible access action a , and contextual conditions c . Let e_0 and e_1 designate two specified relational arrangements, with e_1 containing the candidate cross-context modification. For any measurable set B of retrieved record bundles, the event-conditioned change in retrieval probability is given by Equation 15.

$$\Delta_{o,\rho}^{\text{ret}}(B; e_1, e_0) = K_{o,\rho}(B \mid h_0, e_1, a, c) - K_{o,\rho}(B \mid h_0, e_0, a, c). \quad (15)$$

Equation 15 is a comparison of modeled observation conditions and contains no presumption about its sign. Its probability-kernel difference is not automatically a causal effect: identifying an effect of an intervention on the relational arrangement requires a consistent treatment definition, adequate control of alternative changes, and a justified observer population. For B defined as the retrieval of an authenticated version of a target record, a positive contrast would represent improved retrieval opportunity under these specifications. If B is a bundle of unreliable summaries, a positive contrast could have a very different substantive interpretation. The formulation holds the access action and specified conditions constant, which may be a useful experimental design but can be restrictive in actual relational settings: a new connection may itself change the feasible actions, the observer’s priorities, or the permissions available. In that case the analyst should report the altered action set and interpret the result as a comparison of explicitly different regimes rather than as a pure effect of one relation.

One can also state a restricted monotonicity result for purely potential access. Suppose a represented system includes a set $\mathcal{P}_o(e)$ of admissible pathways available to observer o under arrangement e . Define $\mathcal{A}_o(e)$ as the target records reachable through at least one pathway in $\mathcal{P}_o(e)$, using a common criterion of record identity and admissibility. The following proposition describes what follows when the new arrangement preserves every previous admissible pathway.

Proposition 5.1 (Potential-access preservation under pathway extension). *Fix an observer, historical target representation, record-identification rule, and admissibility criterion. If $\mathcal{P}_o(e_0) \subseteq \mathcal{P}_o(e_1)$ and all pathways retained from e_0 preserve their record outcomes under e_1 , then*

$$\mathcal{A}_o(e_0) \subseteq \mathcal{A}_o(e_1). \quad (16)$$

Proposition 5.1 follows directly from the existence of an admissible path for each element of $\mathcal{A}_o(e_0)$. Its assumptions are strong and should remain visible. A new intermediary can introduce exclusivity, withdraw an old permission, alter an identifier, make a previously public archive inaccessible, or redirect an observer toward an inferior version. In these situations pathway preservation fails. Equation 16 also says nothing about frequency of retrieval, costs, source independence, review completion, or warranted trust. Even a genuine enlargement of $\mathcal{A}_o$ may leave the observer’s examination unchanged. The proposition identifies a sufficient structural condition for an expansion of potential access, not a general law of social connectivity.

Pathways vary in robustness. A record obtained through a single brokered summary may depend on the continuing reliability and cooperation of one intermediary. Another arrangement may permit inspection of the underlying artifact and its provenance through separate interfaces. The second may provide stronger opportunities for contestation or recovery following an access failure. However, nominally separate routes can carry the same copied claim, and additional retrieval routes do not necessarily yield independent evidence. The present section treats path robustness as a property to be documented, with the statistical dependence of testimony developed in Section 6. Higher-order representations in Section 8 will consider situations where a pathway cannot be represented adequately as a sequence of ordinary pairwise edges.

5.2 Unchanged Historical Contributions under New Observation

Retrospective recognition requires careful specification of what remains unchanged. In a generative relational framework, the broader history and the conditions of its representation can evolve; there is no need

to posit an immutable, fully known object containing every relation of the world. The narrower claim concerns a deliberately held *documentary target core*: a delimited collection of contribution records, associated claims, and available provenance whose represented contents are preserved across the comparison. The observer’s access to that core may change, as may its positioning within a larger relational system. Distinguishing these components makes the explanatory claim testable.

Let $D_{\rho,0}$ and $D_{\rho,1}$ denote the documentary components of two compatible historical representations and let C identify the delimited target material. Suppose an explicit restriction or correspondence operation res_C maps both documentary components to the same target record collection d_C . The preservation condition is expressed in Equation 17.

$$\text{res}_C(D_{\rho,0}) = \text{res}_C(D_{\rho,1}) = d_C. \quad (17)$$

Equation 17 preserves the selected records and their represented content for the comparison; it does not establish that every claim in d_C is correct or that all relevant historical relations have been recorded. Nor does it require the observer, the surrounding interactions, or the entire incidence structure to be identical. Indeed, the argument concerns how a modification outside the preserved documentary core can change what an observer may know about it. Where new evidence changes attribution or corrects the record itself, the strict preservation condition no longer holds for that component. The analyst may then hold a smaller common core fixed and treat the correction as additional material, or conduct a different comparison with openly changed targets.

The distinction matters because an apparent improvement in reputation may have several sources. A contributor may produce a new substantive result, an existing result may receive additional independent validation, an older document may become accessible to another audience, or a familiar claim may be amplified through affiliation with a prominent intermediary. These are analytically different developments. Only the access-based comparison asks what happens when the recorded contribution is held fixed while the evidence environment changes. Even within that restricted comparison, different observers can reach different judgments because they encounter different records or apply different relevant standards.

For the paper’s present purposes, *retrospective recognition* designates an observer’s evidenced identification and assessment of a contribution already represented within the held historical core, where a relational transformation changes the conditions under which the observer can consider that contribution. The term does not imply public acclaim, favorable evaluation, or material reward. Recognition may consist in correctly identifying a contributor, locating a source, assessing the reliability of an old claim, or assigning an appropriate share of credit under a declared procedure. An observer may also recognize that an attributed contribution is unreliable. Public visibility, institutional endorsement, and the conversion of recognition into material return involve additional mechanisms, some addressed in Paper I and others reserved for companion papers.

An instructive contrast concerns direct access and delegated testimony. Suppose a participant in one context directs an evaluator in another context to an existing technical record. The evaluator may inspect the record itself, in which case the cross-context event helps explain the encounter but the assessment can rest on the record and its validity. Alternatively, the evaluator may merely accept the intermediary’s description. In that case the relation may modify credibility through delegated testimony or status cues without providing independent access to the underlying work. Either channel may sometimes be justified under relevant constraints, and epistemic dependence is a familiar feature of specialized knowledge [15]. Nevertheless, they warrant distinct interpretations in the model. Source access, independent validation, and reliance on testimony should be separately recorded.

The retrospective dimension also raises a danger of attributing causal force to the most visible encounter. If the target document was already reachable through another repository, the new relational link may add a redundant path while the observer’s examination results from unrelated circumstances. If the observer was already assessing the record, a newly documented relationship may coincide with recognition without explaining it. A rigorous account therefore needs an admissible counterfactual or a clear process trace, rather than an inference from the apparent order of recorded events alone. A partially ordered historical representation can support claims about documented dependencies without imposing

Table 4: OpenAlex-reported expansion of OJS-indexed coverage in October 2026. Counts are descriptive provider reports, not measured trust or causal effects.

Coverage measure	Before expansion	After expansion
Active OJS journals with articles in OpenAlex	44,464 (80%)	52,927 (95%)
Associated article records from OJS journals	14.6 million	18.8 million
OJS journals harvested from direct feeds	50	21,864

a universal linear narrative.

A further possibility is that the new connection alters *interpretability* even if retrieval probability does not change. An evaluator may possess a technical artifact but lack the metadata needed to determine its contributors, its methodological dependencies, or the significance of a result within another discipline. A cross-context encounter may supply a translation, an authentication procedure, or a route for querying the original producers. Such an addition can make a previously available record intelligible under a specified assessment question. The historical record of the contribution can remain stable while the evidential interpretation becomes more adequate. As with access, interpretive assistance can also be misleading; its benefits depend on the accuracy of the translation and the ability to test its claims.

These examples suggest that *recognizability* should be operationalized through a sequence of discriminable observations rather than a single prestige score. A research design might record whether an artifact was discovered, whether its identity and provenance were verified, whether substantive examination occurred, whether attribution was corrected, and whether an evaluation changed. It should also allow a null outcome at each point. This preserves the crucial distinction between the existence of a structural opportunity and its realized epistemic consequence.

5.3 Bibliographic Expansion as a Retrospective-Access Case

The indexing of previously published scholarship offers a concrete historical case of the access transformation described above. A bibliographic record is not the scholarly artifact, and a journal's admission to an index does not itself verify the accuracy of its articles. In the counterfactual comparison, the held documentary core is the specified prior publication, while its added index entry, retrieval metadata, and subsequent search encounters belong to the evolving observational surroundings. Nevertheless, index inclusion may add a discoverability route that did not previously exist for observers who depend on that index. The October 2026 OpenAlex expansion supplies unusually direct descriptive information about such a change. The provider reports an increase in active OJS journals with at least one article represented in its index, together with increased article coverage and an expanded number of direct journal feeds [25]. Table 4 records these provider-reported values.

The reported reference population comprised 55,705 OJS journals that were online, published in 2025, and possessed an ISSN. This denominator is specific to the Public Knowledge Project's Beacon list and should not be generalized to all journals globally. OpenAlex described a change in harvesting arrangements: rather than receiving information principally through existing cross-reference services and aggregators, the index added direct harvesting from journal-maintained feeds. The announcement also noted thousands of journals that remained without records and technical obstacles to harvesting some servers [25]. The difference between its before-and-after article totals is a change in recorded coverage, not a verified record-by-record count of distinct previously unpublished, formerly inaccessible, or newly examined works. Establishing which historical artifacts entered the index requires stable identifiers, archived snapshots, and deduplication checks. Consequently, the contrast is not between an era of total exclusion and an era of universal discoverability. It is a bounded institutional transformation with incomplete coverage.

The epistemic object remains the document, its provenance, and the claims that can be assessed from it. A record newly exposed through an index may have been available for years through the publisher or another repository; the new pathway therefore changes a particular observer's practical means of finding

1318 it. Alternatively, the added index record may point to incomplete metadata, duplicate content, or a source
1319 requiring specialist interpretation. An observer’s search query, language, access rights, and decision to
1320 examine the result then determine whether the new route is used. These distinctions prevent aggregate
1321 index growth from being mistaken for aggregate growth in justified trust.

1322 A related case concerns *representational reclassification*. In October 2026, OpenAlex also reported
1323 revising the model that assigns topic labels to unchanged article records, while retaining the topic hier-
1324 archy [26]. Inclusion and reclassification are analytically different interventions. Inclusion can modify
1325 the set of records retrievable through an index; reclassification can change which searches or subject-
1326 specific filters retrieve a record already present. Both are plausible sources of retrospective change in
1327 evidence access. Neither automatically changes the artifact’s technical correctness, historical authorship,
1328 or independence of its witnesses.

1329 The historical-materialist significance of the case lies in the institutional and material work needed
1330 to mediate socially produced knowledge. Preservation of publications, upkeep of journal servers, main-
1331 tenance of open harvesting interfaces, metadata normalization, and classification are forms of infrastruc-
1332 tural labor. Their organization conditions whose earlier contributions can enter a new context of evalua-
1333 tion. The provider announcement establishes an actual change in coverage and technical linkage, while
1334 the broader claim that this change alters the distribution of substantive scrutiny remains a hypothesis to
1335 be tested. Section 9 specifies feasible measurements and identification constraints for that test.

1336 A key novelty challenge arises from established work on delayed citation recognition. The “sleeping
1337 beauties” literature documents long periods of limited citation followed by increased attention, includ-
1338 ing cases with cross-disciplinary recognition [27, 19]. Those studies provide empirical precedents for
1339 delayed visibility and recognition; an additional link or index entry does not establish a previously un-
1340 studied phenomenon. The contribution claimed here is narrower: a specified causal or structural contrast
1341 between evidence-access arrangements for a held documentary target, paired with separate measure-
1342 ments of actual examination, provenance-sensitive evidential content, and warranted assessment. Cita-
1343 tion awakening might reflect a newly available pathway, but it can also reflect changing research agendas,
1344 genuine later usefulness, publicity, prestige, or measurement coverage. Identifying a relational-access
1345 mechanism requires discriminating those possibilities, not simply observing a late citation increase.

1346 5.4 Retrospective Reinterpretation and Contestation

1347 A changed evidence pathway may enable reconsideration of an existing contribution rather than first-
1348 time exposure alone. The observer may acquire an additional methodological appendix, gain access to
1349 a previously inaccessible original artifact, discover a provenance record, or receive an explanation that
1350 makes a technical decision interpretable. Each addition can alter the set of warranted inferences about
1351 the unchanged documentary core. What matters is the relationship between the acquired material and
1352 the target question, including authenticity, independence, consistency, and the possibility of challenge.

1353 Reinterpretation may concern what a contribution demonstrates, who participated in its formation,
1354 or how its dependence on other work should be understood. A publication may support the existence
1355 of an articulated claim but leave open whether the claim was independently verified. A reproducible
1356 software artifact may support a narrower technical competence claim than an institutional description
1357 of the project suggests. A contributor list may correctly identify several participants while remaining
1358 insufficient to infer their particular responsibilities. These distinctions may be brought into view by a
1359 heterogeneous encounter that connects different evidentiary practices. The encounter’s contribution is
1360 an opportunity for comparison; the adequacy of the resulting inference must be assessed through the
1361 substantive evidence.

1362 Provenance is especially relevant here. The PROV-O vocabulary provides established techniques for
1363 representing derivation and attribution of documentary entities [34]. It can help identify whether a new
1364 statement is a copy, a derived description, or a separately documented activity. Yet a provenance chain
1365 can be complete while its originating assertion is mistaken. Conversely, an incomplete chain may limit
1366 verification without proving that the claim is false. A rigorous retrospective assessment should therefore

distinguish documented origin, substantive correctness, and the warranted scope of attribution. Section 6 develops the further issue of dependence when several witnesses derive their reports from one source.

The capacity to contest a claim is part of epistemic accessibility. A nominally accessible record may permit reading while offering no route to inspect its supporting data, identify the original source, or challenge a consequential misattribution. A newly available pathway may improve contestability by enabling direct comparison with primary records or by making the relevant custodian reachable. Such improvements can be important even when the observer's final evaluation does not change. They can also reveal that the original assessment was overconfident. This suggests an outcome dimension distinct from favorable recognition: the degree to which an assessment is open to justified correction under stated evidentiary procedures.

A bounded version of retrospective recognition can be framed as a conditional research hypothesis.

Hypothesis 5.2 (Retrospective assessment through transformed evidence access). For a delimited, representationally compatible historical core whose documentary content is held fixed, a cross-context relational transformation may change an observer's opportunity to retrieve, authenticate, interpret, or contest relevant evidence. Under a specified examination procedure, such changes may alter warranted attribution or assessment. Their magnitude and direction depend on the content and provenance of the evidence, and the same transformation may produce favorable, null, or unfavorable outcomes for different targets or observers.

Hypothesis 5.2 makes no prediction that an unusual bridge will generally increase positive recognition. Its substantive content lies in the conditional mediation through evidentiary opportunity. It is falsifiable in an operational setting: if an experimentally introduced access route has no effect on access, examination, attribution, or warranted judgments across otherwise comparable cases, the hypothesized route-mediated effect is unsupported in that setting. An intervention can also reveal the wrong mechanism. If favorable evaluations change only when the intermediary's title is displayed, with no change in direct evidence access or examination, the finding would support an authority-cue explanation rather than the evidence-access mechanism proposed here. If the accessible record itself differs between treatment and comparison groups, the held-core assumption requires explicit reconsideration.

The causal interpretation is especially delicate when observers select which evidence to examine. Suppose a bridge raises the fraction of cases in which an archived contribution is read. Average ratings among read cases may fall, because the added cases include weaker contributions that would otherwise have remained unexamined, even though the standards used for each artifact are unchanged. A comparison restricted to examined cases could wrongly attribute a change in average rating to the bridge's effect on evaluative judgment. The design should therefore distinguish retrieval probabilities, examination selection, and conditional assessment while recording nonexamination as a meaningful outcome. Analogous attention to conditional independence is important when analyzing observations obtained through selected pathways [9].

The term *retrospective* does not require treating a single privileged present as the ontological point from which all past meaning is reassigned. It indexes the analytical relation between a held documentary core and alternative configurations of access, interpretation, and assessment. One can compare those configurations through documented dependencies or counterfactual regimes without asserting a globally ordered historical sequence. The formal task is to state what is preserved, what can vary, and what observation would discriminate among the competing explanations. In this sense retrospective recognition is a relational epistemic possibility rather than a necessary developmental stage of trust.

5.5 Positive, Null, and Negative Evidentiary Outcomes

The account can be clarified through four hypothetical configurations. Each holds an explicitly identified documentary target core fixed while varying surrounding access conditions. The configurations are schematic, non-identifiable, and intended to distinguish mechanisms; they do not supply empirical frequency estimates. Table 5 summarizes the comparisons and their principal interpretive risks.

Table 5: Hypothetical cross-context transformations and distinct epistemic outcomes for an unchanged documentary core.

Configuration	Potential evidentiary consequence	Main interpretive limitation
Direct archival access	An evaluator retrieves and authenticates an existing contribution record; justified attribution can improve.	Access and validation must be observed separately from a favorable rating.
Redundant route	A connection points to a record already accessible and examined; assessment remains stable.	A visible new link need not have a causal epistemic effect.
Counterevidence access	The observer examines an existing record that disconfirms a reliability or attribution claim.	An unfavorable trust update may be epistemically warranted.
Reputational relay	An intermediary supplies endorsement without an inspectable primary source.	Reputation or source dependence may explain the change; independent access is unestablished.

In the first configuration, an evaluator in one technical domain encounters a verified artifact from another domain through a newly established communication pathway. The artifact's content and recorded authorship are unchanged. The pathway makes the artifact discoverable and provides enough provenance for the evaluator to check that it was created by the attributed contributors. Examination may support a favorable revision of attribution or competence, conditional on the artifact's actual validity. The hypothetical illustrates an improved opportunity for justified recognition, not an automatic reward from social affiliation. A study should distinguish the effect of finding the artifact from the effect of its substantive quality by keeping the artifact fixed across access conditions.

In the second configuration, the new relationship offers an additional route to the same record, but the observer can already retrieve and has examined an authenticated copy through a public archive. The relation may be socially important and structurally heterogeneous while contributing no additional diagnostic evidence under the chosen assessment. The correct epistemic prediction can be a null update. The new route could still improve resilience against later access failure or provide alternative contact arrangements, but these additional effects would require their own observation and should not be confused with a contemporaneous change in warranted judgment.

In the third configuration, a cross-context encounter gives an auditor access to an existing methodological record that contradicts a previously accepted claim. The auditor verifies the record and determines that an earlier attribution or reliability judgment was too favorable. A negative update follows under the stipulated evidentiary standard. Nothing in the access mechanism entails that the subject is inherently untrustworthy; the result depends on the content and probative strength of the record. The example shows why an increase in justified scrutiny can coincide with lower confidence. Any theory defining successful trust formation exclusively through increases in confidence would obscure this important possibility.

In the fourth configuration, an intermediary's public endorsement draws an observer's attention to a contributor, but no primary record or independent verification becomes available. The observer may change a judgment because of the intermediary's credibility, status, or apparent proximity to the contribution. That update may be reasonable or unreasonable under the circumstances, yet the model must distinguish reliance on testimony from access to the underlying record. Repeated versions of the same endorsement may appear to supply corroboration even when they stem from one report. Such source dependence can amplify visibility without supplying commensurate independent information, a problem reserved for the next section.

These examples illuminate different meanings of *recognition*. Identification of a contribution, verification of attribution, assessment of reliability, favorable reputation, and institutional reward may diverge. A new relational event can improve one dimension and leave others unchanged. A subject may become more visible while receiving a less favorable but better supported evaluation. An authenticated contri-

bution may be understood yet remain outside a decision maker's remit. A valid assessment may fail to attract sustained attention because the observer lacks sufficient capacity to examine all available material. Accordingly, the analysis should report the specific outcome measure rather than treat trust or recognition as an undifferentiated favorable response.

Several observations would challenge an excessively broad version of the argument. If a purportedly heterogeneous event adds no new admissible pathway, the access mechanism is absent. If a new pathway retrieves copies that are indistinguishable from previously examined information, the diagnostic gain may be nil. If evaluators increase trust without encountering, examining, or otherwise obtaining new relevant evidence, the access-centered explanation is incomplete. If an access improvement coincides with a changed artifact or an altered assessment criterion, the comparison no longer isolates the originally specified mechanism. These limitations are substantive: they make it possible to test the proposed contribution against publicity, status, quality variation, and selection-based alternatives.

Cross-context change can alter what an observer may learn from an unchanged documentary target. The result depends on the accessibility, provenance, interpretation, and diagnostic content of evidence, together with the procedure of examination. Section 6 addresses a remaining source of error: apparently distinct pathways may reproduce the same testimony. This distinction connects the historical example of expanded index coverage to the question of what genuinely independent evidence enters an assessment.

6 Witness Dependencies and Epistemic Constraints

Additional paths to a document do not necessarily provide additional independent evidence. Building on Section 5, this section analyzes the dependence of testimonies and documentary reports by separating accessible records from their evidential origins. Conditional probability models clarify assumptions about corroboration; provenance analysis examines whether those assumptions fit a particular history. Neither the count of messages nor the appearance of multiple witnesses is sufficient to establish informational independence.

The argument proceeds through four inquiries. The first considers reports with shared sources, correlated errors, and genuinely supplementary observations. The second separates credibility, authentication, institutional credentials, and evidence of substantive reliability. The third analyzes disagreement and the possibility of well-founded negative trust revisions. The fourth addresses incomplete documentary histories, source loss, and the limits of reconstructing independence. The account remains deliberately local to the epistemic opportunities created by changing relations. Mechanisms of human memory, attentional bias, and social inference are reserved for Paper III; systematic institutional production of dependence and authority is reserved for Paper IV. The present section instead asks what can be inferred from a specified evidentiary configuration, what remains unidentified, and which alternative configurations would challenge the inference.

6.1 Source Independence and Correlated Testimony

Two endorsements may constitute two communicative acts while transmitting one informational origin. A reviewer may obtain several recommendations for a contributor, each worded differently, without knowing that all recommenders relied on the same preliminary report. A technical claim may circulate through independent websites while every version derives from one unverified measurement. Conversely, two accounts distributed through a common repository may originate in independent observations. Communication pathways and evidential lineages are therefore distinct relational structures. A larger set of accessible witnesses is compatible with redundant, partly dependent, or substantially independent evidential origins.

This distinction concerns the conditions of evidential accumulation rather than a general suspicion of testimony. Specialized knowledge routinely involves reliance on others whose work an evaluator cannot directly reproduce [15]. Formal epistemology also studies how the reliability and independence of testimony affect its probative force; the relevant assumptions must be made explicit rather than read

from the number of speakers [6]. A witness can be trustworthy in communicating what was received while supplying no independent grounds for the original claim. Thus fidelity of transmission, originality of evidence, and accuracy about the target proposition should be represented separately.

Consider a binary target proposition Θ , such as the claim that a specified result passed an explicitly stated validation criterion. Let T_1 and T_2 represent two reports and let C denote the observer's declared background information, including relevant scope conditions. Conditional independence of the reports under both alternatives to Θ is an unusually strong modeling assumption. Where justified, it gives the factorization in Equation 18.

$$P(T_1, T_2 \mid \Theta = h, C) = P(T_1 \mid \Theta = h, C)P(T_2 \mid \Theta = h, C), \quad h \in \{0, 1\}. \quad (18)$$

The formula describes a relationship among random variables within a specified probability model. It does not claim that identifiable human witnesses generally satisfy this condition. In particular, being acquainted with one another does not prove dependence, and having distinct names or affiliations does not prove independence. Shared documents, common institutional procedures, coordinated preparation, and common measurement faults may create dependence even when the communicative acts are separate. Witnesses can also share background conventions that matter for interpreting the validity of a result. A defensible statistical model must declare which such conditions are included in C , which are represented as latent common causes, and which remain unobserved.

For nonzero prior odds and well-defined likelihood ratios, Bayesian updating always admits a sequential conditional expression. Equation 19 makes explicit how the information from a second report depends on what the first report has already supplied.

$$\frac{P(\Theta = 1 \mid T_1, T_2, C)}{P(\Theta = 0 \mid T_1, T_2, C)} = \frac{P(\Theta = 1 \mid C)}{P(\Theta = 0 \mid C)} \frac{P(T_1 \mid \Theta = 1, C)}{P(T_1 \mid \Theta = 0, C)} \frac{P(T_2 \mid T_1, \Theta = 1, C)}{P(T_2 \mid T_1, \Theta = 0, C)}. \quad (19)$$

Only under appropriate conditional independence can the final factor be replaced with an unconditional likelihood ratio for the second report. Multiplying two marginal likelihood ratios while ignoring dependence therefore applies a special-case rule outside its stated domain. The result may overstate evidence, but dependence need not always move the result in one direction. Shared error mechanisms, antagonistic reporting practices, and heterogeneous source reliabilities can affect the joint likelihood in different ways. The general conditional decomposition remains valid only insofar as the underlying conditional probabilities are coherently specified and the conditioning observations have nonzero probability.

A simple numerical comparison illustrates the importance of origin dependence. Suppose two reports are both positive about a binary proposition with prior probability one half. Each report, considered alone, has sensitivity 0.8 and false-positive probability 0.2. Under conditional independence given either state, two positive reports yield posterior odds of 16 to 1, or posterior probability approximately 0.941. If the second report instead repeats the first report perfectly, the pair contains the same diagnostic evidence as the first report alone, producing posterior probability 0.8. Both observational situations feature two apparent reports and a positive pair of messages. Their evidential significance differs because their generating structures differ. The numbers are invented for a methodological example and do not estimate witness behavior in any real setting.

The supplementary value of another report can also be expressed as conditional mutual information. Let $\mathcal{T}_1$ and $\mathcal{T}_2$ be the informational contents of the reports under a fixed joint distribution. Equation 20 describes the expected additional information about Θ supplied by the second content conditional on the first and on C .

$$I(\Theta; \mathcal{T}_2 \mid \mathcal{T}_1, C) = H(\Theta \mid \mathcal{T}_1, C) - H(\Theta \mid \mathcal{T}_1, \mathcal{T}_2, C). \quad (20)$$

Here $H(\cdot \mid \cdot)$ is conditional Shannon entropy, whereas Θ denotes the target proposition throughout Sections 4 and 6. For discrete variables with finite entropy, the quantity is nonnegative under the specified distribution. It equals zero when the second content supplies no additional information about the target beyond the first and the conditioning context, including the case of an exact deterministic copy. This is

an expected information criterion. It does not require the realized posterior for every particular message to rise, and it does not distinguish warranted reliance from favorable evaluation. In applications, the joint distribution and its conditional-independence assumptions are precisely what would need independent support. Observing a sample with many concordant statements does not alone identify the conditional mutual information of their informational origins [9, 21].

Proposition 6.1 (Evidential redundancy under perfect copying). *Suppose, conditional on background information C , the content $\mathcal{T}_2$ is a deterministic function of $\mathcal{T}_1$, with no additional observations incorporated in the generation of $\mathcal{T}_2$. Then $I(\Theta; \mathcal{T}_2 \mid \mathcal{T}_1, C) = 0$, and conditioning on both report contents yields the same posterior distribution over Θ as conditioning on $\mathcal{T}_1$ and C alone, whenever these conditionals are defined.*

Proposition 6.1 is a standard implication of deterministic conditional redundancy, stated here to discipline the interpretation of multiple evidence pathways. Its proof follows because the second content is measurable with respect to the first: knowing the first fixes the second, so the conditional entropy of the target is unchanged. It concerns report *content* under specified background information. The identity or behavior of the second messenger might still carry additional metadata, such as independently authenticated timing or a demonstration of access to a restricted record. In that case the complete observation is richer than the copied content and the proposition cannot be applied to the entire observation without qualification. It would also be misleading to infer that every correlated report is perfectly redundant; partial dependence can coexist with genuine marginal information.

Information-lineage analysis offers a necessary complement to such abstractions. Rather than assigning a numerical independence coefficient based on superficial similarity, one can reconstruct how each witness or document obtained its claim, whether an independent observation occurred, and which transformations or omissions intervened. Tucker’s treatment of multiple testimony specifically emphasizes tracing information flows and offers a critical perspective on explanations relying exclusively on formal independence assumptions [30]. This alternative does not eliminate formal models; it supplies an important test of whether their variables and conditional relationships have been individuated adequately for the evidential problem. For the present research, source provenance and probabilistic sensitivity analysis should be mutually constraining practices.

6.2 Reliability, Provenance, and Credential Signals

The epistemic role of a source cannot be represented by one undifferentiated measure of social credibility. A report has a claimed author or origin, a path of transmission, an evidential target, an interpretation rule, and possible grounds for independent evaluation. Source authentication concerns whether a record has the alleged origin. Transmission integrity concerns whether relevant contents were preserved through the recorded transformations. Competence may concern the ability to observe, measure, or assess the target. Reliability concerns performance or error characteristics under a specified kind of task and relevant conditions. Sincerity, conflicts of interest, and institutional position can be considered where they materially affect the warranted assessment, but none substitutes automatically for evidence about the proposition being evaluated.

This separation has practical implications for cross-context trajectories. An observer may receive an archived technical statement endorsed by a well-known institution. Institutional custody can provide a valuable authentication cue and improve discoverability. Yet the substantive proposition may still depend on an unreplicated measurement. In another case a modestly circulated contribution may contain reproducible code, primary measurements, and a complete derivation that allow a capable evaluator to check the target directly. Institutional credentials and direct evidentiary access can both matter; they support different inferences under different task and resource constraints. The problem of deciding which expert deserves confidence is an established concern in social epistemology. Goldman discusses arguments, agreement, assessments by other experts, interests, and track records as possible considerations, each requiring critical interpretation [12].

One useful representation is a *claim-specific provenance graph*. Its nodes can include recorded claims, document versions, observations, transformations, responsible agents, and attestations. Links assert such locally defined relations as derivation, revision, validation, custody, or communication. A provenance vocabulary such as the W3C PROV ontology offers technical concepts for entities, activities, agents, and derivation relations [34]. Adopting such a vocabulary facilitates documentation while remaining an incomplete representation of the social and epistemic processes of knowledge production. A syntactically valid provenance record can contain mistaken claims, fabricated links, inaccessible dependencies, or missing participants. Provenance is a record of asserted relations, not a certification that every assertion is true.

The provenance graph should also remain open to revision of its individuation. One purported source may represent a composite workflow, while one actor may generate several observations using genuinely distinct procedures. Document versions can be rewritten, partial records aggregated, and collective contributors compressed under one institutional label. Those transformations can matter for the apparent independence of downstream reports. The inquiry should therefore preserve both the declared granularity of the graph and the procedure by which the graph was constructed. A graph of signed messages may establish that distinct parties signed particular text. It does not establish that the parties produced the underlying results independently. Conversely, a jointly authored artifact can contain independently obtained checks, the lineage of which may require finer-grained reconstruction.

Several distinct evidentiary questions should consequently be asked of an intermediary. Can the intermediary identify the underlying claim and its original record? Is the record accessible to an appropriately qualified examiner? Are there authenticated transformations connecting the presented version to its source? Does the testimony contain an independent observation or a judgment derived from accessible evidence? Which sources of error are shared across apparently separate endorsements? Can the claimant, subject, or an affected party correct a mistaken attribution or contest the interpretation? These questions do not comprise a universal checklist that settles trust. They specify observable dimensions that can be recorded and compared across institutional settings, including settings where some dimensions are unavailable for legitimate reasons.

The distinction between credentials and probative information is especially salient when encounters span heterogeneous contexts. A title or affiliation that serves as an effective expertise marker within one domain may have uncertain predictive value in another. A credential might legitimately establish training or responsibility for a restricted procedure without establishing reliability concerning an unrelated technical result. The reverse possibility also matters: a person outside recognized institutional channels may possess pertinent evidence while lacking a credential that facilitates attention. Paper II need not infer a general credibility penalty from either condition. The structural claim is that the evidentiary relevance of a credential depends on its relationship to the task, the underlying observation, and the available independent checks. More comprehensive accounts of institutional production of credential authority remain for Paper IV.

Table 6 summarizes the distinctions needed to evaluate new testimony pathways. These dimensions can overlap, and an empirical study may be unable to observe all of them. Their analytical separation nonetheless helps prevent transmission density, social endorsement, and verified evidence from being counted as interchangeable contributions to confidence.

6.3 Contradictory Evidence and Negative Trust Updates

Witness disagreement is often treated as a problem to be repaired before reaching a judgment, yet disagreement can itself reveal something important about the evidentiary configuration. It may indicate measurement error, divergent access, different referents, distinct versions of a document, contradictory standards, or strategic misrepresentation. The first task is to establish whether two statements concern the same proposition under comparable conditions. When a claim changes scope between its initial statement and a later retelling, apparent disagreement may result from incomplete translation rather than incompatible evidence. When the records really do conflict, provenance can help identify whether the

Table 6: Distinct evidentiary dimensions of a reported contribution and their principal limits.

Dimension	Potentially relevant observation	Important limitation
Origin authentication	An attributable and inspectable source record	Authentic origin does not establish substantive truth.
Transmission integrity	Documented derivation or version history	Preserved text can preserve an error.
Source competence	Task-relevant track record or validated skill	Institutional prestige may be weakly relevant to the target.
Source independence	Distinct observation or validation lineages	Distinct channels can conceal shared upstream data.
Diagnostic relevance	Evidence discriminating specified alternatives	A reliable source may report irrelevant information.
Contestability	Means to examine, correct, or challenge claims	Formal access alone may not secure practical examination.

conflict originates in underlying observations, transmission, or interpretation.

A useful model distinguishes the reliability of a *specific assertion* from confidence in a subject's more general competence or integrity. Suppose one authenticated record contradicts a previously accepted claim of technical validation. The observer may reasonably reduce confidence in that claim. Wider conclusions about the claimant's capacities require further premises concerning responsibility for the error, the evaluation standard, and the expected relationship between a single failure and wider practice. A negative update about a proposition, a revised attribution of authorship, and a negative evaluation of a subject's trustworthiness are conceptually separate outcomes. Treating them as synonymous would reintroduce the undifferentiated notion of trust that the present research seeks to refine.

Equation 19 permits opposed reports without requiring a positive conclusion. If T_1 favors Θ while T_2 provides evidence against Θ , the final posterior depends on the conditional likelihood of the contradictory report given the first. The second report can outweigh the first, leave the posterior close to the prior, or produce a modest revision. A simple count of favorable and unfavorable statements cannot determine which outcome is warranted. One strong, independent disconfirming record may have greater diagnostic value than several retransmissions of a favorable assertion. Conversely, a contradictory statement may be traced to a known transcription error and carry little residual probative weight once its generating conditions are understood.

The conditional nature of these interpretations is crucial. A newly discovered negative record can be an achievement of the relational evidence-access mechanism even when the target's public standing deteriorates. It can improve the observer's evidential position by exposing a previously inaccessible limitation. But this does not mean every reported contradiction supplies useful knowledge. Some conflicts remain insoluble under available evidence. Others arise because models disagree about how a result ought to be interpreted, or because the data required to decide among explanations have been lost. An epistemically responsible outcome can be suspension of judgment, a narrower conclusion, or disclosure of unresolved alternatives.

The apparent accumulation of mutually supporting reports also requires attention to contestability. A record can persist long enough to influence many intermediaries while the original contributor lacks any channel through which to correct an error. In that circumstance a large network of repeated statements may make a claim appear settled even though its evidential lineage is shallow. The inverse configuration is possible: one accessible primary record and a transparent correction mechanism may permit more discriminating assessment than many inaccessible endorsements. The paper's structural focus concerns whether the corrective information has a usable path to the observer and whether the observer's procedure permits that information to bear on the claim. Systematic governance of admissibility and unequal authority to issue corrections are treated more fully in Paper IV.

Four hypothetical cases help clarify the range of outcomes without introducing identifiable actors or institutions. A laboratory archive contains a valid but initially unexamined calibration record; indepen-

dent access supports an existing measurement. Several newsletters repeat the same inaccurate summary of that record; additional reports do not create independent corroboration. An auditor obtains a signed revision record revealing that the reported measurement refers to a different sample; this justifies revision of the original proposition’s assessment. Two independent teams reach incompatible results under non-identical protocols; the documents establish an open methodological discrepancy while leaving broader accusations unwarranted. The cases share no assumption that endorsement, disagreement, or source number determines trust. Each requires inquiry into the relation between the claim and the evidence actually produced.

An experimental design can distinguish some of these mechanisms by holding the substantive target record and report content fixed while varying source lineage information. One arm can present two independent validation records; another two messages deriving from a single validation record; a third an endorsement lacking source access; and a fourth a contradictory authenticated record. Outcomes would include perceived evidential independence, accuracy of the task-specific posterior judgment, willingness to examine primary data, and the extent of justified confidence revision. Such a study must account for what the evaluator actually sees, distinguish recognition from warranted assessment, and avoid defining success exclusively through favorable judgments. It should also ensure that hypothetical lineage assignments are believable and ethically disclosed to participants. Detailed identification and measurement protocols belong in Section 9.

6.4 Limits of Epistemic Reconstruction

A trajectory reconstructed from surviving records may differ markedly from the generative processes that produced those records. Missing evidence can arise from deliberate withholding, ordinary archival loss, incompatible formats, legal restrictions, selective attention, or the absence of recording infrastructure. Some missingness is related to the very properties under investigation: failed results may be recorded less systematically, successful cases may receive repeated publication, and institutional repositories may privilege particular kinds of output. In such situations, a documentary corpus is a selected observation of a wider relational history. Treating it as exhaustive may lead to exaggerated estimates of source independence, support for a proposition, or historical continuity.

Provenance reconstruction has limits even when every currently available record is authenticated. One can document that two records are distinct and trace their visible sources. Unrecorded communications, shared analytic conventions, or common instrumental faults may nonetheless remain. A missing link in a provenance graph provides weaker evidence of independence than a validated distinction between underlying observations. Equally, discovering that two witnesses communicated does not establish that their substantive observations were dependent. These asymmetries complicate simple classifications of sources as either independent or duplicated. An adequate analysis should permit partial dependence, uncertain linkage, and competing reconstruction hypotheses.

One option is to report an *identified set* of assessments rather than one unsupported posterior. Let D_o denote an observer’s available documentary evidence and $\mathcal{M}(D_o, C)$ the class of probabilistic models that satisfy declared provenance, accuracy, and admissibility restrictions. Equation 21 defines a range of model-consistent probabilities for a target Θ under that declared class.

$$\left[\underline{p}_o(\Theta), \bar{p}_o(\Theta) \right] = \left[\inf_{M \in \mathcal{M}(D_o, C)} P_M(\Theta \mid D_o, C), \sup_{M \in \mathcal{M}(D_o, C)} P_M(\Theta \mid D_o, C) \right]. \quad (21)$$

The construction presupposes a nonempty model class with well-defined conditional probabilities. It is a sensitivity representation, not an empirically estimated interval or an assertion that all reasonable interpretations have been enumerated. Narrow bounds would require explicit, defensible restrictions on source reliability, source dependence, and the process producing the observed documents. If the model class includes broadly incompatible dependence structures, the interval may remain too wide for a decisive judgment. That result can be informative: the accessible evidence and stated assumptions do not suffice to justify the desired precision. Where no defensible quantitative restrictions are available,

a structured qualitative account of unresolved alternatives may be more appropriate than a numerical interval.

The relation between record retention and epistemic stability also merits attention. A new cross-context bridge can expose a contribution to scrutiny but may depend on a single intermediary who can later become unreachable. Another bridge may preserve independent archival mirrors, auditable derivations, and routes through which affected parties can contest a mistaken report. These configurations may supply equal immediate access yet differ in resilience to the loss or alteration of one channel. Network redundancy has epistemic value only when the alternative paths preserve the relevant records, remain practically usable, and avoid replicating one undetected error. Counting edge-disjoint paths in a graph alone cannot establish these conditions. Formal comparison of such configurations is reserved for Section 8, where models can distinguish connectivity, lineage, and recoverability under explicit failure scenarios.

Epistemic dependence cannot realistically be eliminated from complex inquiry [15]. The methodological objective is to make dependencies visible to the extent required by the question, to avoid counting shared information repeatedly, and to identify where confidence rests on records that cannot presently be checked. In some settings a qualified observer must reasonably rely on a documented expert judgment because direct replication would be disproportionate or impossible. In others, the stakes justify requiring independent measurements or an adversarial review process. The relevant evidentiary standard is therefore contextual, but context dependence should be recorded rather than treated as permission for arbitrary credibility assignments.

The section yields a conditional structural hypothesis suitable for later empirical examination.

Hypothesis 6.2 (Lineage-sensitive epistemic gain). Holding the target claim, presented report contents, and the observer's task fixed, an intervention that discloses credible source-lineage information may change the observer's capacity to discriminate independent corroboration from retransmitted information. Under suitable comprehension and examination conditions, this should improve the calibration of claim-specific assessments relative to procedures that treat every reported endorsement as informationally independent. The direction of any resulting change in favorable trust is unspecified.

Hypothesis 6.2 does not assert that disclosure alone suffices for better assessment. Detailed lineage records can overwhelm a decision maker, conceal decisive omissions, or fail to resolve underlying reliability uncertainty. Nor does the formal redundancy proposition imply that observers will spontaneously recognize dependence. The testable issue is whether an adequately designed evidentiary interface allows distinctions among independent observations, shared sources, and unverified reports to influence claim-specific judgments in a manner consistent with independent validation. A finding that provenance disclosure fails to improve the targeted discrimination under well-understood, properly controlled conditions would qualify the proposal. A finding that provenance primarily changes evaluations through institutional prestige would point toward an alternative mechanism.

The distinction among *path plurality*, *source plurality*, and *independent evidential content* is central. A relational event can multiply communication paths while preserving one underlying source; it can also introduce corroboration or disclose counterevidence. Warranted assessment consequently depends on identifiable lineages and claim-specific diagnostic content. Section 7 investigates the institutional conditions governing which lineages are preserved, disclosed, admitted, and examined.

7 Power-Conditioned Observability

Relational evidence travels through arrangements that govern encounters, documentary survival, disclosure, retrieval, and admissibility. This section identifies those interfaces as conditions on observability, including the labor and infrastructure needed to sustain them. It distinguishes selection into documented history from selection into substantive assessment and considers legitimate restrictions arising from privacy, confidentiality, and procedural protections. Its account is deliberately conditional: how authority, control, and asymmetry themselves develop is the research object of Paper IV.

For this analysis, *power-conditioning* refers to a declared set of asymmetries in the practical capacity to enable, block, alter, authorize, preserve, or prioritize particular relational operations. It is an operational description relative to a modeled interface and inquiry. The definition neither equates power with formal office nor presumes that every asymmetric capacity is oppressive. Control may be dispersed across technical maintainers, employers, archive custodians, professional reviewers, service providers, intermediaries, and the subjects whose information is concerned. These roles can overlap, conflict, or change; they should not be frozen into natural categories of participants. The relevant analytical question is which operations an arrangement makes feasible for whom, under which rules, and with which evidentiary consequences. An observer can also participate in changing the relations and representations being examined. Consequently, it would be misleading to treat power as an external parameter that has no possible feedback into the studied trajectory.

7.1 Control over Encounter and Disclosure

An observer's access to a subject's documentary history can be conditioned well beyond whether a path exists in a graph. One arrangement determines which participants may encounter one another or enter a particular review setting. Another determines which documents are created, accepted, preserved, indexed, disclosed, or revised. A further arrangement determines who can request the retained material, what can be verified about its provenance, and whether an assessor has an opportunity to examine it. A single nominal pathway may pass through several such interfaces. Control at any indispensable interface can prevent a complete evidentiary operation despite structural connectivity elsewhere.

The distinction between *encounter opportunity* and *evidence access* is especially important. A candidate may be permitted to contact an evaluator without being allowed to submit supporting documents. A repository may contain an independently verifiable record whose indexing and access permissions make it practically invisible to otherwise qualified assessors. An existing contribution can also be available for retrieval while institutional workload rules ensure that only selected files receive substantive examination. Conversely, a well-resourced intermediary may make a record prominent even though its relevance to the target assessment remains weak. These configurations describe different mechanisms, and observing their common outcome of limited recognition does not establish a single explanation.

The documentary interface may modify the effective history encountered by an observer without changing the underlying historical target selected for comparison. Section 2 distinguished events from representations of them, and Section 5 held a documentary core fixed across counterfactual access arrangements. These methodological choices remain useful here. In a comparison where the recorded contribution itself is constant, altered indexing, permissions, intermediary cooperation, or examination capacity can change what an evaluator retrieves. Yet documentary fixity is a local experimental restriction. In actual settings an encounter may lead to further work, correction, record creation, or the withdrawal of authorization. Such interventions change the wider relational configuration, and a study seeking to isolate access must say how those additional changes are handled.

The same distinction applies to the authority of a document's custodian. Technical custody can support preservation and authentication, but custody alone does not make a record true. An authoritative signature may substantiate the origin of a document without substantiating the accuracy of every claim it contains. A repository can document derivation and attribution using a vocabulary such as *PROV-O* [34]; a resulting provenance account must still be evaluated for completeness, integrity, and the reliability of its asserted origins. No amount of structured metadata converts an unverifiable testimony into an independent observation merely by changing its formal presentation. The source-lineage cautions of Section 6 continue to apply wherever custodians select or transform the accounts accessible to others.

Control over disclosure also has legitimate functions. Confidential research, protected personal information, trade secrets, confidential peer review, safety-sensitive records, and commitments to participants can warrant restrictions. A complete theory of defensible evidentiary practice must distinguish an unauthorized demand for private information from a justified request for records necessary to evaluate a public claim. The availability of an alternative pathway, redacted documentation, independent confidential au-

1820 diting, authenticated attestations, or an opportunity to contest a finding may be more appropriate than
 1821 public disclosure. Consequently, an increase in unrestricted access is not a general criterion of epistemic
 1822 improvement. Privacy protection, informed consent, scientific scrutiny, and procedural fairness require
 1823 contextual balancing. A broader normative inquiry must address these competing interests; the present
 1824 section identifies the access conditions relevant to the structural theory.

1825 A further consideration is the cost of exercising a formally available right. An observer may be
 1826 authorized to retrieve evidence but face prohibitive search expenses, incompatible interfaces, language
 1827 barriers, inaccessible formats, or review requirements exceeding available capacity. A subject may be
 1828 authorized to contest an attribution but lack the resources needed to establish source provenance under the
 1829 institution's procedures. The asymmetry is then neither a missing graph edge nor necessarily an explicit
 1830 denial of permission. It is a difference in the feasibility of completing the evidentiary operation. This
 1831 provides a precise reason to treat the resource requirements of an access pathway as part of its conditions
 1832 rather than as an optional social interpretation added after the formal analysis.

1833 7.2 Selection in Event and Observation Distributions

1834 The construction of a recorded relational history usually involves selection at multiple points. Some po-
 1835 tential encounters become realized interactions; some realized interactions are documented; some doc-
 1836 uments survive retention rules; and some retained records are visible to a particular observer. These
 1837 operations can depend on institutional access, documentation resources, recognized status, language,
 1838 technical infrastructure, or confidentiality commitments. As a result, the distribution of events *observed*
 1839 *in an archive* can differ substantially from the distribution of interactions described by the research ques-
 1840 tion. This distinction matters directly to Section 3, where heterogeneity and novelty were explicitly
 1841 conditioned on a declared reference population.

1842 Let Z be a provisional, measurable relational descriptor under a fixed representation, C the declared
 1843 reference conditions, and $G = g$ a specified access or documentation regime. Let $S = 1$ indicate
 1844 inclusion in an analyst's observed record set. Suppose the relevant population law admits a conditional
 1845 density or mass function $p(z \mid C, g)$, and write $\pi(z, C, g) = \Pr(S = 1 \mid Z = z, C, G = g)$. For a
 1846 nonzero inclusion probability, the distinction between the target and observed distributions is stated by
 1847 Equation 22.

$$1848 \quad p(z \mid C, g, S = 1) = \frac{\pi(z, C, g) p(z \mid C, g)}{\int_{\mathcal{Z}} \pi(u, C, g) p(u \mid C, g) d\mu(u)}. \quad (22)$$

1849 The integral is taken with respect to the declared reference measure μ ; in a discrete representation
 1850 it is a sum. Equation 22 is a probability identity under the stated definitions, not a sociological law.
 1851 When inclusion varies with relational descriptors, an unusual configuration may appear common in the
 1852 visible archive, or an ordinary configuration may appear exceptional, without any corresponding change
 1853 in the target population. If access rules condition which cross-context encounters can occur, then G may
 1854 change the target law itself. If rules instead affect only which interactions are recorded or disclosed, then
 1855 the selection probability π changes. Actual systems may exhibit both mechanisms at once. They cannot
 1856 be distinguished reliably from a selected archive alone without further assumptions or information.

1857 The general statistical concern that estimates based on selected samples can misrepresent relation-
 1858 ships in an intended population is established in the sample-selection literature [16]. The present appli-
 1859 cation is an analytical extension rather than a claim that the original estimator is appropriate for every
 1860 relational network. Networks and multi-party events create dependent inclusion processes, and archival
 1861 omissions may be difficult to parameterize. In particular, the probability of being observed may depend
 1862 on facts that are themselves unavailable to the analyst. An apparently representative network sample
 1863 can also arise through compensating biases. A model that simply fits the observed frequencies and calls
 1864 them the true event distribution would evade the principal difficulty.

1865 A second selection operation concerns *who receives an assessment*. Let $A = 1$ indicate that a speci-
 1866 fied contribution was examined under a declared assessment protocol, and let T denote a resulting claim-
 1867 specific assessment when $A = 1$. An observed average among examined contributions is represented by

Equation 23.

$$\mathbb{E}[T \mid A = 1, G = g] = \int \mathbb{E}[T \mid X = x, A = 1, G = g] dF(x \mid A = 1, G = g), \quad (23)$$

where X collects measured attributes of the candidate records and relevant review conditions. Both the composition of examined cases and the judgments assigned within those cases can vary with the regime. Consequently, a higher average assessment among examined records does not imply that eligible contributions as a whole are better assessed or enjoy more equal opportunities. A regime may increase selectivity while preserving or even improving measured ratings among those who pass its threshold. Conversely, improved access can lead evaluators to examine previously excluded, difficult, or contradictory cases, yielding lower average ratings while providing better population coverage.

Equation 23 should not be read as an estimate of a latent assessment that exists independently for every unexamined case. The outcome T may be undefined in practice when examination does not occur. A study wishing to compare decisions under alternative review regimes must specify a common evaluation protocol, a counterfactual outcome definition, and an eligible population. Randomized assignment of dossier visibility can help identify some access effects, but subsequent voluntary examination can itself create selection. Ethical and practical constraints may preclude assigning sensitive documents to observers. Where selection cannot be experimentally controlled, sensitivity analyses, partial-identification bounds, and direct measurements of missingness can be more defensible than a point estimate based on untestable assumptions.

Historical recognition research provides a relevant motivation for distinguishing scientific reward and communication from underlying contribution. Merton’s analysis of cumulative advantage in scientific recognition examines how reward and communication practices can favor already recognized participants [24]. That historically situated analysis does not identify the present paper’s proposed event-level mechanisms, establish all contemporary access inequalities, or imply that prestigious participants invariably obtain favorable evaluations. It does, however, reinforce the methodological importance of measuring visibility and recognition pathways separately from scientific contribution. The structural explanation proposed here must be established in the specified case rather than inferred from a general label such as *gatekeeping*.

Selection also interacts with the informational concepts of Section 4. Surprisal calculated from an institution’s submissions is a property of that selected submission distribution. Surprisal calculated from all documented encounters concerns a different sample. If recognition grants access to the archive from which novelty is measured, the measurement process can reinforce the institutional filtering under investigation. One remedy is to report multiple defensible reference distributions and document which comparisons remain stable. Another is to retain information about cases excluded at intermediate stages, subject to privacy and appropriate authorization. In settings where the excluded cases cannot be measured, the analyst should explicitly bound the generalization of any novelty or trust claim to the observed population.

7.3 Authority, Admissibility, and Evidentiary Standards

Institutional authority can determine whether a record is eligible for consideration, which assessor may evaluate it, what qualifies as acceptable provenance, and which remedies are available when an evidentiary decision is challenged. These functions cannot be collapsed into a single positive or negative notion of power. A rigorous admissibility rule can exclude fabricated material and prevent careless endorsement. A poorly calibrated rule can also exclude valid unconventional evidence, elevate institutional affiliation above content, or prohibit correction by those whose contributions are being represented. The analytic task is to specify the rule, the evidentiary aim it serves, and the population to which it is applied.

For a specified target proposition Θ , observer o , representation ρ , and institutional regime g , let $K_{o,\rho,g}(\cdot \mid h, e, a, c)$ denote a regime-conditioned version of the observation kernel from Equation 12. This notation describes retrieval outcomes under a fixed historical target h , candidate relational event

Table 7: Selected institutional and relational interfaces conditioning evidence observability.

Interface	Possible conditioning operation	Relevant observation or audit
Encounter	Permit, redirect, or limit substantive contact.	Eligibility rules, invitations, and opportunities for interaction.
Documentation	Preserve, omit, index, or aggregate records.	Retention procedures, archive coverage, and provenance lineage.
Disclosure	Authorize, redact, delay, or deny release.	Permissions, access outcomes, privacy basis, and secure alternatives.
Admissibility	Accept or exclude forms of evidence under a review protocol.	Stated evidentiary rules, authenticity checks, and correction rights.
Examination	Allocate assessment time and reviewer attention.	Assigned dossiers, completed examination, and independent validation.
Remedy	Permit correction, appeal, or source-lineage challenge.	Reviewable reasons, accessible procedures, and observed dispositions.

e , access action a , and declared contextual conditions c . Equation 24 compares two explicitly stated regimes for a measurable set B of retrieved record bundles.

$$\Delta_{o,\rho}^{\text{reg}}(B; g_1, g_0) = K_{o,\rho,g_1}(B \mid h, e, a, c) - K_{o,\rho,g_0}(B \mid h, e, a, c). \quad (24)$$

The superscript *reg* distinguishes this regime-conditioned contrast from the event-conditioned retrieval contrast in Equation 15. The compared regimes must refer to an explicitly common target population, historical record, and access measurement; otherwise the difference can also reflect changed composition. The contrast is descriptive unless regime assignment or a credible identification design licenses causal interpretation. It has no predetermined sign. A stricter rule can reduce the retrieval of inadmissible summaries and improve source integrity while decreasing the number of records that pass through the interface. A broader rule can increase retrieval of authentic records and also raise the volume of misleading material. The relevant outcome may be the probability of access to a *valid and assessment-relevant* record, actual examination of such a record, or an appropriately calibrated posterior judgment. None of these is identical to the raw number of documents retrieved. Moreover, a regime change may alter feasible actions or the contexts in which encounters happen; holding a and c constant isolates only a particular comparison and must not be mistaken for the total institutional effect.

Table 7 separates the main observability interfaces, possible operations, and corresponding evidentiary checks. The table is a methodological map, not a purported exhaustive catalogue of kinds of power. The operations overlap and may be exercised by several participants jointly. Their identification requires observing actual institutional processes, documents, or technical constraints rather than assigning an intention to a named actor on the basis of an unfavorable outcome.

The possibility of epistemic injustice supplies a relevant normative concern. Fricker’s analysis identifies ways in which credibility and shared interpretive resources can affect persons in their capacity as knowers [11]. The present structural paper draws a narrower methodological implication: when evidence is excluded or discounted, researchers should investigate whether the stated rule is relevant to reliability, applied consistently, open to warranted challenge, and sensitive to barriers that prevent an eligible subject from presenting evidence. A failure on one of these dimensions may motivate a justice inquiry, but unfairness is not inferred automatically from unequal exposure. The normative analysis requires attention to legitimate institutional purposes, evidentiary standards, competing rights, and the situated consequences of alternative arrangements.

A further danger concerns self-confirming review protocols. Suppose an institution evaluates an unfamiliar record using prior institutional recognition as a necessary admissibility condition, while recognition itself normally requires admission to the institution’s review process. The resulting circular dependency can exclude some potentially valid contributions without permitting their substantive examination. Even in that case, a researcher must distinguish arbitrary closure from defensible accreditation or quality-control requirements. The structure creates a testable question: which alternative forms of authentication

and independent verification are accepted, and what happens to otherwise identical records when only the affiliation or access channel changes? A careful experiment could vary provenance guarantees and affiliation cues separately, provided the design meets applicable ethical constraints.

Hypothesis 7.1 (Conditioned access and assessment divergence). For a declared population of contributions and a fixed assessment task, differences in encounter, documentation, admissibility, and examination conditions may generate systematic differences between potential evidence access, actual examination, and observed trust assessments, even when the independently evaluated quality of the target records is held constant. Disclosing the relevant institutional conditions and source lineages should permit more accurate discrimination among those mechanisms under suitable measurement and identification conditions. The direction of favorable trust is unspecified.

Hypothesis 7.1 is deliberately conditional. It allows null results when institutional rules are irrelevant to the selected evidence or when existing procedures already supply reliable access and contestation. It allows unfavorable revisions when relaxed access exposes valid counterevidence. It also allows restrictions to be necessary for confidentiality or participant safety. The empirically significant question is whether the mechanisms being modeled can be observed and separated. Unequal visibility alone cannot establish discrimination, and an equitable design need not produce equal evaluations of substantively different claims. A framework that failed these distinctions would confuse evaluative justice with uniformly favorable recognition.

7.4 Material Conditions of Epistemic Infrastructure

A historically situated account of observability must identify the work, resources, and control arrangements that make an observation channel available. Repository servers require maintenance and storage. Indexes depend on metadata normalization, identifier reconciliation, harvesting permissions, and technical staff. Search and recommendation systems use classification schemes, language-processing capacities, and computational resources. Institutions also establish subscriptions, admission standards, archival retention rules, and procedures through which contested claims can be assessed. The existence of a digital trace does not eliminate these production and maintenance requirements. The conditions of possible observation are therefore linked to the social organization of continuing infrastructural labor.

In historical-materialist terms, the relation between developing technical capacities and existing institutional arrangements offers a question about *uneven development*, not a ready-made verdict. An infrastructure may allow newly inexpensive record duplication while keeping provenance examination costly. Search may become easier even as professionally qualified attention remains scarce. Publication archives may become openly accessible while indexing, identity resolution, or recognition interfaces remain unevenly distributed. Such configurations can generate differential access to the same underlying corpus without presupposing that privately operated infrastructure is necessarily unreliable or that publicly operated infrastructure is invariably more inclusive. The relevant explanatory variables are the concrete governance arrangements, capacities, dependencies, and operating rules of each interface [23].

International open-science evidence suggests why this cannot be reduced to licensing status. UNESCO's 2023 global assessment reports rising open-science activity alongside persistent divisions in access to funding, skills, tools, and opportunities for participation [32]. A publication may carry an open licence while remaining practically difficult to retrieve, process, translate, authenticate, or preserve. Conversely, restrictions concerning confidential personal data or protected research materials can have justified epistemic and ethical purposes. An adequate account of the historical conditions of observation must therefore distinguish legitimate barriers, remediable technical friction, and institutionally structured inequalities. The latter cannot be inferred merely from the presence of different observed outcomes.

The concentration or fragmentation of mediation also bears on structural robustness. Several archives can share one identifier registry; several retrieval services can depend on a common provider; independent journal repositories can contribute records to a shared, widely queried index. These arrangements present distinct failure, censorship, maintenance, and access dependencies. A system may gain reach

through centralized metadata aggregation while retaining resilience through decentralized source preservation. A contrary arrangement may look decentralized at the user interface but fail when a single underlying authorization or data provider becomes unavailable. Higher-order and dependency-sensitive representations developed in Section 8 can make such distinctions explicit without treating ownership as a sufficient proxy for reliability.

The 2025 comparison of Dimensions and Web of Science illustrates another methodological consequence. Differences in indexed publisher populations lead to different numerical portraits of scholarly concentration [3]. The authors' analysis concerns particular proprietary databases and coverage windows, and its results should not be converted directly into claims about the motives of publishers or index operators. It nevertheless shows that claims about the social organization of scientific production can themselves depend on historically produced instruments of observation. For the present paper, that reflexivity is crucial: an inquiry into unequal observability must examine the boundaries of its own archive and its own evidence-collection arrangements.

These considerations identify interfaces through which changing production relations might affect the formation of epistemic opportunities. Establishing whether an arrangement constitutes extractive control, distributive exclusion, appropriate stewardship, or a justified protection requires a separate normative and institutional investigation. The present paper's bounded contribution is to specify what must be measured at the observability interface before such claims can be meaningfully evaluated. The companion investigation of power will address the reproduction, contestation, and legitimacy of authority in greater depth.

7.5 Scope of the Power Interface and Boundary to Paper IV

Power-conditioned observability is introduced here as a set of conditioning relationships among relational encounters, archive formation, authorization, examination, and epistemic assessment. Its contribution to Paper II is methodological: the informational meaning of an observed trajectory depends in part on how that trajectory became observable. Equations 22, 23, and 24 distinguish selection in records, selection into assessment, and conditional retrieval under alternative regimes. Together with the independent-testimony analysis of Section 6, they specify why apparently rich and widely circulated documentation can coexist with important gaps in independent evidence and opportunities for scrutiny.

The framework remains agnostic about any unique foundation of power. Institutional position, material resources, control over infrastructure, technical competence, recognized legitimacy, interpersonal dependence, and capacity to make or enforce rules may participate in different configurations. Modeling those mechanisms as a single scalar index would conceal relevant heterogeneity and would likely introduce an unjustified comparability assumption. A structural analysis can instead represent a limited set of action constraints and permissions, specify which actors can change them under the modeled arrangements, and ask what differences arise in evidentiary outcomes. Such a representation makes a limited comparison possible without asserting that every form of power shares one invariant essence.

At the same time, treating G as given has serious limits. Permissions, institutions, and standards can be transformed by the very interactions that they regulate. A successful challenge to an attribution rule may alter who can later submit evidence. An audited repository may revise its indexing and provenance practices. An observer who learns about a suppressed record may initiate a new event that modifies the surrounding configuration. Thus the fixed-regime contrasts of the present section are local analytical interventions within an evolving relational process. They do not describe a final, stationary social equilibrium. Their validity depends on clearly identifying which aspects of the process are held constant and whether doing so is meaningful for the question posed.

A defensible empirical program would therefore record not only final trust ratings but also opportunities to encounter, documentation survival, retrieval attempts, admissibility decisions, examination completion, and reasons for refusal or correction. In many settings these data are sensitive, and their acquisition could itself worsen the asymmetry under study. Privacy-preserving access, independent oversight, informed permission, and limited-purpose audit logs may sometimes protect subjects while allowing

meaningful evaluation. Other settings will prohibit access to the needed data, leaving partial identification as the responsible conclusion. The present paper cannot settle the normative priority among all relevant interests; it can make their locations in the evidence pathway explicit.

The boundary to Paper IV is substantive. Paper IV can investigate how asymmetries in constraints, resources, authority, and historical dependence themselves emerge and evolve; why some rules acquire legitimacy; and how control over interpretation, contestability, and evidentiary infrastructure becomes self-reinforcing or vulnerable to challenge. Those problems require a fuller account of institutions, governance, normative authority, and potentially endogenous subject formation. Paper II asks the narrower question of how specified conditioning arrangements affect the evidentiary possibilities relevant to a given trust inquiry. Its hypotheses should remain testable without requiring acceptance of the companion theory of power.

Section 8 compares models that retain the dependencies identified here: event representation, documentary selection, access gates, evidential provenance, and admissibility. The relevant question is which counterfactual access and source-dependence claims each representation can support, including cases where revising the representation becomes necessary.

8 Formal Representations and Structural Examples

Sections 2–7 identify representational and evidentiary distinctions that a formal model must preserve. This section compares locally specified temporal graphs with higher-order incidence structures, dependency-aware access models, and probabilistic observation channels. Worked counterfactuals expose situations where nominal connectivity conceals a shared permission gate or documentary source. The representations are evaluated by the inferences they support and the dependencies they omit, without assigning vertices, edges, or higher cells a universal social ontology.

Three requirements organize the inquiry. A representation should make relevant dependencies inspectable without manufacturing independent testimony from repeated transmission. It should allow the analyst to compare access conditions while identifying a stable documentary target, as in Equation 17. It should also separate structural possibility from actual retrieval and from warranted trust assessment. These requirements call for several coordinated objects, since a graph that answers a reachability question may be too coarse for provenance or confidentiality, and a sophisticated higher-order representation can still lack the data needed to justify a probabilistic update. The section considers a typed temporal graph with revisable descriptors, higher-order alternatives, worked counterfactuals, and tests of representational adequacy and failure.

8.1 Context-Specified Temporal Graph Construction

An initial working representation is a finite directed incidence structure assembled from documentary observations and declared modeling decisions. For an inquiry q , an observer o , a representational resolution ρ , and a specified access regime g , let V_ρ be a set of provisional tokens for participants, artifacts, accounts, and operations; let L_ρ be a collection of directed incidences between these tokens; and let $\preceq_\rho$ record dependency relations when these are supportable. The words *participant*, *artifact*, and *operation* indicate possible interpretive roles within the chosen inquiry, not a fixed inventory of beings or event types. An artifact token can be refined into several versioned objects, and an operation that is a single incidence at one resolution can be represented as a substructure at another. Accordingly, a graph's identity conditions belong in the research documentation.

The working object in Equation 25 records these choices together with a provenance annotation and access constraints. Here Π_ρ records available derivation and attribution relationships, while $\Gamma_{o,g}$ gives the observer- and regime-conditioned admissibility conditions on relational operations.

$$\mathcal{G}_{o,\rho,g} = (V_\rho, L_\rho, \preceq_\rho, \Pi_\rho, \Gamma_{o,g}). \quad (25)$$

The graph notation is intentionally modest. A directed incidence may document a repository pointer, a request, an attestation, a dependency, or an attribution claim. Its exact semantics are set locally and can be revised if new evidence shows that a claimed relation conflates distinct operations. A dependency arrow may express a supported prerequisite without claiming that every pair of represented objects admits a chronological comparison. Where the underlying records provide only a partial ordering, a total ordering would introduce an unjustified distinction. Work on temporal networks and distributed-event orderings provides methodological resources for representing interaction patterns and local dependencies [18, 22]. Neither literature establishes that a represented ordering corresponds to a complete social chronology.

For example, consider a documentary artifact d recorded within context A , an observer o situated in a different review setting, a broker b , and a repository r . A simple directed representation may connect o to b , b to r , and r to d . The edges indicate candidate operations: the observer can request assistance, the intermediary can supply a repository location, and the repository can deliver the claimed artifact. The graph establishes a possible composition only after the individual operations have compatible input and output conditions. An intermediary who can name a repository need not possess authority to disclose its restricted contents. A location identifier that points to the wrong version does not preserve document identity. A reviewer who can retrieve the file need not be assigned time or competence to examine it. These are failures in the proposed operation sequence even if an ordinary graph shows a connected path.

To represent the difference, associate each step $\ell \in L_\rho$ with an admissibility indicator $\gamma_{o,g}(\ell; z)$ under a specified state z containing the applicable permissions, record identity conditions, and technical prerequisites. For a proposed path p the conjunction in Equation 26 gives a simple, deliberately restrictive condition for its operational admissibility.

$$A_{o,g}(p; z) = \prod_{\ell \in p} \gamma_{o,g}(\ell; z), \quad \gamma_{o,g}(\ell; z) \in \{0, 1\}. \quad (26)$$

Equation 26 assumes that the conditions are well defined for the composition and can be checked against a common state. In practical settings, performing one operation may change the next operation's permissions or the state of the represented trajectory. The path must then be evaluated through a state-dependent transition relation, rather than by multiplying indicators fixed in advance. The elementary indicator remains useful as a diagnostic: a visible link at a particular resolution is insufficient when an indispensable permission or identity check fails. If the analyst observes only metadata announcing a connection, the values of these indicators may be unknown. It is then appropriate to report indeterminacy rather than replace unknown admissibility with success.

These restrictions also help distinguish access from independent evidence. A network of redundant pointers may contain numerous paths to a single document. Its path count concerns access routes; it does not multiply the informational content of the document. Likewise, a network in which several apparent witnesses cite the same statement cannot justify an independence assumption solely from their separation as vertices. The witness-lineage conditions developed in Section 6 must remain associated with the retrieved reports. Their retention is important when moving from the graph representation to the observation kernel of Equation 12.

For some inquiries, the same participant can operate in multiple overlapping contexts, such as a research repository, a disciplinary review procedure, and a collaborative investigation. A multilayer representation can preserve those contextual associations and specify cross-layer operations. Such networks are well-established formal tools for representing interacting subsystems [20]. The layers here are analytical partitions tied to a declared task. Neither the participant nor the record thereby acquires several naturally separate identities. Layer membership may change with access policies, institutional arrangements, or a different analytical question. Consequently, a multilayer graph should be judged by its ability to keep relevant operations distinguishable, rather than by the apparent elegance of the resulting diagram.

8.2 Hypergraph and Higher-Order Alternatives

A pairwise graph may be inadequate when a single represented operation depends jointly on several participants or records. Suppose three persons prepare one joint attestation, whose content derives from a shared documentary source. A graph may connect each person to each other and to the attestation. If the analyst then treats every person-to-person edge as a separate confirmation, the projected representation manufactures evidential independence. The original operation is more faithfully described as one relation involving several participants with specified roles and one documentary output. A hyperedge or an incidence node can preserve that joint dependence without converting the attestation into multiple evidentiary origins.

Representations of interactions beyond pairs include hypergraphs and simplicial complexes, with different assumptions about what an interaction involving a collection of units entails [2]. Their usefulness for this paper lies in preserving joint constraints and transformations when those are part of the available evidence. A hypergraph allows one represented relation to be incident to more than two provisional elements. An incidence-bipartite description can instead make the relation itself an explicit node linked to its participants and outputs. Both can carry provenance and access annotations. Which description is more useful depends on whether the research question concerns the joint operation, a particular output, or possible sequences of documentary derivation.

A simplicial representation requires additional caution. In an abstract simplicial complex, the presence of a simplex entails the presence of all its faces as combinatorial objects. That downward-closure property may be useful for certain structural analyses, including the study of higher-order closure [4]. It does not follow that a documented group attestation establishes every pairwise interaction among its signatories, nor that the evidentiary content of the group act can be decomposed into independently warranted lower-order claims. If the research requires a simplicial or cellular construction, faces, boundaries, incidence orientation, and the meaning of closure must therefore be stipulated and justified locally. A CW-complex or other incidence-based structure may allow different attachment rules, but its greater expressive freedom also enlarges the burden of interpretation and identification.

A higher-dimensional cell should not be introduced merely because the historical narrative feels complex. A two-dimensional face could encode a documented relation among several path compositions, such as an explicit equivalence between two derivations, a verified consistency constraint, or a recorded dispute about which paths preserve an artifact's provenance. It should not automatically be read as physical surface, causal mechanism, or evidentiary validation. Higher-dimensional models may help preserve relations *between* relational paths, yet the existence of a modeled face does not settle whether the documentary claims it connects are truthful. The original provenance evidence and the formal meanings of the incidence maps must remain available for inspection.

Consider a joint attestation with contributor tokens a_1, a_2, a_3 and documentary output d . An analyst could use a hyperedge incident to the three contributors and d , with a provenance record indicating that one draft was circulated among the contributors and endorsed jointly. A pairwise projection of that hyperedge may contain many edges, but the observational unit remains one underlying statement for the relevant truth assessment. If an independent auditor later examines the original material and creates a separate report, a new provenance lineage can be added. It may supply additional diagnostic evidence if its error mechanisms are suitably independent and its findings are relevant to the proposition under assessment. The gain follows from the new evidence-generating process and its conditions, rather than from the graph gaining another participant or relation.

These examples favor a *representation portfolio* over an assumed single canonical geometry. A directed graph can capture elementary request and retrieval operations. A multilayer graph can preserve distinct overlapping procedures. A hypergraph can encode collective acts and joint prerequisites. A two-complex may encode verified relations among paths when those are substantively warranted. The portfolio should retain explicit translation maps among representations wherever possible. A projection that forgets which witnesses shared a documentary origin may be computationally convenient for reachability analysis while being inadmissible for independent-evidence calculations. Loss of such information is a property of the projection, not an intrinsic property of the history.

8.3 Counterfactual Evidence Access in Worked Examples

The formal alternatives can be evaluated through counterfactuals involving a held documentary core. Let d be a version-identified contribution record represented under the restriction in Equation 17. Consider a baseline relational regime g_0 and a modified regime g_1 in which a new cross-context operation is admitted. The comparison requires a documented correspondence between the target artifact in the two representations. If the new event changes the content of d or revises its authorship, a narrower common core must be selected and the correction separately represented. The following cases are hypothetical. Their probabilities are stipulated for logical illustration and are not estimates of actual social or institutional behavior.

A recoverable historical contribution. Suppose a reviewer in context B initially knows only that a technical contribution is mentioned by a colleague in context A . In g_0 , the colleague's statement cannot be checked against a primary artifact because the identifier has not been supplied. A new cross-context encounter in g_1 supplies a persistent identifier and a route to an authenticated record. The recorded contribution is unchanged, while the feasible operations now include inspection of its method and attribution. If the reviewer retrieves and examines the artifact, the encounter can enable a warranted retrospective assessment. That assessment can be favorable, neutral, or unfavorable according to the actual content. The formal result at the access level is only that an admissible operation has become available under the declared conditions. The observer's examination decision and inferential standards require their own measurements.

A shared permission gate and redundant routes. Suppose two apparent retrieval paths p_1 and p_2 reach the same authenticated artifact. Both rely on a common permission gate that succeeds with stipulated probability q . Conditional on gate availability, path-specific operations succeed independently with probabilities p_1 and p_2 . The probability that at least one path succeeds under this common-gate arrangement is given in Equation 27.

$$P_{\text{shared}} = q[1 - (1 - p_1)(1 - p_2)]. \quad (27)$$

For comparison, suppose each path has a separate gate with the same success probability q , the two gate outcomes are independent, and the path-specific operations also remain independent. Equation 28 then gives the probability of reaching the same artifact through at least one route.

$$P_{\text{separate}} = 1 - (1 - qp_1)(1 - qp_2). \quad (28)$$

The contrast in Equation 29 follows by expanding Equations 27 and 28. Because the two regimes impose different dependence structures, the result is a conditional comparison of stipulated reliability models, rather than the effect of merely renaming two physical routes. It identifies an access-robustness advantage from independent gates under these particular assumptions.

$$P_{\text{separate}} - P_{\text{shared}} = q(1 - q)p_1p_2 \geq 0. \quad (29)$$

For the purely illustrative choices $q = 0.6$, $p_1 = 0.8$, and $p_2 = 0.5$, the two access probabilities are 0.54 and 0.636, respectively. The difference of 0.096 represents greater probability of obtaining the artifact under independent access gates. It says nothing about the artifact's veracity or about trust after inspection.

The inequality in Equation 29 is an algebraic consequence of the stipulated marginal gate probabilities and independence across the separated gates. It is not a distribution-free theorem that organizational decentralization improves evidence access. Both gates could depend on the same infrastructure, authentication service, or outage; the creation of a second gate could also change each path's reliability, maintenance costs, and permitted actions. Under positively correlated gate failures the gain may be smaller, and under changed marginal success probabilities its sign is not determined by the displayed calculation.

A comparison of institutional architectures must therefore measure dependency, total cost, and feasible access rather than infer superiority from the number of nominal gates. Both routes can deliver one identical documentary source, and their operational independence does not confer evidential independence upon that source.

Proposition 8.1 (Independent gates in the stipulated two-path model). *In the two-path retrieval model above, fix $q, p_1, p_2 \in [0, 1]$ and assume the stated independence conditions for each regime. Separating a shared Bernoulli gate into two independent gates with the same marginal success probability weakly increases the probability of accessing the target artifact. The improvement is strictly positive when $0 < q < 1$ and both path-specific success probabilities are positive.*

Proposition 8.1 is an elementary result of the stipulated probabilistic construction. It should not be generalized to circumstances in which duplicated infrastructure increases error risk, the route failures depend on a common outage, permissions are mutually exclusive, the alternative paths transmit different artifacts, or the added complexity changes their success probabilities. Such circumstances require a different model. In particular, a nominal count of network paths cannot justify the independence assumptions required by Equation 28.

One statement circulated by several witnesses. Suppose a collaborator distributes an unverified claim to three intermediary participants, each of whom repeats it to an evaluator. The evaluation interface receives three messages, and a simple projected graph shows three paths. A provenance-aware representation shows one originating statement with three dependent transmissions. The repeated messages may increase the chance that the claim is noticed. They do not multiply independent likelihood ratios for the underlying proposition. If one intermediary obtains an independently authenticated primary record, the new record constitutes a distinct evidential object whose incremental value must be evaluated under the conditional-dependence model of Section 6. Thus an expanded communication graph, greater document reachability, and independent corroboration constitute distinct transformations.

A bridge carrying counterevidence or inaccessible records. A cross-context encounter can reveal that a previously attributed contribution contains an uncorrected methodological error. The historical artifact remains fixed for the comparison, but an observer obtains an authenticated analysis identifying its problem. A negative trust revision may then be epistemically warranted. In another case, the encounter supplies only a citation to a record behind an inaccessible permission interface. Graph connectivity increases while operational access remains unchanged. These cases show why a structural effect should be reported with the accessible artifact, permitted actions, source lineage, and observed examination outcome, rather than with a favorable-recognition label alone.

Table 8 summarizes the contrast between the questions each representation can answer and the evidence it cannot provide automatically.

8.4 Model Comparisons and Failure Conditions

Formal representations should be assessed against the inferential question rather than ranked by complexity. For reachability under simple access rules, a directed graph can be adequate and auditable. To preserve a joint attestation, a hypergraph or incidence model may prevent the misleading proliferation of pairwise relations. To compare two institutional access regimes, an explicitly parameterized observation kernel can capture probabilities unavailable from a static connectivity diagram. To study how several historical reconstructions relate, a higher cell or explicit mapping between representations can encode a constrained comparison when the data warrant it. Each addition carries modeling and identification costs. An elaborate complex without valid interpretation of its cells can be less informative than a small graph with well-documented operations.

A criterion of *question-relative adequacy* follows. Before using a representation to support a conclusion, the analyst should specify the target documentary core, the admissible evidence standard, the

Table 8: Representational choices, supported questions, and characteristic failure conditions.

Representation	Suitable analytical question	Limitation requiring additional evidence
Directed temporal graph	Which documented operations and locally supported dependencies compose into a candidate access path?	Edge existence alone does not establish identity, permission, completion, or diagnostic value.
Multilayer graph	Which context-specific interfaces permit or restrict cross-context operations?	Layers may be provisional and overlapping; labels alone do not determine causal mechanisms.
Hypergraph or incidence model	Which participants, artifacts, and operations jointly constitute one represented act?	Joint incidence neither guarantees independent testimony nor verifies the act's claims.
Simplicial or cellular representation	Which documented relations among incidences, paths, or attachment constraints are preserved?	Closure and boundary rules may impose relations absent from available records.
Probabilistic observation channel	What is the specified distribution of retrieval or examination outcomes under a regime?	Requires justified probability laws and cannot infer reliable belief revision solely from retrieval.

observer and its action set, the identity and provenance rules, and the outcome to be estimated. The representation is adequate for a claim only when those distinctions needed by the claim are preserved or the information lost through projection is explicitly shown to be irrelevant. For instance, projecting a hypergraph to a pairwise network may preserve certain reachability relations but destroy whether three reports share one origin. Such a projection can remain useful for one analysis and invalid for another. The criterion is procedural: it does not assert an ontologically privileged encoding of relational histories.

The same discipline applies to counterfactual claims. A modeled difference between g_0 and g_1 is a structural contrast, not automatically an identified causal effect. The relational event may change which observers participate, what records are made, how permissions are interpreted, and what subsequent questions become meaningful. If these components change together, a causal interpretation requires an explicit intervention, a justified comparison regime, or a defensible process-tracing design. The sample-selection difficulties discussed in Section 7 also recur here. Observed assessment outcomes among those who retrieved and examined evidence do not necessarily identify outcomes for those excluded by the access gate. A robust study should report the examination opportunity, the actual retrieval and review processes, and the inferential assumptions connecting these measurements.

Representation change introduces a further source of error. Suppose the document called d under one resolution is split into two versioned artifacts under another, or an apparent event is reconstructed as an overlapping set of partially ordered operations. A numerical change in observed connectivity may reflect this revision of individuation rather than any modification to participants' actual possibilities. Comparison should therefore include explicit correspondences among the objects that are held fixed across the two resolutions, and document the objects for which no valid correspondence exists. When no common identity criterion can be justified, the analyst should avoid claiming to have measured the same event or contribution under two encodings. The failure of a translation can itself reveal a substantive epistemic limitation.

Uncertainty about provenance is equally consequential. An archive can authenticate that a particular version was stored without establishing the truth of every assertion it contains. A cryptographically valid record may attest to a signature whose author lacked direct knowledge of the target proposition. An independently retrieved replica can remain informationally redundant when it carries the same underlying evidence. Similarly, a relation that makes a record visible can modify observer attention, but the present paper does not assign a universal psychological mechanism to that response. Those mechanisms belong to the companion analysis of human recognition. A formal comparison of access opportunities should be presented alongside the limits of testimony, representation, and available behavioral measurements.

In the present framework, structural robustness is consequently multidimensional. Persistence of

nominal connectivity differs from persistence of admissible access. Independent permissions differ from independent documentary origins. Recoverability from record loss differs from the possibility of contesting an attribution. A history may be richly connected but epistemically fragile because its records all depend on one unavailable source; another may possess fewer pathways but stronger provenance and clearer opportunities for independent challenge. The two-path calculation offers one tightly controlled example of this distinction, while Section 6 explains why the informational consequences depend on distinct witness relationships. No single scalar measure of network redundancy captures all these dimensions under arbitrary conditions.

Hypothesis 8.2 (Representationally conditioned access robustness). For specified historical targets and observer populations, access models that preserve shared permission dependencies and documentary source lineages may better predict retrieval failures and redundant evidential updates than models using nominal path counts alone. The difference should be investigated with matched outcome definitions, comparable observational data, and explicit tests of model complexity and predictive calibration.

Hypothesis 8.2 is an empirical proposal. Its truth depends on the observational setting, the quality of provenance records, the availability of access-log data, and the complexity of the additional parameters. Cases may exist in which simpler graph measures suffice, higher-order attributes are too poorly observed to be useful, or participant behavior defeats the assumed operational model. These would constrain the theory's applications rather than imply that the complexity of a representation provides independent epistemic authority.

The examples identify different tasks for different representations. Temporal graphs expose possible connections; higher-order incidence can preserve joint participation; access models distinguish independent gates from shared dependencies; provenance models distinguish communication from independent evidence. Their joint value lies in clarifying which relational transformation occurred and which inference follows under stated assumptions. Section 9 addresses whether those distinctions survive experimental and observational tests with missing or selectively examined records.

9 Research Designs and Limitations

The proposed mechanisms are empirically distinguishable only if studies separate changes in relational configuration from changes in documentation, evidence access, source independence, and evaluation. This section specifies controlled relational-access experiments, differentiated measures of retrieval and examination, observational identification strategies, and the ethical limits of intervening on evolving histories. Its primary estimand concerns access to evidence about a held documentary target; the accuracy and direction of subsequent trust judgments form separate outcomes. The distinctions modeled in Section 8 guide what must be measured rather than supplying the missing empirical evidence.

An empirical study must declare its observational unit, the meaning of the intervention, the historical target, the relevant reference domain, and the measurement of evidence. An observer–artifact pair can serve as a unit for some controlled experiments, whereas a situated community, repository, or collaborative group may be necessary when one person's informational environment affects others. A recorded contribution can be held constant within a designed comparison, although the subsequent encounter or retrieval constitutes a new part of the wider trajectory. The distinction introduced in Section 2 between the preservation of a specified documentary target and the evolution of its surrounding structure is particularly important here. Inferences about an unchanged document do not establish that the whole history remains unchanged. Likewise, a stable experimental dossier does not establish that its records comprehensively or correctly represent the events being studied.

The hypotheses in Sections 3–8 are conditional. A failed attempt to observe an effect may result from weak or absent changes in accessibility, from the irrelevance of the records to the stipulated assessment, or from an observer already possessing sufficient evidence. Conversely, an apparent improvement in trust may be driven by prestige cues, a change in the documentary target, selective admission into review, or the reproduction of one testimonial source. These alternatives imply different research designs. The

aim is therefore a family of partially complementary inquiries, rather than one experiment claimed to reproduce the full complexity of evolving relational life.

9.1 Controlled Relational-Access Experiments

A first design uses consented, fictionalized or purpose-built research dossiers, each containing a fixed historical record of an independently scorable contribution. The dossier might document a technical analysis with checkable steps, a methodological artifact with executable tests, or another contribution whose evidential properties can be evaluated without reliance on the participant’s personal circumstances. The represented actors and affiliations would be hypothetical or expressly consenting. Every condition would preserve the same target content, version identifiers, and independent scoring rubric. The experimental manipulation would concern the surrounding path through which an observer becomes able to encounter and inspect the dossier.

One dimension could vary a cross-context introduction, such as the availability of a verified repository pointer through a newly introduced intermediary. A second could vary the practical accessibility of the underlying record, such as whether authentication and retrieval are possible within the evaluation session. A third could vary the evidential status of the accompanying statement: direct source documentation, an authenticated but derivative summary, or a claim whose lineage is unspecified. A fourth, when independently justified, could manipulate the structural uncommonness of the connection relative to a stated reference population. These dimensions should not be conflated in a single high-visibility treatment. A novel-looking introduction may attract attention because it carries an apparent prestige cue, independently of whether it makes evidence accessible. Experimental conditions should separate those possibilities to the extent compatible with interpretable treatments.

The analysis of event novelty requires special care. A study might pretest the relative unfamiliarity of alternative relational configurations within a given participant population, but the resulting scale would be a declared feature of that population and measurement instrument. Participants should be allowed to report that a configuration is familiar, ambiguous, or inadequately described. No design should require treating the proposed configurations as a natural taxonomy of event kinds. Alternative coding resolutions should be preregistered or analyzed as sensitivity specifications. A change of resolution may dissolve one apparent event into several operations, and the associated novelty score may change accordingly. Consistent with Section 3, such variation is part of the object of study, rather than automatically an error to be averaged away.

A workable experimental sequence separates at least two assessment stages. In an *opportunity stage*, the observer encounters an invitation, introduction, or referral and can choose whether to request, retrieve, and examine the target dossier. The study records each step separately, including unsuccessful attempts and reasons for access failure. In a *standardized examination stage*, a separate randomized panel, or a suitably counterbalanced subsequent stage, receives the full verified dossier under a common review protocol and produces an assessment of its evidential strength and of the stipulated claim. The latter stage makes competence and evidence appraisals measurable even for dossiers that an unconstrained observer would not choose to inspect. A forced review is an experimental measurement regime, not a representation of what every real institution ought to require.

Let i index eligible observer–dossier units in a specified experimental population, and let $Z_i \in \{0, 1\}$ assign a relational-access condition. Under a design with a stable treatment definition, no relevant interference between units, and well-defined potential outcomes, $R_i(z)$ indicates whether the target record would be successfully retrieved under condition z . Equation 30 defines the average causal contrast in retrieval for that experimental population, in the spirit of the potential-outcome framework [28].

$$\tau_R = \mathbb{E}[R_i(1) - R_i(0)]. \quad (30)$$

The estimand in Equation 30 concerns retrieval alone. It says neither whether the observer used the evidence nor whether the observer’s trust was warranted. In particular, access can be restored through an

operational channel without adding a new independently generated informational source. For some interventions, randomization may affect not only retrieval but also the participant's expectation about credibility; such a design estimates the total assigned-condition effect, rather than a pure effect of evidence transport. Disaggregated measures and carefully chosen contrasts are needed to interpret the mechanism. Random assignment controls pre-treatment differences in expectation under its design conditions, but it does not ensure that a compound treatment has only one causal component.

A different outcome records assessment under a standardized information protocol. Let $Y_i(z; \mathcal{D})$ denote the assessment that a designated evaluator would give after a prescribed examination of the same dossier $\mathcal{D}$, with the relational-context condition z displayed as specified. Comparing $Y_i(1; \mathcal{D})$ and $Y_i(0; \mathcal{D})$ can isolate a context-cue response when the evidence and evaluation task are held fixed. This comparison remains sensitive to the meaning of the cue: an affiliation, a source lineage, and a valid certification may legitimately contain different information. A negative context effect becomes evidence of miscalibration only when an independent criterion establishes that the disfavored cue has no relevant diagnostic bearing within the study's domain. An evaluator can rationally revise an assessment after learning that a purportedly independent witness derived an assertion from the same source.

Another design would keep the accessible channel and reviewer conditions constant while varying the diagnostic direction of a newly revealed, authenticated record. The record could confirm a stipulated claim, contradict it, or fail to discriminate between the competing possibilities. This design tests the asymmetry emphasized in Sections 4–6: increased information may justify favorable, unfavorable, or unchanged judgments. Outcome evaluation should use a proper scoring rule or another explicitly defended calibration criterion wherever the target is probabilistically assessable. Evaluator confidence and evaluative favorability should be recorded separately. The first may rise as uncertainty is resolved even when the second falls. Artificial scenarios are useful for identifying these distinctions, while their external validity remains limited by the controlled nature of their information structures.

Exposure to one condition can influence later responses through learning or recollection. If a within-subject design is used, treatment order, carryover effects, and the identity of repeated dossiers require explicit handling. Between-subject randomization avoids some carryover problems but may demand larger samples and cannot by itself remove cross-participant information sharing. In real collaborative networks, an intervention delivered to one person may reach another through communication. The no-interference assumption supporting the simple unit-level contrast may then fail. Cluster-level randomization, exposure mappings, and interference-aware estimands may be appropriate when the communication process is observable and bounded. Work on randomized causal inference under network interference supplies methods for making such exposure assumptions explicit [1]; it offers methodological possibilities, not evidence that heterogeneous connections generally increase trust.

9.2 Evidence-Pathway and Examination Outcomes

A useful empirical program needs a measurement architecture corresponding to the distinct theoretical objects. The first layer records structural possibilities: whether a putative bridge exists in the selected representation, which operations it purports to support, and which permissions and document-identity checks remain necessary. The second records access attempts and successful retrieval, including errors and legitimate refusals. The third records examination: whether a person or evaluator actually inspected the appropriate document, its provenance, and any competing material. The fourth records informational assessment, such as judgments about source independence, diagnostic relevance, uncertainty, and evidentiary contradictions. The fifth records decisions and warranted outcomes, such as whether a claim is supported under a declared criterion. A positive trust rating cannot substitute for independent evidence that the rating is calibrated.

Table 9 summarizes a compact observation scheme. Its entries are illustrative operationalizations. Some contexts will permit a record of retrieval but prohibit recording the evaluator's internal notes; others may disclose a decision while withholding the evidence considered. The resulting omissions should be treated as part of the identification problem, with the costs and protections of measurement

Table 9: Distinct observable stages and illustrative measurements for empirical study.

Analytical stage	Possible measurement	Principal interpretive risk
Relational opportunity	Verified route and its required operations.	A visible connection may lack workable permission or identity conditions.
Access and retrieval	Attempts, successful authenticated retrieval, refusal category.	Success may concern a wrong, incomplete, or derivative record.
Substantive examination	Review completion, version inspected, independent checking performed.	Reported inspection may be superficial or selectively documented.
Evidence independence	Source-lineage map and overlap among purported witnesses.	Multiple reports may reproduce a single informational origin.
Epistemic assessment	Confidence, likelihood judgment, calibration against declared criterion.	Favorable impression may diverge from evidential accuracy.
Institutional consequence	Reasoned decision, correction procedure, and support offered.	Resource and policy constraints may differ from evidentiary assessment.

stated openly.

The difference between route redundancy and independent corroboration merits a dedicated design. Consider three arrangements with the same target record: one authenticated path, two paths sharing one authorization gate, and two paths requiring genuinely separate gates. Under specified failure probabilities, experiments can measure the operational robustness of access as gates fail or remain available. A separate manipulation changes the documentary provenance of two reports: two distinct independent observations versus two statements derived from a common source. Because these two interventions operate on different mechanisms, their outcomes should be compared separately before considering interactions. Access robustness is measured through delivery and retrievability; corroborative value is measured through source relationships and the diagnostic likelihood of the contents. The illustrative analysis in Section 8 yields a structural prediction under explicitly stated independence assumptions, not a claim that naturally occurring gates behave independently.

A further difficulty arises from the meaning of *examination*. A person may open a file without evaluating its contents, consult an abstract without checking the methods, or seek an outside expert whose own evidence is derivative. Depending on the inquiry, an evaluation protocol could record the amount of material inspected, whether key claims were checked against source documents, and which uncertainties remained unresolved. Such measurements should avoid equating time spent with intellectual diligence or number of clicks with epistemic achievement. An expert can recognize an invalid argument rapidly, while a prolonged review can remain uninformative. External adjudicators can score a subset of decisions against predeclared criteria, with intercoder disagreement reported rather than suppressed. Their judgments are themselves situated and may be contestable, especially when contributions are creative, interdisciplinary, or otherwise lack agreed reference standards.

A principled design also distinguishes the information made *available* from the information actually *used*. When both are recorded, it becomes possible to test whether heterogeneous connections principally alter opportunities, whether observers exercise the opportunities, and whether the new evidence is relevant to their target judgments. When access succeeds but the added record is duplicated, the expected gain in independent evidence may be small. When a previously inaccessible, authenticated contradictory record becomes available, favorable trust may decrease even though examination quality improves. A theory that counted only favorable decisions would conceal precisely the epistemic value that its evidentiary analysis is intended to explain.

The notion of a “true” or authoritative historical record also requires local justification. Technical dossiers with objective pass–fail checks offer high measurement reliability within a limited task, but they exclude important dimensions of scholarly, ethical, and artistic value. Historical case studies may have richer relational texture but lack an uncontested baseline. A study should specify whether it investigates *accuracy against a stipulated task*, *agreement among qualified observers*, *procedural defensibility*, or *the accessibility of contested claims*. These are distinct dependent variables. Their disagreement may be

a finding about the evaluative setting rather than a reason to discard one measure in favor of another.

9.3 Identification, Missingness, and Selection

Observational investigations can examine naturally occurring cross-context encounters, repository reforms, changes in disclosure policies, or the adoption of independent verification channels. Their advantages include authentic institutional processes and evolving records; their principal difficulty is identifying a defensible counterfactual. A participant who receives an unexpected introduction may differ beforehand from participants who do not. More active collaborators can have both richer documentation and more encounters. A newly visible contribution may appear especially credible because it was already selected into an archive by a trusted institution. These processes can generate associations between structural novelty, evaluation, and trust in the absence of the proposed mechanism.

A longitudinal design should therefore document eligibility for possible encounters, baseline contribution characteristics, existing access paths, prior assessment opportunities, and changes in the relevant institutional regime. A carefully specified natural policy discontinuity may allow a stronger causal comparison than a retrospective story about one successful introduction. Yet the analyst must establish why the discontinuity changed the access interface and whether contemporaneous changes in standards, reviewer capacity, or candidate composition undermine the comparison. A difference-in-differences analysis, for example, needs a plausible account of the untreated trend and of interference between comparison groups. An instrumental-variable approach would require a credible exclusion restriction. Simply naming a statistical method cannot supply its identifying assumptions. General principles for defining estimands, conditioning appropriately, and evaluating observational comparability are well developed in causal-inference methodology [17].

Missingness is central because the process being investigated determines which records are visible. Evidence absent from an observer's archive may never have been created, may have been excluded from documentation, may have been lost, or may be inaccessible under justified restrictions. These mechanisms need not be distinguishable from the available data. Conditioning an analysis on archived records can select for institutional recognition, technical capacity, resource availability, or other factors related to the substantive outcome. Section 7 describes separate opportunities for selection in recording and selection into review. Heckman's classic sample-selection analysis provides a methodological warning about such selective observation [16], but it does not license a universal correction formula for the present setting.

The distinction becomes especially sharp when ratings are observed only for examined records. Suppose treatment Z changes the probability of examination $S_i(z)$, and a rating is reported only when $S_i(z) = 1$. The conditional contrast in Equation 31 compares different selected populations when Z affects examination.

$$\Delta_{\text{examined}} = \mathbb{E}[Y_i \mid Z_i = 1, S_i = 1] - \mathbb{E}[Y_i \mid Z_i = 0, S_i = 1]. \quad (31)$$

Even if Z is randomized, Equation 31 generally lacks the interpretation of an average causal effect on ratings, because examination occurs after assignment. The observable ratings may be conditioned on a variable affected by the intervention and related to latent quality or perceived importance. The problem can arise even if the treatment has no effect on the standardized rating that would be given after a full examination. Conversely, a treatment that leads reviewers to examine previously neglected, substantively strong evidence may lower the mean rating among reviewed items if the newly examined set also includes many weak items. Neither sign establishes the direction of a within-unit competence-attribution effect.

One approach records review selection for the full randomized pool and obtains standardized independent ratings for a random sample across both treatment arms, irrespective of natural examination. These ratings measure a deliberately defined assessment task and avoid relying solely on the self-selected dossiers. Another approach treats actual examination as part of the causal outcome, reporting its effects separately and refraining from estimating a missing counterfactual rating without explicit assumptions.

Principal stratification offers a formal language for comparisons within latent groups defined by their potential posttreatment examination states [10]. The relevant strata, such as records that would be examined under either access condition, are ordinarily not directly observed for each unit. Their effects are not point identified without further design features or assumptions, and principal stratification is not an automatic remedy for selection bias.

For transparent partial identification, suppose a bounded assessment $Y_i(z) \in [0, 1]$ is meaningful for every eligible unit under one well-defined standardized protocol. Assume the observed score for an examined unit is consistent with that same protocol under its assigned condition; voluntary impressions elicited under a different review procedure would not satisfy this assumption. Let $q_z = \Pr(S_i = 1 \mid Z_i = z)$ and $\mu_z = \mathbb{E}[Y_i \mid Z_i = z, S_i = 1]$ where $q_z > 0$. Under random assignment, consistency of scores and selection indicators, and the usual positivity requirements for the observed arm, Equation 32 gives elementary worst-case bounds on the mean of the standardized potential assessment, without assuming values for the unexamined units. If $q_z = 0$, the interval is $[0, 1]$.

$$q_z \mu_z \leq \mathbb{E}[Y_i(z)] \leq q_z \mu_z + (1 - q_z). \quad (32)$$

Equation 32 assumes that a well-defined potential standardized assessment exists for unexamined records and that the score scale is bounded. If an actual trust judgment has meaning only after voluntary examination, that estimand may be inappropriate; the researcher should instead measure the intervention's effect on examination and explicitly defined decisions. When the bounds are wide, the data may support only a range of plausible conclusions. Narrower intervals would require stronger substantive restrictions, independently measured outcomes, or additional experimental design. Disclosing these requirements is preferable to reporting a precise estimate whose apparent precision is purchased by unexamined assumptions.

Interference and evolving representations pose further identification problems. A new connection may change the evidence available to several observers, so unit-level assignment effects depend on which other observers are treated. A repository reform may induce changes in documentation practices, in the sources that contributors choose to preserve, or in the institution's subsequent admission rules. The observer's information regime is then partially endogenous. Researchers can study bounded interventions over a declared interval and report the limits of that comparison, or specify network exposure relationships and account for spillovers [1]. The availability of richer observational data does not eliminate the need to justify the assumed interference structure or the relevant unit of comparison.

Finally, a study needs negative controls and sensitivity analyses directed at the theory's distinctive alternatives. An irrelevant but attention-grabbing connection can test whether the observed effect is primarily a novelty or prestige cue. A verified duplicate of an existing document can test the difference between new access routes and new informational content. A changed file version can reveal sensitivity to failure of target-content preservation. Alternative event boundaries, measurement resolutions, reference distributions, and assumptions about unknown witness dependencies should be examined explicitly. The strongest empirical support would come from convergent results across designs that distinguish relational opportunity, evidentiary independence, and warranted appraisal, rather than from one favorable association between an unusual event and a trust rating.

9.4 Historical Indexing and Classification Interventions

The historical evidence discussed in Sections 3, 5, and 7 permits a more concrete extension of the empirical agenda. Two recent changes within bibliographic infrastructure create candidate settings for studying retrospective observability: the October 2026 expansion of OJS harvesting by OpenAlex and the contemporaneous replacement of its topic-assignment model [25, 26]. These are documented interventions in a specific technical environment. They are not randomized experiments, and the available provider announcements by themselves do not establish effects on the evaluation or trustworthiness of the indexed research. The appropriate task is to design reproducible comparisons that differentiate newly recorded content, newly reachable existing content, and reclassified content whose record remains available.

For the *indexing expansion*, the primary unit could be a documentary artifact with a stable identifier, publication date, journal source, and independently verified pre-expansion location. A researcher would first reconstruct the pre-expansion corpus from archived index snapshots and the publishers' own records. Each item could be classified according to whether it was already indexed, entered through direct feed harvesting during the expansion window, or remained outside the system. The intervention of interest is the addition of a documented retrieval route for an older artifact. The added metadata may be new, although the publication itself predates the intervention; these distinct objects should not be merged when enforcing the fixed-document comparison. Publication time, index-entry time, repository-preservation time, and the date when an observer first encounters the artifact must remain distinct. Without this separation, a rise in indexed volume could be misreported as a surge in historical production.

Three classes of outcomes should be measured independently. *Availability measures* include search-result presence, retrieval through specified queries, valid persistent links, metadata completeness, and rates of accessible full text. *Examination measures* include observed clicks or document requests when lawful and available, time spent inspecting the record in a study setting, independent verification attempts, and use of cited methods or datasets. *Assessment measures* include claim-specific judgments produced under controlled evaluation protocols, with the original document and diagnostic criteria held fixed. Citation counts can be reported as a secondary circulation indicator, with temporal lags and disciplinary norms documented. Neither citations nor download counts should be equated with warranted trust.

A feasible observational contrast would compare older articles newly entering the index with comparable articles that were already indexed before the change, matching or weighting on publication year, field, language, source size, metadata completeness, licensing arrangements, and measured pre-period attention. Repeated snapshots would permit event-time plots of changes in observable search presence and subsequent indicators. A difference-in-differences or staggered-entry analysis would require examining pre-trends, anticipation, time-varying confounding, and heterogeneous timing. Provider-driven journal selection, feed accessibility, and server configuration may influence both treatment assignment and outcomes. A null change in an aggregate citation metric would not invalidate the narrower access mechanism if newly indexed records demonstrably became retrievable; conversely, increased citations would not by itself establish that substantive evaluation improved.

The design also needs to recognize *interference*. An indexing change may displace one result with another in ranking-limited search interfaces. It can change the reference universe used to classify other works and alter recommendation behavior affecting both treated and control records. Journals might adjust their metadata or server permissions because they expect new harvesting. A nominally untreated article can therefore experience a changed observation environment. The analysis should define the relevant search environment and exposure conditions, use sensitivity analyses for shared-source and shared-query dependencies, and avoid assuming that treatment effects are isolated at the article level. Such questions connect directly to the interference concerns discussed earlier in this section [1].

For the *classification revision*, the advantage is that the published artifact can in principle be held exactly fixed. The provider reports preserving the same topic hierarchy while replacing the model that assigns topics to works; it also provides old topic labels, comparison files, and access to the earlier classifier implementation [26]. Researchers could apply both published classifier versions to identical document sets, with identical available metadata and a specified retrieval protocol, then compare subject-specific query recall, rank placement, and the probability that an independent evaluator retrieves a relevant historical contribution. The case is analytically different from adding new publications to the database. For non-English work, a reported improvement in agreement with AI-generated comparison labels from 9% to 72% motivates an audit, but those agreement figures are vendor-reported and depend on the particular test construction. Independent human assessment and multilingual subject specialists would be required before treating them as evidence of epistemic improvement. The announced evaluation compared assignments with reference topics selected by two AI readers, conditional on the specified judge-agreement protocol; its comparison set is not a universal human-ground-truth classification.

The two interventions could be analyzed in a factorial design using frozen corpora: old and new

Table 10: Historical-infrastructure designs and identification limits for retrospective observability.

Design	Primary contrast and observable outcome	Key limitation
Index expansion	Previously published records before and after addition of an index route; specified search and retrieval success	Nonrandom journal selection, metadata revision, historical snapshot gaps
Classifier replacement	Identical documents under two classifiers; topic-specific retrievability	Vendor-defined labels, unstable query behavior, evaluator disagreement
Corpus comparison	Matched record sets reconstructed from different bibliographic databases	Different inclusion and identity rules; no complete universal reference corpus
Controlled reader evaluation	Random access or search-interface assignment with fixed historical artifacts; examination and claim judgments	Artificial context, evaluation demand effects, interference among search outcomes

coverage with old and new classification rules. This would distinguish (i) adding records, (ii) changing the representation and retrieval of a fixed record population, and (iii) their interaction. Such a retrospective reconstruction is only valid if source timestamps, deduplication rules, corpus versions, and classifier artifacts can be recovered adequately. OpenAlex states that its classifier revision did not modify work-level `updated_date` values; an incremental update keyed only to that timestamp could therefore miss reclassified records. The provider recommends a full reload from its October 14 snapshot. Any proposed reproduction should document full-snapshot provenance rather than presume that an incremental history completely captures the intervention [26]. It must also acknowledge that replayed search results in a frozen environment may differ from the ranking and behavior of a live service. The most informative outcome may be that a set of previously produced contributions becomes findable under one regime, even while independent expert assessments of their quality remain unchanged.

Table 10 summarizes the complementary designs. An adversarial historical comparison should also examine delayed citation trajectories for which no identifiable access-interface change occurred. Existing bibliometric studies demonstrate that long delays followed by attention are possible [27, 19]; these trajectories are legitimate alternatives to the proposed infrastructural mechanism. A predeclared analysis could combine document-level metadata from frozen index snapshots with controlled retrieval tasks, test queries, and independently assessed documentary identity. Suitable negative controls might include documents already retrievable through the target interface before the reported coverage expansion, or classification queries unrelated to the changed topic assignments. Such controls cannot eliminate unmeasured confounding, but they make an explanation resting only on a before–after citation pattern less persuasive. Distinct outcomes should remain distinguishable: changed index presence, successful retrieval, independent examination, subsequent citations, and justified epistemic update.

An important robustness check concerns *historical falsifiers*. If a supposedly newly reachable record was already equally retrievable by the study’s target observers through ordinary queries, the proposed access change is weaker than the index-entry flag suggests. If an apparent increase in recognition occurs with no documented examination and no new diagnostic information, prestige, ranking, or simple salience may be more plausible explanations. If new indexing improves access but reveals unreliable work, the outcome may correctly decrease favorable assessments. A theory that tolerates these results is empirically sharper than one which treats every additional link as successful trust formation.

A final identification concern is the relation between research assessment and its own infrastructural traces. Citation databases supply measures constructed through coverage rules; publisher download statistics can be unavailable or incompatible; detailed user logs may create privacy risks; and cross-language relevance assessments can depend on translators or machine-generated classifications. A credible study should pre-register its observational unit, define the provenance of each measurement, document missingness and selection into evaluation, and report the degree to which findings survive alternative index snapshots and representation choices. These precautions are particularly important when the substantive question concerns how observation itself is conditioned by historical infrastructure.

9.5 Ethical and Interpretive Constraints

The research object creates unusual ethical risks because it concerns access to histories that participants may reasonably wish to keep private. A design that forces disclosure of personal records, creates artificial reputational uncertainty, or mobilizes real gatekeepers to test a hypothetical exclusion mechanism could damage the subjects whose epistemic access it purports to improve. Experimental materials should therefore use non-identifiable, fictional, public-domain, or specifically consented cases whenever possible. When real documents are required, the proposed examination should have a lawful basis, data minimization, proportionate retention, and an appropriate route for correction or withdrawal where feasible. Sensitive information should not be released merely to increase a researcher's measurement power.

In an institutional audit, the reasons for restricting access can be relevant to the epistemic analysis. Confidentiality, research-participant consent, intellectual-property agreements, protection against harassment, and procedural fairness may justify restrictions in a given setting. The empirical question is whether those restrictions are necessary, proportionate, and applied according to the stated purposes. A study can compare secure verification mechanisms or redacted attestations when full disclosure is inappropriate. Such comparisons measure whether reliable assessment can occur under protective constraints. They should not be framed as evidence that the maximization of publicity is an overriding epistemic or ethical objective.

There are also dangers in the measurement of trust. Asking people to assign a confidence score to an individual or institution can convert incomplete documentation into a durable label that affects future opportunities. Researchers should distinguish confidence in a particular documented claim from global judgments about a person's worth, character, or deservingness. The former can sometimes be assessed under an explicit evidentiary task; the latter frequently imports normative, cultural, and psychological assumptions beyond the structural scope of this paper. Participants in a study of historical evaluation should not be encouraged to make personal allegations against non-consenting individuals. Published examples should remain hypothetical or sufficiently de-identified to prevent reverse identification.

The representational instruments themselves may reproduce inequalities. A record-poor participant can appear to lack a history because an institution failed to preserve it, because available records do not conform to expected formats, or because important contributions occurred outside the archive's jurisdiction. Automated extraction or provenance labeling may classify records according to an institutional vocabulary that is unfamiliar or contested elsewhere. Researchers should record how descriptors were selected, what transformations were applied, which relationships were unobservable, and how disagreements about event individuation were handled. An account of heterogeneous trajectories becomes epistemically self-defeating if it privileges one fixed descriptive scheme while claiming to investigate the consequences of novel relational forms.

Evaluation standards also need calibration to the task. An executable artifact can support technical verification without resolving questions of originality, contribution ownership, social benefit, or long-term sustainability. Documentary provenance can establish that a claim passed through a given channel while leaving its truth unsettled. An independent source may provide additional evidence without being more reliable. Similarly, a favorable trust update may be warranted, unwarranted, or indeterminate. Each conclusion requires its own reference standard and uncertainty statement. This discipline is particularly important when attempting to interpret outcomes as epistemic justice or injustice. The structural model can reveal differential conditions for evidence access, while a normative judgment additionally requires defensible standards and attention to relevant rights and institutional purposes [11].

The paper's generalizability is consequently conditional along several dimensions: the representation of events and relationships, the construction of reference distributions, the nature of the documentary target, the availability of provenance information, the degree of source dependence, and the institutional rules governing observation. A controlled experiment with simulated introductions may have high internal clarity but low ecological fidelity. An ethnographic account of a real cross-context relationship may preserve local meaning while permitting few causal contrasts. A repository-policy study may isolate one interface but miss the relational changes induced by the policy itself. Rather than ranking these approaches on a single scale of rigor, the research program should specify which questions each method

can answer and where they provide complementary constraints on interpretation.

A final methodological limit is temporal and reflexive. The initiation of a study, the request for records, and the publication of its results may themselves create relational events. Those interventions can alter what is documented, whose claims become visible, and which actors subsequently acquire authority to interpret a history. A fixed observation window can isolate a local comparison while leaving these longer trajectories outside the estimand. This is defensible when acknowledged and justified; it becomes misleading if the resulting model is presented as a completed account of a continuously evolving social process. The current paper therefore offers testable structural distinctions and illustrative designs, not a universal method for reconstructing relational reality.

The proposed empirical designs must measure access, examination, provenance, informational independence, and claim-specific diagnostic content separately. They must also address selective review, missing records, interference, and plausible competing mechanisms. More favorable trust is not the criterion for success: null or adverse revisions may likewise reflect warranted examination. The research question is whether relational transformations demonstrably alter the opportunity for evidence-grounded assessment under stated historical and institutional conditions.

10 Conclusion

This paper investigates how relational change modifies what observers can learn from already preserved histories. A cross-context encounter, institutional connection, or evidentiary pathway can make a contribution accessible without altering the documentary target. Whether the opportunity supports retrospective recognition, remains uninformative, or warrants distrust depends on actual examination and the evidence obtained. The proposed contribution is a representation-sensitive account of that conditional transformation, coupled with research designs that can distinguish it from prestige effects, repeated testimony, and ordinary changes in visibility.

A first contribution concerns the representation of relational histories. An event is distinguished within a declared analytical resolution and evidentiary purpose. Its boundaries, participating relations, and relevant dependencies can be revisable, particularly when unfamiliar interactions require the descriptive scheme to change. A relational trajectory can accordingly be represented through provisionally individuated events, records, dependencies, and provenance claims without asserting that the represented process consists of naturally separated events or conforms to one global chronology. An observer's available records remain distinguishable from the process those records are meant to describe. This distinction matters when evidence has been lost, translated, aggregated, selectively archived, or retrospectively reorganized. A representation capable of accommodating heterogeneous relational change requires a procedure for revising its descriptors as well as a procedure for evaluating the evidence expressed through them.

A second contribution is the separation of relational heterogeneity from epistemic significance. The structural difference attributed to an event depends on the chosen relational neighborhood, representation, reference distribution, and comparison domain. Distributional entropy concerns uncertainty over specified possibilities, while realized surprisal assigns unexpectedness to an event under a particular probability model. Neither quantity, on its own, establishes whether a historical claim becomes more accessible or whether a resulting observation bears on the proposition an evaluator seeks to assess. A rare encounter may give an observer no new documentary information. A familiar verification procedure may provide reliable and consequential evidence. Comparisons across communities become meaningful only when the reference domains, observed populations, and descriptive transformations are stated. The possibility that these conditions differ across observers is part of the analytical object rather than an error to be concealed by a supposedly universal novelty score.

The informational account consequently distinguishes an accessible pathway from the evidentiary material it may carry. A new relational connection may improve discoverability, authentication, retrieval, contextual interpretation, or opportunities for substantive examination. These possibilities need not move together. A record can be discoverable yet inaccessible because of permissions, retrievable yet

unauthenticated, authentic yet irrelevant to the question at issue, or substantively examined without supporting the initial evaluation. The observation-kernel framework introduced in Section 4 provides one way to specify access under declared observer conditions; it does not encode an automatic behavioral or normative response. The data-processing result in Proposition 4.1 supplies a restricted information comparison when one observation is a garbling of another. More generally, observation channels can be incomparable and their value dependent on the target question and decision rule. Increased exposure is thus an insufficient proxy for increased knowledge.

The paper's central historical insight follows from this separation. A relational event can enable *retrospective assessment* of a documentary contribution whose recorded content is held fixed within a specified counterfactual comparison. The event can connect a distant observer to records, introduce a previously unavailable means of verifying provenance, or permit comparisons across contexts. A change in the observer's assessment can therefore arise from transformed epistemic access even when the recorded contribution is unchanged. The comparison is deliberately local: the event itself changes the larger relational configuration, and the request for access can induce additional recording or interaction. Holding a documentary core fixed is an identification device, not a general thesis that historical meaning, documentary completeness, or underlying social reality remains static. The possibility of changing an assessment of the same record is equally distinct from changing the record's actual evidential quality.

The direction of this transformation remains open. An authenticated record may justify greater confidence in a specified contribution. A newly retrieved account may reproduce evidence already considered and warrant little or no change. An apparently independent endorsement may derive from an earlier single source. Additional scrutiny may uncover contradictions, errors, or limitations that justify a less favorable assessment. Retrospective recognition, therefore, is one potential result of expanded epistemic opportunity; improved warranted understanding also includes justified restraint and the discovery of grounds for distrust. A formal analysis that measures only favorable reputational outcomes would miss this distinction and risk substituting a preferred social result for epistemic adequacy. The relevant unit of trust should be a specified claim, competence, commitment, or practice under declared evidentiary standards, rather than an undifferentiated judgment of a person's worth.

The treatment of testimony sharpens these conclusions. The circulation of a report through several channels need not multiply the underlying evidence. Two apparently distinct witnesses may rely on one document, share an incentive to repeat an account, or inherit correlated observational errors. Conversely, separate investigative procedures can sometimes supply substantial corroboration even when the number of visible reports is small. Source lineage, conditional dependence, authenticity, and reliability must therefore be assessed in addition to the number of routes by which testimony reaches an observer. Proposition 6.1 formalizes the limited case in which a perfectly copied report adds no information about a target once the original report is known. The example is useful precisely because its assumptions are visible. Real witness dependence is often partial, uncertain, and institutionally mediated; its estimation calls for additional evidence rather than automatic multiplication of independent likelihood contributions.

Access itself has a parallel robustness problem. Two routes to an archive can fail together when both pass through one authorization interface, even if their visible network paths differ. Separate admissible gates can improve operational retrieval under assumptions about their failure behavior. Proposition 8.1 establishes one such comparison within a stipulated two-path model. Yet a more reliable retrieval arrangement may deliver only one underlying source, and additional accessible copies may reproduce the same error. The paper accordingly proposes distinguishing *pathway robustness*, concerning the ability to retrieve a relevant record under specified disruptions, from *evidential robustness*, concerning the quality and independence of what is retrieved. Neither measure can substitute for the other. Where the relational structure includes joint attestations, shared authorization, or source dependencies that a simple graph hides, multilayer, hypergraph, or higher-order representations may be appropriate. Their selection remains an empirical and analytical choice, subject to adequacy tests rather than a declaration of ontological priority.

Power-conditioned observability constitutes a necessary limit on the apparent neutrality of the formal comparison. The possibility of an encounter, the creation of a documentary trace, the authority to

disclose it, the conditions for retrieving it, and the standards under which it may be admitted for examination can be governed by different actors and arrangements. The resulting selection can influence which relationships appear in the available event distribution and which observed histories enter an evaluator's sample. An archive with extensive records may nevertheless represent only a restricted set of permitted activities or voices. Similarly, a formally open record can remain difficult to examine when specialist interpretation, time, or institutional access is unevenly available. These possibilities warrant investigation without presuming that every restriction is inappropriate. Confidentiality, consent, privacy, protection of vulnerable participants, and procedural fairness may justify limiting disclosure. The structural question concerns how purposes, restrictions, and alternatives shape access; the wider analysis of authority, strategic control, and contested epistemic standards belongs to the companion study devoted to power structures.

The methodological consequences are substantial. A persuasive test of retrospective epistemic transformation should distinguish a held historical target from the intervention that changes relational access, identify a credible comparison condition, and measure at least the opportunity to retrieve evidence, actual retrieval, substantive examination, and task-specific assessment. Evidence authenticity, informational redundancy, and source dependence require separate measurement. Randomized access experiments can clarify some local causal contrasts when artifacts and instructions are controlled. Observational histories may preserve relational context while presenting stronger problems of confounding, incomplete documentation, and selection. Conditioning on cases that receive examination can induce a biased comparison even when assignment to an access condition was randomized. Section 9 therefore treats the estimand, its missing outcomes, possible interference, and plausible alternative mechanisms as requirements of the design rather than secondary statistical details.

There are correspondingly clear outcomes that would limit the proposed explanation. A relational event might add a visible connection but leave authenticated evidence access unchanged. An apparent increase in trust might be explained fully by prestige, publicity, or a change in the evaluated artifact, with no additional independent evidence from the historical trajectory. The same apparent effect may disappear when observer selection, record duplication, or shared witness lineage is taken into account. An intervention may expand access while recipients elect not to examine the information. Alternative event individuations or reference distributions may reverse measured novelty without altering the relevant access pathway. Findings of this kind would challenge broad interpretations of the hypothesis, delimit a particular mechanism, or motivate revision of the representation. They should be reported alongside supportive cases if the framework is to remain empirically accountable.

The paper also has limits that are theoretical rather than merely logistical. An epistemic pathway model does not settle the metaphysics of a relational event, demonstrate a universal probability distribution over evolving social configurations, or identify the justified standards for every form of trust. Holding a documentary target fixed for local comparison cannot capture every feedback by which recognition, documentation, and later conduct transform one another. Information-theoretic quantities require specified variables and comparable observation laws; their mathematical precision cannot compensate for misspecified targets or incomplete sources. Different representational instruments can preserve different dependencies and may yield non-equivalent reconstructions. In practical inquiry, disagreements over what counts as a contribution, which records are admissible, and whose interests a trust decision serves may be irreducibly normative. The proposed formal vocabulary can locate such disagreements and their consequences while leaving their resolution to justified contextual argument and evidence.

These boundaries help distinguish the current investigation from its companion papers. Paper I studies the recognition paradox associated with AI-mediated expansion of production, including evaluation congestion and the possible separation of recognition from material resource return. The present paper specifies a different mechanism: the relational transformation of access to evidence about a previously recorded contribution. Paper III will address the cognitive processes through which people attend to, remember, interpret, and update judgments about encountered trajectories. Paper IV will investigate the power relations governing the production, circulation, authorization, and assessment of evidence. Paper V will examine the circulation and conversion of relational warrants and associated forms of value. The

interfaces among the papers provide questions for comparative investigation; the structural theory developed here does not establish the cognitive, institutional, or political-economic results reserved for those inquiries.

A practical implication follows for the design of research and knowledge infrastructures, though it remains a proposal for evaluation rather than a validated prescription. Systems that preserve records can also disclose the provenance and dependency structure of their evidentiary claims, permit correction and contestation, and support safe cross-context examination when appropriate. A meaningful comparison of such arrangements should assess whether they improve the retrieval of authentic and relevant materials, reduce dependence on a single fragile pathway, and support judgments calibrated to the evidence. The relevant trade-offs include privacy, maintenance costs, interpretive burden, and the risk of institutionalizing one vocabulary of participation. An infrastructure that maximizes discoverability while obscuring source dependencies or excluding legitimate alternative descriptions may increase visibility without improving warranted assessment. These possible consequences require field-specific analysis and, where feasible, empirical testing.

The historical context specifies why the proposed distinctions warrant investigation in the present period. AI-augmented scientific research is associated with changing individual output patterns and with differences in the measured collective distribution of scientific attention [14]. At the same time, comparative bibliometric evidence shows that different indexes present materially different portraits of already published scholarship [3]. These observations concern different units and designs. Their juxtaposition suggests a research problem concerning uneven development between the capacities to create, preserve, discover, and examine knowledge; it does not amount to a demonstrated causal chain running from AI adoption to institutional exclusion.

A historically materialist interpretation treats those capacities as dependent on work and infrastructure. Computing, repositories, journal systems, metadata pipelines, translation, source verification, and evaluation practices must be produced and sustained under particular institutional arrangements. Their historical development may open new forms of collective inquiry while leaving some groups with fewer usable paths to knowledge or fewer opportunities for substantive examination. Marx's account of the relationship between productive capacities and social relations supplies a methodological orientation for investigating these conditions [23]. Neither the theory nor the present empirical record implies that a particular ownership form or institutional arrangement determines the credibility of individual claims in advance.

The observed fact of delayed scientific attention is an established subject of bibliometric research, including analyses of "sleeping beauties" and their eventual citation uptake [27, 19]. Those studies supply important historical precedents, while their primary outcome measures remain distinct from authenticated evidence access and warranted assessments. The present synthesis should consequently be read as a proposed decomposition and empirical research strategy for one possible family of mechanisms, not as a newly discovered law of delayed recognition. Ordinary information diffusion, evolving scientific relevance, changes in audience, prestige, and selection into documentation remain live alternatives in any concrete case.

The recent OpenAlex OJS expansion and topic-classifier revision provide provider-documented examples of two interfaces: incorporation of older documentary records into an index, and reclassification of records already present in it [25, 26]. In both cases, an observer's practical means of discovering a historical contribution can change while the contribution itself remains fixed for a specified comparison. The published announcements establish descriptive infrastructural changes; their effects on examination, understanding, recognition, and trust remain to be evaluated through the designs proposed in Section 9. A favorable outcome would consist in more reliable opportunities for warranted scrutiny, which can include the discovery of good reasons for doubt.

The investigation consequently connects historical-materialist questions of social knowledge production to a bounded epistemic mechanism. The historical interpretation does not follow as a mathematical theorem from the observation kernels: it specifies institutional processes and research comparisons whose consequences require independent historical and empirical evidence. The historical ques-

tion concerns how institutions organize the conditions through which contributions can become part of collectively usable inquiry. The formal question concerns how changes in relational and observational structure modify evidence access under declared assumptions. The empirical question concerns whether these modifications occur, for whom, and with which diagnostic consequences. Their careful separation supplies a research programme rather than a general law of recognition, a universal theory of power, or a presumed moral ranking of knowledge infrastructures.

Relational events may alter opportunities to examine an existing history, but the epistemic consequences depend on accessible, authenticated, and diagnostically relevant evidence. The paper makes these conditions explicit while preserving revisable event individuation and the separation of institutional access from warranted judgment. Its next task is empirical: to identify settings in which relational change supplies demonstrably new grounds for assessing preserved contributions, and settings in which apparent recognition changes are explained by publicity, source dependence, or selective observation.

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Research Ethics and Source Provenance

Research status. Sections 1–10 constitute a complete revised theoretical and methodological draft, pending author approval, independent scholarly review, and any resulting corrections. No original empirical study or institution-specific outcome is reported. The hypotheses concern conditional structural opportunities, not observed general effects.

Bibliographic policy. Every cited external source was checked against a publisher or trusted scholarly record before its citation was introduced. The verification ledger gives claim-scope limitations.

Illustration policy. Hypothetical cases are non-identifiable and institution-neutral. The provisional mathematical framework describes representations, not a proven ontology of social reality.