

Generativity Contamination and Generative Pollution in Generative Relational Systems

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Abstract

This discussion paper develops two related concepts for examining alterations within Generative Relational Systems: generativity contamination and generative pollution. The distinction begins from the premise that generation depends both on the organization through which a system forms interpretations, possibilities, actions, relations, and revisions, and on the relational conditions under which these generative processes occur. Alteration of the generative organization and degradation of its generative conditions therefore require separate analytical treatment.

The paper reconstructs the concepts of contamination and pollution across several source domains, including water, air, soil, light, noise, thermal environments, radioactive contamination, biological contamination, and analytical carry-over. These domains exhibit different structures of exposure, interference, buffering, accumulation, secondary formation, propagation, persistence, removability, and effect. Their comparison provides conceptual resources for distinguishing alterations of a receiving system from alterations of the field or conditions within which that system operates, while also identifying the limits of transferring environmental and physical concepts to relational systems.

On this basis, generativity contamination provisionally concerns a relation-derived alteration that becomes operative within a system's generative organization or grammar. Generative pollution provisionally concerns degradation or disruptive alteration of the relational conditions or generative landscape within which generation occurs. The paper further distinguishes ontic alteration of a generative system from environmental degradation, observational contamination, and epistemic distortion. A generative system may remain ontically unchanged while polluted conditions distort its observable output, and contaminated observations may in turn support epistemic errors that feed back into later relations.

The resulting framework separates contamination and pollution from effective generative capability impairment, harm, wrongfulness, and responsibility. It also distinguishes exposure from contamination, occurrence from persistence, and environmental pollution from alteration of the generative organization itself. The proposed distinctions provide a provisional vocabulary for tracing how disturbances arise, transform, propagate, recede, and move across levels of Generative Relational Systems without presupposing a pure pre-relational state.

Keywords: generativity contamination; generative pollution; Generative Relational Systems; generative grammar; generative landscape; observational contamination; epistemic distortion

Discussion Paper Note

This paper is a foundational conceptual discussion within the Generative Relational framework (GR). Its purpose is to develop and distinguish two provisional analytical concepts: *generativity contamination* and *generative pollution*. The concepts address different locations of alteration within a Generative Relational System. The paper does not assume that every unfavorable relation contaminates a person, that every difficult environment is polluted, or that either diagnosis by itself establishes harm, wrongfulness, responsibility, or legal status.

The discussion begins from a distinction between a system's generative organization and the conditions under which generation occurs. In the provisional notation of this paper, a Generative Relational System at time t contains at least two analytically distinguishable objects,

$$\mathfrak{S}_t = \langle \Gamma_t, \mathcal{L}_t, \dots \rangle,$$

where Γ_t denotes a generative organization or generative grammar, and $\mathcal{L}_t$ denotes a generative landscape or relational field. The omitted components represent situated states, histories, actors, resources, observation structures, and other objects whose specification depends upon the domain under examination.

A generative grammar concerns the organization through which interpretations, saliences, possible ends, actions, relations, and subsequent revisions are formed. A generative landscape concerns the conditions that shape which trajectories are reachable, costly, stable, recognizable, revisable, or practically exitable. These objects interact continuously. Their analytical separation nevertheless matters because deterioration in generative conditions can occur while the generative organization of a person or system remains substantially intact.

The provisional distinction introduced in this paper can therefore be stated schematically as

$$\Gamma_t \longrightarrow \Gamma'_t \quad \text{generativity contamination,}$$

and

$$\mathcal{L}_t \longrightarrow \mathcal{L}'_t \quad \text{generative pollution.}$$

These expressions record the location of a candidate alteration. They do not by themselves provide sufficient conditions for either diagnosis. The paper develops the additional conditions, boundary cases, and evidential requirements needed to determine when an alteration warrants the respective term.

Generativity contamination provisionally concerns a relation-derived alteration that becomes operative within the generative organization of a receiving person or system. The expression “relation-derived” does not require deliberate influence, transfer of a complete grammar, alignment with another actor's objectives, or benefit to an identifiable source. An alteration may emerge through interaction among the prior organization of the receiving system, another person or set of persons, the surrounding landscape, and the history of their relations.

Consequently, an altered grammar need not reproduce the grammar of another actor. If A participates in a relation through which the generative grammar of B changes, the resulting organization may satisfy

$$\Gamma'_B \neq \Gamma_B, \quad \Gamma'_B \neq \Gamma_A.$$

The resulting form may be relationally emergent. This possibility is central to the concept because interpersonal and institutional influence frequently operates through transformation, adaptation, reinforcement, and interaction instead of literal transmission.

Generative pollution provisionally concerns degradation or disruptive alteration of the relational conditions under which generation occurs. The affected object is therefore principally the generative landscape or field. Noise, interruption, scarcity, surveillance, unstable access, distorted recognition, hostile interaction norms, excessive evaluative pressure, or other environmental conditions may interfere with generation even when the generative grammar of an affected person remains intact.

This distinction gives rise to two important non-implications:

$$\text{Polluted}(\mathcal{L}_B) \not\Rightarrow \text{Contaminated}(\Gamma_B),$$

and

$$\text{Contaminated}(\Gamma_B) \not\Rightarrow \text{CurrentlyPolluted}(\mathcal{L}_B).$$

A person may pass through a polluted generative landscape without undergoing a material grammar-level alteration. Conversely, a grammar-level alteration may remain operative after the person has left the conditions through which it arose.

The distinction between contamination and pollution is inspired by the heterogeneous ways these terms operate across scientific and environmental domains. The paper therefore examines water and marine systems, atmospheric pollution, soil contamination, light pollution, noise pollution, thermal pollution, radioactive contamination, biological contamination, and analytical carry-over. These domains are treated as source domains for conceptual reconstruction. They are not offered as evidence that persons, institutions, or relational systems literally behave like water, soil, radiation, organisms, or optical instruments.

The comparison is useful because different source domains separate phenomena that ordinary language often combines. Exposure can occur without contamination. A receiving medium may buffer or transform an exposure. Secondary products may differ from their original sources. Contamination can occur without demonstrated harm. Persistence can differ from occurrence. Propagation can differ from persistence. Pollution can arise through energy or altered environmental conditions without the insertion of a material substance. Removability and reversibility can vary independently from the initial occurrence of contamination.

The paper uses these distinctions to identify candidate structural dimensions such as source, exposure, receiver interaction, intensity, duration, buffering, transformation, accumulation, secondary formation, propagation, persistence, removability, carry-over, and effect. No source domain is assumed to instantiate every dimension, and no single natural-scientific definition is treated as governing all uses of contamination and pollution.

A further distinction concerns the *location* at which alteration is diagnosed. The paper separates ontic alteration of a generative system, environmental alteration of its generative conditions, contamination of an observation or measurement, and epistemic distortion in the representation or interpretation of the system.

The distinction can be illustrated by astronomical observation. Artificial light may alter the optical environment through which a star is observed while leaving the star itself unchanged. The resulting observation may contain unwanted contributions, and an observer may subsequently form an inaccurate inference from that observation. These are different locations of alteration. Difficulty in observing an object does not establish alteration of the object.

The same distinction applies to Generative Relational Systems. A person's generative organization may remain intact while polluted conditions degrade the person's observable performance. A measurement or evaluation may then provide a distorted representation of the person's generative capability. An observer may form an epistemically inadequate judgment from that representation. If such a judgment subsequently enters the person's relations and contributes to a grammar-level alteration, a process that began as environmental interference may eventually participate in generativity contamination.

A provisional sequence is therefore

$$\begin{aligned} \text{generative pollution} &\longrightarrow \text{observational contamination} \longrightarrow \text{epistemic distortion} \\ &\longrightarrow \text{relational feedback} \longrightarrow \text{possible generativity contamination.} \end{aligned}$$

The arrows express possible pathways. None represents a necessary implication. A polluted environment can coexist with accurate observation. A contaminated observation can be recognized and

corrected. An epistemic error can fail to alter the affected person's grammar. A grammar alteration can arise through other pathways altogether.

This level distinction is especially important because observable output should not be treated as a transparent representation of generative organization. A change in performance can result from altered grammar, polluted conditions, temporary state variation, observational interference, or combinations of these processes. The paper therefore resists direct inference from degraded output to contaminated generativity.

The proposed concepts also remain separate from effective generative capability. A grammar-level alteration may or may not contract the practically reachable trajectories of the affected person. A polluted landscape may constrain effective capability while leaving the person's grammar intact. Capability impairment, where established, still requires a separate evaluative bridge before conclusions concerning harm, injustice, or responsibility are drawn.

The paper accordingly distinguishes several analytical stages:

structural alteration → capability effect → harm → wrongfulness → responsibility.

Each transition requires additional premises. The occurrence of generativity contamination does not establish malicious intent. The existence of generative pollution does not identify a responsible actor. Persistence does not establish severity. Difficulty of revision does not by itself establish wrongfulness.

The terminology also carries an important ontological caution. The concept of generativity contamination does not presuppose a pure, isolated, or pre-relational self whose original grammar supplies a privileged baseline. Persons are already historically and relationally formed. Relational alteration is therefore ubiquitous and cannot itself define contamination. The paper must instead specify which forms of grammar-level alteration warrant the additional classification and under which declared domains, horizons, and comparisons.

Education provides the principal constructed domain for clarifying these distinctions. A noisy classroom may pollute the conditions of learning while leaving a student's generative grammar intact. Repeated discouraging evaluation may later alter how the student generates judgments concerning which abilities can be exercised or which trajectories are available. A student may retain an underlying ability while becoming less able to recognize or apply that ability as a viable possibility. The distinction among environmental interference, observable performance, epistemic judgment, grammar-level alteration, and effective capability is therefore essential.

These examples remain conceptual cases. The paper does not infer psychological mechanisms, educational effects, or causal relationships from constructed examples alone. Empirical applications require longitudinal evidence, alternative causal explanations, domain-specific measures, relational history, and explicit comparison conditions.

The concepts developed here remain provisional analytical means within GR. They are intended to make different locations and pathways of relational alteration more visible. Their usefulness depends upon their ability to distinguish cases, identify counterexamples, accommodate indeterminacy, and remain revisable when neighboring literatures or empirical evidence provide better explanations.

The Introduction develops the motivating problem and specifies the paper's research question, contribution, and limits. The subsequent sections distinguish generative organization from generative conditions, reconstruct contamination and pollution across source domains, develop the concepts of generativity contamination and generative pollution, examine observational and epistemic levels, and assess their relations to capability impairment, harm, neighboring concepts, evidence, and diagnostic uncertainty.

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1 Introduction

This section establishes the problem addressed by the paper, specifies the locations at which contamination and pollution can occur within a Generative Relational System, and defines the scope of the proposed conceptual reconstruction. The argument proceeds in five steps. It first distinguishes a system’s generative organization from the relational conditions under which generation occurs. It then separates alteration of a generative system from interference in the conditions, observations, and epistemic representations through which that system becomes accessible. The section next explains why contamination and pollution are treated as heterogeneous source-domain concepts rather than as terms carrying one universal scientific definition. It then states the paper’s research scope and candidate contribution. Finally, it specifies the comparative method and the boundaries governing the subsequent analysis.

Generative processes depend upon more than the possession of an ability or the production of an observable output. A person who can formulate an interpretation, recognize a possible trajectory, generate an action, enter a relation, or revise a prior orientation does so through an organization that has itself developed historically and relationally. The same person also acts within conditions that make some trajectories available, costly, stable, recognizable, revisable, or inaccessible. Changes in the organization of generation and changes in the conditions of generation can therefore produce similar observable outcomes while representing different underlying processes.

This distinction motivates two provisional concepts developed in the present paper. *Generativity contamination* concerns an alteration that becomes operative within the generative organization or grammar of a person or other specified generative system. *Generative pollution* concerns degradation or disruptive alteration of the conditions, landscape, or relational field within which generation occurs. The distinction does not imply that every grammar-level alteration warrants classification as contamination, nor that every unfavorable environmental condition warrants classification as pollution. The required thresholds and comparison conditions are developed through the paper.

The proposed vocabulary also carries no immediate conclusion concerning harm. Scientific and regulatory uses of *contaminant*, *contamination*, *pollutant*, and *pollution* vary across domains. An IUPAC ecotoxicology glossary, for example, defines contamination through the presence of a contaminant or the process through which a contaminant reaches an affected medium or sample, while one of its definitions of a contaminant explicitly permits undesirable matter to be present without observed adverse effects. The same glossary distinguishes a pollutant by the presence of adverse effects in the relevant environmental use [13]. These definitions do not establish a universal semantic rule. They nevertheless demonstrate that occurrence, adverse effect, and environmental degradation can be analytically separated.

The present paper adopts that separation as a methodological starting point. A diagnosis of contamination or pollution within a Generative Relational System should identify what has changed, where the change is located, through which relations it arose, and what consequences have followed. Capability impairment, harm, wrongfulness, responsibility, and legal classification remain further questions.

1.1 Disturbance across Generative Organization and Conditions

This subsection identifies the two principal objects needed for the paper and clarifies why observable generative difficulty does not by itself distinguish between them. The analysis uses a minimal system representation rather than a complete formal ontology because the present task is diagnostic separation.

Let a Generative Relational System at time t be represented provisionally as

$$\mathfrak{S}_t = \langle \Gamma_t, \mathcal{L}_t, X_t, H_t \rangle,$$

where Γ_t denotes the relevant generative organization or grammar, $\mathcal{L}_t$ the generative landscape or relational field, X_t the situated state and immediately available inputs, and H_t the relevant relational and developmental history.

The expression *generative grammar* refers to the organization through which a system forms and transforms interpretations, saliences, possible ends, actions, relations, and subsequent revisions. The term *grammar* is used in a generative sense. It does not imply that human development possesses the syntax of a natural language or that the relevant organization can be reduced to a finite set of explicit rules.

The expression *generative landscape* refers to the relational, institutional, material, symbolic, temporal, and other situated conditions that shape the practical accessibility of generative trajectories. A landscape may influence which actions can be attempted, which alternatives can be recognized, which relations can be entered or exited, how costly revision becomes, and whether generated forms can persist.

The distinction can be stated minimally as

$$\Gamma_t \longrightarrow \Gamma'_t \quad \text{and} \quad \mathcal{L}_t \longrightarrow \mathcal{L}'_t.$$

The first expression records an alteration in the organization that participates in subsequent generation. The second records an alteration in the conditions within which generation occurs. Neither expression identifies the alteration as harmful, wrongful, irreversible, or attributable to a particular actor.

This distinction becomes important whenever similar outputs can arise through different mechanisms. A student may perform poorly because persistent noise makes concentration difficult while the student's mathematical understanding, confidence, and modes of reasoning remain substantially unchanged. Another student may perform poorly in a supportive environment because repeated relational experiences have changed the way mathematical possibilities are interpreted and generated. A third case may involve both processes.

Observable output therefore occupies a different analytical position from both grammar and landscape. If Y_t denotes generated output, a simplified representation is

$$Y_t \sim P_{\Gamma_t}(\cdot \mid \mathcal{L}_t, X_t, H_t).$$

A change in Y_t can arise from a change in Γ_t , a change in $\mathcal{L}_t$, a temporary change in X_t , historically accumulated effects represented in H_t , or interactions among them. Consequently, degraded performance supplies no direct proof of grammar-level contamination.

The distinction also prevents the person from becoming the sole location of explanation. A system may retain substantial generative organization while conditions for exercising that organization become severely degraded. Conversely, favorable present conditions do not ensure that earlier relation-derived alterations have ceased to operate within the person's generative grammar.

The two proposed concepts therefore concern different potential bearers. Generativity contamination is principally indexed to the generative organization:

$$\text{Contam}(\Gamma_B),$$

while generative pollution is principally indexed to the relevant landscape or field:

$$\text{Pollute}(\mathcal{L}_B).$$

This bearer specification will be refined later. At this stage, its principal function is to prevent environmental adversity, internal alteration, and observable difficulty from being treated as interchangeable descriptions.

1.2 Diagnostic Location and Access to Generative Systems

This subsection separates changes in a generative system from changes in the conditions through which that system is observed and known. The distinction is necessary because interference with access to an object can resemble alteration of the object itself. The method begins from optical observation, where the separation is particularly visible, and transfers only the structural distinction to generative systems.

Light pollution provides an instructive case. Artificial light at night can degrade the astronomical quality of the terrestrial night-sky environment and interfere with astronomical observation while the distant astronomical objects being observed remain physically unaffected by that local interference. Contemporary astronomical site-protection work therefore treats artificial skyglow as an alteration of observational conditions surrounding ground-based astronomy [8].

A related distinction appears within optical instrumentation. Stray light can produce substantial errors in spectroradiometers and imaging instruments even when the source being measured has not changed. Instrument characterization and correction can reduce such errors because the relevant disturbance lies partly in the measurement process rather than in the measured source [22].

The general lesson concerns diagnostic location. Let S_t denote a system, $\mathcal{L}_t^O$ the conditions through which it becomes observable, O_t the resulting observation, and $K_t(S)$ an observer's epistemic representation of the system. The sequence can be represented as

$$S_t \longrightarrow \mathcal{L}_t^O \longrightarrow O_t \longrightarrow K_t(S).$$

Alteration can occur at several positions in this sequence.

First, the system itself may change. In the present paper, a grammar-level change in Γ_B is an ontic alteration of the generative organization.

Second, the field through which generation occurs or becomes observable may change. A noisy classroom, unstable institutional environment, or distorted recognition structure can alter the conditions under which a person's generativity is exercised.

Third, the observation can become contaminated. Performance measured under polluted conditions may provide an inadequate representation of the underlying generative organization.

Fourth, an observer can form an epistemically distorted representation from that observation. An evaluator may attribute a contextually depressed performance to an enduring inability, or may infer a stable generative trait from evidence whose conditions of production have not been adequately examined.

These locations should remain distinct because propagation across them is possible without being necessary. Environmental interference can distort performance while a competent observer correctly recognizes the interference. An observational distortion can therefore occur without producing an epistemic error. An epistemic error can occur without altering the person being judged. Subsequent relations can nevertheless feed the error back into the person's generative conditions or grammar.

Consider an educational sequence. Persistent environmental noise lowers a student's observed performance. An evaluator interprets the resulting score as evidence of low mathematical ability. Repeated negative evaluation then enters the relation between teacher and student. Over time, the student may begin to generate mathematical possibilities through a self-limiting interpretive rule, even though the earlier observation did not accurately represent the student's underlying ability.

The possible pathway is

$$\begin{aligned} \text{generative pollution} &\longrightarrow \text{observational contamination} \longrightarrow \text{epistemic distortion} \\ &\longrightarrow \text{relational feedback} \longrightarrow \text{possible generativity contamination.} \end{aligned} \tag{1}$$

Each arrow requires evidence. The sequence is therefore a mechanism schema rather than a general law.

The epistemic level also has an existing philosophical literature. Levy uses *epistemic pollution* to describe features of epistemic environments that undermine reliable deference and trust, particularly where institutions and informational environments cease to provide dependable cues concerning expertise and credibility [10]. The present paper does not appropriate that term as a new contribution. Instead, the existing use demonstrates the importance of indexing pollution to the field and function under examination. Generative pollution and epistemic pollution may overlap, but they concern different analytical objects unless a particular case establishes otherwise.

The distinction between object and access is consequently central to the paper's diagnostic discipline. A degraded observation of generativity does not establish degraded generativity. A polluted environment

does not establish a contaminated grammar. An epistemically distorted representation of a person does not establish that the represented person possesses the attributed generative structure.

1.3 Contamination and Pollution as Source-Domain Concepts

This subsection explains why the paper reconstructs contamination and pollution through multiple scientific and environmental domains. Its objective is to identify recurring structural distinctions while avoiding the assumption that one source domain supplies a complete model for generative relations. The method is comparative and selective: each domain contributes only those distinctions that survive explicit examination of the analogy limits.

Scientific terminology does not supply a single invariant relation between *contamination* and *pollution*. The IUPAC ecotoxicology glossary records several meanings of *contaminant*, including a minor impurity, extraneous material added to an analytical sample, an undesirable component, and environmentally present matter for which adverse effects need not yet have been observed. It also notes contexts in which *contaminant* and *pollutant* overlap [13]. The same glossary uses *pollutant* for undesirable matter causing adverse effects and defines pollution more broadly through the introduction or presence of pollutants or undesirable modification of an environmental medium.

Atmospheric terminology adds another distinction. A primary pollutant can be emitted directly from an identifiable source, whereas a secondary pollutant can be generated within the atmosphere through subsequent chemical changes [1]. This distinction is conceptually important for Generative Relational Systems because a relation-derived alteration need not reproduce what any contributing actor already possessed.

If person *A* participates in a relation through which person *B*'s generative grammar changes, the resulting grammar may satisfy

$$\Gamma'_B \neq \Gamma_B, \quad \Gamma'_B \neq \Gamma_A.$$

The second inequality prevents contamination from being reduced to transfer or copying. The resulting organization may emerge through interactions among the receiving grammar, the relation, wider conditions, and accumulated history.

Other source domains supply different distinctions. Water and marine contamination foreground exposure, transport, dilution, and background conditions. Soil foregrounds buffering, accumulation, delayed release, and propagation. Light and noise demonstrate that environmental pollution can operate through energy and interference without the insertion of a persistent material substance. Thermal pollution shows that changing environmental parameters can alter a receiving system's conditions even where no propositional content is transferred. Radioactive contamination separates occurrence from hazard magnitude and introduces differences in persistence and removability. Biological and analytical contexts distinguish contamination from subsequent proliferation, survival, and carry-over.

The paper treats these domains as a comparative conceptual laboratory. Their function is to generate distinctions such as

source, exposure, receiver interaction, intensity, duration, buffering, transformation, accumulation, secondary formation, propagation, persistence, removability, carry-over, and effect.

These dimensions are deliberately presented in prose because the paper does not assume that they form one measurable vector or that they possess a common scale across domains.

Several preliminary non-implications already follow from the comparison. Exposure can occur without contamination. Environmental pollution can occur without contamination of a particular receiver. Contamination can be remediated and therefore need not be permanent. Persistence can occur without continued exposure. Secondary alteration can differ from its initiating source. Contamination in some technical vocabularies can be identified before a demonstrated adverse effect.

None of these source-domain relations automatically transfers to persons. Their value lies in preventing premature conceptual closure. The subsequent sections therefore examine each domain separately before extracting cross-domain features and identifying the limits of transfer.

1.4 Research Scope and Conceptual Contribution

This subsection specifies the paper’s research object, the level of ambition appropriate to the proposed concepts, and the principal conditions under which the contribution should be rejected or revised. The paper develops a foundational vocabulary within Generative Relational theory while keeping novelty claims conditional upon comparison with neighboring literatures.

The central research problem concerns the classification of disturbances within Generative Relational Systems. More specifically, the paper examines the conditions under which an alteration becoming operative within a generative grammar can be distinguished from degradation of the generative landscape, and how both can be distinguished from contamination of observation, epistemic distortion, capability impairment, and downstream normative evaluation.

The provisional distinction is

generativity contamination	↗	alteration within generative organization,
generative pollution	↗	degradation of generative conditions.

The arrows indicate conceptual orientation rather than complete definitions.

The first candidate contribution is a bearer-sensitive distinction between internal generative alteration and field-level degradation. A polluted generative landscape does not imply a contaminated person. A person’s generative grammar may also remain altered after the environmental conditions through which the alteration arose have ended. The two diagnoses can therefore occur independently or jointly.

The second candidate contribution is a level-sensitive distinction among ontic, environmental, observational, and epistemic disturbance. The paper argues for diagnostic discipline in locating the bearer of each alteration before drawing causal or normative conclusions.

The third candidate contribution concerns relational emergence. Generativity contamination does not require deliberate contamination, benefit to the contributing actor, alignment with that actor’s objectives, or transfer of that actor’s grammar. A relation can contribute to a new generative organization that no participant previously possessed in the same form.

The fourth candidate contribution is the separation of occurrence from downstream evaluation. The paper retains the sequence

structural alteration → capability effect → harm → wrongfulness → responsibility.

The arrows mark separate research obligations. Contamination or pollution may contribute to effective generative capability impairment, yet the structural diagnosis alone does not establish such impairment. Capability impairment in turn requires an independent bridge to harm. Wrongfulness and responsibility require further premises.

The paper therefore does not offer a general theory of interpersonal harm, educational injustice, manipulation, coercive control, colonization, epistemic injustice, or legal responsibility. These literatures provide neighboring concepts and boundary tests. Their relationship to the proposed framework must be established rather than assumed.

A further restriction concerns the bearer of generativity contamination. The principal constructed cases concern persons because grammar-level relational alteration is clearest at that scale. The title refers more broadly to Generative Relational Systems because the paired distinction between generative organization and generative conditions may eventually apply to other systems. Group, institutional, ecological, and technical extensions remain conditional. The paper does not infer that every such system possesses a generative grammar in the same sense as a person.

The proposed concepts should also be abandoned or substantially revised if the literature demonstrates that existing concepts already perform the same diagnostic work with equal or greater precision, if grammar-level alteration cannot be distinguished from ordinary relational development, or if the framework cannot specify evidence capable of defeating a contamination or pollution diagnosis.

1.5 Conceptual Method and Paper Structure

This subsection states the method used to develop the concepts and locates the remaining sections within that method. The paper combines conceptual analysis, cross-domain reconstruction, constructed cases, formal bookkeeping, and explicit counterexample testing. The formal expressions organize relations among objects; they do not substitute mathematical notation for empirical or normative premises.

The analysis proceeds through four methodological constraints.

First, every contamination or pollution diagnosis should specify a bearer. Statements that a system is simply “contaminated” or “polluted” can hide whether the relevant alteration concerns a person, a generative grammar, a landscape, an observation, a dataset, an epistemic environment, or another object.

Second, every diagnosis should specify a level. Ontic change in the object, environmental change in its conditions, observational interference, and epistemic distortion can interact while remaining analytically distinct.

Third, every comparative diagnosis requires a declared domain, horizon, and comparison family. A pre-relation state cannot automatically function as a normatively privileged baseline. Persons are historically and relationally formed, and the framework does not assume an uncontaminated authentic self existing prior to social relations.

Fourth, analogical transfer must remain directional and defeasible. A distinction identified in atmospheric chemistry, soil science, radiometry, or another source domain may generate a question for Generative Relational analysis. Resemblance alone does not establish a shared causal law.

Section 2 develops the distinction among generative grammar, generative landscape, effective generative capability, and generated output. The following section separates ontic, environmental, observational, and epistemic locations of disturbance. The source-domain analysis then examines water, air, soil, light, noise, thermal pollution, radioactive contamination, biological contamination, and analytical carry-over before identifying cross-domain structures and analogy limits.

The subsequent sections develop generativity contamination and generative pollution separately before examining their independence, interaction, feedback, and possible propagation. Educational cases provide a bounded constructed domain in which environmental interference, observed performance, evaluation, grammar alteration, and capability effects can be distinguished. Later sections compare the framework with neighboring concepts and specify evidential, counterfactual, and operational requirements.

The paper closes by identifying scope conditions and unresolved questions. The resulting framework is intended as a revisable analytical vocabulary. Its value depends upon whether the distinctions improve diagnosis across cases, survive counterexamples, and remain sufficiently precise to support empirical or normative investigation without predetermining its results.

2 Generative Organization and Generative Conditions

This section establishes the analytical objects on which the later diagnoses of generativity contamination and generative pollution depend. Its objective is to distinguish the organization through which generation occurs from the conditions that shape its practical operation, and then to separate both from effective generative capability and realized output. The section proceeds from a minimal representation of a Generative Relational System to generative grammar, generative landscape, effective generative capability, and generated output. The method is stipulative and relational. The formal objects are used to identify different locations of change and comparison. They do not assume that the represented components are ontologically independent, directly measurable, or reducible to scalar variables.

2.1 Generative Relational Systems

A Generative Relational System is treated here as an analytically specified system in which the capacity to generate interpretations, actions, relations, artifacts, values, practices, or further generative conditions depends upon both an organized mode of generation and the relations through which that organization operates and changes. The expression does not require a claim that relations constitute the only ontological substance of the system. Relation serves as an analytical means for tracing how generative states, possibilities, constraints, and transformations arise.

For the purposes of this paper, a minimal state representation is

$$\mathfrak{S}_t = \langle \Gamma_t, \mathcal{L}_t, X_t, H_t \rangle, \quad (2)$$

where Γ_t denotes the generative organization or grammar, $\mathcal{L}_t$ denotes the generative landscape or relational field, X_t denotes the situated state and immediately relevant inputs, and H_t denotes the relational and developmental history relevant to the analysis.

Equation 2 is intentionally incomplete. Depending upon the domain, a fuller representation may need to distinguish persons, institutions, resources, observation structures, physical conditions, communication channels, normative arrangements, technologies, or other objects. The present paper retains only those components required to locate contamination and pollution without prematurely constructing a complete ontology of a Generative Relational System.

The four components also occupy different analytical roles. The generative grammar concerns how the system generates. The generative landscape concerns the conditions within which generation becomes practically possible. The situated state concerns what is immediately present at a particular moment. The historical component records that present generation can depend upon earlier relations and transformations even after their original sources are absent.

This temporal dimension is important because the current state of a system cannot always be explained by its current environment alone. A relation that ended at t_0 may have contributed to an alteration that remains operative at t_1 . Conversely, an adverse environment at t_1 may constrain generation while leaving the underlying generative organization substantially unchanged. The distinction between present organization, present conditions, and relational history therefore precedes any diagnosis of contamination or pollution.

A Generative Relational System also need not generate one homogeneous type of output. The same person, group, or institution may generate differently across domains. Mathematical reasoning, interpersonal trust, artistic creation, political participation, language use, and institutional action can depend upon overlapping yet non-identical structures and conditions. For this reason, later diagnoses should normally specify a domain D and, where temporal effects matter, a horizon H .

The analysis therefore resists treating generativity as one global quantity. A system can retain extensive generative possibilities in one domain while experiencing severe restriction in another. A landscape can support one form of generation while interfering with another. These possibilities will later matter when the paper distinguishes domain-relative pollution from grammar-level contamination.

2.2 Generative Grammar

This subsection specifies the internal analytical object to which generativity contamination will principally be indexed. Its objective is to distinguish grammar-level organization from individual beliefs, preferences, behaviors, and outputs. The subsection uses a typed profile to identify different functions within generation while leaving their empirical realization open.

Let the generative grammar of a bearer B at time t be represented provisionally as

$$\Gamma_{B,t} = \langle \mathcal{I}_{B,t}, \mathcal{E}_{B,t}, \mathcal{A}_{B,t}, \mathcal{U}_{B,t} \rangle, \quad (3)$$

where $\mathcal{I}_{B,t}$ concerns the formation and transformation of interpretations, $\mathcal{E}_{B,t}$ concerns the formation of ends, saliences, and practical orientations, $\mathcal{A}_{B,t}$ concerns the generation of actions and relations, and

$\mathcal{U}_{B,t}$ concerns the processes through which the grammar itself is revised or updated.

The coordinates in Equation 3 are analytical types. They are neither assumed to be independent nor claimed to exhaust the organization of human generation. Interpretation can affect salience, salience can shape action, action can restructure relations, and new relations can transform subsequent interpretation. The profile therefore serves as a way to locate candidate alterations without presuming a modular psychology.

The word *grammar* is used because the object concerns organization that participates in the production of further states and possibilities. It does not imply that a person’s generative organization has the syntax of a natural language. It also does not imply that every generative process can be written as an explicit rule available to introspection.

A grammar-level alteration should be distinguished from a change in one generated state. A student who decides not to answer one mathematical question has generated an action. The event alone supplies little evidence about the organization through which mathematical possibilities are normally interpreted or evaluated. Repeatedly generating the judgment that mathematical challenges fall outside one’s viable space of action may provide stronger evidence of an altered generative organization, particularly where the pattern extends across situations and participates in subsequent self-revision.

The distinction also applies to preferences. A person can prefer one option over another while retaining the capacity to recognize both options, reconsider the preference, generate new alternatives, and revise the standards through which the options are evaluated. A deeper grammar-level alteration may concern the processes through which alternatives become recognizable in the first place, the criteria through which they acquire salience, or the update relations through which later experiences can modify those criteria.

The update component $\mathcal{U}_{B,t}$ is therefore especially important for the later analysis of contamination. A relational alteration may affect what a person currently believes or chooses. A more extensive alteration may also change how later evidence, relations, failures, successes, and possibilities can modify the person’s generative organization. The second case introduces recursive effects because the alteration becomes relevant to the processes through which subsequent alteration occurs.

A minimal historical update can be represented as

$$\Gamma_{B,t+1} = \mathcal{U}_B (\Gamma_{B,t}, X_{B,t}, \rho_{B,t}, \eta_t), \quad (4)$$

where $\rho_{B,t}$ denotes the relevant relational configuration and η_t denotes wider conditions omitted from the local representation. The notation permits relational conditions to contribute to grammar change without implying that the resulting grammar copies any participant in the relation.

Equation 4 also makes clear why the framework does not presuppose a pure pre-relational grammar. The grammar at time t already contains a history of earlier generation and relation. A counterfactual comparison therefore cannot automatically treat the earliest observed state as authentic, natural, or normatively privileged.

The same point limits the eventual concept of generativity contamination. Relational alteration is an ordinary feature of development. Education, friendship, conflict, migration, professional practice, language learning, care, and intimate relations can all contribute to grammar-level change. The later contamination diagnosis must therefore identify additional conditions beyond the existence of relationally produced alteration.

2.3 Generative Landscapes

This subsection specifies the principal object to which generative pollution will be indexed. Its objective is to represent the conditions that shape the practical accessibility, cost, stability, recognition, revision, and exit of generative trajectories. The method remains relational and domain-sensitive, because the same environmental feature can affect different bearers or forms of generation differently.

A generative landscape $\mathcal{L}_{B,t}$ is the relational configuration within which bearer B generates at time t . Depending upon the domain, the landscape may include material resources, spatial arrangements,

institutional rules, communication structures, temporal constraints, recognition systems, social relations, technologies, evaluative practices, legal permissions, cultural expectations, and available routes of entry, transition, or exit.

The term *landscape* does not imply a static background. Generative conditions can change in response to the actions of the bearer and other participants. A classroom changes when students respond to teachers. An institution changes when its members reproduce or contest its evaluative norms. A platform changes when user behavior modifies recommendation or moderation processes. The landscape is therefore part of the relational dynamics rather than an inert container surrounding the generative system.

Several properties of a trajectory can depend upon the landscape even where the grammar remains stable. A trajectory may be formally permitted yet practically inaccessible because the required resources are absent. It may be technically reachable while carrying prohibitive social or economic costs. It may remain available yet become difficult to recognize because relevant information channels disappear. It may be entered easily while offering no effective route of exit.

For this reason, the landscape should be described through the conditions of practical movement rather than through a single environmental quality score. Relevant dimensions may include reachability, transition cost, stability, recognizability, contestability, revisability, portability, and effective exit. Which dimensions matter depends upon the declared domain.

This relational understanding also clarifies why generative pollution can occur without direct alteration of the generative grammar. Persistent noise can make concentrated reasoning difficult. Institutional scheduling can fragment the time needed for sustained inquiry. Resource scarcity can close otherwise recognizable trajectories. Surveillance can change the practical cost of experimentation. An evaluative regime can make certain forms of inquiry institutionally unrewarding. Each condition may interfere with generation while leaving the bearer capable of recognizing the interference and retaining a substantially intact grammar.

The reverse configuration is also possible. A person may enter a supportive landscape while carrying an earlier grammar-level alteration that continues to shape what possibilities are generated or recognized. Present landscape and present grammar therefore require separate observation.

This distinction will later support a central non-implication of the paper:

$$\text{Polluted}(\mathcal{L}_{B,t}) \not\Rightarrow \text{Contaminated}(\Gamma_{B,t}). \quad (5)$$

The converse non-implication can also hold because grammar-level alteration may persist after a polluted landscape has been left or repaired. These relations will be developed in Section 7.

2.4 Effective Generative Capability

This subsection separates the organization and conditions of generation from the practically reachable repertoire that results from their interaction. Its objective is to prevent capability impairment from being treated as a synonym for contamination or pollution. The analysis defines effective generative capability through reachable trajectories under declared conditions, domains, and horizons.

Effective generative capability concerns what a bearer can practically generate, pursue, revise, or enter from a situated position. It therefore differs from latent potential, formal permission, observed achievement, and hypothetical capacity under unspecified favorable conditions.

A person may possess the underlying knowledge required for an activity while lacking practical access to the resources needed to exercise it. A person may also possess formal permission while facing transition costs that make the permitted trajectory effectively unavailable. Conversely, a person may produce a successful output once without possessing stable capability to reproduce, revise, or extend that achievement.

Let $\mathcal{T}_B^{D,H}$ denote candidate trajectories available for analysis in domain D over horizon H . A provisional effective generative capability set can be written as

$$\mathcal{G}_{B,t}^{D,H} = \left\{ \tau \in \mathcal{T}_B^{D,H} \mid \tau \text{ is practically reachable from } \mathfrak{S}_{B,t} \right\}. \quad (6)$$

The expression *practically reachable* carries the substantive burden of the definition. Reachability may depend upon grammar, landscape, resources, time, relational support, transition cost, recognition, safety, and the possibility of revision or exit. These conditions must be specified for the domain rather than hidden inside a universal scalar threshold.

Equation 6 also permits capability to change through several different pathways. If a landscape becomes polluted, the reachable set can contract even while the grammar remains intact. If a grammar becomes contaminated, the bearer may cease to generate or recognize some trajectories even after external conditions improve. A capability contraction can also arise through mechanisms unrelated to either concept.

Accordingly,

$$\Delta \mathcal{G}_{B,t}^{D,H} \prec 0 \not\equiv \text{Contaminated}(\Gamma_{B,t}) \vee \text{Polluted}(\mathcal{L}_{B,t}). \quad (7)$$

The notation $\prec 0$ records a material contraction relative to a declared comparison. It does not require capability to be reduced to one numerical quantity. Different trajectories may become more or less reachable simultaneously, and some changes may remain incomparable.

This non-scalar treatment is particularly important when generativity is heterogeneous. An educational environment may increase the capacity to produce standardized examination responses while reducing the capacity to generate exploratory questions. A professional institution may expand access to resources while narrowing the range of recognizable research trajectories. A single aggregate score could conceal these mixed effects.

Effective generative capability therefore functions as a downstream object in the present paper. Contamination and pollution concern candidate structures and conditions through which capability may change. Capability analysis asks what practically reachable possibilities remain after those processes have operated.

2.5 Generated Output

This subsection completes the analytical separation by locating generated output downstream from grammar, landscape, situated state, history, and effective capability. Its objective is to prevent observed performance from being treated as direct evidence of the internal organization or environmental condition that produced it. The method focuses on causal and epistemic underdetermination.

Generated output $Y_{B,t}$ refers to what is actually produced or realized through a particular generative episode. Depending upon the domain, an output may be an action, interpretation, answer, artifact, relationship, decision, institutional response, research question, or other realized form.

The realized output depends upon several components of the Generative Relational System. A compact representation is

$$Y_{B,t} \sim P_{\Gamma_{B,t}}(\cdot \mid \mathcal{L}_{B,t}, X_{B,t}, H_{B,t}). \quad (8)$$

Equation 8 records conditional dependence rather than a fully specified probabilistic model. Its function is to make explicit that the same output can arise under different grammars and landscapes, while the same grammar can generate different outputs under different conditions.

This distinction matters directly for observation. A low examination score may reflect a grammar-level difficulty, environmental interference, temporary illness, sleep deprivation, unfamiliar instructions, measurement error, or interactions among several factors. The observed score alone does not identify which component changed.

Likewise, stable output does not establish stable generativity. A person may continue producing institutionally acceptable work while the grammar through which future possibilities are generated has narrowed substantially. Alternatively, a polluted landscape may require increasing effort merely to maintain the same observed performance.

The four objects developed in this section can therefore be arranged analytically as

$$(\Gamma_{B,t}, \mathcal{L}_{B,t}) \longrightarrow \mathcal{G}_{B,t}^{D,H} \longrightarrow Y_{B,t}, \quad (9)$$

with situated state and relational history affecting each transition. Equation 9 records an analytical ordering rather than a deterministic causal chain. Feedback can run in the opposite direction. Generated outputs can change recognition, relationships, and institutional conditions. Repeated actions can also participate in later grammar change.

The distinction among grammar, landscape, capability, and output supplies the basic diagnostic architecture for the remainder of the paper. Generativity contamination will principally concern alteration of Γ . Generative pollution will principally concern degradation of $\mathcal{L}$. Effective capability analysis will examine changes in $\mathcal{G}^{D,H}$. Observation and epistemic analysis will ask how Y , and the conditions under which Y is produced, support or fail to support claims about the other objects.

Keeping these locations distinct makes it possible for later sections to trace propagation across them without treating propagation as identity. A polluted landscape can contribute to capability impairment. Capability impairment can alter observed output. Distorted observations can support epistemic errors. Epistemic errors can enter later relations and contribute to grammar-level alteration. Each transition remains a separate empirical or conceptual obligation.

3 Locations of Contamination, Pollution, and Observational Interference

This section establishes a level-sensitive framework for locating contamination, pollution, observational interference, and epistemic distortion. Its objective is to prevent a disturbance affecting access to a system from being attributed prematurely to the system itself. The section proceeds through six analytical locations. It first distinguishes ontic alteration of a generative system from pollution of the field within which generation occurs. It then separates both from contamination of observations and from pollution or distortion at the epistemic level. The final two subsections examine propagation across these locations and formulate a bearer-and-level requirement for subsequent diagnoses. The method is relational and location-sensitive. Each diagnosis is indexed to the object in which the relevant alteration is claimed to occur, while causal propagation between objects is treated as an additional question.

3.1 Ontic Alteration of Generative Systems

This subsection specifies the level at which a claimed alteration belongs to the generative system itself. Its objective is to distinguish a change in the system's generative organization from changes in the conditions through which that organization operates or becomes observable. The method compares system states across time or admissible counterfactual trajectories without treating observable performance as a transparent measure of the underlying organization.

Let the generative organization of bearer B at time t be denoted by $\Gamma_{B,t}$. An ontic grammar-level alteration requires a difference in the generative organization itself:

$$\Gamma_{B,t_1} \not\equiv_D \Gamma_{B,t_0}, \quad (10)$$

where D identifies the domain in which the difference is relevant. Equation 10 records a candidate change in the system. It does not determine the cause of that change or classify the change as contamination.

The term *ontic* is used here to identify where an alteration exists. It concerns the state or organization of the bearer under analysis. *Ontological* would carry a broader philosophical burden concerning the categories or nature of being and is therefore avoided for this diagnostic purpose.

Ontic alteration can concern different components of the generative grammar. An interpretive pattern may change. Previously available ends may lose or gain salience. The organization through which actions and relations are generated may be transformed. The rules governing subsequent revision may also change. These alterations need not occur together.

A grammar-level alteration should also be separated from an altered situated state. Fear, fatigue, distraction, temporary discouragement, or acute stress may substantially affect generation at a particular moment without establishing a durable difference in the organization through which later generation proceeds. The difference between state change and organizational change is therefore an evidential problem rather than a distinction available from one observed episode.

The same caution applies to effective capability. A bearer can lose practical access to a trajectory while retaining the generative organization required to recognize or pursue it under different conditions. Conversely, a grammar-level alteration can occur before a substantial contraction of effective capability becomes observable.

The later concept of generativity contamination will principally concern this ontic level. A diagnosis of contamination will therefore require evidence that a relation-derived alteration has become operative within the relevant generative organization. Adverse surroundings, degraded performance, or erroneous evaluation cannot substitute for that evidence.

3.2 Pollution of Generative Fields

This subsection locates generative pollution in the conditions surrounding and structuring generation. Its objective is to distinguish degradation of a generative field from alteration of the generative organization operating within that field. The method treats the landscape as a relational object whose properties can change independently of the grammar of any particular participant.

Let $\mathcal{L}_{B,t}^G$ denote the generative landscape relevant to bearer B . A field-level alteration can be represented as

$$\mathcal{L}_{B,t_0}^G \longrightarrow \mathcal{L}_{B,t_1}^G. \quad (11)$$

Generative pollution concerns a subset of such alterations in which relevant conditions of generation are degraded or disruptively modified. The precise criterion for degradation remains domain-relative and will be developed in Section 6.

The bearer at this level is the generative field or landscape. A classroom can therefore be polluted even when no student's generative grammar has yet changed. A research institution can contain polluted generative conditions while some researchers retain the capacity to recognize, resist, and work around those conditions. An information environment can constrain the practical visibility of alternatives while some participants preserve broader interpretive grammars.

This location is structurally similar to several familiar environmental uses of pollution. Artificial light can degrade the darkness of an astronomical site and thereby alter the conditions required for observation without physically altering the distant astronomical object. Contemporary IAU site protection work consequently treats artificial light at night and artificial skyglow as conditions affecting the astronomical quality of observing sites [8].

The same structure is useful for generative systems. Suppose a student is attempting sustained mathematical reasoning while construction noise repeatedly interrupts concentration. The disturbance principally concerns the conditions under which generation occurs. The student may remain capable of recognizing the problem, preserving mathematical confidence, and resuming the reasoning process once the interference ends.

The relevant diagnosis can therefore be written schematically as

$$\text{Polluted}(\mathcal{L}_{B,t}^G) \not\Rightarrow \text{Altered}(\Gamma_{B,t}). \quad (12)$$

Equation 12 is a non-implication. Polluted conditions can contribute to later grammar-level alteration, yet the transition requires an additional mechanism and additional evidence.

The distinction is particularly important where institutions respond to poor performance by attempting to repair the individual while leaving the generative field unchanged. If the principal disturbance lies in fragmented time, hostile interaction, inaccessible resources, unstable evaluation, surveillance, or environmental interference, an exclusively person-centered diagnosis can mislocate the relevant alteration.

Generative pollution is therefore a field-level concept. Its downstream effects can reach persons, outputs, observations, and institutional judgments, but those effects should be traced rather than incorporated into the field diagnosis by definition.

3.3 Observational Contamination

This subsection identifies contamination at the level of observation, measurement, or recorded representation. Its objective is to distinguish an altered observation from an altered object and from an altered environment. The method treats observation as a generated relation among the target, measurement conditions, observation process, and additional contributions.

Let $Y_{B,t}$ denote the target phenomenon or output relevant to an observation and let $O_{B,t}$ denote the recorded observation. A simplified measurement relation can be written as

$$O_{B,t} = \mathcal{M}(Y_{B,t}, \mathcal{L}_t^O) + \xi_t, \quad (13)$$

where $\mathcal{M}$ denotes the observation or measurement process, $\mathcal{L}_t^O$ denotes conditions of observation, and ξ_t collects contributions not belonging to the target phenomenon under the declared measurement purpose.

Observational contamination occurs when such additional contributions become operative in the recorded observation in a way that matters for the measurement or representation. The object under observation need not have changed.

Optical measurement provides a clear source-domain example. NIST describes stray light arising from scattered or improperly imaged radiation within optical instruments as an important source of measurement error and develops procedures for characterizing and correcting its effects [22]. The relevant error arises in the observation system. The existence of stray light does not establish a corresponding change in the object being measured.

Astronomical observation makes the distinction especially intuitive. Let S denote a distant star. Artificial skyglow may degrade the local observational field while the physical state of S remains unchanged. The recorded signal may contain contributions from both the astronomical source and local or instrumental interference:

$$O = \mathcal{M}(S) + C^O + \epsilon, \quad (14)$$

where C^O represents an observationally contaminating contribution and ϵ represents other measurement error.

It would therefore be a category mistake to infer

$$\text{Contaminated}(O) \Rightarrow \text{Contaminated}(S). \quad (15)$$

The implication in Equation 15 is not accepted. The observational record and the observed object are different bearers.

The same problem arises when observing generativity. Examination performance, employee evaluation, publication output, recorded behavior, self-report, or institutional metrics can all function as observations of some aspect of a person's activity. Each is produced under conditions that may contribute to the recorded result.

Suppose a student retains a stable mathematical generative grammar while noise degrades examination performance. The examination result can then be a contaminated observation of the student's generative capacity if the score contains effects of environmental interference that the evaluation procedure treats as if they arose from the target capacity.

The distinction can be stated as

$$\Delta O_{B,t} \not\Rightarrow \Delta \Gamma_{B,t}. \quad (16)$$

This non-implication is central to the paper. Changes in observed output can provide evidence relevant to grammar-level change, but their evidential force depends upon the conditions through which the observation was generated.

Observational contamination can also occur without generative pollution. A measurement instrument may be poorly calibrated in an otherwise supportive environment. An evaluator may record data incorrectly. A dataset may mix observations from heterogeneous conditions without preserving provenance. The observation level therefore requires independent analysis rather than being treated as a simple consequence of field pollution.

3.4 Epistemic Pollution and Inferential Distortion

This subsection separates conditions for knowing from the epistemic states formed under those conditions. Its objective is to distinguish pollution of an epistemic environment from an inaccurate judgment about a generative system. The method introduces an epistemic field between observation and inference and uses existing work on epistemic pollution as a neighboring concept rather than as terminology originating in the present framework.

Let $\mathcal{L}_{A,t}^E$ denote the epistemic environment available to an observer A and let $K_{A,t}(B)$ denote A 's epistemic representation of bearer B . A simplified inferential relation is

$$K_{A,t}(B) = \mathcal{I}_A(O_{B,t}, \mathcal{L}_{A,t}^E, H_{A,t}), \quad (17)$$

where $\mathcal{I}_A$ represents the observer's inferential process and $H_{A,t}$ records relevant prior information and history.

The epistemic environment includes the informational and social conditions through which evidence is interpreted. It can include available records, provenance, institutional classifications, testimony, reputational cues, measurement standards, expertise signals, and opportunities for correction or challenge.

Levy develops the concept of an *epistemically polluted environment* in which agents' ordinary reliance on cues concerning expertise and informational reliability becomes less dependable because those cues can be mimicked, manipulated, or otherwise degraded [10]. This established use is relevant to the present framework because it locates pollution in an environment for cognition and epistemic dependence.

The present paper therefore distinguishes *epistemic pollution* from *inferential distortion*. Epistemic pollution concerns degradation of conditions for forming reliable epistemic judgments. Inferential distortion concerns the resulting representation or judgment when it fails to track the relevant target adequately.

The distinction matters because an observer can recognize polluted epistemic conditions and compensate for them. Likewise, an observer can form a false judgment under an epistemically favorable environment through an independent reasoning error.

Accordingly,

$$\text{Polluted}(\mathcal{L}_{A,t}^E) \not\Rightarrow \text{Distorted}(K_{A,t}(B)), \quad (18)$$

and

$$\text{Distorted}(K_{A,t}(B)) \not\Rightarrow \text{Polluted}(\mathcal{L}_{A,t}^E). \quad (19)$$

These relations mirror the distinction between environmental pollution and receiver-level contamination elsewhere in the paper.

A further distinction separates epistemic distortion from ontic alteration of the represented person. If an evaluator concludes that a student lacks mathematical ability because an environmentally contaminated examination score was interpreted without adequate contextual information, the evaluator's representation may be distorted while the student's generative grammar remains unchanged:

$$\text{Distorted}(K_A(B)) \not\Rightarrow \text{Altered}(\Gamma_B). \quad (20)$$

The distinction is essential because institutional representations can acquire practical force even when they misdescribe their targets. A classification, score, recommendation, or reputation can affect later access to resources, relationships, and opportunities. Epistemic distortion can therefore become causally consequential without becoming ontically accurate.

3.5 Cross-Level Propagation

This subsection examines how disturbances located at different levels can become causally connected over time. Its objective is to distinguish propagation from identity and to show how an initially external disturbance can eventually contribute to an ontic alteration. The method traces possible paths across field, observation, epistemic, relational, and grammar levels while treating every transition as defeasible.

The simplest architecture can be represented as

$$\Gamma_B \longleftrightarrow \mathcal{L}_B^G \longrightarrow Y_B \longrightarrow O_B \longrightarrow K_A(B), \quad (21)$$

where the double direction between grammar and generative landscape indicates that persons can respond to and reshape the conditions in which they generate. The remaining arrows indicate a minimal route from generation to observation and epistemic representation. In practice, feedback can occur between every stage.

A disturbance originating in the generative landscape may propagate through several levels. Consider the following constructed educational sequence.

First, persistent environmental interference degrades the conditions under which a student performs mathematical work:

$$\mathcal{L}_B^G \longrightarrow \mathcal{L}_B^{G'}. \quad (22)$$

Second, the degraded conditions contribute to lower observed performance while the student's generative grammar initially remains substantially intact.

Third, an evaluator interprets the recorded performance as evidence of a stable deficiency in mathematical ability.

Fourth, the resulting judgment enters the student's relational environment through repeated discouraging feedback, reduced opportunities, altered expectations, or changed forms of recognition.

Fifth, the student may eventually begin generating mathematical possibilities through a different grammar. Tasks that were previously recognized as attemptable may cease to appear as viable trajectories. At this later stage, a process that began as field-level pollution may have contributed to an ontic grammar-level alteration.

The complete candidate pathway is

$$\text{Pollute}(\mathcal{L}^G) \longrightarrow \text{Contam}(O) \longrightarrow \text{Distort}(K) \longrightarrow \Delta\rho \longrightarrow \Delta\Gamma. \quad (23)$$

Equation 23 expresses one possible mechanism. None of its arrows is necessary. Pollution may leave observed performance intact. Observational contamination may be detected and corrected. An evaluator may resist an epistemically misleading observation. A mistaken judgment may never reach the person concerned. Relational feedback may occur without producing a grammar-level alteration.

The pathway can also reverse direction. A grammar-level alteration in one or more participants can contribute to the reproduction of a polluted field. A former student who has acquired a restrictive evaluative grammar may later participate in institutional practices that narrow the generative conditions of subsequent students.

A recursive sequence can therefore occur:

$$\Delta\Gamma_{B,t} \longrightarrow \Delta\mathcal{L}_{t+1}^G \longrightarrow \Delta\Gamma_{C,t+2}. \quad (24)$$

Table 1: Diagnostic Levels and Principal Bearers

Level	Principal bearer	Candidate diagnosis
Ontic	Generative organization Γ	Grammar-level alteration and possible generativity contamination
Environmental	Generative landscape $\mathcal{L}^G$	Generative pollution
Observational	Observation, measurement, or recorded output O	Observational contamination or interference
Epistemic environment	Conditions of epistemic access $\mathcal{L}^E$	Epistemic pollution
Epistemic representation	Judgment or representation K	Inferential or epistemic distortion

This possibility will become important when the paper later considers contamination-to-pollution feedback and cross-generational propagation. At the present stage, the point is narrower. A pathology can move across levels while remaining a different phenomenon at each level.

Cross-level propagation also explains why historical evidence matters. Current environmental conditions may be favorable while a grammar-level alteration produced through earlier relations remains operative. Current grammar may be intact while a polluted field continues to suppress observable performance. A snapshot of either the person or the environment is therefore insufficient for many diagnoses.

3.6 Bearer and Level Specification

This subsection consolidates the preceding distinctions into a diagnostic requirement for the remainder of the paper. Its objective is to ensure that every use of contamination, pollution, or distortion identifies the affected object, analytical level, domain, and temporal scope. The method uses a typed diagnostic record rather than a scalar pathology score.

A minimal diagnostic statement should specify at least

$$\mathfrak{D} = \langle T, B, L, D, H \rangle, \quad (25)$$

where T denotes the type of disturbance, B the bearer, L the analytical level, D the declared domain, and H the relevant temporal horizon.

The disturbance type T may include contamination, pollution, observational interference, or epistemic distortion. The bearer B may be a generative grammar, relational field, measurement, dataset, institutional record, epistemic environment, or another explicitly identified object. The level L identifies whether the diagnosis concerns ontic organization, environmental conditions, observation, or epistemic representation.

The distinction is summarized in Table 1.

Table 1 is intentionally asymmetric. The paper does not require every disturbance term to have an equally useful application at every level. *Generativity contamination* is principally reserved for the generative organization. *Generative pollution* is principally reserved for the generative landscape. *Observational contamination* concerns the observation or measurement. Existing uses of *epistemic pollution* principally concern epistemic environments, while inaccurate representations are described here as epistemic or inferential distortions.

This bearer-sensitive vocabulary prevents several category errors. Difficulty observing a star does not establish pollution of the star. A degraded examination environment does not establish contamination of the student. A low examination score does not establish a grammar-level impairment. An evaluator’s inaccurate representation does not establish that the represented person possesses the attributed property.

The requirement can be expressed as a diagnostic discipline:

$$\text{Diagnosis} \Rightarrow \text{Specify}(T, B, L, D, H) . \quad (26)$$

Equation 26 does not claim that the five fields are sufficient for a complete diagnosis. Source, mechanism, comparison, intensity, persistence, reversibility, and effect may also be required. The tuple records the minimum location information needed before those additional questions become coherent.

The distinction established in this section changes the role of the source-domain analysis that follows. Water, air, soil, light, noise, thermal environments, radioactive contamination, biological contamination, and analytical carry-over will be examined with explicit attention to their bearers and levels. The objective is therefore to identify which structural features belong to the affected medium, which belong to a receiver, which belong to an observation, and which concern downstream interpretation. This location-sensitive reconstruction provides the basis for defining generativity contamination and generative pollution without conflating a change in a generative system with a change in the conditions or representations through which that system becomes accessible.

4 Source-Domain Structures of Contamination and Pollution

This section reconstructs contamination and pollution across several natural-scientific, environmental, and analytical domains in order to identify structural distinctions that may inform the later definitions of generativity contamination and generative pollution. Its objective is comparative rather than terminological standardization. Scientific domains use *contamination*, *pollution*, and neighboring terms in heterogeneous ways, and no single source domain is treated as supplying a universal definition. The section therefore examines each domain separately, identifies the bearer and location of the relevant alteration, and extracts only those relations that remain conceptually useful after the source-specific content is removed. The final subsections synthesize the recurring structures and state the limits governing their transfer to Generative Relational Systems.

4.1 Water and Marine Contamination

This subsection uses water and marine terminology to separate exposure, contamination, environmental degradation, and adverse effect. Its objective is to show that presence within an altered environment, alteration of a receiving medium, and pollution of that environment can occupy different analytical positions. The method compares established marine definitions with the location-sensitive framework developed in Section 3.

A useful distinction appears in the marine-pollution terminology associated with GESAMP. Marine pollution is defined through the direct or indirect introduction by human activity of substances or energy into the marine environment where deleterious effects result. These effects can include harm to living resources, hazards to human health, interference with marine activities, impairment of seawater quality for relevant uses, and reduction of amenities [6]. In the same terminology, contamination is distinguished through elevated concentrations relative to the natural background level of the relevant area or organism [16].

The distinction is useful because it separates at least three analytical questions. The first concerns whether a substance or contribution is present above a declared background. The second concerns whether the environmental medium has been adversely altered. The third concerns which organisms, activities, or uses are affected by that alteration. These questions can be related without becoming equivalent.

The water example also clarifies the difference between environmental exposure and receiver-level alteration. Suppose water flows through an area containing a potential contaminant. Passage through the area identifies an exposure pathway. Whether the water itself acquires a relevant concentration of the substance is a further question. Whether that alteration subsequently impairs drinking, ecological, industrial, or another declared use is a further question again.

This sequence provides an important source-domain distinction for Generative Relational analysis:

$$\text{Exposure} \not\Rightarrow \text{Contamination} . \quad (27)$$

Equation 27 expresses a structural non-implication rather than a physical law transferred from water to persons. A bearer can encounter an adverse environment without undergoing the receiver-level alteration required for contamination.

Water also makes the role of comparison explicit. A claim that a concentration is elevated requires some reference condition, such as background level, regulatory threshold, upstream condition, historical condition, or another domain-specific baseline. Different comparisons answer different questions. A background concentration does not automatically provide a normative standard of purity, and a historical state does not automatically provide the appropriate environmental objective.

This caution transfers directly to the later generativity analysis. A person's earlier generative grammar cannot automatically serve as an uncontaminated baseline merely because it precedes a focal relation. Likewise, the prior state of an institution cannot automatically define an unpolluted generative landscape. Comparison must be declared and justified.

The principal contribution of the water and marine source domain is therefore the separation of *exposure*, *receiver-level presence or alteration*, *environmental degradation*, and *adverse consequence*. It also introduces the need for an explicit comparison condition. These features will recur throughout the later source domains in different forms.

4.2 Atmospheric Pollution and Secondary Formation

This subsection examines atmospheric pollution in order to introduce intensity, duration, source transformation, and secondary formation. Its objective is to challenge a transmission model in which an affected receiver must reproduce the form originally emitted by a source. The method draws on IUPAC atmospheric terminology and extracts the distinction between direct emission and subsequent formation within an intervening environment.

IUPAC defines air pollution through the presence of substances in the atmosphere at sufficient concentration, for sufficient time, and under circumstances that interfere with human comfort, health, welfare, or the environment [1]. The formulation is significant because the presence of a substance alone does not determine the diagnosis. Concentration, duration, receiving circumstances, and effects jointly matter.

Atmospheric terminology also distinguishes primary and secondary pollutants. A primary pollutant is emitted directly into the atmosphere from an identifiable source. Secondary pollutants, including ozone in the standard example, arise through chemical changes occurring after primary pollutants have entered the atmosphere [1]. The resulting pollutant therefore need not be identical to the material initially emitted.

This structure provides one of the most important source-domain inspirations for generativity contamination. A relation-derived alteration of person *B* need not consist in the transfer of a generative grammar already possessed by person *A*. The interaction can instead contribute conditions from which a different organization emerges.

For later purposes, the relevant structural relation can be represented as

$$s \longrightarrow e \longrightarrow z, \quad z \neq s, \quad (28)$$

where *s* denotes an originating contribution, *e* the intervening relational environment or transformation process, and *z* the resulting form. Equation 28 does not represent atmospheric chemistry itself. It records the abstract structure that motivates a later relational question.

Applied to generative grammar, the corresponding possibility is

$$\Gamma'_B \neq \Gamma_A, \quad (29)$$

even where a relation involving *A* contributes materially to Γ'_B .

The atmospheric example also cautions against assigning one scalar “exposure” variable to every case. A short intense exposure and a low-level persistent exposure may have different consequences. Repeated exposure can also interact with changing environmental conditions, other sources, and the state of the receiver. The later GR framework should therefore preserve intensity, duration, history, and interaction as potentially distinct dimensions.

A further implication concerns causal authorship. Where a secondary pollutant forms through interactions occurring after emission, identifying the original source does not by itself describe the complete causal process that produced the final substance. In relational systems, the same caution applies with greater force. A person can participate in a relation that contributes to a later grammar alteration without possessing, intending, or controlling the resulting form.

Atmospheric pollution therefore contributes four source-domain distinctions: intensity, duration, transformation, and secondary formation. Among these, secondary formation is especially important because it supports a non-transmission model of generativity contamination.

4.3 Soil Contamination, Buffering, and Accumulation

This subsection uses soil pollution to introduce buffering, finite absorptive capacity, accumulation, delayed effects, and transfer across environmental compartments. Its objective is to distinguish exposure from immediate alteration and to show how repeated inputs can remain partially absorbed before later changes become visible. The method draws on FAO and UNEP soil-pollution work while treating the resulting concepts as structural resources rather than models of human psychology.

FAO describes soil as both a filter and a buffer for contaminants and emphasizes that this buffering capacity is finite. When the capacity of soil to mitigate contaminating inputs is exceeded, contaminants can pass into groundwater, become available for plant uptake, enter food chains, and contribute to degradation in other environmental compartments [5]. Soil pollution can therefore involve storage, accumulation, delayed release, and downstream transfer rather than one immediate source-to-effect transition.

The concept of buffering is particularly important for the later analysis of generative systems. A receiver can encounter an adverse contribution and respond through existing interpretive, relational, institutional, or practical resources. The exposure may be resisted, transformed, compartmentalized, or rendered temporarily inconsequential. Repeated exposure can nevertheless interact with the receiver’s changing state and available resources.

The soil analogy therefore directs attention toward a sequence such as

$$\text{repeated input} \longrightarrow \text{buffering} \longrightarrow \text{accumulation} \longrightarrow \text{possible threshold transition.} \quad (30)$$

The expression is deliberately generic. Generative systems should not be assumed to possess one measurable buffering capacity, and a person’s resilience should not be represented as a passive storage volume. The useful point concerns temporal structure. Repeated exposure can fail to produce an immediate observable change while still contributing to a later transition.

Soil also introduces the possibility that what is retained in one compartment later affects another. A contaminant stored in soil may become mobile under changed conditions. It can then enter water, organisms, or food chains [5]. For Generative Relational Systems, the analogous question concerns whether an alteration initially localized to one domain, relation, or practice later becomes operative elsewhere.

A student, for example, might learn to suppress questions only in one highly punitive classroom while retaining exploratory inquiry elsewhere. Later institutional experiences may stabilize the learned pattern across a wider range of contexts. Such a sequence would require empirical evidence before it could be described as propagation, yet the soil source domain reminds the analysis to keep localization and later spread distinct.

Another useful feature is finite recovery capacity. Environmental systems can absorb disturbance within limits while preserving many functions. An observed absence of immediate failure therefore provides weak evidence about the absence of accumulated disturbance. Conversely, accumulated material does not guarantee a later threshold event because remediation, transformation, export, or changed

conditions can intervene.

The principal structural contributions from soil are consequently *buffering*, *accumulation*, *threshold sensitivity*, *latency*, and *cross-compartment transfer*. These features will later help distinguish contamination occurrence from the temporal pathways through which contamination becomes persistent or propagates.

4.4 Light Pollution and Observational Contamination

This subsection uses artificial light and optical observation to sharpen the distinction among field-level pollution, observational contamination, and change in an observed object. Its objective is to demonstrate that degradation of access to an object can occur while the object itself remains unchanged. The method separates the optical environment, measurement process, observation, and astronomical source.

Artificial light at night can increase skyglow and degrade the darkness of astronomical observing sites. IAU site-protection work treats the artificial contribution to night-sky brightness as a condition requiring measurement, limitation, and reduction in order to protect astronomical observations [8]. The relevant pollution is located in the terrestrial observational environment.

A distant star observed through that environment need not undergo any corresponding physical alteration. The degradation concerns the field through which astronomical information becomes accessible to an observer. The same distinction applies at the instrument level. Stray light within an optical instrument can contribute error to a measured signal, and characterization of the instrument can support correction of that error [22].

The light domain therefore separates at least three bearers:

$$S \longrightarrow \mathcal{L}^O \longrightarrow O, \quad (31)$$

where S is the astronomical source, $\mathcal{L}^O$ the observational field, and O the resulting observation.

Pollution of $\mathcal{L}^O$ can coexist with an unchanged S . Contamination of O can also coexist with an unchanged S . The later epistemic interpretation of O introduces another level again.

This source domain is particularly valuable for the present paper because generative systems are frequently known through output. A student's examination result, an employee's performance record, a researcher's publication count, or an institution's metric can be treated as an observation of an underlying capacity or organization. The light analogy warns that degradation of the conditions producing an observation can change the observation without establishing a change in the underlying generative object.

The relevant source-domain non-implication is

$$\text{Polluted}(\mathcal{L}^O) \not\Rightarrow \text{Altered}(S). \quad (32)$$

Transferred to the generative framework, this motivates the requirement that evidence of polluted educational, institutional, or relational conditions cannot by itself establish generativity contamination.

Light also demonstrates that pollution need not involve insertion of a material substance into the affected field. The disturbance can consist in additional energy that modifies conditions of visibility and measurement. This feature broadens the later concept of generative pollution beyond material scarcity or the presence of a foreign object.

The principal contribution from light is therefore a level-sensitive distinction among *object*, *field*, *observation*, and eventually *epistemic representation*. It provides the clearest source-domain support for refusing to infer ontic alteration from degraded access or contaminated observation.

4.5 Noise Pollution and Receiver-Relative Interference

This subsection uses noise pollution to examine interference that depends upon the relation among an environmental signal, a receiver, an activity, and a context. Its objective is to show that a disturbance can

be physically real while its generative significance remains receiver- and function-relative. The method extracts the relational structure of interference without reducing generative pollution to subjective dislike.

EPA describes noise in the traditional environmental sense as unwanted or disturbing sound and emphasizes interference with activities such as sleep and conversation, as well as broader effects on quality of life [19]. The important structural feature is that sound becomes environmentally significant partly through its relation to ongoing activities and receiving conditions.

The same acoustic event can therefore have heterogeneous effects across contexts. Sound that is relevant information within one activity can function as interference within another. A level that is tolerable for a brief period can become disruptive when exposure is prolonged. A person performing a highly attention-sensitive task can experience greater interference than a person engaged in an activity less dependent upon sustained concentration.

The source-domain structure can be represented schematically as

$$I = F(s, r, a, c), \quad (33)$$

where s denotes the signal or disturbance, r the receiver, a the activity, and c the surrounding context. The expression is an analytical schema rather than a quantitative noise model.

This structure matters for generative pollution because an environmental condition should rarely be classified in isolation from the form of generation under examination. Continuous conversation nearby may interfere severely with linguistic composition while having less effect on another activity. Constant institutional notification can fragment sustained conceptual work while supporting rapid coordination tasks. Strong evaluative monitoring can inhibit exploratory inquiry while increasing compliance with standardized procedures.

Generative pollution should therefore be indexed to a domain and function. An environment can be polluted relative to one generative process while remaining compatible with another. This domain sensitivity also prevents the concept from becoming a general label for environments that an observer personally dislikes.

Noise adds another caution. Receiver-relative significance does not imply that the disturbance exists only subjectively. Sound pressure, exposure time, spatial configuration, and task interference can all be investigated empirically. Likewise, generative pollution can involve objective institutional or environmental conditions while their consequences differ among bearers.

The principal contributions of the noise domain are consequently *receiver relativity*, *activity relativity*, *context dependence*, and *interference*. These features will later support a domain-indexed concept of generative pollution.

4.6 Thermal Pollution and Environmental Condition Alteration

This subsection uses thermal pollution to examine environmental degradation that operates through changed conditions rather than through the introduction of propositional content or a persistent foreign object. Its objective is to broaden the concept of pollution from material admixture to parameter-level alteration of a field. The method focuses on the regulatory recognition of heat as a pollutant and on the structural difference between changing an environment and changing the internal organization of a receiver.

The United States Clean Water Act expressly includes heat within the statutory definition of a pollutant and defines pollution as human-induced alteration of the chemical, physical, biological, and radiological integrity of water [20]. Thermal effects are therefore capable of entering a pollution framework even though heat is not a foreign material constituent in the same sense as a persistent chemical contaminant.

This source domain provides a particularly useful model for generative pollution. A generative landscape can be degraded through changes in conditions without anyone communicating a belief, norm, instruction, or interpretive grammar to the affected person. Institutional parameters can change the dynamics of generation directly.

Examples include shortened decision times, fragmented schedules, increased surveillance, accelerated evaluation cycles, unstable access to resources, altered dependency structures, or increased costs of revision and exit. These conditions can influence what forms of inquiry or action remain practically viable even where the bearer understands the mechanism and retains a substantially intact generative grammar.

The abstract structure is

$$\theta_{\mathcal{L}} \longrightarrow \theta'_{\mathcal{L}}, \quad (34)$$

where $\theta_{\mathcal{L}}$ represents a set of conditions governing the operation of a landscape. The expression records parameter-level alteration without assuming a particular physical analogue.

Thermal pollution also reminds the analysis that some environmental disturbances can dissipate relatively rapidly once the source changes, whereas others persist through stored material, altered infrastructure, or ecological feedback. Persistence should therefore remain analytically separate from the occurrence of pollution.

For generative systems, the same distinction matters. A noisy environment can be restored quickly when the source stops. A resource structure may require institutional reconstruction. A learned relational pattern can remain after the environment improves. Different temporal properties belong to different levels of the process.

The principal contribution from the thermal domain is therefore *condition alteration without content transfer*. This feature supports a field-centered account of generative pollution and prevents the concept from being reduced to the presence of harmful messages, beliefs, or persons.

4.7 Radioactive Contamination, Persistence, and Removability

This subsection uses radioactive contamination to separate occurrence, hazard, persistence, transferability, and removability. Its objective is to show that identification of contamination can be analytically prior to an assessment of the magnitude of the associated harm or hazard. The method draws on IAEA safety terminology and retains only the distinctions relevant to the paper's diagnostic architecture.

The IAEA defines radioactive contamination through radioactive substances on surfaces or within solids, liquids, gases, including the human body, where their presence is unintended or undesirable, or through the process giving rise to that presence. The IAEA explicitly cautions that the term *contamination* identifies presence and does not itself indicate the magnitude of the hazard [9].

This is a significant conceptual distinction for the present framework:

$$\text{ContaminationOccurrence} \not\equiv \text{HazardMagnitude} . \quad (35)$$

The source-domain relation supports the broader methodological principle that structural diagnosis and downstream evaluation should remain separate. Generativity contamination, if established, need not automatically establish the magnitude of capability impairment or harm.

IAEA terminology also distinguishes fixed contamination from non-fixed or removable contamination [9]. The distinction introduces a property that is independent of initial occurrence. Two contamination events can therefore differ substantially in transferability and ease of removal while sharing the same general classification at the occurrence level.

This distinction is useful for generativity contamination, although its transfer requires caution. A grammar-level alteration might be highly revisable once the relevant relation ends. Another alteration might remain stable across new environments and resist ordinary opportunities for reconsideration. These cases differ in persistence and revisability, even if both satisfy the eventual occurrence criterion for contamination.

Accordingly, the later framework should keep at least four questions separate:

$$\langle \text{occurrence, persistence, removability, effect} \rangle . \quad (36)$$

The tuple does not imply common measurement scales. It records distinctions that should be reported independently.

The radioactive source domain also helps correct an earlier temptation to make persistence a necessary element of contamination itself. A condition can be identified as contamination and subsequently removed. Successful decontamination does not retroactively establish that contamination never occurred. For the generativity framework, persistence may therefore be a property of a contamination trajectory rather than a universal occurrence condition.

The language of *fixed* contamination should not be transferred literally to persons. Human generative systems are reflexive, relational, and capable of forms of revision unavailable to physical surfaces. The useful structural lesson concerns separation among occurrence, persistence, revisability, and hazard.

Radioactive contamination therefore contributes a particularly important discipline to the paper: a contamination diagnosis should specify what is present or altered and where, while severity, danger, persistence, and remediation remain further dimensions.

4.8 Biological Contamination, Proliferation, and Survival

This subsection uses foodborne-illness investigation to distinguish contamination from processes occurring after contamination. Its objective is to prevent the concepts of occurrence, proliferation, and persistence from being merged into one diagnosis. The method draws on the CDC classification of contributing factors while abstracting from the specific biological mechanisms.

CDC organizes contributing factors for foodborne illness outbreaks into three classes: contamination, proliferation, and survival. Contamination concerns how a pathogen or other etiological agent gets onto or into food. Proliferation concerns conditions that allow relevant bacterial or fungal agents to increase in number or produce toxic products. Survival concerns failures of processes that should have killed or sufficiently reduced the relevant pathogen population [2].

The classification yields the source-domain separation

$$\text{Contamination} \neq \text{Proliferation} \neq \text{Survival} . \quad (37)$$

The inequality indicates conceptual distinction rather than mutual exclusion. A single outbreak process can involve all three.

This distinction is highly relevant to generativity contamination. An initial grammar-level alteration may occur without subsequently expanding across domains. Another alteration may become self-reinforcing through later relations. A third may remain present because the conditions that would normally support revision or attenuation are absent.

The paper should therefore distinguish at least:

- the occurrence of a relation-derived grammar alteration;
- the propagation or proliferation of that alteration;
- the persistence or survival of the alteration through time;
- the conditions that inhibit, revise, or remove it.

These stages can have different causes. A relation contributing to the initial alteration need not be the relation that later stabilizes it. A polluted institutional environment might sustain a pattern produced elsewhere. A later supportive relation might reduce or transform the pattern without altering the historical fact that the earlier contamination occurred.

Biological contamination also emphasizes that a receiving environment can affect what happens after the contaminating event. Temperature, time, and other environmental conditions influence proliferation in foodborne cases [2]. In a Generative Relational System, the subsequent landscape can likewise affect whether a grammar-level alteration remains localized, expands, weakens, or is revised.

The analogy must remain limited. A generative grammar is not a pathogen population, and propagation of a learned or relationally generated pattern cannot be equated with biological replication. The transferable distinction concerns temporal decomposition: *entry or occurrence*, *subsequent amplification*, and *continued persistence* require separate analysis.

The biological source domain therefore strengthens the paper’s decision to remove persistence from any simple definition of contamination occurrence and to treat later propagation as an independently observable process.

4.9 Analytical Carry-Over and Historical Dependence

This subsection examines analytical carry-over as a source-domain model of historical dependence. Its objective is to show how a contribution originating in an earlier interaction can affect a later observation after the original source is no longer directly involved. The method draws on IUPAC clinical chemistry terminology and transfers only the temporal structure of cross-episode influence.

IUPAC defines carry-over as transfer of specimen material or reagents from one container or reaction mixture into another to which they do not belong. Carry-over can occur across a series of specimens or assays. In the related clinical-chemistry definition, contamination from a preceding sample probe can influence a following specimen and thereby affect multiple assays associated with that specimen [7].

This structure highlights a form of historical dependence:

$$E_{t_0} \longrightarrow \Delta S_{t_1} \longrightarrow O_{t_2}, \quad t_0 < t_1 < t_2, \quad (38)$$

where an earlier event E_{t_0} contributes to a later state ΔS_{t_1} , which then affects an observation at a still later time.

For Generative Relational Systems, the relevant insight concerns *carry-over after source absence*. A person can leave a relation while an alteration generated through that relation remains operative in later interpretation, action, or relation formation. The original actor need not be present in the later episode.

For example, a student’s earlier evaluative environment may cease after graduation. Yet a learned rule concerning which questions are safe to ask may continue shaping later academic relations. The present environment can be supportive while the historical alteration remains operative.

This structure supports another central non-implication:

$$\text{Contaminated}(\Gamma_{B,t}) \not\Rightarrow \text{CurrentlyPolluted}(\mathcal{L}_{B,t}). \quad (39)$$

The current field does not uniquely identify the historical conditions that generated the present grammar.

Analytical carry-over also clarifies why provenance matters. If a later observation is affected by residue from an earlier sample, interpretation requires knowledge of the preceding sequence. Similarly, evidence concerning generative grammar can be misleading when relational history is ignored.

The analogy again has clear limits. A person is not a specimen cup, and earlier relations do not simply leave separable material residues. Later grammar can transform earlier influence, combine it with new relations, and generate forms that were never present in the original interaction. The transferable structure is therefore historical dependence rather than literal residue.

Analytical carry-over contributes the concepts of *sequence*, *provenance*, *source absence*, and *later effect*. These concepts will become important when the paper develops contamination persistence and cross-level feedback.

4.10 Cross-Domain Structural Features

This subsection synthesizes the preceding source domains into a shared analytical vocabulary. Its objective is to identify recurring structural features without imposing one definition of contamination or pollution across heterogeneous sciences. The method treats each feature as a candidate dimension whose relevance must be justified separately in the receiving domain.

Table 2: Source-Domain Structures and Their Generative-Relational Relevance

Source domain	Principal structure	Generative-relational relevance
Water and marine systems	Background, exposure, environmental degradation	Separation of exposure, receiver alteration, pollution, and adverse effect
Atmospheric systems	Concentration, duration, secondary formation	Relation-derived outcomes can differ from originating contributions
Soil	Buffering, accumulation, threshold sensitivity	Repeated exposure can be absorbed, accumulated, delayed, or propagated
Light	Field pollution and observational interference	Altered access or observation does not establish alteration of the object
Noise	Receiver- and activity-relative interference	Pollution can depend upon the relation between condition and generative task
Thermal systems	Environmental parameter alteration	Pollution can occur without transmission of material or propositional content
Radioactive contamination	Occurrence, hazard, persistence, removability	Contamination occurrence can be separated from severity and remediation
Biological systems	Contamination, proliferation, survival	Occurrence, propagation, and persistence require separate diagnosis
Analytical carry-over	Sequence, provenance, later influence	Historical relations can remain relevant after the original source is absent

The comparison reveals a recurring sequence involving a source or disturbance, a pathway or exposure, interaction with a receiving medium or field, a possible alteration, and later consequences. The sequence is neither universal nor linear. Some domains emphasize field alteration, others receiver-level presence, and others contamination of observations.

A general source-domain record can be represented as

$$\mathbf{P}^{(d)} = \langle s, e, r, i, \tau, b, x, a, p, q, v, f \rangle_d, \quad (40)$$

where d denotes the source domain and the coordinates provisionally record source, exposure, receiver, intensity, duration, buffering, transformation, accumulation, propagation, persistence, reversibility or removability, and effect. The symbols are bookkeeping devices. They do not imply common units, independence, or scalar aggregation.

The source domains and their principal structural contributions are summarized in Table 2.

As summarized in Table 2, the source domains emphasize different structural features rather than supplying a single cross-domain definition. Several cross-domain non-implications can now be stated.

First,

$$\text{Exposure} \not\Rightarrow \text{Contamination}. \quad (41)$$

Second,

$$\text{PollutedField} \not\Rightarrow \text{ContaminatedReceiver}. \quad (42)$$

Third,

$$\text{Contamination} \not\Rightarrow \text{Persistence}. \quad (43)$$

Fourth,

$$\text{Contamination} \not\Rightarrow \text{Harm} . \quad (44)$$

Fifth,

$$\text{ResultingAlteration} \not\Rightarrow \text{SourceReplication} . \quad (45)$$

These statements summarize structural possibilities supported by the comparative reconstruction. Their later use in Generative Relational Systems still requires independent conceptual justification.

The source-domain analysis also suggests that contamination and pollution are best treated as bearer-sensitive concepts. Pollution frequently concerns the condition of an environmental medium or field. Contamination frequently concerns the presence or operation of an unintended, extraneous, or contextually undesirable contribution within a receiving medium, sample, observation, or system. Actual scientific usage contains overlap and exceptions, as IUPAC explicitly acknowledges [13]. The distinction should therefore be treated as an analytical reconstruction rather than a report of universal scientific usage.

Within the present framework, this reconstruction motivates a provisional allocation:

$$\text{GenerativityContamination} \rightsquigarrow \Gamma, \quad \text{GenerativePollution} \rightsquigarrow \mathcal{L}^G . \quad (46)$$

The symbol $\rightsquigarrow$ indicates principal analytical association. The complete definitions remain for Sections 5 and 6.

The cross-domain comparison therefore supplies a vocabulary of mechanisms and dimensions rather than a ready-made theory of generativity. Its value lies in making distinctions available that would otherwise be easily collapsed: exposure and uptake, pollution and contamination, occurrence and persistence, primary contribution and secondary formation, buffering and accumulation, object alteration and observational interference, current conditions and historical carry-over.

4.11 Limits of Source-Domain Transfer

This subsection establishes the methodological boundary between source-domain reconstruction and claims about persons or other Generative Relational Systems. Its objective is to prevent environmental, chemical, biological, and analytical concepts from being naturalized into a theory of subject formation. The method identifies structural differences that restrict which analogical features can be transferred and specifies the permitted inferential direction for the remainder of the paper.

The first limit concerns purity. Water, analytical samples, and physical surfaces can sometimes be compared with declared background or reference states in ways that permit identification of extraneous constituents. A person's generative grammar has no equivalent presocial reference state available to the present framework. Human generative organization is already historical and relational.

Generativity contamination therefore cannot be defined through deviation from a pure original self:

$$\Gamma_B^{\text{pure}} \text{ is not presupposed.} \quad (47)$$

A pre-relation grammar can function as one empirical comparison under specified conditions, yet chronological priority does not grant it normative authority.

The second limit concerns passive reception. Physical media can often be described through uptake, storage, concentration, or deposition. Persons can interpret, contest, transform, reject, reframe, and strategically respond to relational influence. The receiving system can also act back upon the source and alter the surrounding field.

A more appropriate relational architecture is therefore

$$\Gamma_A \longleftrightarrow \rho_{AB} \longleftrightarrow \Gamma_B, \quad (48)$$

with both participants embedded in wider conditions. The resulting alteration can be co-generated and asymmetrically distributed.

The third limit concerns separability. A chemical contaminant may sometimes be identified as a constituent distinguishable from the receiving medium. A relation-derived grammar alteration may have no separable component that can be attributed to one source. The altered organization can be emergent.

The fourth limit concerns function. Environmental sciences can often evaluate pollution relative to ecosystem integrity, regulatory standards, health, potability, visibility, or another specified use. Persons and relational systems possess heterogeneous and contested forms of generativity. The paper therefore rejects a universal scalar function against which all generative alterations can be measured.

The fifth limit concerns reflexive observation. Scientific samples do not usually revise their behavior because they have been classified by the observer. Persons and institutions can respond to observation, classification, evaluation, and prediction. An epistemic judgment can become part of the later causal environment of the person it describes.

This reflexivity enables the cross-level pathway developed in Section 3.5:

$$\text{observation} \longrightarrow \text{judgment} \longrightarrow \text{relation} \longrightarrow \text{possible ontic alteration.} \quad (49)$$

The sixth limit concerns normativity. Environmental uses of *pollution* frequently contain explicit adverse-effect or degradation criteria. Technical uses of *contamination* vary in their evaluative content. The present paper cannot infer the normative status of a grammar-level alteration merely from these source-domain semantics.

The permitted inferential direction is therefore

$$\begin{aligned} \text{source-domain distinction} &\longrightarrow \text{GR analytical question} \\ &\longrightarrow \text{independent conceptual test} \\ &\longrightarrow \text{conditional GR definition.} \end{aligned} \quad (50)$$

The prohibited shortcut would treat similarity of vocabulary as evidence that persons or institutions instantiate the same physical mechanism.

The source-domain analysis consequently performs a bounded role. It reveals that contamination and pollution can differ in bearer, level, temporal structure, dependence on adverse effect, relation to persistence, and mechanism of propagation. It also provides concepts of buffering, secondary formation, receiver-relative interference, removability, and carry-over. The following sections use these distinctions to construct definitions appropriate to Generative Relational Systems while leaving behind the physical ontology of the source domains.

5 Generativity Contamination

This section develops the paper’s provisional definition of generativity contamination. Its objective is to identify the conditions under which a relation-derived alteration becomes sufficiently operative within a bearer’s generative organization to warrant a contamination diagnosis. The section proceeds from bearer specification to relational source, grammar-level uptake, primary and secondary alteration, persistence and propagation, revisability and recovery, and the distinction between structural occurrence and adverse effect. The method is conditional and level-sensitive. Each component is introduced separately so that contamination is not inferred from exposure, environmental adversity, observable performance, persistence, or harm alone.

5.1 Bearer and Affected Generative Organization

Generativity contamination is principally indexed to the generative organization of a specified bearer. For the person-centered cases developed in this paper, the primary bearer is person B , and the affected object is the person’s generative grammar $\Gamma_{B,t}$.

The location of the diagnosis can therefore be written as

$$\text{Contam}_G(\Gamma_{B,t}), \quad (51)$$

where the subscript G identifies the contamination as generativity-related.

This location distinguishes generativity contamination from pollution of the generative landscape, contamination of an observation, and epistemic distortion. A hostile classroom can be polluted while a student's grammar remains intact. An examination result can be contaminated by environmental interference while the underlying generative organization remains unchanged. An evaluator can form an inaccurate judgment about a student without altering the student's generativity.

A contamination diagnosis therefore requires evidence concerning the generative organization itself.

The relevant alteration can affect different parts of the grammar introduced in Section 2.2. It may change how interpretations are formed, how possible ends acquire salience, how actions or relations are generated, or how the grammar responds to later experience and revision. The alteration need not affect every component simultaneously.

A useful minimum condition is therefore

$$\Gamma_{B,t_1}^f \not\equiv_D \Gamma_{B,t_1}^q, \quad (52)$$

where Γ_{B,t_1}^f denotes the factual grammar trajectory, Γ_{B,t_1}^q an admissible comparison trajectory, and D the declared domain.

Equation 52 establishes only a grammar-level difference. It does not yet establish contamination. Relational development routinely produces differences of this kind.

The contamination concept therefore requires additional conditions concerning the source, operation, and material significance of the alteration.

5.2 Relational Sources and Emergent Alteration

This subsection specifies how another person or relational configuration can participate in generativity contamination without functioning as the author of a transferred grammar. Its objective is to preserve relational causation while avoiding a transmission model. The analysis distinguishes causal or constitutive contribution from intention, objective, benefit, and identity of form.

Let $\rho_{AB,t}$ denote a relevant relation involving person A and person B . A relation-derived grammar alteration can be represented schematically as

$$\Gamma_{B,t+1} = \mathcal{U}_B(\Gamma_{B,t}, X_{B,t}, \rho_{AB,t}, \eta_t), \quad (53)$$

where η_t records wider conditions relevant to the transition.

The relation is one constitutive or causal element in the change. The expression does not imply that person A controls the update process or supplies the resulting grammar in complete form.

Several non-implications follow.

First,

$$\text{Contam}_{A \rightsquigarrow B} \not\Rightarrow \text{Intent}_A. \quad (54)$$

A person can contribute to an alteration without intending to change the other person's generative organization.

Second,

$$\text{Contam}_{A \rightsquigarrow B} \not\Rightarrow \Gamma'_B = \Gamma_A. \quad (55)$$

The altered grammar need not reproduce the grammar of the contributing actor.

Third,

$$\text{Contam}_{A \rightsquigarrow B} \not\Rightarrow \text{GoalAlignment}(\Gamma'_B, \text{goal}_A). \quad (56)$$

Fourth,

$$\text{Contam}_{A \rightsquigarrow B} \not\Rightarrow \text{Benefit}_A. \quad (57)$$

These distinctions separate generativity contamination from concepts that require deliberate manipulation, directional control, or extraction of benefit.

The resulting grammar can instead be relationally emergent:

$$\Gamma'_B \neq \Gamma_B, \quad \Gamma'_B \neq \Gamma_A. \quad (58)$$

The form of Γ'_B can arise through the interaction of B 's prior grammar, the relation with A , wider environmental conditions, and the history of earlier relations.

This structure is analogous only at a high level to the secondary-formation distinction developed in Section 4.2. The analogy concerns non-identity between source contribution and resulting alteration. It does not imply a chemical mechanism of subject formation.

The relational-source requirement can also be satisfied by a distributed configuration. An institution, platform, group, or repeated sequence of interactions may contribute to grammar alteration without one actor serving as the sole source. The person-centered framework therefore permits

$$\rho_{AB,t}, \quad (59)$$

where $\mathcal{A}$ denotes a relevant set or organization of contributing actors.

The important criterion is relational contribution to the grammar-level alteration. Attribution of responsibility remains a later question.

5.3 Exposure, Uptake, and Grammar-Level Change

This subsection separates relational exposure from the transition through which a relation becomes operative within the generative grammar. Its objective is to prevent mere contact with an adverse person, institution, or environment from being classified as contamination. The method decomposes the process into exposure, uptake, incorporation into generative organization, and candidate contamination.

A person can encounter a relation without undergoing a material grammar-level alteration. Repeated criticism, evaluative pressure, ideological content, or a hostile institutional environment may be recognized and resisted. A person may also experience temporary emotional or behavioral effects that later subside without reorganizing subsequent generation.

The minimum sequence is therefore

$$\text{exposure} \longrightarrow \text{possible uptake} \longrightarrow \text{possible grammar alteration}. \quad (60)$$

Each transition is defeasible.

Exposure identifies contact with a relevant relational source or condition.

Uptake identifies a process through which the encounter affects the bearer's subsequent interpretation, salience, action generation, relation formation, or self-revision.

Grammar-level change identifies a state in which the effect has become operative within the organization that participates in later generation.

The term *uptake* is used cautiously. It does not require passive reception or literal incorporation of external content. A person can transform what is encountered, react against it, generate a compensatory rule, or produce an emergent pattern absent from the initiating source.

Consider repeated discouraging evaluation in education. A teacher tells a student that the student is poor at mathematics. Several trajectories remain possible.

The student may reject the judgment and retain the earlier grammar.

The student may experience temporary discouragement while later returning to the previous pattern of mathematical engagement.

The student may reduce participation because the classroom has become costly while still recognizing mathematical activity as a viable personal trajectory.

The student may eventually generate a more general rule through which mathematical challenges cease to appear as realistically attemptable.

Only the last case clearly approaches grammar-level contamination.

The distinction can therefore be written as

$$\text{Exposure}_{A \rightsquigarrow B} \not\Rightarrow \text{Contam}_G(\Gamma_B). \quad (61)$$

A further distinction concerns output. Reduced performance after exposure does not establish grammar-level uptake:

$$\Delta Y_B \not\Rightarrow \Delta \Gamma_B. \quad (62)$$

This separation becomes especially important in polluted environments, where changes in output can arise through environmental interference while the grammar remains intact.

For the present paper, a candidate contamination event therefore requires a relation-derived alteration that becomes operative within the generative organization beyond the immediate episode in which the exposure occurs. The extent of persistence remains a separate property developed below.

5.4 Primary and Secondary Generative Alteration

This subsection distinguishes alterations closely tied to a relational contribution from alterations generated through subsequent transformation. Its objective is to capture the possibility that contamination can arise through a sequence in which the later grammar differs substantially from the form of the initiating influence. The method adapts the primary-secondary distinction from the source-domain analysis while avoiding literal transfer of atmospheric terminology.

A *primary generative alteration* can be provisionally understood as a grammar-level change whose operative form remains relatively close to the content or pattern introduced through the focal relation.

For example, repeated external evaluation may contribute to a stable rule such as

“Questions resembling this type should be avoided because they invite punishment.”

The resulting generative rule remains closely related to the relational experience through which it arose.

A *secondary generative alteration* concerns a later organization that emerges through transformation of the earlier relational contribution.

Suppose repeated discouragement initially produces avoidance of one mathematical activity. Over time, the person develops a broader interpretive grammar through which intellectual risk itself becomes associated with anticipated failure. The later alteration is no longer a simple reproduction of the teacher’s original statements.

The structure can be represented as

$$\rho_{AB,t_0} \longrightarrow \Delta \Gamma_{B,t_1}^{(1)} \longrightarrow \Delta \Gamma_{B,t_2}^{(2)}, \quad (63)$$

where the second alteration is generated partly through the operation of the first.

This distinction is useful because the later state may have no direct verbal or behavioral equivalent in the original relation. A person can therefore display a grammar-level effect that cannot be reconstructed by searching for a matching statement or rule in the contributing actor.

Secondary alteration also complicates causal attribution. The initial relation may remain relevant to the historical pathway while later conditions, self-generated interpretations, additional relationships, and institutional structures contribute to the resulting form.

The distinction should therefore be treated as historical rather than authorial. *Primary* and *secondary* identify positions within a trajectory of transformation. They do not assign responsibility or imply that the earlier actor could have predicted the later form.

Secondary alteration can also amplify, attenuate, or redirect the effect of the original relation. A restrictive experience can generate resistance and thereby expand later generativity. A supportive relation can be interpreted through an existing restrictive grammar and contribute unexpectedly to later closure. The direction of transformation must therefore be investigated rather than inferred from the valence of the initiating relation.

5.5 Persistence, Propagation, and Carry-Over

This subsection separates the occurrence of contamination from its temporal continuation and spread. Its objective is to distinguish persistence, propagation, and historical carry-over as properties of a contamination trajectory rather than necessary components of the occurrence definition. The method follows the distinctions developed from radioactive, biological, and analytical source domains in Sections 4.7, 4.8, and 4.9.

A contamination event can occur and later be revised. Successful recovery does not imply that the earlier alteration never occurred. Persistence should therefore be treated as an additional temporal property.

Let t_c denote the time at which a candidate grammar-level contamination has become operative. Persistence over horizon H concerns whether the alteration remains relevant to subsequent generation:

$$P_B^H = \text{Persist}(\Delta\Gamma_{B,t_c}, [t_c, t_c + H]). \quad (64)$$

The expression does not impose a universal duration threshold. Persistence can be domain-relative. A pattern relevant to one high-stakes decision may matter over a shorter period than a pattern claimed to shape long-term identity or professional development.

Propagation concerns a different property. An alteration initially localized to one domain or relation can become operative in additional domains.

For domains D_1 and D_2 ,

$$\text{Contam}_G^{D_1} \longrightarrow \text{PossiblePropagation}^{D_2}. \quad (65)$$

The arrow expresses a possible transition. It does not imply that contamination necessarily spreads.

Carry-over concerns the continued relevance of an earlier relational history after the focal relation or polluted environment has ended. A student may leave a restrictive educational environment while an altered rule for generating possible intellectual trajectories remains operative.

The relevant non-implication is

$$\text{Contam}_G(\Gamma_{B,t}) \not\Rightarrow \text{CurrentlyPolluted}(\mathcal{L}_{B,t}^G). \quad (66)$$

This distinction is essential for identifying contamination without requiring continued exposure.

Persistence, propagation, and carry-over can also vary independently. A grammar alteration may persist for years while remaining limited to one domain. Another may spread rapidly across domains and then weaken. A third may reappear only under conditions resembling the original relation.

The contamination profile should therefore report these properties separately:

$$\mathbf{T}_B^C = \langle o, p, g, c \rangle, \quad (67)$$

where o denotes occurrence, p persistence, g propagation, and c carry-over.

The tuple is descriptive. It does not assign weights or aggregate the dimensions into one severity score.

5.6 Revisability, Removability, and Recovery

This subsection examines the conditions under which a contaminated generative grammar can be reconsidered, transformed, or cease to operate. Its objective is to distinguish reversibility from occurrence and to identify revisability as a relational capacity rather than a purely internal act of will. The method treats recovery as a trajectory through which alternative generative organization becomes practically accessible.

The source-domain concept of removability cannot be transferred literally to persons. A grammar-level alteration is not a detachable substance. The relevant generative analogue concerns the conditions under which the person can recognize the operation of the altered grammar, encounter alternatives, experiment with different trajectories, and revise the organization through which later possibilities are generated.

Let

$$\mathcal{R}_{B,t}^{D,H} \quad (68)$$

denote the effective revision possibilities available to person B in domain D over horizon H .

Revisability can depend upon both grammar and landscape. A person may possess the reflective resources needed to reconsider an alteration while lacking access to alternative relationships, information, time, safety, or institutional support. Another person may have abundant external alternatives while the altered grammar prevents those alternatives from becoming recognizable as viable.

The relevant object is therefore effective revisability:

$$\mathcal{R}_{B,t}^{D,H} = F(\Gamma_{B,t}, \mathcal{L}_{B,t}^G, H_{B,t}). \quad (69)$$

Equation 69 is schematic. It identifies the relational dependence of revision without claiming a measurable scalar function.

Several forms of recovery can then be distinguished.

Recognition recovery occurs when the person becomes able to identify the presence or operation of the altered grammar.

Alternative recovery occurs when previously inaccessible or unrecognizable generative trajectories become available for consideration.

Revision recovery occurs when the grammar itself changes in a way that restores or creates further possibilities of generation.

Relational recovery occurs when environmental and interpersonal conditions supporting continued alteration are removed or transformed.

These processes can occur separately.

Recovery also need not restore a prior grammar:

$$\Gamma_B^{\text{recovered}} \neq \Gamma_B^{\text{pre}}. \quad (70)$$

A person may move beyond both the earlier and contaminated organizations and generate a third configuration.

This point is theoretically important because the framework does not privilege return to an earlier self. Recovery concerns restored or newly generated conditions for viable revision and generation rather than restoration of historical identity.

Revisability may nevertheless matter to the eventual evaluation of contamination severity. An alteration that is easily recognized and revised differs from one that systematically restricts the conditions through which its own operation can be reconsidered.

The latter case introduces recursive closure:

$$\Delta\Gamma_B \longrightarrow \Delta\mathcal{R}_B \longrightarrow \text{ReducedProbability}(\text{Revision}(\Delta\Gamma_B)). \quad (71)$$

The expression is conceptual rather than statistical. It identifies a possible mechanism through which grammar alteration becomes self-stabilizing.

Recursive restriction of revisability may become an important marker of severe or adverse contamination. The paper nevertheless keeps it separate from the minimum occurrence condition because some contamination events may be readily revisable.

5.7 Adverse and Non-Adverse Contamination

This subsection addresses the evaluative threshold carried by the term *contamination*. Its objective is to distinguish the structural occurrence of relation-derived grammar alteration from adverse generative effects while acknowledging that ordinary language often gives contamination a negative valence. The method adopts a two-level terminology that preserves diagnostic separation and leaves normative conclusions for later sections.

The source-domain analysis demonstrated that contamination does not always encode demonstrated harm. Radioactive contamination, for example, can be identified independently of hazard magnitude, while environmental terminologies sometimes use contamination for presence above a relevant background without requiring the full conditions of pollution [9, 16]. These uses support a structural distinction between occurrence and adverse consequence.

Human relational development creates an additional problem. If every relation-derived grammar alteration were called contamination, the concept would become excessively broad. Education, friendship, language acquisition, care, artistic experience, and intellectual transformation can all alter the organization through which future generation occurs.

The present paper therefore distinguishes *generative alteration* from *generativity contamination*.

A *relational generative alteration* occurs when a relation contributes materially to a grammar-level change.

Generativity contamination is provisionally reserved for relational generative alterations that satisfy an additional condition of *contextually undesirable or generatively compromising operation*.

A provisional occurrence criterion can therefore be written as

$$\text{Contam}_G(A \rightsquigarrow B; D, H) = R_{AB} \wedge G_B \wedge M_D \wedge C_D, \quad (72)$$

where:

- R_{AB} records a supported relational contribution to the alteration;
- G_B records that the alteration is located in the generative grammar rather than only in one output or environmental condition;
- M_D records material significance within declared domain D ;
- C_D records an independently defensible contamination condition distinguishing the alteration from ordinary generative development.

The final component C_D carries the principal theoretical burden.

Candidate contamination conditions include impairment of effective revisability, systematic narrowing of recognizable alternatives, production of self-reinforcing restrictions on subsequent generation, or other domain-specific forms of generative compromise. No single candidate is assumed to be universally sufficient.

The paper therefore retains a plural contamination witness:

$$\mathbf{C}_{A \rightsquigarrow B}^{D, H} = \langle c^{\text{relation}}, c^{\text{grammar}}, c^{\text{material}}, c^{\text{compromise}}, c^{\text{uncertainty}} \rangle. \quad (73)$$

The final coordinate records diagnostic uncertainty because many real cases will remain underdetermined even where relational alteration is strongly supported.

Persistence is deliberately absent from the minimum witness. Propagation is also absent. Both remain trajectory properties developed in Section 5.5.

The distinction between contamination and harm is equally important. A generatively compromising alteration can still vary in seriousness. It may affect a narrow domain while leaving most generativity intact. It may be readily revised. It may coexist with gains in other domains. It may be reflectively endorsed while remaining difficult to compare with an admissible alternative.

Accordingly,

$$\text{Contam}_G \not\Rightarrow \text{Harm} . \quad (74)$$

The later harm analysis must consider capability effects, comparison conditions, distribution, reversibility, and other normative premises.

A beneficial transformation provides an important counterexample. Suppose a teacher profoundly changes a student's grammar of mathematical inquiry. The student begins generating questions that were previously unavailable, recognizes a wider range of methods, becomes more capable of revising prior assumptions, and gains access to new intellectual trajectories. The transformation is relational, grammar-level, material, and persistent.

Under the present definition, these properties establish relational generative alteration. They do not establish contamination because the additional contamination condition C_D is unsupported.

This counterexample prevents the framework from pathologizing relational development itself.

The resulting conceptual ordering is therefore

$$\text{relational exposure} \longrightarrow \text{possible generative alteration} \longrightarrow \text{possible generativity contamination} \longrightarrow \text{possible capability} \quad (75)$$

Each transition requires additional evidence or premises.

The definition developed in this section is therefore conditional rather than closed. Generativity contamination identifies a relation-derived, materially significant grammar-level alteration that additionally satisfies a defensible criterion of generative compromise. The diagnosis does not require intent, copying, benefit, current pollution, persistence, propagation, or harm. These properties can affect mechanism, severity, responsibility, or remediation while remaining analytically distinct from occurrence.

Section 6 develops the complementary field-level concept. The distinction between the two will then permit analysis of polluted conditions without contaminated persons, contaminated persons outside current polluted conditions, and recursive pathways through which the two processes interact.

6 Generative Pollution

This section develops the paper's provisional definition of generative pollution. Its objective is to identify when alterations of a generative landscape or relational field become sufficiently disruptive to warrant a pollution diagnosis while remaining distinct from grammar-level contamination. The section proceeds from bearer specification to material and non-material forms of pollution, intensity and duration, buffering and accumulation, domain-relative interference, and environmental persistence and recovery. The method is field-centered and conditional. Pollution is diagnosed through changes in the conditions under which generation occurs, while downstream effects on grammar, capability, output, observation, or harm remain separate questions.

6.1 Bearer and Affected Generative Conditions

Generative pollution is principally indexed to the generative landscape or relational field within which a specified bearer generates. Its primary affected object is therefore $\mathcal{L}_{B,t}^G$, rather than the generative grammar $\Gamma_{B,t}$.

A candidate diagnosis can be located as

$$\text{Pollute}_G (\mathcal{L}_{B,t}^G), \quad (76)$$

where the subscript G identifies the disturbance as generative rather than epistemic, ecological, or another form of pollution.

The landscape includes the conditions that shape whether relevant trajectories can be recognized, attempted, sustained, revised, or exited. Depending upon the domain, these conditions can include physical environment, time, resources, communication channels, institutional rules, recognition systems, evaluation structures, dependency relations, technologies, social norms, legal permissions, and available forms of support.

Generative pollution therefore concerns alteration of the conditions of generation rather than alteration of the generative organization itself.

A minimal field-level difference can be represented as

$$\mathcal{L}_{B,t_1}^{G,f} \not\equiv_D \mathcal{L}_{B,t_1}^{G,q}, \quad (77)$$

where the superscripts f and q denote factual and admissible comparison landscapes and D denotes the declared generative domain.

Equation 77 identifies a difference in conditions. It does not establish pollution because environmental change can be beneficial, neutral, mixed, or irrelevant to the generative process under study.

A pollution diagnosis therefore requires an additional criterion of generative interference or degradation.

The distinction between field and grammar is central:

$$\text{Pollute}_G (\mathcal{L}_{B,t}^G) \not\equiv \text{Contam}_G (\Gamma_{B,t}). \quad (78)$$

A person can remain critically aware, preserve the ability to generate alternatives, and retain a substantially intact grammar while operating in conditions that make generation difficult.

The educational example illustrates this distinction. Continuous noise can make sustained reasoning difficult. Severe time fragmentation can prevent extended inquiry. An unstable evaluation regime can increase the practical cost of experimentation. None of these conditions establishes that the student's generative grammar has changed.

Generative pollution is therefore a diagnosis of the field in which generation occurs. Its relevance to persons arises through the interaction between field conditions and situated generative processes.

6.2 Material and Non-Material Pollution

This subsection distinguishes pollution produced through material scarcity or physical interference from pollution produced through temporal, informational, institutional, symbolic, and relational conditions. Its objective is to avoid reducing generative pollution to the introduction of a harmful substance or message. The method draws on the source-domain observation that environmental pollution can arise through energy, altered parameters, and interference as well as material contaminants.

Material conditions can directly constrain generation. A laboratory may lack required equipment. A student may lack access to books, space, electricity, or reliable communication. An institution may remove resources needed to pursue a previously viable trajectory.

These cases alter practical conditions without requiring grammar-level change.

Physical interference provides another material route. Persistent noise, crowding, heat, poor lighting, or unstable access to a workspace can change the environmental conditions under which concentration, experimentation, or interaction occurs.

Generative pollution can also be non-material.

Temporal pollution can arise when scheduling structures fragment the periods required for sustained generation. Constantly changing deadlines, unpredictable meetings, or very short response cycles can reduce the practical availability of reflective or exploratory work.

Informational pollution can arise when relevant channels become saturated, obscured, or structured in ways that make useful signals difficult to distinguish from competing input. This category should remain separate from epistemic pollution when the principal effect concerns the conditions of generation rather than the reliability of belief formation.

Relational pollution can arise through interaction structures that make questioning, experimentation, disagreement, or revision excessively costly. Examples can include persistent ridicule, arbitrary interruption, unstable expectations, or systematic non-recognition of certain contributions.

Institutional pollution can arise when rules, metrics, incentives, or dependency structures reshape the practical conditions under which generativity is exercised. An institution can narrow available time, concentrate evaluative authority, reduce effective exit, or make only a small set of outputs institutionally recognizable.

These examples illustrate a general point:

$$\text{Pollution} \not\Rightarrow \text{MaterialInsertion} . \quad (79)$$

The source-domain analyses of light, noise, and thermal pollution already demonstrated this structural possibility. Artificial light can degrade an observational field through additional energy. Noise can interfere with an activity without becoming a persistent constituent of the receiver. Thermal pollution can alter an environmental parameter rather than introduce propositional content [8, 19, 20].

The generative analogue concerns altered conditions of operation.

A teacher need not tell a student what to think in order to pollute a generative environment. Constant surveillance, interruption, unstable evaluation, or restricted time can alter the conditions under which thinking, trying, revising, and relating become possible.

The concept should therefore remain neutral concerning the physical form of the disturbance. What matters is whether the relevant conditions of generation have become disruptively or degradatively altered relative to the declared domain and comparison.

6.3 Intensity, Duration, and Distribution

This subsection examines how the magnitude, temporal pattern, and distribution of a disturbance affect a pollution diagnosis. Its objective is to prevent pollution from being treated as a binary property independent of exposure structure. The method separates intensity, duration, frequency, spatial or relational distribution, and heterogeneity of exposure.

Atmospheric and noise source domains already show that disturbance often depends upon more than presence alone. Concentration, duration, receiving circumstances, and interference with relevant activities can all matter [1, 19].

The same structure applies to generative landscapes.

A brief interruption during one task may produce little effect. Continuous interruption over months can materially alter the practical conditions for sustained inquiry. A highly intense but short evaluative episode can have different consequences from low-level persistent monitoring.

A pollution profile can therefore record several dimensions without aggregating them:

$$\mathbf{P}_B^G = \langle i, \tau, f, d \rangle , \quad (80)$$

where i denotes intensity, τ duration, f frequency, and d distribution across persons, locations, relations, or domains.

The tuple is descriptive. It does not imply comparable units across dimensions.

Distribution is especially important in relational systems because a polluted field can affect participants unequally. One student may be repeatedly interrupted while another is rarely interrupted. One worker may depend upon a single evaluator while another has several channels of recognition. A rule that appears formally uniform can therefore generate heterogeneous exposure.

A field-level diagnosis should accordingly distinguish between

- pollution of a shared environment;
- unequal exposure within that environment;
- unequal sensitivity to the same exposure;
- unequal access to buffering or compensatory resources.

The same environment can therefore be polluted without producing identical effects across participants.

Intensity and duration should also be distinguished from severity of harm. A highly intense disturbance may be rapidly reversible. A low-intensity disturbance may accumulate over years and contribute to more consequential downstream effects.

The pollution diagnosis should therefore describe the structure of exposure before evaluating its consequences.

6.4 Buffering, Accumulation, and Threshold Effects

This subsection examines the capacity of a generative landscape and its participants to absorb, redirect, or compensate for disturbance. Its objective is to distinguish pollution pressure from immediately visible failure and to identify accumulation and threshold effects as possible temporal structures. The method adapts the buffering distinction developed from soil pollution without treating persons or institutions as passive environmental media.

FAO and UNEP emphasize that soil can buffer contaminating inputs while that capacity remains finite, and that accumulated contaminants can later become mobile or affect other environmental compartments [5]. The transferable structural insight concerns delayed consequence under repeated disturbance.

A generative field can also contain buffering resources.

These may include supportive peers, alternative information channels, institutional redundancy, flexible scheduling, multiple evaluators, access to quiet space, financial reserves, or effective exit.

A polluted condition can therefore exist while immediate generative output remains stable because buffering resources compensate for the disturbance.

This produces an important non-implication:

$$\text{StableOutput} \not\Rightarrow \text{UnpollutedLandscape} . \quad (81)$$

A researcher can maintain publication output while using increasingly large amounts of time to manage fragmented institutional demands. A student can maintain examination performance by investing additional effort under noisy conditions. The output conceals the changing environmental burden.

Repeated disturbance can also accumulate.

The relevant structure is

$$p_{t_1}, p_{t_2}, \dots, p_{t_n} \longrightarrow A_{[t_1, t_n]}, \quad (82)$$

where p_{t_i} denotes pollution pressure at time t_i and $A_{[t_1, t_n]}$ denotes accumulated environmental burden over the interval.

No additive interpretation is assumed. Interactions among disturbances, buffering resources, and changing conditions may be nonlinear.

A threshold effect occurs when the structure of available generation changes after accumulated disturbance passes a relevant functional boundary. For example, occasional interruption may be manageable while sufficiently frequent interruption makes extended reasoning practically impossible. Moderate evaluative pressure may coexist with experimentation while an additional concentration of authority makes failure too costly to risk.

Threshold language should remain descriptive unless empirical evidence supports a measurable transition. The paper does not assume that every generative field contains a critical numerical threshold.

Buffering can also fail asymmetrically. Participants with financial, relational, linguistic, institutional, or technical resources may compensate for a polluted environment more effectively than others.

A pollution diagnosis should therefore record both the disturbance and the available buffering conditions. Resilience of one participant does not imply that the field itself is unpolluted, and vulnerability of another does not alone establish that the field is polluted.

The relevant object remains the relation between the environmental condition and the generative process under examination.

6.5 Domain-Relative Generative Interference

This subsection specifies the additional condition distinguishing ordinary environmental variation from generative pollution. Its objective is to define pollution through material interference with declared generative conditions while avoiding a universal standard of favorable environment. The method indexes pollution to a domain, horizon, comparison, and relevant generative function.

Environmental change alone is insufficient:

$$\Delta \mathcal{L}^G \not\Rightarrow \text{Pollute}_G. \quad (83)$$

A classroom can become more demanding while improving learning conditions. A research institution can introduce tighter deadlines while simultaneously improving coordination. A public environment can become noisier while the new activity expands other forms of social or creative generation.

Generative pollution therefore requires a further condition of material interference, degradation, or disruptive alteration within a declared domain.

A provisional definition is

$$\text{Pollute}_G(\mathcal{L}_B^G; D, H) = L_B \wedge M_D \wedge I_D, \quad (84)$$

where:

- L_B records a supported alteration of the relevant generative landscape;
- M_D records material significance within domain D ;
- I_D records a defensible condition of generative interference or degradation.

The interference component I_D should be defined through the generative process affected rather than through generalized discomfort.

Candidate forms of interference include reduced practical reachability, increased transition cost, reduced recognizability of alternatives, fragmentation of sustained generation, reduced contestability, impaired revision conditions, or loss of effective exit.

These dimensions should remain plural.

The same condition can support one form of generation while polluting another. An institution optimized for rapid standardized production can support short cycle output while degrading conditions for long-term exploratory research. A highly structured educational environment can support routine performance while constraining open-ended inquiry.

Accordingly,

$$\text{Pollute}_G^{D_1} \not\Rightarrow \text{Pollute}_G^{D_2}. \quad (85)$$

The diagnosis is domain-relative rather than globally evaluative.

The comparison condition also matters. A factual landscape can be compared with a feasible institutional alternative, an earlier configuration, a relevant external benchmark, or a set of admissible comparisons. No single comparison is automatically privileged.

A historical baseline can be informative while remaining normatively inadequate. An earlier educational environment may have been less noisy yet more exclusionary. A prior workplace may have provided more autonomy while lacking necessary safety protections.

The pollution diagnosis should therefore separate

- factual environmental change;
- generative interference;
- comparative disadvantage;
- normative evaluation.

The present concept concerns the first three. A complete account of harm or wrongfulness remains downstream.

The provisional pollution witness is

$$\mathbf{P}_B^{D,H} = \langle p^{\text{landscape}}, p^{\text{material}}, p^{\text{interference}}, p^{\text{distribution}}, p^{\text{uncertainty}} \rangle. \quad (86)$$

The final coordinate records diagnostic uncertainty. A field can contain several interacting disturbances whose causal contribution cannot be identified precisely.

This witness parallels the contamination witness developed in Section 5.7 while preserving the different bearer.

6.6 Persistence and Environmental Recovery

This subsection separates the occurrence of generative pollution from its persistence and from the recovery of the affected landscape. Its objective is to distinguish temporary field disturbance, persistent pollution, structural lock-in, and post-pollution effects. The method treats recovery as a trajectory of environmental change rather than as proof that no earlier pollution occurred.

Generative pollution can be transient.

Noise can stop. Temporary resource shortages can be repaired. A restrictive rule can be revoked. An unstable schedule can be reorganized.

The end of a polluted condition does not negate its previous occurrence:

$$\text{Recovered}(\mathcal{L}_{t_1}^G) \not\Rightarrow \neg \text{Polluted}(\mathcal{L}_{t_0}^G), \quad t_0 < t_1. \quad (87)$$

Persistence therefore remains a temporal property of pollution.

A field can also contain structural forms of persistence. Infrastructure, institutional rules, dependency structures, recognition systems, or historically accumulated resource distributions can continue reproducing polluted conditions after the initiating actors or decisions have changed.

The persistence of a field can be represented schematically as

$$\mathcal{L}_t^G \longrightarrow \mathcal{L}_{t+1}^G \quad (88)$$

where the current configuration contributes to the reproduction of later conditions. This relation does not require a single intentional polluter.

Environmental recovery can occur at several levels.

Source removal occurs when the disturbance generating polluted conditions is removed.

Condition restoration occurs when the relevant environmental parameters or relations return to a viable range.

Structural reconstruction occurs when institutional or relational arrangements that reproduced pollution are altered.

Buffer restoration occurs when resources that allow participants to absorb or compensate for disturbance are restored or expanded.

These processes can occur independently.

The recovery of the field also does not guarantee recovery of every person previously exposed to it:

$$\text{Recovered}(\mathcal{L}_{B,t}^G) \not\Rightarrow \text{Recovered}(\Gamma_{B,t}). \quad (89)$$

This non-implication is central to the distinction between pollution and contamination.

A student can move from a hostile school into a supportive educational environment while continuing to generate self-limiting interpretations formed through earlier relations. The generative field has recovered for the student while the grammar-level alteration remains.

The reverse case is also possible. A person can revise an earlier grammar alteration while remaining in a polluted field. Critical recognition, supportive relationships, or alternative resources can protect or restore generativity without correcting the environmental source.

The temporal relation between pollution and contamination must therefore be traced rather than inferred from present conditions.

The provisional definition developed in this section can now be summarized. Generative pollution concerns a materially significant degradation or disruptive alteration of the generative landscape relative to a declared domain, horizon, and admissible comparison. It does not require material insertion, contamination of any particular person, grammar-level alteration, persistence, or demonstrated harm. Its effects can be buffered, distributed unequally, accumulate, cross thresholds, or recede through environmental recovery.

Section 7 examines the interaction between this field-level diagnosis and generativity contamination. That interaction includes polluted landscapes without contaminated persons, contaminated persons outside currently polluted landscapes, pathways through which pollution contributes to contamination, and feedback through which grammar-level alterations reproduce polluted fields.

7 Relations between Generative Pollution and Generativity Contamination

This section develops the relation between generative pollution and generativity contamination after defining the two diagnoses separately. Its objective is to show that field-level degradation and grammar-level contamination form analytically independent dimensions that can nevertheless interact through temporally extended relational processes. The section first examines pollution without contamination and contamination without current pollution. It then considers their joint occurrence, pathways through which pollution can contribute to contamination, feedback through which contaminated generative organizations can reproduce polluted fields, and recursive or cross-generational propagation. The method is configurational and mechanism-sensitive. Co-occurrence does not establish causal direction, and each proposed transition requires independent evidence.

7.1 Pollution without Contamination

This subsection examines configurations in which a generative landscape is polluted while the generative grammar of a focal bearer remains substantially intact. Its objective is to establish the logical independence of field-level degradation from grammar-level contamination. The method compares the affected bearer at each level and identifies mechanisms through which polluted conditions can impair generation without becoming operative within the person's generative organization.

Let

$$P_B^{D,H} = \text{Pollute}_G(\mathcal{L}_B^G; D, H) \quad (90)$$

denote a supported generative-pollution diagnosis for bearer B , and let

$$C_B^{D,H} = \text{Contam}_G(\Gamma_B; D, H) \quad (91)$$

denote a supported generativity-contamination diagnosis.
The first configuration is

$$P_B^{D,H} = 1, \quad C_B^{D,H} = 0. \quad (92)$$

The polluted field can constrain what the person can practically do while the person continues to recognize the source of the interference, generate alternatives, and retain the organization required to act differently under improved conditions.

A noisy classroom provides a simple case. Persistent construction noise can fragment attention and reduce the time available for sustained mathematical reasoning. The student may nevertheless continue to understand the material, retain confidence in mathematical ability, recognize the noise as the source of difficulty, and resume ordinary reasoning when the interference ends.

The relevant change is therefore located principally in

$$\mathcal{L}_B^G$$

rather than in

$$\Gamma_B.$$

The same structure can occur in institutional settings. A researcher may work under fragmented schedules, unstable resource access, or excessive administrative interruption while retaining a broad grammar of worthwhile research questions. The polluted environment can reduce practical productivity without altering the organization through which research possibilities are generated.

This configuration also reveals why poor output is insufficient for a contamination diagnosis. The pathway

$$\text{Pollute}_G(\mathcal{L}_B^G) \longrightarrow \Delta Y_B \quad (93)$$

can occur without an intervening grammar-level change.

A second form of pollution without contamination occurs where the person develops effective buffering resources. Supportive peers, alternative workspaces, multiple evaluators, financial reserves, or access to external institutions can compensate for polluted local conditions. Stable or even strong output under these circumstances does not establish that the environment is unpolluted.

The configuration therefore supports two non-implications:

$$P_B^{D,H} \not\Rightarrow C_B^{D,H}, \quad (94)$$

and

$$\Delta Y_B \not\Rightarrow C_B^{D,H}. \quad (95)$$

These relations prevent a field pathology from being relocated into the person without evidence of grammar-level alteration.

7.2 Contamination without Current Pollution

This subsection examines configurations in which a grammar-level contamination remains operative after the focal polluted environment has ended or been repaired. Its objective is to separate present environmental conditions from the historical relations through which a current generative organization was formed. The method uses temporal indexing and relational provenance.

The second configuration is

$$P_{B,t_1}^{D,H} = 0, \quad C_{B,t_1}^{D,H} = 1. \quad (96)$$

This configuration can arise when contamination carries over from earlier relations.

Suppose a student experienced repeated public discouragement in an earlier school. The student later enters a supportive institution with quiet study space, encouraging teachers, multiple routes of recognition, and practical opportunities to attempt advanced mathematics. The current landscape is no longer polluted in the relevant respect.

The student's grammar may nevertheless continue generating mathematical possibilities through a restrictive rule such as

“Advanced mathematical work is outside the range of trajectories available to me.”

The current environmental conditions and the current generative organization therefore carry different histories.

A minimal temporal representation is

$$\mathcal{L}_{B,t_0}^G \longrightarrow \Delta\Gamma_{B,t_1} \longrightarrow \Gamma_{B,t_2}, \quad t_0 < t_1 < t_2, \quad (97)$$

where the polluted condition at t_0 has ceased by t_2 , while the grammar-level alteration remains operative.

This structure makes relational provenance essential. Examination of present conditions alone can fail to explain the current grammar. Conversely, historical adversity cannot establish contamination merely because it preceded the current state. Evidence must support the relevant causal or constitutive pathway.

Contamination without current pollution also shows why environmental recovery and personal recovery require separate analysis. Repairing the field can remove continuing exposure and create new revision opportunities while leaving earlier alterations intact.

The distinction can be written as

$$\text{Recovered}(\mathcal{L}_{B,t}^G) \not\Rightarrow \neg \text{Contam}_G(\Gamma_{B,t}). \quad (98)$$

The configuration does not imply that contamination is permanent. Improved conditions may later support recognition, revision, and recovery. The analytical point concerns temporal lag between field recovery and grammar reorganization.

7.3 Combined Pollution and Contamination

This subsection examines cases in which polluted generative conditions and grammar-level contamination coexist. Its objective is to show how the two diagnoses can reinforce each other while retaining different bearers and mechanisms. The method treats joint occurrence as a configuration before considering causal direction.

The combined configuration is

$$P_B^{D,H} = 1, \quad C_B^{D,H} = 1. \quad (99)$$

This state can arise through several histories.

Pollution may precede contamination. A persistently humiliating educational environment can first degrade the conditions for asking questions and later contribute to a grammar in which questioning itself ceases to appear viable.

Contamination may precede current pollution. A person carrying a restrictive grammar can enter an institution in which that grammar interacts with local rules and contributes to the production of polluted conditions.

Both can also arise through a wider process without one serving as the sole cause of the other.

The joint state should therefore be represented as a configuration rather than a causal conclusion.

The four logically available pollution–contamination configurations are summarized in Table 3.

Table 3: Configurations of Generative Pollution and Generativity Contamination

	No contamination	Contamination
No pollution	Relatively intact field and grammar with respect to the declared diagnosis	Grammar contamination outside a currently polluted field
Pollution	Polluted field with no demonstrated grammar contamination	Combined field pollution and grammar contamination

Table 3 does not describe generative quality globally. A cell marked “no pollution” or “no contamination” means only that the corresponding diagnosis is not supported within the declared domain, horizon, and comparison.

The combined configuration can increase diagnostic difficulty because current output can reflect both levels simultaneously. If a student generates little mathematical work, part of the reduction may arise from an altered grammar and part from continuing environmental interference.

Observed output can therefore be represented as depending on both:

$$Y_{B,t} \sim P_{\Gamma_{B,t}}(\cdot \mid \mathcal{L}_{B,t}^G, X_{B,t}, H_{B,t}). \quad (100)$$

The presence of both diagnoses does not determine their relative causal importance.

The combined state can also create mutually stabilizing conditions. A polluted field can reduce access to experiences that would challenge a contaminated grammar. The contaminated grammar can make the polluted field appear natural, necessary, or difficult to contest. This possibility motivates the feedback analysis developed below.

7.4 Pollution-to-Contamination Pathways

This subsection develops mechanisms through which degradation of a generative landscape can contribute to later grammar-level contamination. Its objective is to specify possible transitions while avoiding an environmental determinism in which polluted conditions automatically alter every exposed person. The method decomposes the pathway into exposure, relational mediation, uptake, transformation, and grammar-level operation.

A generic pathway is

$$\text{Pollute}_G(\mathcal{L}_{B,t_0}^G) \longrightarrow E_B \longrightarrow \rho_B \longrightarrow \Delta\Gamma_{B,t_1}, \quad (101)$$

where E_B denotes relevant exposure and ρ_B denotes the relational process through which the exposure contributes to grammar alteration.

Several mechanisms can occupy the intermediate positions.

Repetition can make a relational pattern increasingly available in later generation. Repeated discouraging feedback can contribute to stable expectations concerning which trajectories are safe or worthwhile.

Adaptation can make an initially external constraint part of the person’s later generative organization. A student who repeatedly learns that asking difficult questions produces humiliation may begin avoiding such questions before any external sanction is present.

Normalization can alter the range of conditions perceived as ordinary. A persistently restrictive institution can make limited alternatives appear to be the natural structure of the domain.

Recognition asymmetry can contribute to grammar alteration when only a narrow class of outputs receives stable acknowledgment. A person may gradually generate possibilities in accordance with what can be institutionally seen or rewarded.

Dependency can alter the practical cost of experimenting with alternatives. Where access to resources, credentials, or future opportunities depends heavily upon one relational channel, repeated accommodation can later participate in grammar-level change.

These mechanisms remain hypotheses requiring domain-specific evidence.

The pathway can also include observational and epistemic mediation. A polluted field can depress output, the resulting observation can be misinterpreted, and the misinterpretation can return to the person through evaluation:

$$\text{Pollute}_G \longrightarrow \text{Contam}(O) \longrightarrow \text{Distort}(K) \longrightarrow \Delta\rho \longrightarrow \Delta\Gamma. \quad (102)$$

This mechanism is especially important in education and institutional assessment.

Suppose a noisy testing environment depresses a student's performance. An evaluator interprets the score as evidence of low ability. The evaluation changes which courses the student is encouraged to enter. Repeated judgments also influence the student's interpretation of personal ability. A field-level disturbance can thereby contribute indirectly to grammar contamination through an observational and relational loop.

The pathway remains defeasible at every stage. A student can identify the environmental source of poor performance. An evaluator can correct for testing conditions. Alternative teachers can provide competing recognition. The student can reject the resulting classification.

Accordingly,

$$P_B^{D,H} = 1 \not\Rightarrow C_B^{D,H} = 1. \quad (103)$$

A pollution-to-contamination diagnosis therefore requires evidence of the intervening mechanism rather than temporal sequence alone.

7.5 Contamination-to-Pollution Feedback

This subsection examines the reverse pathway through which grammar-level alterations can contribute to degraded generative fields. Its objective is to show that contaminated persons need not remain passive recipients of earlier conditions and can become participants in the reproduction of those conditions. The method traces how generative organization enters action, institutional practice, recognition, and relational structure.

A person's grammar affects which actions and relations are generated. Consequently, a grammar-level alteration can alter the landscape encountered by other participants.

A generic pathway is

$$\Delta\Gamma_{B,t} \longrightarrow \Delta A_{B,t} \longrightarrow \Delta R_t \longrightarrow \Delta\mathcal{L}_{t+1}^G, \quad (104)$$

where $\Delta A_{B,t}$ denotes altered action generation and ΔR_t denotes the resulting relational change.

Consider a student whose earlier educational experience generated a stable grammar in which intellectual uncertainty is interpreted as incompetence. The student later becomes a teacher. If that grammar shapes evaluation of students, the teacher may discourage exploratory questions, reward only rapid correctness, or structure the classroom around avoidance of visible error.

The resulting classroom can become a polluted generative field for later students.

This pathway should not be described as simple transmission. The later teacher's grammar may already differ substantially from the grammar of earlier teachers. Institutional rules, workload, class composition, assessment systems, and other actors can transform the resulting field.

A contaminated grammar can therefore contribute to pollution without being a sufficient cause of it.

The reverse pathway also raises a responsibility problem. A person whose grammar was shaped through earlier contamination can later participate in polluting another person's field. Historical explanation of the person's grammar does not by itself resolve responsibility for later conduct.

The present paper leaves that normative question open. Its task is to distinguish the locations and pathways involved.

Contamination-to-pollution feedback also operates through institutions. Members whose generative grammars have adapted to narrow evaluative structures can reproduce those structures when designing metrics, hiring criteria, curricula, workflows, or recognition systems.

The field can thereby acquire persistence that exceeds the presence of any single actor.
A feedback relation can be represented as

$$\Gamma_{B,t} \longrightarrow \mathcal{L}_{t+1}^G \longrightarrow \Gamma_{C,t+2}. \quad (105)$$

Equation 105 does not imply that B 's grammar is transferred to C . The field created partly through B 's actions becomes one condition of C 's later generation.

This distinction preserves the relational emergence developed in Section 5.2.

7.6 Recursive and Cross-Generational Propagation

This subsection extends the feedback analysis across repeated temporal and relational cycles. Its objective is to identify how contamination and pollution can become self-reproducing at the system level without assuming a single intentional source or unchanged content across generations. The method treats propagation as a sequence of transformations across grammar and landscape.

A minimal recursive cycle is

$$\mathcal{L}_t^G \longrightarrow \Gamma_{B,t+1} \longrightarrow \mathcal{L}_{t+2}^G \longrightarrow \Gamma_{C,t+3}. \quad (106)$$

Each transition can transform the structure inherited from the previous stage.

This process can operate within one institution. An evaluative regime shapes the practices of current members. Those members later reproduce or redesign the evaluative regime. New participants then encounter the transformed field.

It can also operate across social generations. Educational practices, professional norms, family expectations, or institutional habits can be reproduced through persons whose own generative grammars were formed within earlier configurations.

The term *cross-generational* is used broadly here to include succession across cohorts, institutional generations, or interpersonal generations. It does not require biological inheritance.

The resulting process should be distinguished from direct copying:

$$\Gamma_{C,t+3} \neq \Gamma_{B,t+1} \quad (107)$$

can hold even where the earlier grammar materially contributed to the field through which the later grammar developed.

The system can therefore preserve a structural pathology while changing its specific content.

For example, one generation may suppress inquiry through explicit authority. A later generation may reject overt authority while reproducing the same restriction through metrics, reputational incentives, or access control. The generative field has changed form while retaining a relational structure that continues to narrow particular generative trajectories.

This possibility makes provenance more complex. Searching for one original polluter or contaminating actor may fail when the current condition emerged through repeated transformations.

A recursive diagnosis should therefore distinguish:

- the initiating or earlier disturbance;
- intermediate grammar alterations;
- field-level reproduction;
- transformation of the mechanism;
- current contamination or pollution;
- persistence of structural effects across changing actors.

The same recursive process can also become self-correcting. A person formed in a polluted field may recognize the pattern and construct a more supportive environment for later participants. A later field can therefore interrupt the cycle rather than reproduce it.

The possible sequence is

$$\Delta\Gamma_B \longrightarrow \text{Recognition}_B \longrightarrow \Delta\mathcal{L}_{\text{repair}}^G \longrightarrow \text{ReducedExposure}_C. \quad (108)$$

This countertrajectory is important because recursive transmission is not inevitable.

The relation between generativity contamination and generative pollution can now be summarized as two analytically independent diagnoses embedded in a potentially recursive relational system. Pollution concerns degradation of generative conditions. Contamination concerns a qualifying alteration of the generative organization. Either can occur without the other. Each can contribute to the emergence, persistence, or recovery of the other through additional mechanisms.

The remainder of the paper therefore treats the two concepts neither as synonyms nor as isolated pathologies. Their interaction is a temporally open process in which field conditions shape generative organization, generative organization reshapes fields, observations and epistemic judgments can mediate the transitions, and later actors can reproduce, transform, or interrupt the resulting dynamics.

8 Observation, Representation, and Epistemic Error in Generative Systems

This section develops the epistemic consequences of the distinctions established between generative organization, generative conditions, and observable output. Its objective is to explain how observers gain access to generative systems, how that access can be distorted by environmental and measurement conditions, and how epistemic errors can later become causally relevant to the systems they describe. The section proceeds from the relation between generative state and observable performance to environmental interference, contaminated measurement, epistemic representation, relational feedback, and self-reinforcing observational loops. The method is inferential and level-sensitive. Observations are treated as condition-dependent traces of a generative process rather than transparent readings of an underlying grammar.

8.1 Generative State and Observable Performance

This subsection distinguishes the state of a generative system from the outputs through which that state becomes observable. Its objective is to prevent performance, behavior, or recorded production from being treated as direct equivalents of generative organization. The analysis begins from the conditional production relation developed in Section 2.5.

Let $Y_{B,t}$ denote an output generated by bearer B at time t . The output depends upon the interaction among the generative grammar, generative landscape, situated state, and relevant history:

$$Y_{B,t} \sim P_{\Gamma_{B,t}}(\cdot \mid \mathcal{L}_{B,t}^G, X_{B,t}, H_{B,t}). \quad (109)$$

The same grammar can therefore produce different outputs under different conditions. Different grammars can also produce superficially similar outputs.

This many-to-many relation creates an identification problem. Observation of one output, or even a sequence of outputs, does not uniquely determine the generative organization through which those outputs arose.

A student can produce a correct answer through stable understanding, memorization, external assistance, guessing, or a highly constrained procedure. A researcher can publish regularly while the range of questions considered worth pursuing has narrowed substantially. Another researcher can produce little visible output while preserving a broad and active generative grammar under conditions of severe resource or time constraint.

The inference

$$Y_{B,t} \longrightarrow \Gamma_{B,t} \quad (110)$$

therefore requires additional premises concerning the conditions of production, the stability of the observed pattern, alternative explanations, and the relation between the selected output and the generative domain under study.

The same caution applies to effective generative capability. Realized output records what occurred along an actual trajectory. Capability concerns the range of trajectories that remain practically reachable. A person can possess substantial unexercised capability, and a realized success does not establish that similar trajectories remain sustainably accessible.

Observation of generativity is therefore structurally indirect. The observer usually encounters behavior, artifacts, decisions, recorded performance, language, or other traces. Claims about the underlying grammar require interpretation of these traces within their relational conditions.

8.2 Environmental Interference in Observed Output

This subsection examines how polluted generative conditions can alter observable performance while leaving the underlying grammar substantially unchanged. Its objective is to distinguish environmental effects on output from ontic changes in the generative system. The method traces the route from landscape condition to realized performance before any measurement or evaluation is introduced.

Suppose bearer B possesses a relatively stable generative grammar Γ_B . A change in the landscape can nevertheless alter the output:

$$\mathcal{L}_{B,t}^G \longrightarrow \mathcal{L}_{B,t}^{G'} \longrightarrow Y_{B,t}', \quad (111)$$

while

$$\Gamma_{B,t}' \approx \Gamma_{B,t}. \quad (112)$$

The approximation symbol records substantial stability for the declared domain rather than exact identity.

An educational example makes the distinction clear. A student can understand a mathematical problem and retain the generative organization needed to solve similar problems while persistent environmental noise interrupts the particular attempt. The resulting answer can be incomplete or incorrect. The observed performance has deteriorated even though the relevant grammar has not been shown to deteriorate.

Institutional contexts provide similar cases. A person working under fragmented time, unstable access to records, or repeated interruption can generate fewer visible outputs. The environmental burden may also increase the effort required to preserve the same output level.

This gives rise to two different observational patterns.

In the first,

$$\Delta \mathcal{L}^G \longrightarrow \Delta Y. \quad (113)$$

The pollution is visible through degraded performance.

In the second,

$$\Delta \mathcal{L}^G \longrightarrow \Delta \text{Effort}, \quad \Delta Y \approx 0. \quad (114)$$

The bearer compensates for the polluted conditions, and the output remains stable.

The second case is especially important because output-based assessment can fail to detect environmental degradation when participants absorb the additional burden themselves.

Stable performance therefore does not establish a stable generative landscape:

$$\Delta Y \approx 0 \not\approx \Delta \mathcal{L}^G \approx 0. \quad (115)$$

Environmental interference can also be heterogeneous across participants. Two students in the same classroom can experience different practical effects from the same noise level because their tasks, positions, available buffering resources, or current states differ.

The observer should therefore distinguish the shared field from the participant-specific conditions through which the field becomes operative.

8.3 Contaminated Measurement and Representation

This subsection examines the transition from generated output to recorded observation. Its objective is to identify circumstances in which the measurement or representation itself contains contributions that interfere with the intended target of observation. The method separates the production of an output from the process through which that output is sampled, recorded, classified, or summarized.

Let $O_{B,t}$ denote an observation of some aspect of bearer B . A general measurement relation can be represented as

$$O_{B,t} = \mathcal{M}(Y_{B,t}, \mathcal{L}_t^O) + C_t^O + \epsilon_t, \quad (116)$$

where $\mathcal{M}$ denotes the observation process, $\mathcal{L}_t^O$ the conditions of observation, C_t^O a contaminating contribution relevant to the declared measurement purpose, and ϵ_t other measurement error.

The term *observational contamination* applies when a contribution outside the intended target becomes operative within the recorded observation in a way that materially affects its interpretation.

The optical source domain developed earlier provides the clearest structural example. Stray light can enter an instrument and affect the measured signal even though the observed source remains unchanged [22]. The relevant contamination belongs to the observation process or recorded signal.

Educational measurement can exhibit an analogous structure. A test intended to measure mathematical reasoning can also contain effects of language complexity, environmental noise, fatigue, unfamiliar interface design, unequal time access, or other factors. Some of these factors may be legitimate components of the construct under one measurement purpose and contaminating contributions under another.

Observational contamination is therefore purpose-relative.

If the intended target is

T = mathematical reasoning under ordinary instructional conditions,

then severe construction noise may count as a contaminating condition.

If the intended target is

T = performance under noisy emergency conditions,

the same noise may belong to the construct rather than contaminate it.

The diagnosis therefore requires a declared observational target.

Institutional records can also become contaminated through classification. A record may combine achievements produced under different access conditions, mix voluntary and compulsory activities, or collapse heterogeneous forms of contribution into one metric.

The problem need not involve numerical measurement. Narrative evaluations, recommendation letters, interview impressions, and informal reputations are also observations or representations generated under particular conditions.

A contaminated observation can remain useful if the contamination is recognized and corrected. This is another reason to separate observation from epistemic judgment.

The relation is therefore

$$\text{Contam}(O) \not\approx \text{Distort}(K). \quad (117)$$

An evaluator who knows that a test occurred under severe environmental interference can discount the result, request additional evidence, or treat the observation as indeterminate.

Observational contamination becomes epistemically consequential when the conditions generating the observation are hidden, ignored, or misclassified.

8.4 Epistemic Distortion of Generative Capacity

This subsection examines the formation of beliefs, classifications, and institutional representations concerning another person’s generativity. Its objective is to distinguish an epistemically distorted judgment from the observation on which it is based and from the actual generative organization of the represented person. The method treats epistemic representation as an inferential process situated within an epistemic environment.

Let $K_{A,t}(B)$ denote observer A ’s epistemic representation of bearer B . The representation depends on observation, background information, interpretive standards, and the surrounding epistemic environment:

$$K_{A,t}(B) = \mathcal{I}_A (O_{B,t}, \mathcal{L}_{A,t}^E, H_{A,t}) . \quad (118)$$

An epistemic distortion occurs when the resulting representation materially mischaracterizes the relevant generative object within the declared domain.

Several forms of distortion are possible.

Source neglect occurs when the observer attributes environmentally generated variation to the person’s grammar.

Output essentialization occurs when one observed output is treated as a stable property of the person.

Capability compression occurs when the observed trajectory is treated as if it represented the full space of reachable trajectories.

Context erasure occurs when differences in resources, timing, evaluation conditions, or relational constraints are omitted from the representation.

Historical erasure occurs when the observer interprets a current state without considering relevant relational processes through which that state was formed.

These forms can occur independently or together.

Suppose a student performs poorly under a polluted testing environment. An evaluator can make the inference

$$\text{low score} \longrightarrow \text{low mathematical ability}.$$

The inference may be epistemically inadequate if the score is heavily affected by environmental conditions irrelevant to the target construct.

The resulting error concerns

$$K_A(B),$$

rather than

$$\Gamma_B.$$

The represented person can therefore remain ontically unchanged while the institutional representation becomes distorted.

Epistemic environments can also become polluted. Levy’s account of epistemically polluted environments emphasizes conditions in which ordinary cues for epistemic trust and reliable deference become less dependable [10]. Within the present framework, this existing concept is useful for distinguishing degradation of epistemic conditions from an individual inferential error.

An institution can contain both.

For example, an evaluation system dominated by narrow performance metrics may create an epistemically polluted environment if decision makers systematically lack reliable access to broader evidence of generativity. Individual evaluators can then form distorted judgments within that environment.

The pollution and distortion should still be separated:

$$\text{Pollute}(\mathcal{L}^E) \not\Rightarrow \text{Distort}(K). \quad (119)$$

Competent observers can sometimes correct for polluted epistemic conditions. Conversely, an evaluator can make an inferential error in a comparatively favorable epistemic environment.

The distinction becomes especially important once institutional judgments acquire causal force.

8.5 Feedback from Misrecognition to Generative Alteration

This subsection examines how an epistemically distorted representation can enter the relational environment of the represented person and contribute to later changes in generativity. Its objective is to connect epistemic error with generative dynamics while preserving the distinction between misdescription and ontic alteration. The method traces the transition from judgment to relational consequence and then to possible grammar change.

An inaccurate judgment can remain epistemically isolated. An evaluator can privately form a mistaken belief that never affects the represented person. In that case, no generativity contamination follows.

Institutional and interpersonal judgments often have practical consequences, however. A classification can influence access to courses, opportunities, resources, recognition, recommendation, responsibility, or future evaluation. A repeated judgment can also enter direct communication with the person.

The candidate pathway is

$$\text{Distort}(K_A(B)) \longrightarrow \Delta\rho_{AB} \longrightarrow \Delta\mathcal{L}_B^G \longrightarrow \Delta\Gamma_B. \quad (120)$$

The pathway contains several analytically distinct transitions.

The distorted representation first changes how A relates to B .

The altered relation can then modify the generative landscape encountered by B .

Repeated or consequential relational changes can subsequently contribute to grammar-level alteration.

Consider an evaluator who incorrectly classifies a student as lacking mathematical ability. The evaluator may provide fewer advanced problems, discourage application to a course, interpret uncertainty as confirmation of weakness, or reduce future opportunities.

The student's generative landscape changes before any grammar-level contamination is established.

If the student later begins generating possible trajectories through the classification itself, the process may reach the grammar level.

A phrase such as

“This is probably beyond what someone like me can do”

can eventually become part of the student's own generation of possibilities.

The important transition is from an external attribution to an operative generative rule.

This transition is neither inevitable nor equivalent to simple internalization. The student may reject the classification, reinterpret it, use it as a source of resistance, or generate a new orientation that differs from both the prior grammar and the evaluator's judgment.

The eventual grammar can therefore remain emergent:

$$\Gamma'_B \neq K_A(B), \quad (121)$$

even where the judgment materially contributed to its formation.

This mechanism also clarifies why epistemic injustice, misrecognition, and generativity contamination should remain distinct concepts. An epistemic wrong can occur without grammar-level contamination. Grammar contamination can arise without a prior epistemic wrong. The present framework concerns one possible relational pathway connecting them.

8.6 Self-Reinforcing Observational Loops

This subsection examines feedback processes in which an initially distorted observation or judgment contributes to later changes that make the original judgment appear increasingly accurate. Its objective is to identify a self-reinforcing observational mechanism without treating the eventual agreement between observation and person as evidence that the initial judgment was correct. The method reconstructs the temporal sequence of observation, classification, relational response, grammar alteration, and subsequent observation.

Let an initial observation O_{B,t_0} be generated under polluted or otherwise distorting conditions. Observer A forms a representation

$$K_{A,t_0}(B)$$

that underestimates the relevant generative capacity of B .

The judgment then changes the relational field:

$$K_{A,t_0}(B) \longrightarrow \mathcal{L}_{B,t_1}^G. \quad (122)$$

Reduced opportunity, discouraging evaluation, changed expectations, or restricted recognition can follow.

If these altered conditions contribute to a grammar-level change, the later state becomes

$$\Gamma_{B,t_2} \neq \Gamma_{B,t_0}. \quad (123)$$

Later output can then shift in the direction originally predicted by the evaluator:

$$\Gamma_{B,t_2} \longrightarrow Y_{B,t_3} \longrightarrow O_{B,t_3}. \quad (124)$$

The evaluator may now interpret O_{B,t_3} as confirmation of the original judgment.

The complete sequence is

$$O_{t_0} \longrightarrow K_{t_0} \longrightarrow \Delta \mathcal{L}_{t_1}^G \longrightarrow \Delta \Gamma_{t_2} \longrightarrow O_{t_3}. \quad (125)$$

This temporal structure creates a serious epistemic problem. Agreement between the later observation and the earlier judgment cannot establish that the earlier judgment accurately described the person at t_0 .

The later observation may partly reflect a process generated by the earlier classification.

The framework therefore requires provenance-sensitive interpretation:

$$O_{t_3} \not\Rightarrow K_{t_0} \text{ was accurate at } t_0. \quad (126)$$

The mechanism can become more complex in institutions. A low initial score can reduce access to advanced opportunities. Reduced access can lower later performance. The later record then becomes evidence used to justify the original restriction. Classification and opportunity allocation jointly construct part of the trajectory being measured.

A similar loop can operate positively. A favorable evaluation can increase access, recognition, confidence, and opportunities, contributing to later performance that appears to validate the original evaluation.

The existence of positive loops prevents the mechanism from being defined solely through adverse outcomes. The analytical issue concerns reflexive feedback between representation and the represented generative system.

Self-reinforcing loops also interact with generative pollution. An institution whose records repeatedly transform environmentally conditioned outcomes into stable classifications can reproduce a polluted generative landscape. Participants then encounter unequal opportunities generated partly through earlier observations.

The resulting architecture can be represented as

$$\mathcal{L}^G \longrightarrow O \longrightarrow K \longrightarrow \mathcal{L}^{G'} \longrightarrow \Gamma' \longrightarrow O'. \quad (127)$$

The sequence illustrates why observation cannot remain external to the theory of Generative Relational Systems. Observers, evaluators, metrics, and classifications can become participants in the later generative field.

The distinction developed through this section can therefore be summarized through four objects:

$$\Gamma \longrightarrow Y \longrightarrow O \longrightarrow K, \quad (128)$$

with $\mathcal{L}^G$ and $\mathcal{L}^E$ conditioning different stages and feedback returning from K to later relational conditions and grammar.

A change in any one object should not be attributed automatically to another. The analytical task is to identify the location of the disturbance, reconstruct the mechanism connecting levels, preserve temporal provenance, and allow the possibility that a later observed state partly results from earlier acts of observation and classification.

The educational cases developed in the following section use this framework to compare environmental interference, discouraging evaluation, retained ability, grammar contamination, beneficial transformation, and heterogeneous responses under shared conditions.

9 Educational Cases

This section applies the preceding framework to a bounded set of constructed educational cases. Its objective is to test whether generative pollution, generativity contamination, observational contamination, epistemic distortion, and effective capability impairment can be distinguished within situations that are intuitively accessible while remaining structurally complex. The section proceeds from environmental interference to discouraging evaluation, retained ability, combined pollution and contamination, beneficial transformation, and heterogeneous responses under shared conditions. The cases are analytical constructions rather than empirical claims about educational psychology. Their role is to expose distinctions, counterexamples, and diagnostic obligations that later empirical work would need to investigate.

9.1 Environmental Interference in Learning

This subsection examines a case in which the principal disturbance is located in the conditions of learning while the learner's generative grammar remains substantially intact. Its objective is to provide a clear instance of generative pollution without demonstrated generativity contamination. The method holds the learner's relevant generative organization approximately stable while varying the educational landscape.

Consider student B , who is capable of sustained mathematical reasoning and regularly generates alternative approaches to unfamiliar problems. During a period of construction near the classroom, persistent noise repeatedly interrupts concentrated work. The student completes fewer problems, makes more errors, and requires more time to recover the reasoning sequence after each interruption.

The principal alteration is located in the educational landscape:

$$\mathcal{L}_{B,t}^G \longrightarrow \mathcal{L}_{B,t}^{G'}. \quad (129)$$

The case supplies no corresponding evidence that the student’s generative grammar has materially changed:

$$\Gamma'_{B,t} \approx \Gamma_{B,t}. \quad (130)$$

The learner continues to recognize mathematical problems as attemptable, retains confidence in the relevant forms of reasoning, and resumes ordinary work when the environmental disturbance is removed.

The diagnosis is therefore principally one of generative pollution.

The case also illustrates the distinction between pollution and capability. If the noise makes sustained reasoning practically unavailable during the affected period, effective generative capability can contract even though the grammar remains intact. The pathway is then

$$\text{Pollute}_G(\mathcal{L}_B^G) \longrightarrow \Delta \mathcal{G}_B^{D,H}, \quad (131)$$

without requiring an intervening contamination of Γ_B .

Observable performance can also decline:

$$\text{Pollute}_G(\mathcal{L}_B^G) \longrightarrow \Delta Y_B. \quad (132)$$

If an evaluator treats the degraded output as a direct measure of the learner’s underlying mathematical generativity, the case can then move from field-level pollution to observational and epistemic error.

The environmental-interference case therefore establishes an important baseline. A learner can experience materially degraded conditions of generation while retaining the organization through which mathematical possibilities are interpreted and pursued.

9.2 Discouraging Evaluation and Relational Exposure

This subsection examines how evaluative speech and relational positioning can move from external exposure toward grammar-level alteration. Its objective is to identify intermediate stages between an adverse interaction and generativity contamination. The method compares several trajectories following the same initial evaluative event.

Suppose teacher A tells student B ,

“You are not good at mathematics.”

The statement alone does not establish contamination.

Several responses remain possible.

In the first trajectory, B rejects the evaluation. The statement is recognized as inaccurate or irrelevant, and the student’s later generation of mathematical possibilities remains substantially unchanged.

In the second trajectory, B becomes temporarily discouraged. Participation decreases for several days, after which the earlier pattern of inquiry returns. The episode affects the learner’s situated state without sufficient evidence of a grammar-level alteration.

In the third trajectory, B begins avoiding mathematical participation in the teacher’s classroom because visible mistakes carry a high social cost. The learner still recognizes mathematics as a viable domain and continues exploratory work elsewhere. The principal effect may remain localized to the relational landscape.

In the fourth trajectory, repeated evaluative interactions contribute to a more general alteration. Mathematical challenges increasingly generate a self-classification such as

“Problems of this kind are outside the range of things I can realistically attempt.”

The relation has then become relevant to the organization through which later possibilities are generated.

The sequence can be represented as

$$\rho_{AB} \longrightarrow \text{exposure} \longrightarrow \text{possible uptake} \longrightarrow \Delta\Gamma_B. \quad (133)$$

The transition to $\Delta\Gamma_B$ remains contingent.

The fourth trajectory approaches the contamination concept because the evaluation no longer operates only as an external statement. A relation-derived alteration has become operative in the learner's own generation of possible actions.

The resulting grammar need not reproduce the teacher's statement literally. The teacher may have made one narrow judgment about classroom performance, while the student later develops a broader rule concerning intellectual risk, ability, or deservingness.

Accordingly,

$$\Gamma'_B \neq K_A(B) \quad (134)$$

can hold even where the evaluator's judgment contributed materially to the alteration.

The case therefore illustrates relational emergence and separates discouraging exposure from contamination occurrence.

9.3 Retained Ability and Restricted Generative Application

This subsection examines a case in which an underlying ability remains available while the grammar governing recognition or application of that ability changes. Its objective is to distinguish generativity contamination from literal destruction of competence. The method separates latent or demonstrable ability from the generation of trajectories through which that ability becomes practically usable.

Suppose student B retains the knowledge and reasoning required to solve a class of mathematical problems. When directly instructed to solve one of the problems in a supportive context, the student can still perform successfully.

The relevant competence therefore remains demonstrable.

However, when selecting courses, research projects, competitions, or future study, the student no longer generates advanced mathematics as a realistic personal option.

The contrast can be expressed schematically as

$$\text{Ability}_B^D \approx \text{Ability}_{B,\text{prior}}^D, \quad \mathcal{G}_B^{D,H} \prec \mathcal{G}_{B,\text{comparison}}^{D,H}. \quad (135)$$

The capability contraction can arise because the altered grammar changes which possibilities become salient or recognizable.

A relevant grammar-level rule may have shifted from

“Difficult mathematical work is something I can attempt and evaluate through experience”

toward

“Advanced mathematics does not belong to the range of trajectories available to me.”

The student's mathematical ability has not disappeared. The organization governing the generation and recognition of possible applications has changed.

This case clarifies the object of generativity contamination. The concept can apply where the primary alteration concerns the generative use, recognition, or extension of an ability rather than the ability itself.

It also prevents capability from being reduced to competence. A person can possess a skill while lacking effective access to trajectories through which the skill would be exercised.

The distinction can be summarized as

$$\text{RetainedAbility} \not\equiv \text{RetainedEffectiveGenerativeCapability}. \quad (136)$$

The reverse inference is also unsafe. A person can lose effective capability through polluted external conditions while retaining both ability and grammar.

The case therefore separates at least three objects:

$$\text{ability}, \quad \Gamma_B, \quad \mathcal{G}_B^{D,H}. \quad (137)$$

This separation is important whenever the later effects of discouraging relations are assessed through observed competence alone.

9.4 Polluted Educational Fields and Grammar Contamination

This subsection examines a combined case in which polluted educational conditions contribute over time to grammar-level contamination. Its objective is to illustrate the pollution-to-contamination pathway developed in Section 7.4 while preserving the mechanisms connecting the two diagnoses. The method traces a temporally extended educational trajectory rather than treating co-occurrence as proof of causation.

Consider a school in which visible mistakes are routinely ridiculed, only rapid correct answers receive recognition, questioning teachers is discouraged, and access to advanced opportunities depends heavily on the judgment of a small number of evaluators.

The shared educational landscape contains several candidate forms of generative pollution:

- high social cost for experimentation;
- narrow recognition of successful output;
- concentrated evaluative authority;
- restricted opportunities for low-cost revision;
- limited alternative channels for recognition.

The field-level diagnosis concerns these conditions regardless of whether a particular student's grammar has changed.

Student B initially recognizes the structure critically. The student continues asking exploratory questions in private and distinguishes classroom evaluation from personal mathematical ability.

At this stage,

$$P_B^{D,H} = 1, \quad C_B^{D,H} = 0. \quad (138)$$

Repeated exposure can nevertheless contribute to adaptation. The student begins selecting only problems likely to produce rapid success. Questions with uncertain outcomes are avoided before any teacher explicitly prohibits them.

Later, the distinction between classroom strategy and intellectual possibility weakens. The student begins to experience exploratory inquiry itself as evidence of inadequate preparation.

A candidate transition has then occurred:

$$P_B^{D,H} = 1, \quad C_B^{D,H} = 1. \quad (139)$$

The important mechanism is not simply repetition of the institution's explicit rules. The learner's later grammar may be a secondary relational formation. Institutional pressure, personal interpretation, prior history, peer comparison, and adaptive strategies can jointly generate an organization that no single actor intended.

The case also permits observational feedback. As the student increasingly avoids uncertain problems, visible performance becomes concentrated in familiar tasks. Evaluators may interpret the narrowing as evidence that the student lacks broader ability.

The resulting judgment can further restrict opportunities, creating the loop

$$\mathcal{L}_{\text{polluted}}^G \longrightarrow \Delta\Gamma_B \longrightarrow \Delta Y_B \longrightarrow K_A(B) \longrightarrow \mathcal{L}_B^{G'}. \quad (140)$$

The later state may therefore reflect both field pollution and grammar contamination.

The case remains defeasible. Another student can experience the same institutional conditions without developing the same grammar. A later supportive relation can interrupt the trajectory. The student's interpretation of the field can also generate resistance rather than adaptation.

The case therefore illustrates a possible pathway rather than a deterministic effect of adverse education.

9.5 Beneficial Generative Transformation

This subsection introduces a counterexample in which a relation produces deep, persistent, and grammar-level change while expanding rather than compromising the learner's generative possibilities. Its objective is to prevent the contamination concept from absorbing ordinary or beneficial relational development. The method holds several structural features of contamination constant while varying the additional contamination condition.

Suppose teacher A introduces student B to a new mathematical way of reasoning.

Before the relation, the student treats mathematical problems largely as tasks with predefined methods. Through sustained interaction with the teacher, the student begins generating conjectures, comparing alternative representations, questioning assumptions, and constructing new problems.

The relation has changed the student's generative grammar:

$$\Gamma'_B \not\equiv_D \Gamma_B. \quad (141)$$

The alteration is relation-derived.

It is materially significant.

It can persist after the teacher is absent.

It can affect the student's later update processes.

It may also propagate into other intellectual domains.

These features remain insufficient for a contamination diagnosis.

The resulting grammar expands the recognition of alternatives, increases effective revisability, and opens new viable trajectories. The additional contamination condition introduced in Section 5.7 is therefore unsupported.

The case is classified as

$$\text{RelationalGenerativeAlteration} = 1, \quad \text{GenerativityContamination} = 0. \quad (142)$$

This counterexample is central because relational development is constitutive of human learning. A framework that identified every persistent grammar-level change as contamination would pathologize education itself.

The case also shows why persistence and second-order change cannot define contamination. A good education can permanently change the rules through which a person learns, revises, and generates further possibilities.

The relevant distinction concerns the generative operation of the alteration.

A beneficial transformation can make prior possibilities less attractive or less frequently chosen. It can also stabilize new commitments. Such stabilization does not establish contamination when the person retains or gains adequate pathways for recognizing alternatives, revising assumptions, and generating further trajectories.

The counterexample therefore sharpens the role of C_D in Equation 72. The contamination condition must distinguish generatively compromising alteration from deep developmental transformation without relying on simple magnitude, persistence, or source externality.

9.6 Heterogeneous Responses under Shared Conditions

This subsection examines variation among learners exposed to the same educational field. Its objective is to prevent generative pollution from being treated as environmental determinism and to prevent heterogeneous outcomes from being used to deny field-level pollution. The method holds a shared landscape approximately constant while allowing differences in grammar, history, situated state, buffering resources, and relational position.

Consider students B and C within the same polluted classroom.

Both encounter persistent ridicule of mistakes and narrow evaluative criteria:

$$\mathcal{L}_{B,t}^G \approx \mathcal{L}_{C,t}^G = \mathcal{L}_{\text{polluted},t}^G. \quad (143)$$

Their responses can nevertheless diverge.

Student B may possess supportive relationships outside the classroom, recognize the local evaluative structure as contingent, and maintain alternative spaces for exploratory inquiry.

Student C may depend heavily upon the focal teacher for recognition, possess fewer alternative relational channels, and have a prior history that makes the evaluative judgments more salient.

The resulting trajectories can therefore satisfy

$$\Gamma'_B \neq \Gamma'_C \quad (144)$$

despite substantial overlap in environmental exposure.

One student may remain uncontaminated while another undergoes a material grammar-level alteration.

This heterogeneity does not establish that the environment was harmless:

$$\exists B [\neg C_B] \not\Rightarrow \neg P. \quad (145)$$

The existence of resistant or well-buffered participants cannot by itself defeat a field-level pollution diagnosis.

The converse inference is equally unsafe. If one student develops a restrictive grammar, the shared environment cannot automatically be identified as the cause. Relational history, other institutions, family relations, peer interactions, personal interpretation, and unobserved conditions may also contribute.

Accordingly,

$$C_B \not\Rightarrow P \text{ caused } C_B. \quad (146)$$

A supported causal claim requires evidence connecting exposure to the grammar-level change.

Heterogeneous response therefore creates an evidential requirement rather than an objection to relational analysis. The relevant question concerns why similar fields become differently operative across different generative systems.

A fuller analysis may need to consider

$$\Gamma_{B,t}, \quad H_{B,t}, \quad X_{B,t}, \quad \mathcal{B}_{B,t}, \quad \rho_{B,t}, \quad (147)$$

where $\mathcal{B}_{B,t}$ denotes relevant buffering resources.

The variables should not be aggregated into a universal susceptibility score. Their role is to guide investigation of heterogeneous trajectories.

The six educational cases collectively clarify the architecture developed in the preceding sections. Environmental interference can pollute a learning field while leaving grammar intact. Discouraging evaluation can remain an external exposure or become part of later grammar. Ability can remain while the generation of viable applications contracts. Polluted fields can contribute to contamination through repeated relational mechanisms. Beneficial education can produce deep grammar-level transformation without satisfying the contamination criterion. Shared polluted conditions can also produce heterogeneous responses.

The educational domain therefore provides a bounded conceptual test of the paper’s principal distinction:

$$\text{GenerativePollution} \neq \text{GenerativityContamination}, \quad (148)$$

while preserving the possibility of causal interaction between them.

These cases also prepare the diagnostic separation developed in the following section. Establishing pollution or contamination does not by itself determine whether effective generative capability has been impaired, whether the affected person has been harmed, whether the process was wrongful, or which actor bears responsibility.

10 Diagnostic Separation from Capability Impairment and Harm

This section separates the structural diagnoses developed in the preceding sections from downstream judgments concerning effective generative capability, harm, wrongfulness, and responsibility. Its objective is to prevent generativity contamination and generative pollution from functioning as compressed moral conclusions. The section proceeds through five analytical stages: structural diagnosis, capability effect, harm, wrongfulness, and responsibility. The method is explicitly conditional. Each transition requires additional premises, comparison conditions, and evidence, and failure at one stage blocks inference to the later stages.

10.1 Structural Diagnosis

This subsection clarifies the limited content of a contamination or pollution diagnosis. Its objective is to identify what such a diagnosis establishes before any conclusion concerning capability, harm, or wrongdoing is drawn. The method treats the two concepts as bearer-specific structural classifications.

A supported diagnosis of generativity contamination establishes that a relation-derived, materially significant alteration has become operative within the relevant generative grammar and satisfies the additional contamination condition developed in Section 5.7.

A supported diagnosis of generative pollution establishes that the relevant generative landscape has been materially and disruptively altered within a declared domain and comparison.

These diagnoses can be represented as

$$C_B^{D,H} = \text{Contam}_G(\Gamma_B; D, H), \quad (149)$$

and

$$P_B^{D,H} = \text{Pollute}_G(\mathcal{L}_B^G; D, H). \quad (150)$$

Neither predicate specifies the magnitude of downstream consequence.

A contamination diagnosis can concern a narrow domain and remain highly revisable. A pollution diagnosis can concern a temporary field disturbance that disappears once the source is removed. Both can also coexist with gains elsewhere.

The structural diagnosis therefore answers questions such as:

- what object has changed;
- at which analytical level the change is located;
- whether the change is materially relevant within the declared domain;
- whether the required contamination or pollution condition is satisfied.

It does not yet answer:

- whether the bearer has lost effective generative capability;
- whether the bearer has been harmed;
- whether the process was wrongful;
- whether any actor bears responsibility;
- what remedy, if any, is justified.

The first diagnostic discipline is therefore

$$C_B^{D,H} \vee P_B^{D,H} \not\Rightarrow \text{Harm}_B. \quad (151)$$

This non-implication preserves the distinction between locating an alteration and evaluating its normative significance.

10.2 Effective Generative Capability Effects

This subsection examines the first downstream question: whether contamination or pollution changes the set of practically reachable generative trajectories. Its objective is to connect structural diagnoses to capability without treating capability contraction as automatic. The method compares factual and admissible comparison trajectories within a declared domain and horizon.

Let

$$\mathcal{G}_{B,t}^{D,H} \quad (152)$$

denote the effective generative capability set introduced in Section 2.4.

A structural disturbance can affect capability through several pathways.

Generativity contamination can alter which possibilities become recognizable, salient, attemptable, or revisable. Generative pollution can increase the cost of reaching trajectories, reduce access to resources, fragment sustained generation, restrict recognition, or reduce effective exit.

A candidate capability contraction can be represented as

$$\mathcal{G}_{B,t}^{D,H,f} \prec \mathcal{G}_{B,t}^{D,H,q}, \quad (153)$$

where the factual capability set is judged materially worse than an admissible comparison within domain D and horizon H .

The partial-order notation is important because capability change can be mixed. One set of trajectories can become less reachable while another becomes more reachable. A polluted institutional environment may narrow exploratory inquiry while increasing standardized output. A grammar alteration may reduce one family of alternatives while supporting stability or competence elsewhere.

Accordingly,

$$C_B^{D,H} \not\Rightarrow \mathcal{G}_B^{D,H,f} \prec \mathcal{G}_B^{D,H,q}, \quad (154)$$

and

$$P_B^{D,H} \not\Rightarrow \mathcal{G}_B^{D,H,f} \prec \mathcal{G}_B^{D,H,q}. \quad (155)$$

The structural diagnosis may remain significant even where capability loss is not demonstrated. The converse also holds: capability impairment can arise through mechanisms unrelated to contamination or pollution.

A person can lose access to an educational trajectory because of financial scarcity without any grammar contamination. A person can experience temporary illness that contracts practical capability without

establishing a polluted generative landscape. Capability impairment is therefore a distinct downstream object.

The analysis should also distinguish capability contraction from unchosen non-use. A person can retain practical access to a trajectory while deciding not to pursue it. Reduced observed activity does not establish reduced capability.

The relevant inference therefore requires evidence concerning practical reachability, comparison, and materiality rather than output alone.

10.3 Generative Harm

This subsection separates effective generative capability impairment from a claim of harm. Its objective is to preserve an independent normative bridge between descriptive or functional loss and pro tanto adverse significance. The method treats harm as a further evaluative classification rather than as a property built into contamination or pollution.

A capability contraction can matter substantially without automatically constituting harm under every normative account. Some contractions accompany valuable commitments, specialization, maturation, care, safety, or coordination. A person who commits to one demanding project necessarily forgoes other reachable trajectories. A child can encounter justified limits that restrict immediate options while supporting later development.

The inference

$$\mathcal{G}_B^{D,H,f} \prec \mathcal{G}_B^{D,H,q} \quad (156)$$

therefore requires an additional bridge before

$$\text{Harm}_B \quad (157)$$

is established.

A provisional harm bridge can be represented as

$$\text{Harm}_B^{D,H} = \text{CapabilityImpairment}_B^{D,H} \wedge \mathcal{N}_B^{D,H}, \quad (158)$$

where $\mathcal{N}_B^{D,H}$ represents the additional normative conditions required to interpret the impairment as pro tanto harm.

The content of $\mathcal{N}_B^{D,H}$ is not fully specified in this paper. Possible considerations include seriousness, the importance of the affected domain, reversibility, distribution, available alternatives, the bearer's interests, and the relation between the lost trajectories and other valuable commitments.

The paper therefore retains the non-implication

$$\text{CapabilityImpairment} \not\Rightarrow \text{Harm} \quad (159)$$

without denying that capability impairment can provide strong evidence relevant to harm.

The educational cases illustrate the distinction. A student whose grammar changes in a way that removes advanced mathematics from the space of recognizable possibilities may experience a serious generative loss. Whether the loss counts as harm still depends upon the domain, comparison, later revision possibilities, and the broader normative account.

The same framework also permits mixed cases. A relation can contaminate one domain while expanding another. A polluted environment can impose burdens while producing valuable coordination. Harm analysis therefore requires more than identifying the structural pathology.

10.4 Wrongfulness

This subsection separates harm from wrongfulness. Its objective is to prevent the existence of a harmful generative effect from being treated as sufficient evidence that an actor acted wrongly. The method introduces independent normative premises concerning justification, authority, consent, proportionality, role, and countervailing reasons.

A harmful outcome can occur through accident, justified intervention, conflicting duties, emergency, or diffuse relational processes in which no single actor acts wrongfully.

The relevant distinction is

$$\text{Harm}_B \not\Rightarrow \text{Wrong}_{A \rightsquigarrow B}. \quad (160)$$

Wrongfulness therefore requires an additional evaluative bridge.

A provisional structure is

$$\text{Wrong}_{A \rightsquigarrow B} = \text{Harm}_B \wedge \mathcal{W}_{A \rightsquigarrow B}, \quad (161)$$

where $\mathcal{W}_{A \rightsquigarrow B}$ collects the normative premises relevant to the relation.

Depending upon the domain, those premises may concern:

- the legitimacy of the actor's authority;
- the presence or absence of adequate consent;
- whether the intervention was proportionate;
- whether less restrictive alternatives were available;
- whether the affected person had meaningful opportunities for contestation or exit;
- whether the actor violated a role-based or relational duty;
- whether countervailing reasons justified the interference.

These criteria cannot be inferred from the contamination or pollution diagnosis itself.

A teacher may unintentionally contribute to grammar contamination through an otherwise ordinary interaction. A school may create a polluted environment while attempting to meet competing safety or resource constraints. An institution can impose restrictions that are burdensome yet justified under a declared emergency condition.

Wrongfulness therefore belongs to a later normative layer.

The distinction also protects the paper from defining pollution through moral disapproval. A field can be generatively polluted because its conditions materially interfere with generation even before responsibility for producing those conditions has been established.

Similarly, generativity contamination can be diagnosed without assuming that the contributing person acted with malicious or manipulative intent.

10.5 Responsibility

This subsection separates wrongfulness and structural contribution from responsibility. Its objective is to identify the additional dimensions needed before responsibility can be assigned for contamination, pollution, capability impairment, or harm. The method treats responsibility as a profile involving causal position, control, knowledge, role, capacity, and temporal relation to the relevant disturbance.

Responsibility can take several forms.

Causal responsibility concerns contribution to the mechanism through which the relevant alteration occurred.

Culpability concerns fault, intention, negligence, knowledge, or another standard of blame.

Role responsibility concerns duties arising from institutional, professional, relational, or legal position.

Forward-looking responsibility concerns who is best placed to prevent continuation or recurrence.

Remedial responsibility concerns who should participate in repair, transition, compensation, or reconstruction.

These forms can diverge.

An actor can contribute causally without culpable intent. An institution can bear a role-based duty to correct polluted conditions even when no present member caused the original arrangement. A person with little causal responsibility may possess substantial capacity to repair the problem. A historically involved actor may lack current control over the relevant field.

A responsibility profile can therefore be represented as

$$\mathbf{R}_{A \rightsquigarrow B} = \langle r^{\text{causal}}, r^{\text{control}}, r^{\text{knowledge}}, r^{\text{role}}, r^{\text{capacity}}, r^{\text{temporal}}, r^{\text{countervailing}} \rangle. \quad (162)$$

The coordinates identify questions rather than producing a scalar responsibility score.

This profile also accommodates diffuse processes. Generative pollution can be produced by many actors whose individual contributions are small. Grammar contamination can emerge through interaction among family, institution, technology, peer group, and the affected person's own adaptive responses. Responsibility therefore cannot always be assigned through a simple source-to-victim model.

The absence of malicious intent is especially important:

$$\text{Contam}_{A \rightsquigarrow B} \not\Rightarrow \text{CulpableIntent}_A. \quad (163)$$

Likewise,

$$\text{Pollute}_G(\mathcal{L}^G) \not\Rightarrow \exists A \text{ SolelyResponsible}(A). \quad (164)$$

The recursive processes developed in Section 7.6 complicate responsibility further. A person formed within a polluted field can later participate in reproducing that field for others. Historical explanation may mitigate one dimension of responsibility while leaving forward-looking or role-based duties intact.

The present paper does not develop a complete responsibility theory. Its purpose is to prevent the contamination and pollution concepts from silently performing that work.

The diagnostic architecture developed through this section can therefore be summarized as

$$\text{structural diagnosis} \longrightarrow \text{capability effect} \longrightarrow \text{harm} \longrightarrow \text{wrongfulness} \longrightarrow \text{responsibility}. \quad (165)$$

The arrows indicate separate argumentative bridges.

Failure to support one stage blocks automatic inference to the next. A polluted landscape can exist without demonstrated capability impairment. Capability impairment can exist without established harm. Harm can exist without wrongfulness. Wrongfulness can exist without assigning every form of responsibility to the same actor.

The sequence also permits later legal analysis to remain separate. Legal classification can depend upon jurisdiction, doctrine, protected interests, causation standards, institutional competence, available remedies, and procedural requirements that are not supplied by the present conceptual framework.

Generativity contamination and generative pollution therefore remain foundational structural concepts. Their principal role is to identify where and how generative disturbances occur. Normative and institutional conclusions require further argument.

11 Boundaries with Neighboring Concepts

This section locates generativity contamination and generative pollution among neighboring concepts in philosophy, education, social theory, and political thought. Its objective is to identify areas of overlap

while preventing the proposed vocabulary from redescribing established phenomena under new names. The section proceeds through relational development, education, manipulation and indoctrination, coercive control, adaptive preference, epistemic pollution, colonization and coloniality, and exploitation. The method is comparative and non-reductive. Each neighboring literature is treated as having its own object, criteria, normative commitments, and evidential requirements. The present framework is retained only where its bearer-sensitive distinction between generative organization and generative conditions performs analytical work that the neighboring concept does not already perform.

11.1 Socialization and Relational Development

This subsection distinguishes generativity contamination from the ordinary relational constitution and development of persons. Its objective is to prevent the contamination concept from presupposing an isolated subject whose generative organization exists prior to social relations. The method compares the proposed grammar-level diagnosis with relational accounts of autonomy and socially embedded agency.

Relational approaches to autonomy explicitly challenge conceptions of persons that treat autonomy as independence from social relations. The collection edited by Mackenzie and Stoljar examines the social and relational dimensions of autonomy, agency, identity, self-conception, self-worth, and responsibility, including ways in which oppressive relations can impair autonomy [11]. The relevance of this literature to the present framework is methodological as much as substantive. A person's generative organization should be expected to develop through relations.

Consequently,

$$\text{RelationDerived}(\Delta\Gamma_B) \not\Rightarrow \text{Contam}_G(\Gamma_B). \quad (166)$$

Relational origin cannot be the pathology criterion.

A person's language, interpretive repertoire, practical identity, habits of attention, standards of evidence, emotional expectations, and forms of self-understanding can all change through education, friendship, family, professional life, political participation, and intimate relations. Such changes can be deep, persistent, and second-order because they can affect how later experience is interpreted.

The present framework therefore rejects a contrast between an "authentic pre-relational grammar" and a later socially altered grammar. There is no required state

$$\Gamma_B^{\text{pure}} \quad (167)$$

against which all relational development is measured.

Generativity contamination instead identifies a narrower class of relation-derived grammar alterations satisfying the additional contamination condition C_D developed in Section 5.7.

The distinction can be summarized as

$$\text{relational development} \supset \text{relational generative alteration} \supset \text{possible generativity contamination}. \quad (168)$$

The set relation is conceptual rather than empirical. Its purpose is to locate contamination within the broader fact of relational development.

Relational autonomy also raises a further caution. If autonomy itself depends partly upon social and relational conditions, then the evaluation of a grammar-level alteration cannot be reduced to whether the change originated outside the person. External support can enable autonomy, and apparently self-generated preferences can arise within oppressive conditions. The relevant question concerns the structure and operation of the resulting generative organization and the conditions under which it remains open to recognition, contestation, and revision.

Generativity contamination therefore does not compete with relational theories of subject formation. It presupposes the broader relational fact and attempts to isolate one possible form of generatively compromising alteration within it.

11.2 Learning and Education

This subsection distinguishes generativity contamination from learning and educational transformation. Its objective is to preserve the possibility that education legitimately and beneficially changes a learner's generative grammar. The method compares grammar-level alteration with philosophical discussions of education, critical evaluation, and indoctrination.

Education routinely aims at durable changes in how a learner interprets, reasons, acts, evaluates evidence, and generates further questions. A successful education can therefore modify several components of Γ_B . The depth of a change cannot distinguish education from contamination.

Philosophy of education has long treated the boundary between education and indoctrination as a central problem. Existing analyses have variously focused on the content taught, the instructor's intention, methods of instruction, and the outcome for the learner. A recurring concern is whether learners remain able to subject what they acquire to appropriate critical evaluation [3].

This literature reinforces one of the present framework's principal counterexamples. A teacher can transform a learner's generative grammar while expanding the learner's ability to examine assumptions, generate alternatives, and revise inherited frameworks.

Such a case can satisfy

$$\Delta\Gamma_B \neq 0 \quad (169)$$

while

$$\text{Contam}_G(\Gamma_B) = 0. \quad (170)$$

The distinction developed in Section 9.5 therefore remains essential.

The present framework differs from a general philosophy of education in its object of analysis. It does not attempt to define good education, educational authority, curriculum, pedagogical legitimacy, or the epistemic aims of teaching. It asks a narrower question: whether a relational process has produced a qualifying alteration in the generative organization through which a learner subsequently forms possibilities and revisions.

The educational domain is consequently both a source of positive cases and a source of counterexamples. It demonstrates that persistent grammar alteration is ordinary and sometimes valuable, while also providing situations in which learning conditions or evaluative relations may become generatively restrictive.

11.3 Manipulation and Indoctrination

This subsection compares generativity contamination with manipulation and indoctrination. Its objective is to distinguish a diagnosis centered on the resulting generative organization from concepts that often focus more directly on the method, intention, rational pathway, or epistemic character of an influence. The method identifies possible overlap while preserving the non-implications concerning intent and source replication.

Philosophical accounts of manipulation remain heterogeneous. Contemporary surveys distinguish approaches centered on bypassing or undermining reason, trickery, pressure, vulnerability, and combinations of these mechanisms [12]. Susser, Roessler, and Nissenbaum, in the more specific context of online manipulation, define manipulation through covert influence on decision making that targets and exploits decision-making vulnerabilities [18].

These accounts identify mechanisms that can contribute to generativity contamination, but the concepts are not coextensive.

Manipulation typically concerns an influencing act or strategy. Generativity contamination principally concerns a qualifying alteration in the receiving generative grammar.

Accordingly,

$$\text{Manipulation}_{A \rightsquigarrow B} \not\equiv \text{Contam}_G(\Gamma_B). \quad (171)$$

A manipulative attempt can fail. It can alter one decision without materially reorganizing subsequent generation.

The converse can also hold:

$$\text{Contam}_G(\Gamma_B) \not\Rightarrow \text{Manipulation}_{A \rightsquigarrow B}. \quad (172)$$

Generativity contamination can arise through relations lacking a deliberate strategy of influence. The contributing person may be unaware of the effect, and the resulting grammar may be an emergent relational formation.

Indoctrination provides a closer neighboring concept because successful indoctrination is often analyzed through the learner's later inability or unwillingness to subject acquired material to adequate critical evaluation [3]. This overlaps substantially with candidate contamination conditions involving impaired revisability or systematic closure of alternative recognition.

The difference is again one of scope and object. Indoctrination is particularly concerned with belief formation and educational or quasi-educational transmission. Generativity contamination can concern interpretation, salience, action generation, relation formation, or self-revision beyond propositional belief.

A person can also undergo grammar contamination without acquiring a doctrine. Repeated relational experiences may generate avoidance, narrowed salience, or self-restricting possibility formation without transmitting a stable body of beliefs.

The relation among the concepts is therefore one of possible mechanism and overlap:

$$\text{Indoctrination} \cap \text{GenerativityContamination} \neq \emptyset, \quad (173)$$

while neither concept is treated as generally equivalent to the other.

11.4 Coercive Control

This subsection compares generativity contamination and generative pollution with coercive control. Its objective is to distinguish control over another person's practical environment from grammar-level alteration while recognizing that coercive control can affect both. The method treats coercive control as a substantive neighboring literature with its own empirical and normative domain.

Stark's account of coercive control shifts attention from isolated incidents of physical violence toward patterns of domination and entrapment affecting liberty, autonomy, everyday conduct, and practical life [17]. The framework emphasizes the constraining structure surrounding the victim rather than treating each harmful episode as an independent event.

This orientation overlaps strongly with the concept of generative landscape. A relation that restricts movement, communication, economic access, social contact, or practical alternatives can degrade the conditions under which a person generates and exercises trajectories.

Such a case can therefore support a candidate generative-pollution diagnosis:

$$\text{CoerciveControl} \longrightarrow \text{PossiblePollution}(\mathcal{L}_B^G). \quad (174)$$

The implication remains conditional because the concepts have different criteria.

Coercive control can also contribute to generativity contamination if the relational process alters the person's grammar of recognizable alternatives, expected consequences, self-evaluation, or revision.

Yet control and contamination remain distinct.

A person can be effectively trapped while retaining a grammar that clearly recognizes the relation as oppressive and continuously generates alternative possibilities. The primary pathology may then concern the landscape:

$$\text{Restricted}(\mathcal{L}_B^G) \quad (175)$$

while

remains comparatively intact.

Conversely, a grammar-level contamination can persist after effective control ends.

The present framework therefore uses coercive control as an important boundary case demonstrating that practical entrapment, field pollution, and grammar contamination can overlap without being identical.

11.5 Adaptive Preference

This subsection compares generativity contamination with adaptive preference. Its objective is to examine cases in which preferences themselves have been formed under constrained conditions while avoiding the reduction of generative grammar to preference. The method focuses on the epistemic and normative difficulty of using expressed preference as the sole indicator of well-being or endorsement.

Nussbaum's discussion of adaptive preferences addresses the problem that people can form or express preferences within conditions of deprivation, inequality, or restricted options. Her capabilities approach consequently resists treating every existing preference as an adequate basis for political evaluation and emphasizes capability and meaningful choice [14].

This problem is directly relevant to generativity contamination because the present framework also rejects simple reliance on current endorsement.

Suppose person B has undergone a grammar-level alteration and later states that the resulting condition is fully acceptable. The endorsement is evidentially relevant, but it cannot automatically settle the diagnosis if the same generative organization under examination shapes which alternatives become recognizable and which standards of evaluation appear available.

The difficulty can be represented as

$$\Gamma'_B \longrightarrow \text{Endorsement}_B (\Gamma'_B) . \quad (177)$$

The endogenous relation between grammar and endorsement creates a potential circularity.

The present framework nevertheless differs from adaptive-preference analysis in at least two respects.

First, generative grammar is broader than preference. A contamination process can alter what options are generated or recognized before a preference among those options is formed.

Second, contamination is a structural diagnosis requiring a relational source and qualifying grammar alteration. A preference can adapt to deprivation without satisfying the proposed contamination criteria, and contamination can affect generative processes that are not well represented as preferences.

Adaptive-preference theory therefore provides a major warning against naïve endorsement criteria while leaving the object of generativity contamination distinct.

11.6 Epistemic Pollution

This subsection clarifies the relation between generative pollution and the existing concept of epistemic pollution. Its objective is to avoid presenting pollution of epistemic environments as a novelty of the present framework and to specify when the generative and epistemic diagnoses overlap. The method compares the function of the affected field in each concept.

Levy describes epistemically polluted environments as environments in which agents' dependence on social and institutional cues becomes less reliable, including contexts in which cues of expertise and informational reliability can be imitated or degraded [10]. The concept is explicitly environmental: pollution affects conditions under which reliable belief formation and epistemic deference occur.

Generative pollution has a different target function.

Let

$$\mathcal{L}^E$$

denote conditions of epistemic access and

$$\mathcal{L}^G$$

denote conditions of generation.

Then

$$\text{Pollute}(\mathcal{L}^E) \quad (178)$$

and

$$\text{Pollute}_G(\mathcal{L}^G) \quad (179)$$

can overlap without being identical.

An information environment saturated with deceptive signals may impair reliable belief formation and therefore be epistemically polluted. If the same environment also makes the generation, recognition, or revision of practical or intellectual trajectories materially more difficult, it may additionally be generatively polluted.

Conversely, persistent physical noise can pollute a student's generative field by interfering with sustained reasoning while leaving the epistemic quality of available information largely unchanged.

The distinction is therefore function-sensitive:

$$\text{EpistemicPollution} \not\equiv \text{GenerativePollution}. \quad (180)$$

This boundary also reinforces the level distinction developed in Section 3.4. Epistemic pollution concerns the conditions of knowing. Epistemic distortion concerns a judgment or representation. Generative pollution concerns conditions of generation. Generativity contamination concerns the generative organization itself.

11.7 Colonization and Coloniality

This subsection compares generativity contamination and generative pollution with colonization and coloniality. Its objective is to prevent colonial relations from being reduced to an analogy for interpersonal grammar change while recognizing that colonial systems can reshape both generative conditions and subject formation. The method treats colonial and decolonial literatures as historically and theoretically heterogeneous comparison families.

Colonial processes operate across political, territorial, economic, legal, racial, linguistic, cultural, epistemic, and institutional dimensions. Quijano's account of coloniality of power, for example, links the colonial formation of modern power with durable racial classification, Eurocentrism, and structures that outlast formal colonial administration [15]. Fanon's analysis of colonial racial experience also examines the formation of subjectivity within a racialized colonial world, including language, recognition, self-relation, and the lived experience of racialization [4].

These traditions demonstrate why colonization cannot be reduced to grammar-level contamination.

A colonial regime can operate through land seizure, coerced labor, legal hierarchy, political domination, restricted movement, extraction, institutional restructuring, or infrastructural control even where no individual grammar-level alteration has been demonstrated.

Many such mechanisms are more naturally represented at the level of the generative landscape:

$$\mathcal{L}^G \longrightarrow \mathcal{L}^{G'}. \quad (181)$$

Colonial relations can also participate in subject formation and thereby contribute to grammar-level alterations. Such cases may intersect with generativity contamination, but the contamination diagnosis requires its own bearer-specific evidence.

The appropriate relation remains

$$\text{Colonization} \cap \text{GenerativityContamination} \neq \emptyset, \quad (182)$$

without assuming

$$\text{Colonization} \Rightarrow \text{GenerativityContamination}, \quad (183)$$

or

$$\text{GenerativityContamination} \Rightarrow \text{Colonization}. \quad (184)$$

The first implication fails because colonial domination can operate through structures that do not require demonstrated grammar alteration in every affected person. The second fails because grammar contamination can occur in dyads, families, schools, organizations, and other relations lacking the historical and political structures required for colonial classification.

The comparison should therefore remain asymmetric. Colonial and decolonial theories provide historically specific accounts of power whose concepts cannot be generalized into ordinary interpersonal relations merely because both involve relational alteration.

Generativity contamination may eventually provide one analytical lens for a particular mechanism within a colonial process. It cannot serve as a general definition of colonization.

11.8 Generativity Exploitation

This subsection distinguishes generativity contamination and generative pollution from exploitation. Its objective is to separate alteration or degradation of generative structures from advantage-taking and benefit relations. The method compares the proposed concepts with philosophical accounts of exploitation while preserving the independent generativity- exploitation diagnostic developed elsewhere in the broader framework.

Philosophical theories of exploitation are diverse, although unfair advantage-taking occupies a central place in many accounts. Wertheimer's analysis is particularly concerned with transactions that can remain mutually advantageous and consensual while still raising questions of exploitation [21]. Contemporary philosophical surveys likewise distinguish transactional from structural exploitation and emphasize debates over benefit, unfairness, vulnerability, and background conditions [23].

Generativity contamination does not require benefit to another actor:

$$\text{Contam}_{A \rightsquigarrow B} \not\Rightarrow \text{Benefit}_A. \quad (185)$$

A caregiver's fear, a teacher's unreflective expectations, or an emergent dyadic pattern can contribute to grammar contamination without producing an identifiable benefit for the contributing person.

Generative pollution likewise need not benefit a polluter. A poorly designed institution can create disruptive conditions for all participants.

Exploitation therefore asks a different family of questions:

- who benefits;
- through what relation the benefit arises;
- whether advantage is unfair;
- whether vulnerability or background structure matters;
- how benefit and burden are distributed.

Contamination and pollution ask principally:

- what object has been altered;

- at what level the alteration is located;
- through which relational process it arose;
- whether the relevant contamination or pollution condition is satisfied.

The concepts can nevertheless overlap.

An exploitative institution can pollute generative conditions. Exploitation can contribute to grammar contamination. A contaminated grammar can also make later exploitation more difficult to recognize or exit.

The overlap should be represented as possible conjunction rather than identity:

$$\text{Exploitation} \wedge \text{Pollution} \wedge \text{Contamination} \quad (186)$$

can occur in one trajectory while each predicate retains independent conditions.

The boundaries developed throughout this section can now be summarized. Generativity contamination is narrower than relational development, distinct from learning, and only partially overlapping with manipulation, indoctrination, coercive control, adaptive preference, colonial subject formation, and exploitation. Generative pollution is distinct from epistemic pollution and from institutional adversity considered without a declared generative-interference criterion.

These distinctions constrain the novelty claim of the paper. The proposed framework is useful only if bearer and level specification permit distinctions that remain obscured when neighboring concepts are used alone. Where an existing concept already explains the relevant mechanism adequately, the present vocabulary should function as a cross-framework mapping device rather than as a replacement terminology.

12 Evidence and Operationalization

This section develops evidential requirements for applying the concepts of generativity contamination, generative pollution, observational contamination, and epistemic distortion beyond constructed cases. Its objective is to prevent the framework from treating theoretical distinctions as self-validating diagnoses. The section proceeds through evidence for polluted generative conditions, evidence for grammar-level contamination, evidence concerning observations and measurements, evidence concerning epistemic distortion, longitudinal and relational reconstruction, counterfactual comparison, and diagnostic uncertainty. The method is plural and defeasible. Different claims require different forms of evidence, and no single behavioral indicator, self-report, metric, or formal model is treated as sufficient across domains.

12.1 Evidence for Generative Pollution

This subsection specifies the evidence required for a field-level pollution diagnosis. Its objective is to distinguish observable environmental adversity from a supported claim that the relevant generative conditions have been materially and disruptively altered. The method examines the condition itself, its relation to the declared generative process, its distribution, and the comparison against which degradation is assessed.

A generative-pollution diagnosis requires evidence concerning the landscape:

$$\mathcal{L}_{B,t}^{G,f} \not\equiv_D \mathcal{L}_{B,t}^{G,q}. \quad (187)$$

The factual and comparison landscapes should be specified sufficiently to identify which conditions differ and why those differences matter within domain D .

Evidence can concern material conditions such as access to space, resources, technology, or physical environmental quality. It can also concern temporal, institutional, informational, or relational conditions

such as interruption, evaluation structures, dependency, recognition channels, surveillance, effective exit, or access to alternative relations.

The presence of an unfavorable condition alone is insufficient. Evidence must connect that condition to the generative process being examined.

For example, persistent noise can be documented through physical measurement. A generative-pollution claim additionally requires a reason to regard the noise as materially interfering with the relevant form of generation. A highly structured schedule can be documented institutionally. Whether it pollutes generative conditions depends upon the domain, temporal requirements of the activity, available buffering resources, and comparison.

The minimum evidential record can therefore be represented as

$$\mathbf{E}_B^P = \langle e^{\text{condition}}, e^{\text{domain}}, e^{\text{interference}}, e^{\text{comparison}}, e^{\text{distribution}} \rangle. \quad (188)$$

The coordinates record:

- evidence that the candidate environmental or relational condition exists;
- specification of the generative domain affected;
- evidence or argument connecting the condition to generative interference;
- an admissible comparison against which the degradation is assessed;
- evidence concerning how the condition is distributed across participants.

Output decline can support the analysis but cannot substitute for landscape evidence. A field can be polluted while participants maintain stable output through additional effort or buffering. Output can also decline for reasons unrelated to the field.

The diagnosis should therefore avoid the inference

$$\Delta Y_B < 0 \Rightarrow \text{Pollute}_G(\mathcal{L}_B^G). \quad (189)$$

The implication is rejected.

Evidence of pollution should instead locate the relevant environmental mechanism directly wherever possible.

12.2 Evidence for Grammar-Level Contamination

This subsection specifies the more demanding evidential requirements for generativity contamination. Its objective is to distinguish grammar-level alteration from transient state change, behavioral adaptation, capability constraint, and observer inference. The method requires convergent evidence concerning change in the organization of generation and relational evidence connecting that change to the relevant history.

A contamination diagnosis concerns

$$\Gamma_{B,t}, \quad (190)$$

which is not directly observable in the same manner as a physical environmental condition.

Evidence must therefore be inferred from patterns across situations, time, relations, and generated responses.

One isolated behavior provides weak evidence. A student declining one advanced course does not establish that advanced mathematics has ceased to be generated as a viable possibility. The decision can arise from cost, scheduling, financial conditions, unrelated interests, or temporary state variation.

Stronger evidence would involve a pattern such as:

- repeated alteration in the generation or recognition of alternatives;

- changes extending across more than one immediate episode;
- altered responses when similar opportunities recur;
- changes in how the bearer interprets the relevant domain;
- changes in the standards through which later experience is used to revise the grammar;
- evidence that the pattern differs from an admissible comparison trajectory.

The evidence should also distinguish grammar from capability. A person may recognize and value a trajectory while lacking practical access to it. Such a case concerns effective capability or landscape rather than necessarily grammar.

Likewise, evidence should distinguish grammar from output. A stable output can coexist with a narrowed grammar, and degraded output can coexist with an intact grammar.

A candidate evidence profile is

$$\mathbf{E}_{A \rightsquigarrow B}^C = \langle e^{\text{grammar}}, e^{\text{relational}}, e^{\text{temporal}}, e^{\text{domain}}, e^{\text{comparison}}, e^{\text{alternative}} \rangle, \quad (191)$$

where the coordinates record evidence for grammar-level change, relational contribution, temporal development, domain relevance, comparison, and alternative explanations.

The relational component is essential. Grammar-level change alone establishes relational generative alteration only when the focal relation is supported as a causal or constitutive contributor.

Temporal sequence by itself is insufficient:

$$\rho_{AB,t_0} \prec_t \Delta \Gamma_{B,t_1} \not\Rightarrow \rho_{AB} \text{ caused } \Delta \Gamma_B. \quad (192)$$

Other relationships, institutions, personal developments, wider historical conditions, and unobserved processes can generate similar changes.

Evidence for contamination must additionally support the contamination condition C_D . Demonstrating grammar alteration is therefore insufficient. The analysis should establish why the alteration qualifies as generatively compromising within the declared domain.

This additional evidential burden is what separates contamination research from a general study of relational development.

12.3 Evidence for Observational Contamination

This subsection specifies evidence for contamination of an observation, measurement, or recorded representation. Its objective is to determine whether the observed signal contains contributions that materially interfere with the declared target of measurement. The method requires explicit specification of the target construct, observation process, environmental conditions, and candidate contaminating contribution.

Let the intended observational target be T . A contamination claim requires a distinction between the target contribution and additional influences on the observation:

$$O = \mathcal{M}(T) + C^O + \epsilon. \quad (193)$$

Operationalization therefore begins with a question of measurement purpose: what is the observation intended to represent?

Without a declared target, the same contribution can be classified differently.

Language complexity in a mathematics examination may be contaminating if the target is narrowly specified mathematical reasoning. It may be part of the construct if the target is mathematical reasoning through complex textual communication.

Evidence for observational contamination can include:

- variation in the observation under different measurement conditions;

- direct evidence of environmental or instrumental interference;
- disagreement across independent measurement channels;
- measurement sensitivity to factors outside the declared target;
- provenance showing that records were generated under heterogeneous conditions;
- correction or replication that materially changes the recorded result.

The central evidential comparison is between

$$O^f \tag{194}$$

and an admissible estimate or observation

$$O^g \tag{195}$$

under conditions more appropriate to the declared target.

Observational contamination should remain distinct from measurement uncertainty generally. All observations contain uncertainty. A contamination diagnosis requires identification of a contribution or condition that is extraneous relative to the declared observational purpose.

The diagnosis should also permit indeterminacy where the contributions cannot be separated adequately.

12.4 Evidence for Epistemic Distortion

This subsection specifies evidence for an inaccurate or inadequately supported representation of a generative system. Its objective is to distinguish epistemic distortion from contamination of the underlying observation and from pollution of the epistemic environment. The method compares the inferential basis of a judgment with the evidence and alternatives available to the observer.

Let

$$K_A(B) \tag{196}$$

denote observer A 's representation of bearer B .

A claim of epistemic distortion requires evidence that $K_A(B)$ materially misrepresents the relevant target or exceeds what the available evidence supports.

Several forms of evidence can be relevant.

First, additional observations can contradict the representation.

Second, contextual information can show that the original observation was generated under conditions that undermine the inference drawn from it.

Third, independent observers or methods can produce materially different representations.

Fourth, the observer's inferential procedure can reveal systematic compression of heterogeneous evidence into an unsupported stable classification.

Fifth, longitudinal evidence can demonstrate that the original judgment failed to track the person's later behavior under changed conditions.

The analysis should distinguish falsehood from overconfidence. An evaluator may possess insufficient evidence to classify a student's generative grammar even when the eventual classification happens to be correct.

Epistemic distortion can therefore include

$$\text{UnsupportedPrecision} \tag{197}$$

as well as demonstrably inaccurate representation.

A useful epistemic status set is

$$\mathbb{V}_E = \{\text{supported, rejected, underdetermined}\}. \quad (198)$$

The framework should permit an evaluator to conclude that available evidence does not support a stable judgment about the underlying generative organization.

This restraint is especially important because epistemic classifications can later feed back into the generative field. Unsupported certainty can become causally consequential even where the original evidence was weak.

12.5 Longitudinal and Relational Evidence

This subsection develops the temporal evidence required to distinguish state variation from generative alteration and current conditions from historical carry-over. Its objective is to reconstruct trajectories rather than infer contamination or pollution from isolated snapshots. The method combines repeated observation with relational provenance and comparison across changing conditions.

A longitudinal record can be represented as

$$\mathcal{H}_B = \{\mathfrak{S}_{B,t_0}, \mathfrak{S}_{B,t_1}, \dots, \mathfrak{S}_{B,t_n}\}. \quad (199)$$

The purpose of the record is not to assume smooth development. It is to locate changes relative to relations, environments, observed outputs, and later revision.

For generativity contamination, especially useful observations include:

- the bearer before, during, and after the focal relation;
- behavior across multiple settings rather than one relationship;
- changes after the relevant external condition is removed;
- responses to newly available alternatives;
- changes in self-interpretation and possibility generation;
- evidence of recovery, resistance, propagation, or domain localization.

For generative pollution, longitudinal evidence can identify whether the field disturbance is temporary, cumulative, structurally reproduced, or repaired.

Relational history should also record changes in relevant actors and institutions. A present grammar-level pattern can reflect several overlapping relations rather than one focal source.

A useful provenance structure is

$$\mathcal{R}_B = \{\rho_{1B}, \rho_{2B}, \dots, \rho_{nB}\}_{[t_0, t_n]}. \quad (200)$$

The set records relevant relational pathways without assuming that their effects can be added independently.

Temporal evidence also helps distinguish persistence from recurrence. A pattern may disappear and later reappear under a similar relational context. Such a trajectory differs from continuous persistence.

Likewise, evidence after environmental improvement can be especially informative. If a person's output improves immediately when pollution is removed while the broader grammar remains stable, the earlier difficulty is more plausibly field-centered. If restrictive possibility generation continues across substantially improved conditions, a grammar-level explanation gains relative plausibility.

Neither pattern by itself proves a causal mechanism. Longitudinal evidence narrows competing explanations rather than eliminating the need for them.

12.6 Counterfactual Comparison

This subsection specifies the comparison discipline required for contamination, pollution, capability, and harm diagnoses. Its objective is to avoid treating chronological precedence as normative authority or assuming that a single counterfactual trajectory is uniquely available. The method permits several admissible comparison families and reports incomparability or uncertainty where necessary.

Let z^f denote the factual trajectory and z^q an admissible comparison trajectory.

The comparison can produce

$$z^f \prec_D z^q, \quad z^f \parallel_D z^q, \quad \text{status}(z^f, z^q) = \text{indeterminate}. \quad (201)$$

The first relation records a domain-specific ordering. The second records incomparability. The third records insufficient support for either conclusion.

Several comparison families can be relevant.

A *pre-relation comparison* asks how the present state differs from an earlier state.

A *feasible non-intervention comparison* asks what trajectory could plausibly have occurred without the focal relation.

An *alternative-institution comparison* asks how the bearer might have developed under another feasible arrangement.

A *restored-condition comparison* asks how generation changes after a candidate pollution source is removed.

A *plural admissible comparison* retains several plausible trajectories where no unique counterfactual is supportable.

No comparison should be treated automatically as normative.

In particular,

$$z_{t_0} \not\equiv z^{\text{normatively preferred}}. \quad (202)$$

The earlier state may itself have been restrictive, polluted, or contaminated.

This point is central to the rejection of a pure pre-relational self. The aim of counterfactual comparison is to investigate causal and evaluative differences, rather than reconstruct an imagined untouched original person.

Counterfactual analysis should also remain sensitive to interaction. Removing one relation can change other relations and environmental conditions. A simple subtraction of one actor from the historical trajectory may therefore produce an implausible comparison.

The comparison family must be justified in relation to the mechanism being investigated.

12.7 Indeterminacy and Diagnostic Uncertainty

This subsection formalizes the role of uncertainty in the application of the framework. Its objective is to prevent the conceptual vocabulary from requiring binary classification where available evidence supports only partial or conditional conclusions. The method treats uncertainty as part of the diagnostic output rather than as a defect to be concealed.

For any diagnostic component d_i , the evidential status can be represented through

$$\hat{d}_i \in \{\text{supported}, \text{rejected}, \text{unresolved}\}. \quad (203)$$

A generativity-contamination witness can therefore contain mixed statuses:

$$\hat{\mathbf{C}}_{A \rightsquigarrow B}^{D,H} = \langle \hat{c}^{\text{relation}}, \hat{c}^{\text{grammar}}, \hat{c}^{\text{material}}, \hat{c}^{\text{compromise}} \rangle. \quad (204)$$

For example, grammar-level alteration may be strongly supported while the causal role of one particular relationship remains unresolved. A field may be clearly degraded while evidence concerning the affected generative domain is mixed.

The framework should report such cases explicitly.
A diagnosis should therefore avoid converting

$$\hat{c}^{\text{grammar}} = \text{supported}, \quad \hat{c}^{\text{relation}} = \text{unresolved} \quad (205)$$

into a confident claim of relation-derived contamination.

Different sources of uncertainty should also be distinguished.

Measurement uncertainty concerns imperfect observation.

Model uncertainty concerns uncertainty about the structure connecting observed data to grammar or landscape.

Counterfactual uncertainty concerns uncertainty about the appropriate comparison trajectory.

causal uncertainty concerns the contribution of a focal relation or field condition.

semantic uncertainty concerns whether the proposed contamination or pollution criterion adequately captures the case.

temporal uncertainty concerns onset, persistence, propagation, and recovery.

These forms of uncertainty need not move together.

Diagnostic restraint is especially important because the concepts developed in this paper can themselves enter social relations. Classifying a person as “contaminated” could alter how others interpret, treat, or evaluate that person. An uncertain diagnosis presented with excessive confidence can therefore contribute to the reflexive processes described in Section 8.6.

The framework consequently treats

$$\text{Indeterminate} \quad (206)$$

as a legitimate analytical result.

Operationalization should aim to make the proposed concepts vulnerable to disconfirmation. A contamination hypothesis should weaken when grammar-level change is absent, when the focal relation fails to distinguish the observed trajectory from alternatives, or when the purported contamination condition does not survive counterexamples. A pollution hypothesis should weaken when the candidate environmental alteration cannot be shown to interfere materially with the declared generative domain or when an alternative explanation better accounts for the observed effect.

The evidential architecture developed in this section can therefore be summarized as

$$\text{observation} \longrightarrow \text{location} \longrightarrow \text{mechanism} \longrightarrow \text{comparison} \longrightarrow \text{diagnostic status}. \quad (207)$$

The sequence is iterative rather than strictly linear. New observations can change the proposed location, mechanism, or comparison. Later relational history can revise earlier interpretations. A diagnostic status should therefore remain open to revision as new evidence becomes available.

The framework’s empirical value depends upon this revisability. Generativity contamination and generative pollution should function as hypotheses about where and how relational disturbances operate. They should not function as labels insulated from counterevidence.

13 Scope Conditions and Analytic Limits

This section specifies the domains within which the concepts developed in this paper can be applied with reasonable analytical discipline and identifies extensions that require additional theoretical work. Its objective is to prevent generativity contamination and generative pollution from becoming unbounded labels for every undesirable relational process. The section proceeds through scalar and domain limits, assumptions concerning authenticity, collective extensions, technical and ecological extensions, and normative and legal boundaries. The method is restrictive. Where the framework lacks a specified bearer, comparison, generative function, or evidential pathway, the appropriate conclusion is limited applicability rather than conceptual expansion by analogy.

13.1 Scalar and Domain Limits

This subsection specifies the scale and domain conditions under which the framework is most directly applicable. Its objective is to distinguish person-centered generative analysis from claims concerning groups, institutions, societies, or other systems whose generative organization may require different formal objects. The method begins from the bearer-sensitive diagnostic discipline established in Section 3.6.

The present paper is developed primarily around person-centered cases. The principal grammar bearer is therefore

$$B = \text{a person}, \quad (208)$$

and the principal generative landscape is the relational field relevant to that person within a declared domain.

The analysis can be applied to domains such as education, professional development, interpersonal relations, institutional participation, and other settings in which a person generates interpretations, actions, relations, or future trajectories.

This scope should not be confused with a claim that persons are the only possible bearers of generativity.

Institutions, groups, technical systems, ecological systems, or hybrid assemblages may also exhibit processes that can be described in generative terms. The formal structure appropriate to those systems, however, may differ substantially from the person-centered grammar developed here.

A scalar transfer should therefore satisfy at least

$$\text{SpecifyBearer} \wedge \text{SpecifyGeneration} \wedge \text{SpecifyLandscape} \wedge \text{SpecifyEvidence}. \quad (209)$$

Without these specifications, the use of the same vocabulary across scales can create false continuity.

A collective, for example, cannot automatically be assigned a grammar merely because several members possess similar individual grammars. Institutional rules, distributed memory, procedures, infrastructures, and coordination mechanisms may generate patterns that are not reducible to any one member.

Likewise, a person's grammar cannot be inferred directly from a macro-level institutional pattern.

The framework therefore rejects a simple scaling relation such as

$$\Gamma_{\text{collective}} = \sum_i \Gamma_i. \quad (210)$$

No additive relation is assumed.

Domain specification is equally important. A disturbance can be materially generative in one domain and comparatively irrelevant in another. Persistent administrative interruption may pollute the conditions for sustained theoretical research while having less effect on short-cycle operational coordination.

Accordingly,

$$\text{Pollute}_G^{D_1} \not\equiv \text{Pollute}_G^{D_2}. \quad (211)$$

The same limitation applies to contamination. A grammar alteration concerning mathematical self-application should not be generalized automatically to political judgment, artistic creation, or interpersonal trust.

Domain localization is therefore a substantive requirement rather than a technical annotation.

13.2 Authentic-Self Assumptions

This subsection clarifies the framework's relation to authenticity and personal identity. Its objective is to prevent contamination language from implying that a person possesses a pure, original, or normatively privileged self whose later relational alteration is inherently suspect. The method treats historical states as comparison points without granting them automatic normative authority.

The framework does not assume

$$\Gamma_B^{\text{authentic}} = \Gamma_B^{\text{pre-relation}}. \quad (212)$$

A person's earlier grammar is already the result of prior relations, interpretations, practices, institutions, and historical conditions.

Chronological priority therefore does not establish authenticity.

The same point applies to expressed preference. A current preference cannot automatically define the authentic self, because the process through which the preference became available or salient may itself be part of the analysis. Earlier preference cannot automatically define authenticity either.

The framework consequently avoids making the contamination diagnosis depend upon recovering the person's "real" preference, "true" identity, or "original" self.

The relevant comparison concerns the generative properties of alternative trajectories.

For example, one grammar may permit broader recognition of alternatives, greater effective revisability, or easier movement between viable trajectories than another. These differences can be investigated without claiming that one state reveals a metaphysically authentic person.

This distinction is particularly important in educational and developmental contexts. A learner is expected to become different through learning. A person's values, interpretive frameworks, and practical identities can change substantially through legitimate relations.

Recovery from contamination therefore need not mean return:

$$\Gamma_B^{\text{recovered}} \neq \Gamma_B^{\text{earlier}} \quad (213)$$

can be entirely compatible with successful recovery.

The framework instead treats recovery as renewed access to viable generation, recognition, contestation, and revision.

This position also limits retrospective judgment. An observer should not identify a later grammar as contaminated merely because it differs from the observer's preferred account of the person's earlier identity.

A contamination claim requires the relational, grammar-level, material, and generative-compromise conditions established earlier in the paper.

13.3 Group and Collective Extensions

This subsection considers whether generativity contamination and generative pollution can be extended from persons to groups and institutions. Its objective is to identify promising directions while preventing premature reification of collective grammar. The method distinguishes collective organization from aggregated individual states.

Groups can exhibit stable procedures for interpreting events, allocating attention, producing decisions, revising rules, and reproducing institutional practices. These patterns suggest that a collective generative organization may be analytically meaningful.

A provisional collective object could be written as

$$\Gamma_{\mathcal{C},t}, \quad (214)$$

where $\mathcal{C}$ denotes a collective bearer.

The existence and content of such an object, however, cannot be assumed merely from the individual grammars of members.

A collective grammar may depend upon:

- institutional procedures;
- decision rules;
- distributed records and memory;

- role differentiation;
- infrastructures;
- communication channels;
- authority relations;
- mechanisms of membership succession.

These components can persist despite turnover among individual participants.

A collective contamination concept would therefore require evidence that a relation-derived alteration has become operative within the generative organization of the collective itself.

For example, an institution might acquire a stable procedure through which novel proposals are systematically translated into already recognized categories. If the procedure persists across personnel changes and governs later organizational generation, it may be appropriate to investigate the institutional grammar rather than attribute the pattern solely to individuals.

Generative pollution can also be applied at collective scale, although the bearer must again be explicit. A research community can encounter polluted conditions through funding structures, information bottlenecks, infrastructural scarcity, or evaluative regimes.

The relation between individual and collective diagnoses is then potentially bidirectional:

$$\Gamma_C \longleftrightarrow \mathcal{L}_B^G \longleftrightarrow \Gamma_B. \quad (215)$$

Institutional organization can shape individual landscapes, while individuals can participate in reproducing or revising institutional organization.

The present paper does not develop criteria sufficient for collective contamination. The extension remains a research program requiring a theory of collective bearer identity, organizational memory, generative function, and evidential attribution.

13.4 Technical and Ecological Extensions

This subsection examines possible extensions beyond human social and institutional systems. Its objective is to distinguish legitimate structural transfer from anthropomorphic or metaphorical expansion. The method requires each proposed extension to identify a generative process appropriate to the system under analysis.

Technical systems can possess architectures that generate outputs, update internal parameters, respond to environments, and alter later behavior. In such systems, contamination terminology may already have established technical meanings concerning data, models, measurements, interfaces, or physical components.

A Generative Relational application to a technical system should therefore avoid replacing established terminology unnecessarily.

The framework may become useful where the analysis concerns interaction among internal generative organization, operating environment, observation, and feedback. For example, a machine-learning system can be affected by changes in training data, deployment environment, measurement channels, and later feedback.

Even in such cases, the relevant grammar object would require a domain-specific definition rather than direct reuse of the human-centered Γ_B .

Ecological systems raise a different difficulty.

Ecosystems exhibit generation, adaptation, succession, interaction, self-organization, and long temporal dependencies. Environmental pollution already possesses mature scientific definitions within these domains. Introducing *generative pollution* would therefore require a clear analytical contribution beyond ordinary ecological pollution.

A potential extension might concern the conditions under which an ecological system can continue generating diverse future configurations, recovering from disturbance, or maintaining pathways of adaptation.

Such an analysis would require independent ecological criteria. Human preferences concerning what an ecosystem should become cannot substitute for the system's own dynamics.

The extension must therefore avoid

$$\text{HumanValuation} \Rightarrow \text{EcologicalGenerativeCriterion} . \quad (216)$$

The ecological case also intensifies the epistemic problem. Slow variables, delayed responses, partial observability, and nonlinear interactions can make the generative consequences of an intervention difficult to infer.

A cautious extension would therefore require:

- a domain-specific definition of generation;
- an empirically defensible bearer;
- a clear distinction between system organization and environmental conditions;
- an observation model appropriate to the system;
- temporal horizons adequate to slow responses;
- explicit uncertainty concerning intervention effects.

The present paper does not claim that these requirements have been satisfied.

Technical and ecological extensions are therefore possible directions for later work rather than demonstrated applications of the current framework.

13.5 Normative and Legal Boundaries

This subsection establishes the boundary between the structural framework and normative or legal classification. Its objective is to prevent contamination and pollution terminology from functioning as implicit conclusions of moral wrongdoing, legal liability, or entitlement to remedy. The method preserves the layered sequence developed in Section 10.

The structural sequence is

$$\text{alteration} \longrightarrow \text{contamination or pollution} \longrightarrow \text{capability effect} \longrightarrow \text{harm} \longrightarrow \text{wrongfulness} \longrightarrow \text{responsibility} . \quad (217)$$

Legal classification introduces a further stage:

$$\text{responsibility analysis} \longrightarrow \text{possible legal classification} . \quad (218)$$

Neither arrow is automatic.

A legal system may recognize harms without using contamination terminology. It may regulate coercion, discrimination, negligence, educational duty, consumer protection, workplace conditions, abuse of authority, environmental risk, or other relations through doctrines developed independently of the present framework.

Generativity contamination should therefore not be proposed as a legal cause of action merely because the structural concept identifies a morally troubling case.

A legal analysis would require additional specification of:

- jurisdiction;

- legally protected interest;
- duty;
- standard of conduct;
- causation;
- foreseeability where relevant;
- evidential standard;
- available remedy;
- procedural competence.

The same caution applies to policy.

A finding of generative pollution does not directly determine which intervention is justified. Removing one disturbance can introduce another. Policies can redistribute generative conditions unevenly. A measure that expands one domain of generativity can restrict another.

Normative analysis must therefore remain plural and context-sensitive.

The framework also carries a reflexive ethical risk. Describing another person as “contaminated” can itself become a form of classification that changes the person’s relational field.

The diagnosis may affect recognition, credibility, agency, or opportunities. The observer can therefore become part of the system under analysis.

This risk supports a principle of diagnostic restraint:

$$\text{UncertainDiagnosis} \Rightarrow \text{AvoidUnwarrantedReification} . \quad (219)$$

Where evidence supports only a possible grammar alteration, the analysis should report that uncertainty rather than convert the hypothesis into an identity claim about the person.

The same principle applies to groups and cultures. The vocabulary of contamination should not be used to classify populations, traditions, or identities as contaminated merely because they emerged through historical relations or contain internal tensions.

The object of diagnosis must remain a specified generative process.

The boundaries established in this section therefore limit the claims of the paper in five ways. The present account is primarily person-centered and domain-indexed. It does not assume an authentic pre-relational self. Collective applications require a separate theory of collective generative organization. Technical and ecological extensions require domain-specific reconstruction. Normative and legal consequences require additional premises beyond structural diagnosis.

These restrictions are part of the framework rather than external qualifications added after the analysis. A concept of contamination that can be applied to every relational change would lose diagnostic value. A concept of pollution that can be applied to every unfavorable environment would collapse into general dissatisfaction. The usefulness of both concepts therefore depends upon maintaining explicit bearers, levels, domains, comparisons, mechanisms, and limits.

14 Discussion

This section evaluates the conceptual architecture developed in the preceding sections and identifies the principal theoretical tensions that remain open. Its objective is to assess the analytical value of distinguishing generativity contamination from generative pollution, clarify the status of the contamination threshold, examine the coupling between generative organization and generative conditions, and identify the strongest challenges to the proposed vocabulary. The section also considers temporal dynamics,

reflexive observation, empirical implications, and directions for further development. The method is critical rather than merely synthetic. The framework is evaluated against counterexamples, possible redundancy with neighboring concepts, and the risk that its own diagnostic language could reproduce the forms of misrecognition it seeks to analyze.

14.1 Analytical Contribution of the Pollution–Contamination Distinction

The principal analytical contribution of the framework lies in separating disturbances located in the conditions of generation from disturbances located in the generative organization of the bearer. The distinction is simple in formal expression,

$$\text{GenerativePollution} \rightsquigarrow \mathcal{L}^G, \quad \text{GenerativityContamination} \rightsquigarrow \Gamma, \quad (220)$$

yet its consequences extend across the entire diagnostic architecture.

Without this separation, several different situations can collapse into one category. A person working in degraded conditions can be treated as personally impaired. A person carrying a persistent grammar-level alteration can be assumed to remain in an adverse environment. A poor output can be attributed to the person when the principal cause lies in the field. A restored environment can be mistaken for complete recovery even when earlier grammar-level effects remain operative.

The two-concept framework permits at least four configurations:

$$(P, C) \in \{(0, 0), (1, 0), (0, 1), (1, 1)\}, \quad (221)$$

where P denotes generative pollution and C generativity contamination.

The analytical value of the distinction is especially visible in the two off-diagonal cases.

The configuration

$$(P, C) = (1, 0) \quad (222)$$

describes a polluted field without demonstrated grammar contamination. The person can remain critically aware of the adverse conditions, preserve the capacity to generate alternatives, and recover quickly when the field changes.

The configuration

$$(P, C) = (0, 1) \quad (223)$$

describes grammar contamination outside a currently polluted field. Historical relations can remain operative in present generation after the original environment has disappeared.

These two cases cannot be represented adequately if pollution and contamination are treated as synonyms.

The distinction also introduces temporal resolution. A process can move through several configurations:

$$(1, 0) \longrightarrow (1, 1) \longrightarrow (0, 1) \longrightarrow (0, 0). \quad (224)$$

The sequence may represent initial field pollution, later grammar contamination, environmental recovery with continuing contamination, and eventual grammar recovery. Other trajectories are also possible.

The framework therefore supplies more than two labels. It provides a way to describe location and transition.

Its strongest contribution may consequently lie in the joint use of *bearer specification*, *level specification*, and *temporal propagation*. Existing concepts can already describe manipulation, oppressive conditions, adaptive preference, coercive control, epistemic pollution, exploitation, or indoctrination. The present distinction is useful where the analytical problem concerns movement among field, organization, observation, and epistemic representation.

The framework should therefore resist a broad novelty claim. Its contribution is better understood as a diagnostic decomposition that permits relations among existing phenomena to be represented with greater positional precision.

14.2 Structural Neutrality and the Contamination Threshold

The most difficult unresolved issue concerns the threshold separating ordinary relational generative alteration from generativity contamination. Earlier sections deliberately rejected the equation

$$\text{RelationalAlteration} = \text{Contamination} . \quad (225)$$

Such an equation would classify ordinary education, friendship, intellectual development, language acquisition, and beneficial transformation as contamination whenever they materially alter the generative grammar.

The framework therefore introduced an additional contamination condition C_D , provisionally associated with some form of generative compromise.

This choice solves one problem while introducing another.

If contamination is defined structurally and neutrally, the term becomes too broad. A teacher who permanently expands a student's capacity for mathematical inquiry would count as contaminating the student merely because a relation-derived grammar alteration occurred.

If contamination is defined through adverse generative effect, the concept acquires normative content and begins to overlap with capability impairment or harm.

The current framework attempts to occupy an intermediate position. Generativity contamination is not fully normatively neutral, yet neither is it equivalent to harm. The additional contamination condition concerns the operation of the generative organization rather than the complete normative evaluation of the resulting life trajectory.

This distinction can be represented as

$$\text{generative alteration} \longrightarrow \text{generative compromise} \longrightarrow \text{possible capability impairment} \longrightarrow \text{possible harm} . \quad (226)$$

The difficult question concerns the content of *generative compromise*.

Several candidates emerged in the paper:

- systematic narrowing of recognizable alternatives;
- reduced capacity to revise the generative grammar;
- self-reinforcing exclusion of possible trajectories;
- increased dependence upon a restricted class of relational signals;
- loss of access to alternative interpretive or practical frames;
- recursive reduction of the conditions through which the alteration itself can be reconsidered.

No candidate is yet sufficient across all domains.

A narrowing of alternatives, for example, can accompany valuable commitment. Expertise often excludes possibilities that a novice would still consider. Moral development can make some formerly viable actions no longer appear acceptable. Long-term relationships can stabilize practical orientations and reduce the relevance of alternatives without thereby compromising generativity.

Revisability is therefore a promising but incomplete criterion. A grammar that cannot revise itself under any condition appears strongly compromised, yet stable commitments are not necessarily pathological merely because they are difficult to revise.

The contamination threshold should consequently remain open to domain-specific refinement.

One possible future formulation would treat contamination as a family resemblance concept supported by several indicators rather than one universal necessary and sufficient condition. Another would define a minimal structural criterion and reserve stronger terms such as *adverse contamination* or *harmful contamination* for subsequent layers.

The current paper selects neither approach conclusively. Its more modest claim is that relation-derived alteration alone is insufficient and that the additional contamination criterion must remain conceptually distinguishable from the later concept of harm.

14.3 Generative Compromise and the Problem of Normative Loading

The contamination threshold raises a related problem concerning the evaluative force of the vocabulary itself. The term *contamination* carries a strong negative connotation in ordinary and scientific language. A theory using the term cannot rely upon readers to interpret it as a purely neutral description.

This semantic loading can be useful because it prevents the concept from collapsing into ordinary relational development. It also creates a danger of premature moralization.

The framework therefore needs to distinguish three levels:

$$\text{negative structural characterization} \neq \text{harm judgment} \neq \text{wrongfulness judgment.} \quad (227)$$

Generative compromise occupies the first level. It records a degradation or restriction in the operation of the generative organization relative to the declared domain and comparison.

Harm requires an additional account of why the restriction matters for the bearer.

Wrongfulness requires further normative premises concerning the conduct, relation, authority, justification, or duties involved.

The distinction remains difficult because any criterion of *compromise* already presupposes some conception of what counts as a better or worse condition of generation.

The framework should acknowledge this explicitly.

Generative compromise cannot be derived from geometry alone. A smaller capability set is not automatically worse. A more stable grammar is not automatically worse. A more revisable grammar is not automatically better. Some valuable practices depend upon commitment, discipline, exclusion, and structural constraint.

The analysis therefore requires a declared evaluative orientation even before the full harm stage is reached.

A plausible minimal orientation is preservation of the conditions under which the bearer can continue to generate, recognize, contest, and revise meaningful possibilities within the declared domain.

This orientation remains weaker than maximizing the number of possibilities.

The framework therefore rejects

$$\text{MorePossibilities} \Rightarrow \text{MoreGenerativity.} \quad (228)$$

An unlimited possibility space can be unusable, incoherent, unstable, or practically inaccessible.

Generativity concerns organized production and revision of viable trajectories, rather than numerical maximization of options.

The contamination concept should therefore remain sensitive to structure, quality of revision, and practical accessibility rather than raw cardinality.

14.4 Internal Organization and Relational Field Coupling

The distinction between grammar and landscape creates another theoretical risk. The analytical separation may appear to reproduce an internal-external dualism in which grammar belongs inside the person and landscape exists outside the person.

Such an interpretation would be inconsistent with the relational commitments of the framework.

The distinction between

Γ_B

and

$\mathcal{L}_B^G$

is diagnostic rather than ontological.

Generative grammar is itself relationally generated. Generative landscapes are partly constituted by how participants interpret, reproduce, and transform relations. The two objects are therefore recursively coupled:

$$\Gamma_{B,t} \longleftrightarrow \mathcal{L}_{B,t}^G. \quad (229)$$

The grammar influences which environmental features become salient, threatening, inviting, relevant, or recognizable. The landscape influences which patterns of interpretation and action become repeatedly generated.

This coupling creates a further complication. The same nominal environment may correspond to different effective landscapes for different bearers.

Let $\mathcal{F}_t$ denote a shared field. Then the effective generative landscape of person B may be written schematically as

$$\mathcal{L}_{B,t}^G = \Phi(\mathcal{F}_t, \Gamma_{B,t}, X_{B,t}, H_{B,t}). \quad (230)$$

The equation does not reduce the environment to subjective interpretation. The shared field constrains the space of possible experience, while the bearer's grammar and history partly determine how those constraints become operative.

This relation helps explain heterogeneous responses under shared conditions.

It also raises a diagnostic question: if the landscape is partly bearer-relative, can pollution be objectively identified?

The framework answers conditionally. Pollution need not be wholly observer- or receiver-dependent. Physical noise, resource deprivation, legal restriction, centralized evaluative authority, or reduced exit can be documented independently. Their generative significance, however, depends upon the relevant activity, bearer, and domain.

Generative pollution is therefore relationally objective rather than context-free.

The same reasoning prevents grammar from being treated as a sealed internal object. The bearer-level location indicates where the alteration becomes operative, not that its causal structure is internal to the person.

A grammar alteration can remain distributed across language, relational expectations, institutional affordances, memory, and repeated interaction.

Future work may therefore require a more explicitly distributed representation of generative organization. The present grammar-landscape distinction should be retained as an analytical decomposition while its boundaries remain porous and dynamically coupled.

14.5 Temporal Dynamics, Persistence, and Recovery

The source-domain comparison led to an important revision of the initial contamination concept. Persistence should not be treated as a necessary condition of contamination occurrence.

A grammar-level contamination can occur and later be revised.

Likewise, a polluted field can be restored.

Occurrence, persistence, propagation, and recovery should therefore remain separate temporal dimensions:

$$\mathbf{T} = \langle o, p, g, r \rangle, \quad (231)$$

where o denotes occurrence, p persistence, g propagation, and r recovery or revisability.

This decomposition matters because different mechanisms can govern different stages.

One relation can initiate a grammar alteration. Another can stabilize it. A later institution can amplify it. A supportive relation can make revision possible.

The causal history of contamination therefore cannot always be assigned to one source.

The same temporal structure applies to generative pollution. One actor can introduce a field disturbance while institutional routines reproduce it after that actor leaves.

Persistence can therefore become structural.

Recovery also requires more careful treatment than simple return to baseline. The framework rejects

$$\Gamma^{\text{recovered}} = \Gamma^{\text{prior}} \quad (232)$$

as a general requirement.

Recovery can generate a third organization that incorporates the historical experience while restoring or expanding the capacity for recognition, revision, and viable generation.

The temporal framework may ultimately be one of the most important extensions of the pollution-contamination distinction. Static diagnosis identifies where a disturbance is located. Temporal analysis identifies how it moves, persists, changes form, and becomes reversible.

A more developed theory would therefore model contamination and pollution as trajectories rather than binary states.

14.6 Observation, Classification, and Reflexive Feedback

The distinction among generative state, observation, and epistemic representation introduces a further consequence: observation is not always external to the generative system being studied.

In many human and institutional contexts, classification changes the conditions encountered by the classified person.

A score can affect course placement.

A diagnosis can alter expectations.

A reputation can modify access to relationships.

An institutional label can change the range of opportunities available.

The observer therefore enters the causal system.

The paper represented one possible loop as

$$O_{t_0} \longrightarrow K_{t_0} \longrightarrow \Delta \mathcal{L}_{t_1}^G \longrightarrow \Delta \Gamma_{t_2} \longrightarrow O_{t_3}. \quad (233)$$

The epistemic significance of this loop is substantial.

A later observation can agree with an earlier classification because the classification contributed to producing the later state.

Later agreement therefore cannot retroactively validate the original observation.

This difficulty creates a methodological obligation to record provenance. Researchers and institutions should distinguish what was observed before an intervention, what was inferred, how the inference changed the field, and which later observations occurred after that change.

The same problem applies to the vocabulary introduced in this paper.

Calling a person “contaminated” can itself alter the person’s relational environment.

The label can reduce perceived agency, invite paternalistic intervention, change credibility judgments, or encourage observers to reinterpret ordinary behavior as evidence of contamination.

The framework is therefore reflexively vulnerable to the pathology it describes.

This risk strengthens the requirement that contamination remain a diagnosis of a specified generative organization within a declared domain rather than an identity attribution.

The appropriate formulation is

$$\text{Contam}_G (\Gamma_B; D, H), \quad (234)$$

rather than

“*B* is a contaminated person.”

The distinction is ethical as well as epistemic.

14.7 Alternative Explanations and Conceptual Redundancy

The strongest challenge to the framework is conceptual redundancy. Many of the phenomena described in this paper already appear in established literatures on socialization, relational autonomy, indoctrination, manipulation, adaptive preference, coercive control, epistemic pollution, coloniality, exploitation, institutional power, and educational inequality.

The framework therefore faces a demanding question: what analytical work is lost if the terms *generativity contamination* and *generative pollution* are removed?

A weak answer would be that the proposed terminology unifies several topics. Unification alone does not justify new concepts if the result merely replaces more precise established language.

A stronger answer concerns positional differentiation.

The framework allows the analyst to state that:

- the field is polluted while the person is not contaminated;
- the person remains contaminated after the field has recovered;
- an observation is contaminated while both field and grammar remain comparatively intact;
- an epistemic representation is distorted without establishing ontic alteration;
- contamination occurs without manipulation or identifiable benefit;
- exploitation occurs without grammar contamination;
- a relationally generated grammar alteration can be beneficial and therefore fail the contamination criterion.

These distinctions cut across neighboring literatures.

The framework may therefore be most useful as a diagnostic coordinate system rather than as a replacement theory.

Its value would be reduced if existing concepts already supply the same coordinate structure with equivalent clarity.

Future work should therefore compare the proposed framework more closely with the strongest neighboring alternatives rather than expanding the vocabulary prematurely.

A practical criterion for conceptual retention is:

$$\text{RetainConcept} \Rightarrow \text{DistinctAnalyticalWork} . \quad (235)$$

If later analysis demonstrates that one of the concepts performs no distinct work, the framework should be simplified.

14.8 Implications for Empirical Research

The framework creates empirical demands that are substantially stronger than ordinary observation of performance.

Generativity contamination is especially difficult to investigate because grammar is a latent analytical object inferred from patterns of generation. A credible empirical study would need to distinguish

grammar change from temporary state variation, environmental constraint, strategic adaptation, and measurement error.

Longitudinal designs are therefore especially important.

A strong study would ideally observe:

- generative patterns before the focal relational process;
- changes during exposure;
- behavior across more than one setting;
- changes after the focal environmental condition ends;
- responses when alternative trajectories become practically available;
- patterns of revision following disconfirming experience.

Generative pollution requires a different evidential strategy. Researchers should measure or reconstruct the relevant environmental conditions directly rather than infer pollution solely from poor outcomes.

Mixed methods are likely to be useful because different levels require different forms of evidence.

Environmental measurement can identify physical or temporal interference.

Institutional analysis can reconstruct rules, dependencies, recognition structures, or access pathways.

Behavioral data can reveal generated trajectories.

Interviews or interpretive methods can provide evidence concerning recognized possibilities and self-revision.

Longitudinal comparison can reveal persistence and recovery.

Observation audits can identify measurement contamination.

No single method is sufficient for all layers.

The framework also suggests that empirical studies should avoid collapsing person and environment into one outcome model. A reduced outcome can arise through several pathways:

$$\Delta Y \Leftarrow \{ \Delta \Gamma, \Delta \mathcal{L}^G, \Delta X, \Delta O, \text{interaction among them} \}. \quad (236)$$

Empirical identification therefore requires competing models rather than one preferred causal narrative.

The strongest future tests of the framework may be cases in which its concepts make different predictions. A particularly useful design would compare persons exposed to the same polluted field who show heterogeneous later grammar trajectories. Another would examine persons who leave a polluted environment and determine whether the relevant generative restriction persists, weakens, or disappears.

Such studies would test whether the distinction between field pollution and grammar contamination corresponds to empirically distinguishable trajectories.

14.9 Directions for Further Development

Several theoretical directions follow from the present analysis.

The first concerns the contamination threshold. The relation among generative compromise, revisability, narrowing of possibilities, and harmful capability loss requires further conceptual testing.

The second concerns formal representation. The current notation identifies objects and relations without claiming a complete dynamical model. A later framework could represent trajectories in a generative state space and examine changes in reachability, attractor structure, transition cost, and revision paths.

Such formalization should remain subordinate to conceptual clarity. Increased mathematical complexity would add little if the underlying bearer and comparison remain ambiguous.

The third direction concerns coupled dynamics. The present paper often treats the focal person and relational environment through simplified interactions. In many cases, the generative grammar of one person responds continuously to the evolving grammar of another:

$$\Gamma_{A,t} \longleftrightarrow \rho_{AB,t} \longleftrightarrow \Gamma_{B,t}. \quad (237)$$

A fuller theory of contamination would therefore require coupled relational dynamics rather than a source-receiver model.

The fourth direction concerns collective systems. Institutional generative organization may persist across individual turnover and could become a distinct bearer of contamination. Developing this extension requires an account of organizational memory, distributed rules, decision procedures, and collective revision.

The fifth direction concerns observation. The reflexive relation between classification and later generation deserves independent treatment. A theory of observational contamination in generative systems could examine how measurement design, institutional metrics, rankings, labels, and predictions enter the trajectories they attempt to describe.

The sixth direction concerns ecological and technical systems. These extensions should proceed only where the relevant generative object and landscape can be defined independently of human analogy.

The seventh direction concerns normativity. The present paper stops before a complete account of generative harm, justice, or responsibility. Future work should clarify which forms of generative compromise matter morally, how heterogeneous values should be handled, and which interventions preserve revisability without imposing another restrictive grammar.

The eighth direction concerns remediation. Recovery should be studied as a generative process rather than restoration of a previous state. The relevant question is how new relational conditions can reopen recognition, revision, and viable trajectory formation after contamination or pollution.

The discussion therefore leaves the framework deliberately incomplete.

Its strongest current claim is limited: disturbances affecting generative systems can occur at different locations, those locations can interact without being identical, and the distinction among them improves causal, epistemic, and normative analysis.

The continued usefulness of the concepts depends upon whether later empirical and philosophical work can refine the contamination threshold, distinguish the proposed objects in real cases, and show that the pollution-contamination architecture performs analytical work unavailable through simpler terminologies.

15 Conclusion

This paper has developed a provisional distinction between *generativity contamination* and *generative pollution* within Generative Relational Systems. The distinction begins from a separation among generative organization, generative conditions, effective generative capability, generated output, observation, and epistemic representation. These objects can participate in one relational trajectory while remaining analytically distinct.

Generativity contamination has been located principally at the level of the generative grammar Γ . It concerns a relation-derived, materially significant grammar-level alteration that additionally satisfies a defensible condition of generative compromise. Generative pollution has been located principally at the level of the generative landscape $\mathcal{L}^G$. It concerns a materially significant degradation or disruptive alteration of the conditions under which generation occurs within a declared domain and comparison.

The central relation is therefore

$$\text{GenerativityContamination} \neq \text{GenerativePollution}. \quad (238)$$

This non-identity permits polluted fields without contaminated persons, contaminated generative organizations outside currently polluted fields, and cases in which both conditions coexist.

The distinction also supports a temporal account. Generative pollution can contribute to later contamination, while grammar-level alteration can participate in the reproduction of polluted fields. Observation and classification can mediate these transitions. A possible relational pathway is

$$\text{Pollute}(\mathcal{L}^G) \longrightarrow \text{Contam}(O) \longrightarrow \text{Distort}(K) \longrightarrow \Delta\rho \longrightarrow \Delta\Gamma. \quad (239)$$

None of these transitions is necessary. Their analytical separation is one of the principal purposes of the framework.

The source-domain analysis further showed that several properties often collapsed into contamination or pollution should remain distinct. Exposure does not establish contamination. Contamination does not require persistence, propagation, source replication, intent, or demonstrated harm. Pollution does not require contamination of a receiver. Recovery of a field does not establish recovery of the generative organization.

The framework therefore preserves a layered diagnostic sequence:

$$\text{structural diagnosis} \longrightarrow \text{effective capability effect} \longrightarrow \text{harm} \longrightarrow \text{wrongfulness} \longrightarrow \text{responsibility}. \quad (240)$$

Each transition requires additional evidence or normative premises.

The framework also rejects a pure pre-relational baseline. Generative organization is already historically and relationally formed. A contamination diagnosis therefore cannot rest merely on deviation from an earlier or supposedly authentic state. Likewise, beneficial education and other forms of relational development can produce deep and persistent grammar-level transformation without constituting contamination.

The resulting proposal is deliberately limited. Generativity contamination and generative pollution are intended as bearer-sensitive and level-sensitive concepts for locating different forms of disturbance within relational generative processes. Their value depends upon maintaining the distinctions among grammar, field, capability, output, observation, and representation, while tracing the mechanisms through which changes can propagate across those levels.

The paper therefore does not propose contamination or pollution as universal descriptions of relational difficulty. It proposes a diagnostic vocabulary for cases in which it matters whether a disturbance has altered the conditions of generation, become operative within the organization of generation, or affected only the observations and representations through which that generative process is known.

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