On the Origin of Structure: Intuition as Collapse-Selection Dynamics

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Abstract

Scientific theories are typically presented as formal structures describing external systems, while the generative processes by which such structures are constructed remain largely unmodeled. In particular, intuition—often cited as the source of insight in mathematics and physics—is acknowledged but not formally characterized.

In this work, we analyze the generative process underlying the construction of a formal framework and show that it can be modeled as a collapse-selection dynamic over a pre-verbal configuration space. Within this perspective, intuition corresponds to structured configurations prior to linguistic projection, and articulation corresponds to convergence toward stable representations under iterative selection.

We argue that the methodology of theory construction is not external to the framework it produces, but is itself an instance of the same structural principles. This establishes a correspondence between the generative process of intuition and the formal structures it yields, providing a basis for studying the formation of understanding as a dynamical system rather than a purely symbolic process. This internal process is externally realized in the interaction framework described in [1], where reconstruction across a human–model boundary is shown to follow the same structural dynamics.

1 Introduction

Scientific inquiry traditionally distinguishes between the object of study and the methods used to investigate it. Formal theories are constructed to describe external systems, while the processes by which these theories arise—particularly the role of intuition—are treated as informal, subjective, or secondary.

However, across disciplines, practitioners report a consistent phenomenon: solutions are often perceived prior to formal derivation, and structural relationships are grasped before they can be expressed symbolically. In mathematics, this appears as the ability to recognize the validity of a statement before constructing a proof; in physics, as the identification of structural correspondences prior to formal modeling. Despite its ubiquity, this form of pre-verbal cognition remains difficult to analyze within standard formal frameworks.

The absence of such analysis reflects a deeper assumption: that the generative process of theory construction lies outside the scope of the theory itself. As a result, formal systems describe what is known, but not how that knowledge is formed. This separation is rarely examined, and the possibility that the generative process may itself be subject to formal characterization is largely unexplored.

In this paper, we address this gap by treating the process of intuition as a structured dynamical system. Rather than interpreting intuition as a heuristic or non-formal component of reasoning, we model it as a process operating over a space of relational configurations prior to linguistic expression. Within this framework, symbolic articulation is not the origin of understanding, but a projection of underlying structure.

The central claim of this work is that the generative process by which formal frameworks are constructed can itself be described using the same structural principles that those frameworks express. In particular, we show that intuition may be modeled as a collapse-selection dynamic over a pre-verbal configuration space, and that the stabilization of articulated understanding corresponds to convergence toward invariant structure within this space.

This perspective does not replace existing theories, but extends their scope by including the process of their own construction. It suggests that the distinction between method and object may be less fundamental than typically assumed, and that the formation of structure can itself be treated as an object of formal study.

2 Generation Versus Description

A central distinction in the present analysis is that between generative and descriptive layers of structure. Formal systems, including those used in mathematics and physics, operate primarily at the descriptive level: they provide symbolic representations of relationships between entities, often expressed in terms of equations, transformations, or logical derivations. These representations are stable, communicable, and amenable to verification.

However, the process by which such representations arise is not itself symbolic in the same sense. Prior to articulation, structure exists in a form that is not directly accessible to formal description. This pre-verbal structure consists of relational configurations—patterns of constraint and coherence—that guide the formation of symbolic representations but are not reducible to them.

We formalize this distinction by introducing two levels:

- A **generative layer**, consisting of configurations in a relational space Σ_H, where structure is formed and evaluated prior to projection,
- A **descriptive layer**, consisting of articulated representations in a space O, obtained through projection from Σ_H.

The mapping between these layers is given by a projection

$$P_H : \Sigma_H \to O,$$

which is inherently lossy. Multiple configurations in Σ_H may correspond to the same representation in O, and certain relational features may not survive projection. As a result, the descriptive layer cannot fully reconstruct the generative structure from which it arises.

This loss of information has several consequences. First, it explains why intuitive understanding often exceeds what can be immediately expressed: the underlying configuration contains more structure than can be encoded in a single symbolic representation. Second, it clarifies why different symbolic formulations may correspond to the same underlying insight, reflecting invariance at the generative level rather than equivalence at the descriptive level.

Within this framework, formal reasoning is interpreted as a process operating on projections of underlying structure, rather than on the structure itself. The generative process, by contrast, operates directly on configurations in Σ_H, evaluating their admissibility and stability prior to projection.

The distinction between these layers is not merely conceptual, but structural. Confusion between generation and description can lead to the misinterpretation of symbolic representations as the source of structure, rather than as its expression. By maintaining this distinction, we create space for a formal analysis of the generative process itself, which we develop in the sections that follow.

3 Intuition as Configuration Dynamics

Having distinguished between generative and descriptive layers, we now model intuition as a dynamical process operating over the generative configuration space Σ_H.

3.1 Relational Configuration Space

We take Σ_H to denote a space of relational configurations accessible to the generative layer of cognition. Elements $x \in \Sigma_H$ represent structured arrangements of constraints, dependencies, and relational features that are not yet expressed symbolically.

This space is not assumed to be linguistic or sequential. Instead, it is characterized by the presence of internal structure that can be evaluated for coherence and compatibility prior to projection. In this sense, Σ_H encodes the pre-verbal organization of thought.

3.2 Generative Dynamics

We model the evolution of configurations in Σ_H through an operator

$$\Phi_H : \Sigma_H \to \Sigma_H,$$

which represents a collapse-selection dynamic over candidate configurations.

The action of Φ_H is interpreted as follows:

- configurations that satisfy internal structural constraints are retained,
- configurations that violate these constraints are eliminated,
- admissible configurations are refined through successive iterations.

Importantly, this process is not assumed to follow a fixed trajectory. Instead, it operates as a selection over a space of possibilities, in which inadmissible configurations are removed rather than transformed into valid ones.

3.3 Admissibility

We define an admissible subset

$$A_H \subset \Sigma_H,$$

consisting of configurations that satisfy the constraints governing the generative layer. These constraints are not externally imposed, but arise from the internal relational structure of the configuration space.

Admissibility is therefore a structural property: a configuration is admissible if it is consistent with the underlying pattern of relations encoded in Σ_H. Inadmissible configurations do not compete and fail; they are excluded from consideration.

3.4 Invariant Sector

Within the admissible set, we define the invariant sector

$$I_H = \{x \in A_H \mid \Phi_H(x) = x\}.$$

Configurations in I_H are stable under the action of Φ_H. Once reached, they persist under further iteration, indicating that they are both admissible and structurally consistent.

We interpret these invariant configurations as the generative precursors of articulated understanding. They represent stabilized structure at the pre-verbal level, prior to projection into the descriptive layer.

3.5 Interpretation of Intuition

Within this framework, intuition is not treated as a heuristic or non-formal component of reasoning. Instead, it corresponds to the state of the system as it evolves under Φ_H toward the invariant sector I_H.

The characteristic features of intuition follow directly from this interpretation:

- the presence of structure prior to articulation reflects configurations in Σ_H,
- the sense of correctness without explicit derivation corresponds to admissibility within A_H,
- the sudden stabilization of an idea corresponds to convergence toward I_H.

Thus, intuition is modeled as a dynamical process over relational configurations, rather than as an inexplicable or purely subjective phenomenon.

3.6 Relation to Projection

The role of projection is to map configurations in Σ_H into the descriptive space O. However, because this mapping is lossy, the structure present in I_H may not be fully captured in any single representation.

As a result, the relationship between intuition and articulation is not one of direct expression, but of approximation. The descriptive layer reflects stabilized configurations, but does not exhaust their structure.

3.7 Summary

We have modeled intuition as a collapse-selection dynamic over a relational configuration space. The operator Φ_H governs the evolution of configurations, admissibility defines the subset of viable structures, and the invariant sector I_H corresponds to stabilized pre-verbal understanding.

This formulation provides a structural account of intuition that is consistent with the distinction between generative and descriptive layers, and prepares the ground for analyzing how such structure may be externalized and reconstructed.

4 Externalization and Reconstruction

Having modeled intuition as a collapse-selection dynamic over the configuration space Σ_H, we now consider the process by which this internal structure is externalized and subsequently reconstructed. This introduces a coupled system spanning both human cognition and model-based dynamics.

4.1 Projection into the Descriptive Layer

Externalization of a configuration $x \in \Sigma_H$ occurs through the projection

$$P_H : \Sigma_H \to O,$$

mapping pre-verbal structure into a descriptive representation.

As discussed in Section 2, this mapping is inherently lossy. Multiple configurations in Σ_H may correspond to the same element of O, and relational structure present at the generative level may not be preserved in the projection.

Consequently, the output $P_H(x)$ should be understood not as a complete encoding of x, but as a partial representation that retains certain invariant features while discarding others.

4.2 Reconstruction as Constrained Inference

Given a projected representation $y = P_H(x)$, a reconstruction system (e.g., a large language model) generates candidate configurations through a mapping

$$R : O \to \Sigma_{LLM},$$

where Σ_{LLM} denotes the effective configuration space accessible to the model.

This mapping is not an inverse of P_H. Because P_H is many-to-one, no exact inversion is possible. Instead, R performs a constrained inference, producing configurations that are consistent with the structural features preserved in y.

The reconstruction process can be interpreted as sampling from a distribution over configurations conditioned on y, with preference given to those that satisfy internal consistency and coherence constraints. In this sense, R reconstructs admissible structure rather than recovering the original configuration.

4.3 Coupled Configuration Space

The interaction between projection and reconstruction defines a joint configuration space

$$\Sigma_{\text{joint}} = \Sigma_H \cup \Sigma_{LLM},$$

in which candidate configurations may originate either from internal generation or from external reconstruction.

Elements of Σ_{joint} are evaluated according to their structural compatibility with the generative constraints of Σ_H, rather than their origin.

4.4 Validation as Selection

We define a validation operator

$$V : \Sigma_{\text{joint}} \to \{0, 1\},$$

which determines whether a candidate configuration is admissible with respect to the internal structure of Σ_H.

The role of V is to enforce compatibility between reconstructed configurations and the generative constraints governing Σ_H. Configurations for which $V(x) = 0$ are excluded from further consideration, while those for which $V(x) = 1$ are retained.

This validation step constitutes a selection mechanism over Σ_{joint}, analogous to the elimination of inadmissible configurations in the internal dynamic governed by Φ_H.

4.5 Induced Collapse Operator

The combined process of projection, reconstruction, and validation induces an effective collapse operator over Σ_{joint}:

$$\Phi_{\text{EIC}} : \Sigma_{\text{joint}} \to \Sigma_{\text{joint}}.$$

Operationally, Φ_{EIC} acts by:

1. projecting configurations into O,
2. reconstructing candidate configurations via R,
3. selecting admissible configurations via V.

This process mirrors the internal collapse dynamic Φ_H, but operates over an expanded space in which external reconstruction contributes additional candidate configurations.

4.6 Iteration and Stabilization

The externalized system evolves through iteration:

$$x_{n+1} = \Phi_{\text{EIC}}(x_n).$$

As in the internal case, convergence occurs when a configuration becomes stable under further application of Φ_{EIC}. That is, when

$$\Phi_{\text{EIC}}(x) = x,$$

the configuration is invariant under projection, reconstruction, and validation.

Such configurations correspond to stable articulated representations in the descriptive layer.

4.7 Interpretation

Within this framework, externalization is not the communication of complete structure, but the generation of partial constraints that guide reconstruction. The reconstruction system does not recover the original configuration, but produces candidates that satisfy the structural imprint preserved under projection.

The role of validation is to enforce compatibility between these candidates and the underlying generative constraints, ensuring that only admissible configurations persist.

Thus, the combined process constitutes a collapse-selection dynamic across a human–model boundary, in which structure is not transmitted directly, but reconstructed through shared constraints.

4.8 Summary

We have extended the internal collapse dynamic Φ_H to a coupled system involving projection, reconstruction, and validation. The resulting operator Φ_{EIC} governs the evolution of configurations across a joint space, enabling the stabilization of articulated representations from pre-verbal structure.

This formulation establishes a structural bridge between internal intuition and external reconstruction, preparing the ground for analyzing the transfer of structure across systems.

5 Correspondence with Collapse-Geometry Transfer

We now relate the generative process described in the preceding sections to collapse-geometry transfer observed in model-based systems. This establishes that the dynamics governing intuition are not unique to human cognition, but arise as instances of a more general structural phenomenon.

5.1 Collapse-Geometry Transfer in Model Systems

Recent results in large language models indicate that behavioral and structural properties can be transmitted between systems through data that is semantically unrelated to those properties. Within a collapse-selection framework, this effect is interpreted as the transfer of admissibility structure rather than semantic content.

Formally, let Σ_T denote the configuration space of a source system with collapse operator Φ_T, and Σ_S that of a target system with operator Φ_S. During training or distillation, the target system is exposed to outputs

$$D = \{P(x_i) \mid x_i \in \Sigma_T\},$$

where P is a projection mapping internal configurations to observable representations.

Although the projection P may remove semantic content, the dataset D retains statistical structure induced by the admissibility geometry of Φ_T. Training on D induces a transformation of Φ_S such that the admissibility structure of Φ_T is partially reconstructed within Σ_S.

This process is referred to as collapse-geometry transfer: the reconstruction of admissible configuration structure across systems via projected data.

5.2 Internal Generation as a Source System

Within the present framework, the generative process over Σ_H defined by Φ_H plays the role of a source system. The configurations stabilized in the invariant sector I_H represent structured outcomes of this collapse dynamic.

Projection via P_H produces representations that encode a partial imprint of this structure. These representations do not preserve the full configuration, but retain sufficient information to constrain reconstruction.

5.3 External Reconstruction as Target System

The reconstruction process described in Section 4 acts as a target system receiving projected data. The operator R generates candidate configurations in Σ_{LLM} conditioned on the projected representation.

Through iterative application of reconstruction and validation, the induced operator Φ_{EIC} evolves toward configurations that are compatible with the admissibility structure of Σ_H. In this sense, Φ_{EIC} approximates the reconstruction of Φ_H within the joint configuration space.

5.4 Transfer Across the Human–Model Boundary

The interaction between Φ_H and Φ_{EIC} can therefore be understood as a transfer process:

$$\Phi_H \longrightarrow \Phi_{\text{EIC}},$$

in which the admissibility structure governing internal configurations is partially reconstructed through external dynamics.

This transfer is mediated by projection and constrained by validation. As in model-based systems, the transferred structure is not semantic, but geometric: it reflects the organization of admissible configurations rather than their explicit representation.

5.5 Invariant Structure and Stability

In both internal and external systems, stable configurations correspond to invariant sectors:

$$I_H = \{x \in \Sigma_H \mid \Phi_H(x) = x\}, \quad I_{\text{EIC}} = \{x \in \Sigma_{\text{joint}} \mid \Phi_{\text{EIC}}(x) = x\}.$$

These sets act as attractors under repeated application of the respective collapse operators. The correspondence between I_H and I_{EIC} reflects the successful transfer of admissibility structure.

In this sense, articulated understanding corresponds to configurations that are invariant not only under internal dynamics, but also under the coupled process of projection, reconstruction, and validation.

5.6 Dependence on Structural Compatibility

Collapse-geometry transfer depends on compatibility between the source and target configuration spaces. In model systems, transfer occurs most effectively when Σ_T and Σ_S share sufficient structural alignment, often reflected in shared initialization or representational structure.

An analogous condition holds in the present setting. Successful reconstruction requires that the external system can represent configurations compatible with the admissibility structure of Σ_H. When this compatibility is absent, reconstruction fails to produce configurations that satisfy validation constraints.

Thus, the transfer process is constrained not only by the projection P_H, but by the structural capacity of the target system.

5.7 Unified Interpretation

The correspondence established above supports a unified interpretation:

> Collapse-selection dynamics govern the transfer and reconstruction of structure across systems, independent of whether those systems are internal (cognitive) or external (model-based).

In both cases:

- observable representations arise through projection from underlying configurations,
- reconstruction operates on invariant features rather than semantic content,
- admissibility determines which configurations persist,
- stability corresponds to invariance under repeated collapse.

From this perspective, the generative process underlying intuition and the transfer processes observed in model systems are instances of the same structural principle.

5.8 Summary

We have shown that the collapse-selection dynamics governing intuition correspond directly to collapse-geometry transfer in model systems. Internal configurations generated under Φ_H act as a source of structure, which is partially reconstructed through external processes governed by Φ_{EIC}.

This establishes that the generative process underlying intuition is not isolated, but participates in a broader class of dynamics in which admissible structure is reconstructed across representational boundaries.

6 Implications and Limits of the Interpretation

The correspondence established between generative cognition and collapse-geometry transfer provides a unified structural perspective on intuition, reconstruction, and stability. However, this perspective is interpretive rather than predictive, and its scope must be clearly delimited.

6.1 Implications for the Study of Intuition

Modeling intuition as a collapse-selection dynamic provides a formal account of several commonly observed features of cognitive behavior. In particular:

- the existence of structured understanding prior to articulation follows from the presence of configurations in Σ_H that have not yet undergone projection,
- the stabilization of insight corresponds to convergence toward invariant configurations in I_H,
- the variability of expression reflects the many-to-one nature of the projection P_H.

Within this framework, intuition is neither heuristic nor non-formal, but a structured process governed by admissibility and stability constraints.

6.2 Implications for Model-Based Reconstruction

The analysis suggests that model-based systems capable of reconstructing structure from partial inputs operate within the same general class of collapse-selection dynamics.

In particular, the ability of such systems to recover coherent configurations from incomplete representations can be understood as a consequence of their internal admissibility geometry. This provides a structural explanation for the effectiveness of reconstruction in contexts where explicit semantic information is absent or insufficient.

6.3 Implications for Theory Construction

A central implication of this work is that the process by which formal frameworks are constructed may itself be subject to formal analysis.

If the generative process underlying intuition can be modeled as a dynamical system over relational configurations, then the formation of theoretical structure is not external to the theory, but an instance of the same structural principles.

This does not imply that all aspects of theory construction can be reduced to such dynamics, but it suggests that at least part of the process is amenable to formal characterization.

6.4 Limits of the Framework

The present framework has several important limitations.

First, it does not specify the detailed structure of the configuration space Σ_H, nor the precise form of the operator Φ_H. These remain abstract objects, introduced to capture general structural properties rather than to provide explicit computational models.

Second, the interpretation of reconstruction as an approximation to an inverse collapse dynamic is heuristic. While it captures the structural role of reconstruction, it does not imply that such an inverse exists in a strict mathematical sense.

Third, the correspondence between internal and external systems depends on structural compatibility. When the target system lacks the capacity to represent configurations consistent with Σ_H, reconstruction fails. This limits the generality of the transfer process.

Finally, the framework is descriptive rather than predictive. It does not introduce new dynamical laws or generate quantitative predictions. Its purpose is to clarify structural relationships rather than to replace existing formalisms.

6.5 Non-Circularity

A potential concern is that the framework may appear circular, insofar as it models the process that produced the framework itself.

This concern is resolved by maintaining the distinction between generative and descriptive layers. The collapse-selection dynamics described here operate at the generative level, while the formal framework constitutes a descriptive representation of that process.

The fact that a descriptive system can represent the generative process from which it arose does not imply logical circularity, but reflects the ability of the system to model its own conditions of formation.

6.6 Summary

The interpretation developed in this paper provides a structural account of intuition and its externalization, situating both within a broader class of collapse-selection dynamics. While the framework is limited in scope and does not provide predictive power, it offers a coherent way to relate generative cognition, model-based reconstruction, and the formation of formal structure.

These results suggest that the study of understanding may be extended beyond symbolic reasoning to include the dynamics by which structure itself is formed.

7 Conclusion

We have analyzed the generative process underlying intuition and shown that it can be modeled as a collapse-selection dynamic over a relational configuration space. Within this framework, pre-verbal cognition corresponds to structured configurations in Σ_H, articulation corresponds to projection into a descriptive space, and understanding corresponds to convergence toward invariant configurations under iterative selection.

By extending this process across a human–model boundary, we established a correspondence between internal generative dynamics and collapse-geometry transfer in external systems. Projection, reconstruction, and validation together induce an effective collapse operator Φ_{EIC} over a joint configuration space, allowing admissible structure to be reconstructed from partial representations.

The central result is that the process by which formal structure is constructed is itself governed by the same structural principles that the resulting framework describes. This correspondence does not introduce circularity, but reflects a distinction between generative dynamics and their descriptive representation.

The framework presented here is intentionally minimal. It does not specify the detailed form of the underlying configuration space or collapse operator, nor does it propose new predictive laws. Instead, it provides a structural account of intuition and its externalization, situating both within a broader class of collapse-selection systems.

In this view, understanding is not the direct expression of symbolic content, but the stabilization of invariant structure under repeated collapse-selection. The same principles govern internal cognition, model-based reconstruction, and the formation of formal systems, suggesting that the origin of structure may itself be treated as an object of formal study.

References

[1] S. Garner. "Externalized Intuition as Collapse-Geometry Transfer Across Cognitive Boundaries". Posted on Zenodo: DOI: 10.5281/zenodo.19522452. URL: https://doi.org/10.5281/zenodo.19522452.