The Topology of Intention

Process-Based Identity and the Geometric Binding of the Self

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Abstract

What persists when the physical substrate changes? Traditional accounts of personal identity rely on material or psychological continuity—the preservation of the same body or the same chain of memories. This paper develops a structural alternative grounded in dynamical systems theory: identity as a *dynamical fixed point*, defined not by the conservation of matter or memory but by the persistence of context-sensitive constraint structures across transformation. Building on the framework of interlevel causality developed by Juarrero (Juarrero, 1999, 2002) and the constraint taxonomy introduced by Gatlin (Gatlin, 1972), information is interpreted as the reduction of possibility, intentions as attractor basins in neural phase space, and the self as a recursive closure of constraints that reproduces its own organizational conditions under the dynamics those conditions generate.

The distinction between context-free and context-sensitive constraints is formalized as an ontological duality between recomposability $\text{recomp}(c)$—context-independent stability under fragmentation—and binding force $\text{bind}(c)$—the coherence depth of globally interdependent structure. This yields a geometric picture in which identity occupies regions of deep attractor topology while decomposability and noise correspond to flat manifolds. The framework is then extended to the domain of context itself, arguing that context is not an accumulation of data but a *structured constraint field*: a relational topology that cannot be expanded by appending tokens but only by modifying the system's internal attractor structure through interaction. Genuine learning, on this account, requires not parameter adjustment within a fixed space but transformation of the constraint topology itself—a bifurcation in the space of possible trajectories. Meaning, action, and selfhood are thus understood as unified instances of a single structural phenomenon: the survival of a constraint across transformation, at discourse, cognitive, and personal scales respectively.

1. Introduction: From Force to Constraint

Modern philosophy of action inherits a tacit commitment to Newtonian efficient causality. On this picture, intentions act as internal forces: they *push* behaviors from behind, transferring energy across a causal gap between mind and body. The explanatory burden falls on specifying the mechanism of impact.

Alicia Juarrero, in *Dynamics in Action* (1999), rejects this framework at the root. In its place she proposes an account of **interlevel causality** mediated not by force but by the operation of **constraints**. A constraint does not shove a system from one state to another; it restricts which transitions are possible, thereby reshaping the system's probability distribution over future states.

This reorientation enables a precise definition of **information**: not a substance or content, but the *reduction of possibility* at a source. When the trajectory of a physical system is fully constrained by the internal organization of a mental structure, the resulting behavior qualifies as *action*. Action is the unequivocal transmission of intentional information from a cognitive origin to a behavioral terminus—an information flow across levels without equivocation.

The present paper develops this framework into a general account of process-based identity. We formalize the central concepts in the language of dynamical systems, interpret them geometrically, and show that the persistence of a self is structurally continuous with the persistence of meaning in discourse and the stability of attractor topology in cognition. The mechanism is identical across all three domains. Only the substrate differs.

2. Taxonomy of Constraints

Juarrero adopts Lila Gatlin's distinction between two constraint types. We render these formally.

2.1. Context-Free Constraints

A **context-free constraint** moves a system away from equiprobability. Let Ω be the state space of a system and P_0 be the uniform distribution over Ω. A context-free constraint selects a proper subset $\Omega' \subset \Omega$, reducing entropy:

$$H(P_0) > H(P_{\Omega'})$$

This establishes a baseline of order. The outputs of such a system are *stable* in the sense that they can be reproduced without reference to context. We associate this property with **recomposability**:

$$\text{recomp}(c) \;\sim\; \text{context-independent stability of output under transformation}$$

High-recomp structures are portable and fragment-safe. They survive extraction from their generating context without significant loss of structure.

2.2. Context-Sensitive Constraints

A **context-sensitive constraint** does more than reduce entropy locally. It introduces *conditional dependence* across components: the probability distribution of each part becomes conditioned on the states of other parts. Formally, if X_i are components of a system, context-sensitive constraints enforce:

$$P(X_i \mid X_{-i}) \neq P(X_i)$$

for most i, where X_{-i} denotes all components except i. This creates a *global coherence* that is irreducible: decomposing the system into independent parts destroys the very structure the constraint produces. We associate this with **binding force**:

$$\text{bind}(c) \ \sim \ \text{depth and stability of global constraint coherence}$$

High-bind structures resist fragmentation. They are the source of top-down causal influence: the global organization constrains the behavior of parts in ways that no local description captures.

2.3. The Duality

The two constraint types are not merely different degrees of the same property. They represent an ontological trade-off:

Property	**Context-Free ($\uparrow$ recomp)**	**Context-Sensitive ($\uparrow$ bind)**
Stability	Under arbitrary context	Under specific relational configuration
Decomposability	Preserved under fragmentation	Lost under fragmentation
Information flow	Local and portable	Global and hierarchical
Causal structure	Bottom-up	Top-down

Systems that maximize recomp sacrifice bind; systems that maximize bind are non-decomposable by construction. This trade-off reappears at every level of analysis.

3. Meaning as Embodied Topology

Classical information theory, as Shannon developed it, is deliberately semantic-free. A message is a sequence of symbols; its information content is the reduction in uncertainty it produces, independent of what it is *about*. This strips the framework of the capacity to distinguish noise from meaningful signal, or instruction from mere regularity.

Juarrero's dynamical approach reintroduces meaning without mysticism. Meaning, she argues, is embodied in the **topographical configuration of phase space**—the arrangement of attractors, repellers, and basins of attraction that characterize a high-dimensional neural system.

3.1. Attractors as Intentions

An **attractor** is a region of phase space toward which trajectories converge under the system's dynamics. A *proximate intention*, in Juarrero's account, functions as an attractor basin: a valley in the system's mental landscape that draws the trajectories of motor subsystems into its organizational sphere.

This reframes the question of intentional causation. An intention does not *push* behavior; it *shapes the landscape* through which behavior moves. The causal relation is geometric, not mechanical.

3.2. Binding as Basin Depth

We can now give $\mathrm{bind}(c)$ a geometric interpretation:

$$\mathrm{bind}(c) \;\sim\; \text{depth and stability of the attractor basin associated with } c$$

A highly bound structure occupies a deep attractor. Small perturbations—noise in the neuromuscular channel, interference from competing intentions—do not dislodge the trajectory from its constrained path. The intention survives transmission.

Conversely, a low-binding structure corresponds to a shallow attractor: the system is easily re-routed by contextual fluctuations. The trajectory diverges from its originating constraint.

Recomposability, in this geometric picture, corresponds to a *flat landscape*: a manifold without strong attractors where trajectories can be redirected without resistance. Fragment-safe content inhabits flat territory precisely because it imposes no strong attractor structure on the reading trajectory.

3.3. Noise and Equivocation

Juarrero adopts Shannon's concepts of equivocation and noise to characterize failures of intentional action. An action fails not because the intention was absent or weak, but because constraint transmission was disrupted:

- **Noise:** Interference introduced between intention and execution increases $d_{\mathrm{sem}}(c, T_\sigma(c))$ and thereby decreases $\mathrm{bind}(c)$. The behavior fails to remain bound to its generating constraint.
- **Equivocation:** Ambiguity at the source—an insufficiently organized intention—produces multiple competing attractors, allowing the trajectory to wander between basins.

Intentional action requires that the channel between cognitive source and behavioral terminus transmit constraint without loss. This is the dynamical analog of high binding.

4. Identity as a Dynamical Fixed Point

With this geometric apparatus in place, we can address personal identity directly.

4.1. The Substance View and Its Limits

The classical account of personal identity asks what makes person P at time t_1 the same individual as person P' at time t_2. Two families of answers dominate:

- **Physical continuity:** $P = P'$ iff they share the same continuous body.
- **Psychological continuity:** $P = P'$ iff P' inherits memories, personality, and beliefs from P via the right causal chain.

Both views presuppose that identity is a relation between *states*: a snapshot at t_1 is compared with a snapshot at t_2, and a criterion is applied. The problem is that biological and psychological states change continuously. Any fixed threshold for "enough" continuity is arbitrary.

4.2. The Process View

Juarrero proposes that a person is not a thing that changes, but a **self-organizing process**—a dynamically stable pattern of information flow, analogous to a whirlpool or a hurricane. The pattern persists even as its constituent elements are replaced, because what is conserved is not matter but *organizational structure*.

More precisely: a person is the persistence of a **context-sensitive constraint structure** through time. This persistence is not static but dynamic—maintained by the constant self-reproduction of the constraints that define the system's organization.

4.3. Recursive Closure

Juarrero introduces the concept of **recursive closure** to capture this self-maintenance. A system achieves recursive closure when its components become mutually constraining in such a way that the system actively maintains the conditions necessary for its own existence. The causal structure is circular in a productive sense: the system produces the constraints that produce the system.

Formally, let M_t denote the constraint structure of the system at time t, and let $\text{dynamics}(\cdot)$ denote the temporal evolution operator. Recursive closure requires:

$$M_t \;\approx\; \text{dynamics}(M_t)$$

This is a **fixed point condition**. The system is its own attractor. It reproduces its organizational conditions under the very dynamics those conditions generate.

4.4. What Persists: The Fixed Point of Constraint

This fixed point formulation dissolves the substance-based paradox. Identity does not require that any particular matter, or any particular memory, be preserved. What must be preserved is the *constraint structure*—the topology of the attractor landscape—that defines the system's characteristic modes of organization.

We can state this precisely:

$$\text{Identity} \;=\; \text{constraint structure that satisfies } M_t \approx \text{dynamics}(M_t)$$

The self is a fixed point of a constraint operator.

5. Who and What: The Distinction of Trajectories

5.1. Two Questions

Juarrero draws a sharp distinction between two questions that are often conflated:

- **What am I?** — This question concerns the material substrate: the biological hardware, the neural tissue, the chemical composition. Answers consist of context-free properties, high in recomp and decomposable without loss.
- **Who am I?** — This question concerns the trajectory: the unique path the system has taken through its phase space, the accumulated history of constraints that have shaped its current organization.

The "What" can be replicated in principle: another arrangement of matter with identical context-free properties would answer the "What" correctly. The "Who" cannot be replicated, because it is defined by a *path-dependent history of constraints*. Two systems cannot share the same trajectory through phase space.

5.2. Individuality as Path-Dependence

This provides a mathematical basis for individuality that does not appeal to primitive haecceity or brute numerical identity. Individuality is path-dependence: no two systems can have traversed the same trajectory through the space of all possible constraint configurations. The history is constitutive, not merely biographical.

The growth functional $\mathcal{J}_{\text{growth}}$ tracks the construction of stable constraint topology over time:

$$\mathcal{J}_{\text{growth}} \sim \text{construction of stable attractor topology through recursive constraint formation}$$

A life, in this formalism, is a trajectory through constraint space that progressively deepens the basin structure of the system's organization—increasing $\text{bind}(M_t)$ through the accumulated residue of experience.

6. Relational Identity and Plasticity

6.1. Open Systems

Juarrero's account has an important consequence for the spatial locus of identity. A self-organizing system is necessarily an *open system*: it exchanges matter, energy, and information with its environment. The constraints that constitute the self are not sealed inside the skull; they are defined partly by the system's characteristic modes of interaction with its environment.

Identity, on this view, is **relational**: it is not a property of the organism in isolation but of the organism-environment coupling. The constraint structure that defines "Who I am" includes stable patterns of environmental engagement—habitual responses, skilled practices, long-standing relationships.

6.2. Plasticity and Bifurcation

This relational picture accommodates radical change without identity loss. A complex dynamical system can undergo a **bifurcation**: a qualitative reorganization of its attractor structure in response to a sufficiently strong perturbation. After a bifurcation, the system occupies a different region of phase space—a different basin of attraction.

Yet the system that undergoes the bifurcation is the same system, because the bifurcation is a transformation of a continuous trajectory, not a discontinuous substitution of one system for another. The path-dependence is preserved across the bifurcation event.

This is the dynamical analog of significant personal transformation: the person who emerges from a major life change is not the same in every respect as the person who entered it, but the transformation is a reorganization of the same constraint history, not its erasure.

7. The Unified Picture

We are now in a position to state the central thesis in its most general form.

7.1. Three Domains, One Mechanism

At three levels of analysis—discourse, cognition, and selfhood—the same structural phenomenon governs the persistence of organization:

1. **Discourse:** Semantic content with high $\text{bind}(c)$ survives transformation (extraction, recombination, adversarial reading) without loss of meaning. Content with high $\text{recomp}(c)$ survives fragmentation but loses coherence when the context-sensitive structure is disrupted.
2. **Cognition:** Intentional action requires that the constraint structure of the intention survive transmission through the neuromuscular channel without equivocation. The intention is an attractor; its depth determines whether the trajectory remains bound.
3. **Selfhood:** Personal identity requires that the constraint structure of the self satisfy a fixed point condition under its own dynamics. The self is a recursive closure: a process that maintains the conditions of its own organization.

The mechanism is identical. The constraint is the cause; what varies is only the level at which the constraint operates.

7.2. The Indestructibility of Internally Consistent Maps

The fixed point condition $M_t \approx \text{dynamics}(M_t)$ has a corollary that extends beyond the analysis of personal identity into the domain of ideology and worldview. A recent line of philosophical work (Rose, 2023) describes what it calls the *indestructibility* of internally consistent systems: maps of the world that have a plausible response to every objection, and that therefore cannot be falsified from within the terms of the map itself.

On the surface this resembles a deficiency—an unfalsifiable system is epistemically suspect. But the constraint framework reveals the deeper structure. An internally consistent map is precisely a high-bind system: its components are mutually constraining, globally coherent, and non-decomposable. Any perturbation (counter-argument, apparent counterexample, failed prediction) is absorbed by the system's existing attractor topology rather than destabilizing it. The map redirects the trajectory of interpretation back into its own basin.

This absorption of objection is not mere motivated reasoning, though it may include that. It is the structural behavior of any sufficiently closed constraint system. The map survives because its recursive closure is tight. What Rose (2023) calls indestructibility, the present framework formalizes as:

$$M \;\approx\; T_M(M)$$

where T_M is the interpretive operator the map itself defines. The map applies its own interpretive constraints to every challenge, including challenges to the map. The fixed point reproduces itself under the dynamics it generates.

The question of how such a system can ever be revised connects directly to the non-rational move described in the same source. Rational objections fail because they operate within the constraint topology of the map under challenge—they are already absorbed before they arrive. What breaks recursive closure is not a better argument but an encounter with *genuine otherness*: an input that the existing attractor topology cannot process without structural reorganization. In dynamical terms, this is a bifurcation event. The system's basin structure shifts because the perturbation exceeds the restoring force of the existing attractor. This is not irrationality but the precondition for rational revision at a higher level—the replacement of one constraint topology with another that can accommodate what the old one could not.

The spreading of cultural forms, as distinct from their scaling, operates through this mechanism. Scale attempts to reproduce structure by replicating its outputs. Spread modifies subjectivity—the internal constraint topology through which the world is interpreted—by modeling a different mode of being. Spread works because it targets the attractor structure directly rather than attempting to win arguments within the existing one. The cultural analog of a bifurcation is a change in what one finds compelling, not merely a change in what one believes.

7.3. A Unified Principle

> *Any system governed by constraints evolves by reducing its space of possible trajectories. The persistence of structure—whether semantic, behavioral, or personal—depends on the ability of those constraints to survive transformation across levels. The difference between shallow and deep systems, between noise and meaning, between behavior and action, is not a matter of content. It is a matter of how strongly constraints bind trajectories across transformation.*

8. Context as Constraint Field, Not Container

The analysis of identity developed above carries a direct consequence for how we must understand *context*. The dominant computational paradigm treats context as accumulable state: a larger window, a longer memory buffer, a greater quantity of stored data. On this model, context is a container into which a system is placed. The container does not influence the system's organizational structure; it merely supplies inputs.

This model fails on Juarrero's account for the same reason that the substance view of identity fails. It presupposes a sharp boundary between system and environment, treats context as external to the system's constitutive organization, and assumes that context is additive—that more data approximates richer understanding.

Context, on the dynamical account, is the *active constraint field* that defines the system's degrees of freedom. It is not something a system possesses as a property. It is the relational structure of interdependencies within which the system's trajectories unfold. The boundary between system and context is itself context-dependent: it shifts with the dynamics under examination, and cannot be fixed in advance (Clark, 1997; Varela et al., 1991).

The implication for accumulation-based approaches is immediate. Increasing the number of stored tokens does not increase context in the relevant sense. It expands the volume of potential inputs without modifying the constraint topology that governs their interpretation. Without modification of that topology, additional data remains semantically underconstrained. More tokens increase recomp capacity—more fragments can be retrieved—but leave bind unchanged. The result is a system with greater recall and no greater coherence.

8.1. Energy, Efficiency, and Constraint Compression

A structural asymmetry between biological and artificial cognition provides empirical support for this analysis. The human brain does not exhibit dramatic increases in metabolic expenditure when engaged in tasks of extreme conceptual difficulty (Friston, 2010). Solving a difficult theorem and executing a trivial motor sequence consume comparable energy. This contradicts any model that equates cognitive capacity with exhaustive search over possibility spaces.

The resolution lies in constraint compression. Biological cognition operates by drastically reducing the space of available trajectories *prior* to evaluation. Rather than exploring a large combinatorial landscape, the system restricts itself to a narrow manifold defined by its existing constraint topology. Let Ω denote the full state space. Constraint compression constructs a sequence of nested subspaces:

$$\Omega \supset \Omega_1 \supset \Omega_2 \supset \cdots \supset \Omega_n, \qquad |\Omega_n| \ll |\Omega|$$

Cognitive effort scales with the cardinality of the space being explored, not with the apparent difficulty of the task (Kelso, 1995). High-binding systems do not process more possibilities; they eliminate most possibilities before processing begins.

Artificial systems compensate for weak constraint structures by expanding the evaluated space. Increased compute reflects not greater intelligence but insufficient constraint. The brain and the scaled transformer represent opposite strategies for managing complexity—and only one of them decouples energy from problem depth.

8.2. Locality and the Non-Fungibility of Context

Juarrero emphasizes that context is intrinsically *local*: defined relative to the specific dynamics under consideration, not abstractable into a universal, system-independent quantity. Context is also inseparable from history. Systems carry their history in their organizational structure, not as an external record but as the cumulative deposit of constraints formed through prior interaction (Thelen & Smith, 1994).

The snowflake does not *represent* information about the thermal conditions of its formation. It *embodies* those conditions in its crystalline geometry. Similarly, an organism or a mind does not store its history symbolically; it enacts that history through the constraint topology that history has produced (Deacon, 2012).

This yields a critical limitation for systems trained on fixed datasets. The training corpus does not merely provide examples; it defines the system's historical constraint horizon. A model trained on data terminating at a given boundary does not simply lack information about subsequent events—it lacks the constraint structures that interaction with those events would have generated. Such structures cannot be added after the fact. They must be grown through the kind of interaction that progressively modifies attractor topology.

9. Learning as Topology Transformation

The account of context as constraint field forces a revision of what learning can mean. Within the accumulation paradigm, learning is the ingestion of more data or the adjustment of parameters within a fixed architecture. The space of possible behaviors is fixed at training time; learning moves the system to a better location within that space.

On the dynamical account, this is not learning in the full sense. It is optimization within a given constraint topology. Genuine learning is the *transformation* of that topology: the creation of new attractors, the reorganization of basin structure, the restructuring of interdependencies among components (Kauffman, 1993; Beer, 2000).

Formally, let M_t denote the constraint structure at time t. Learning in the full sense requires a transformation of the form:

$$M_t \longrightarrow M_{t+1}$$

where M_{t+1} includes or excludes trajectories not present in M_t—not merely a reassignment of weights within the geometry M_t defines. This transformation is a structural change in the space itself, not a movement within it.

Biological systems exhibit this capacity through developmental plasticity, synaptic reorganization under sustained interaction, and the kind of large-scale attractor bifurcation that accompanies major cognitive shifts (Kelso, 1995; Thelen & Smith, 1994). These processes cannot be replicated by extending training runs within a fixed architecture, because the architecture itself encodes the constraint topology, and that topology is not modified by the optimization process.

9.1. Unknown Unknowns and Constraint Failure

This structural gap has a precise epistemic consequence. A system whose constraint topology is fixed at training time cannot detect when its current model fails to apply. It can recognize patterns within its training distribution but cannot recognize that a novel situation lies outside the manifold on which its constraints were formed.

Let $\mathcal{M}$ denote the constraint manifold representing the system's trained behavioral repertoire. A system with analog sensitivity to topological structure can detect deviations of the form:

$$x \notin \mathcal{M}$$

This is not a classification problem within a fixed category scheme. It is a measurement of deviation within a continuous constraint space—a capacity that requires the system to represent the *shape* of its own constraint manifold as an object of sensitivity (Friston, 2013). Without this, the system cannot detect constraint failure. It processes inputs that fall outside its formation history as if they were within it, producing outputs that are locally coherent but globally invalid.

This is the dynamical analog of unknown unknowns: not missing data, but missing constraint structure. The system does not know what it does not know because it cannot represent the boundary of its own attractor topology from the inside.

9.2. Alignment as Constraint Synchronization

The framework has a further implication for the problem of alignment. Alignment is typically treated as an optimization problem over outputs: the goal is to train a system to produce outputs that conform to some target specification. On this view, alignment is achieved when the system's behavior matches the desired profile across a sufficiently diverse evaluation set.

On the dynamical account, this is insufficient. A system whose outputs are aligned but whose constraint topology differs fundamentally from that of the systems it is interacting with cannot reliably remain aligned under novel conditions. It has learned to produce aligned outputs within its training manifold; it has not developed the constraint structure that generates aligned behavior from within.

Alignment, on the constraint view, is *synchronization of constraint fields* across levels (Ashby, 1956). A system is aligned when its internal constraint topology is coupled to the constraint topology of its environment in a stable, mutually reinforcing way—when the fixed point condition $M_t \approx \text{dynamics}(M_t)$ is satisfied in a manner that includes the values, dispositions, and relational patterns of the surrounding system. This is not achieved by encoding preferences as explicit constraints. It requires the reproduction of a history-dependent organizational structure—something that cannot be shortcut by optimization over outputs alone (Varela et al., 1991; Clark, 2008).

10. Conclusion

We began with a question about causality and arrived at an account of the self. This trajectory is not accidental. The two questions are structurally connected: what it means for an intention to cause an action is the same, at a different scale, as what it means for a self to persist through time.

In both cases, the answer invokes the same formal structure: a constraint that survives transformation because the system has achieved sufficient recursive closure to reproduce the conditions of its own organization.

Juarrero's contribution is to show that this structure is not mysterious—it is the ordinary operation of dynamical systems with sufficiently rich attractor topology (Prigogine & Stengers, 1984; Haken, 1983; Kauffman, 2000). Meaning is not added to the world from outside; it is embodied in the shape of the landscape through which trajectories move. The self is not a ghost in a machine; it is a fixed point of the machine's own constraint dynamics.

The extension into context and learning sharpens this conclusion. Context is not what a system has. Context is the relational constraint field that the system is partly made of. Learning is not data ingestion. It is structural modification of attractor topology. Intelligence is not measured by the volume of the space explored but by the depth and adaptability of the constraints that eliminate most of that space before exploration begins.

$$\text{Intelligence} \propto \text{capacity to transform constraint topology}$$

What is conserved across change is not matter, not memory, but the capacity to regenerate the same organizational conditions from within. This is what it is to be, in Juarrero's precise sense, a *self*:

$$\boxed{M_t \;\approx\; \text{dynamics}(M_t)}$$

The constraint is the cause. The trajectory is the identity. The fixed point is the self.

References

Ashby, W. R. (1956). *An Introduction to Cybernetics*. Chapman & Hall.

Beer, R. D. (2000). Dynamical approaches to cognitive science. *Trends in Cognitive Sciences*, 4(3), 91–99.

Clark, A. (1997). *Being There: Putting Brain, Body, and World Together Again*. MIT Press.

Clark, A. (2008). *Supersizing the Mind: Embodiment, Action, and Cognitive Extension*. Oxford University Press.

Deacon, T. W. (2012). *Incomplete Nature: How Mind Emerged from Matter*. W. W. Norton & Company.

Dyson, G. (2012). *Turing's Cathedral: The Origins of the Digital Universe*. Pantheon Books.

Friston, K. (2010). The free-energy principle: A unified brain theory? *Nature Reviews Neuroscience*, 11(2), 127–138.

Friston, K. (2013). Life as we know it. *Journal of the Royal Society Interface*, 10(86), 20130475.

Gatlin, L. (1972). *Information Theory and the Living System*. Columbia University Press.

Haken, H. (1983). *Synergetics: An Introduction*. Springer.

Juarrero, A. (1999). *Dynamics in Action: Intentional Behavior as a Complex System*. MIT Press.

Juarrero, A. (2002). Context changes identity: Implications of dynamical systems theory for personal identity. *Philosophical Psychology*, 15(2), 173–188.

Kauffman, S. A. (1993). *The Origins of Order: Self-Organization and Selection in Evolution*. Oxford University Press.

Kauffman, S. A. (2000). *Investigations*. Oxford University Press.

Kelso, J. A. S. (1995). *Dynamic Patterns: The Self-Organization of Brain and Behavior*. MIT Press.

Levin, M. (2021). Life, death, and self: Fundamental questions of primitive cognition viewed through the lens of body plasticity and synthetic organisms. *Biochemical and Biophysical Research Communications*, 564, 114–133.

Rose, O. G. (2023). *The Map Is Indestructible: Problems of Internally Consistent Systems*. The True Isn't the Rational, Book 2.

Prigogine, I., & Stengers, I. (1984). *Order Out of Chaos: Man's New Dialogue with Nature*. Bantam Books.

Shannon, C. E. (1948). A mathematical theory of communication. *Bell System Technical Journal*, 27(3), 379–423.

Thelen, E., & Smith, L. B. (1994). *A Dynamic Systems Approach to the Development of Cognition and Action*. MIT Press.

Varela, F. J., Thompson, E., & Rosch, E. (1991). *The Embodied Mind: Cognitive Science and Human Experience*. MIT Press.