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Signature Practice as Informational Engineering: An Operator Model of Ritual, Meaning, and Active Inference

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Abstract

Structured practices in ritual and contemplative settings often claim reliable change through formal protocols, disciplined attention, prior alignment, and staged calibration. Debate commonly polarizes between extraordinary causation and generic expectancy accounts. This paper offers a third option: a methodological framework that treats such practices as informational interventions acting on coupled agent–environment systems. A five-operator model represents protocols as ordered sequences of learning, framing, attentional stabilization, invariance constraints, and regulatory feedback. Drawing on convergent findings from ritual psychology, predictive processing and active inference, meaning response research, meditation neuroscience, and semiotic information theory, the model yields discriminative, preregisterable predictions. It predicts diagnostic moderation of effects, scaling with diagnostic certainty, and stage-specific early ordering in a composite divergence measure prior to coarse phenomenological change. It also predicts that symbolically congruent sequences outperform carrier-matched, diagnosis-incongruent sequences under controlled context. The paper does not claim empirical validation; it specifies tests with clear failure modes.

Keywords: signature practice, ritual, informational interventions, active inference, meaning response

1. Introduction

Across many social and cultural contexts, structured practices claim reliable change through formal representations, disciplined protocols, attention training, prior alignment, and staged calibration events. Independent empirical literatures report that such structured interventions can shape affect, attention, and behavior, including work on ritual processes, meditation training, and meaning response effects [1-3]. Yet discussion of these practices remains methodologically fragmented. Many accounts do not specify discriminative conditions for success or failure. Other accounts reduce outcomes to unspecific expectancy, which also fails to predict when effects should exceed context, why they sometimes do not, and how different systems can be compared under a common template.

This article contributes a minimal, testable framework for studying structured practices in a way that is usable across the social sciences and humanities. This framework makes four recurring questions in the social sciences and humanities operational: (1) when ritualized form adds effects beyond social context, (2) how symbolic framing changes outcomes under carrier-equivalent conditions, (3) why some training systems scale with diagnostic fit while others plateau at context level, and (4) how different traditions can be compared without reducing everything to culture-only narratives. In applied work, this supports preregistered contrasts for ritual regulation, meaning-based interventions, attention training programs, and comparative analysis of staged pedagogies. The goal is not to defend any particular tradition, but to provide a shared formal language that links otherwise disconnected empirical findings and supports discriminative tests between competing explanations. The framework is designed to be auditable: it specifies what must be true for a practice to count as specific rather than merely context-driven, and it states in advance what patterns would count as disconfirmation. In practical terms, the framework supports preregistrable contrasts that distinguish context-only effects from practice-specific add-on effects under matched conditions.

In the strict sense used here, a signature practice is a protocol that can be represented as an ordered sequence of five operator types acting on an agent–environment system. In plain terms, these operators correspond to structured learning rules, representational framing, attentional stabilization, invariance constraints, and regulatory feedback. A practice qualifies as practice-specific only if it produces a reproducible reduction in a predefined composite divergence outcome under repeated application and appropriate diagnostics, and if that reduction cannot be explained by context alone under preregistered mismatch and control conditions. A candidate practice that does not yield this discriminative pattern does not qualify as a signature practice in this strict sense. This is a research working definition for discriminative testing, not a claim about how traditions define themselves.

The causal-symmetric language is used only as a modelling metaphor for bidirectional constraints on learning trajectories. It implies no retrocausal influence and no nonstandard dynamics. The formal predictions rely only on the operator kernel, diagnostic moderation, and early ordering patterns; the extended intuition is explained later in the dedicated section on bidirectional constraints.

The paper proceeds as follows. Section 3 reviews convergent mechanisms across the relevant empirical literatures. Section 4 formalizes the operator model and defines measurable proxies. Sections 5 and 6 derive conditions under which practice-specific effects should occur and how they should scale across diagnostics. Section 7 discusses limitations and threats to validity. Sections 8 and 9 specify falsifiable predictions and a minimal preregistrable experimental program designed to discriminate the framework from context-only rivals. This work does not claim empirical validation of the proposed framework; its contribution lies in formal unification, explicit prediction, and the specification of discriminative tests that can be implemented in future preregistered studies.

2. Informational Ontology

This section introduces the minimal informational ontology required for the operator model of signature practice. The aim is not to defend a full metaphysical theory of information, but to specify a working vocabulary in which agents, stages, and transformations can be represented as informational state changes. The account is compatible with semiotic views that treat information as realized in sign processes [4,5] and with dynamical models of agents as systems that update internal states to reduce divergence from their generative expectations [6,7].

2.1 Agent state and attractors

Let a practitioner be represented by an informational state distribution $\rho_A(t)$ over a high-dimensional state space S. This abstraction is analogous to treating an agent's beliefs, habits, and embodied dispositions as a structured probability distribution over internal and external states, as in predictive-processing and active-inference formulations of agency [6,7]. Each developmental stage κ is associated with a coherent attractor σ_Z^κ in S. Coherence here denotes empirically stable fixed-point neighborhoods under reflexive audit R, not metaphysical unity or perfection.

Deviation from a stage-κ attractor is quantified by a divergence

$$D(\rho_A(t) \parallel \sigma_Z^\kappa) \quad (1)$$

The specific divergence family is fixed in preregistration; for example, Kullback–Leibler divergence on standardized proxy variables with Wasserstein distance as a robustness check. Conceptually, $D(\rho_A \parallel \sigma_Z^\kappa)$ measures how far the practitioner's current informational state is from the reference pattern characteristic of stage κ.

Within this ontology, a successful signature-practice protocol should induce a reproducible reduction in divergence, $\Delta D^* < 0$, over a stage-appropriate time window when correctly matched to the practitioner's diagnostic profile. If repeated application of a protocol fails to produce such contractive dynamics relative to σ_Z^κ under controlled context conditions, the protocol does not qualify as an effective signature practice in the strict sense defined in Section 1.

2.2 Bidirectional Constraints in Learning and Regulation

In this paper, the term *causal-symmetric* is used only as a modelling metaphor for bidirectional constraints on trajectories in informational state space. The guiding idea is that both earlier and later boundary conditions help determine which trajectories are stable, so that contraction-type dynamics in divergences such as the composite proxy D^* (defined in Section 4.1) under appropriate protocols are not accidental but reflect how constraints are distributed over time. This language does not assume time-reversal invariance, retrocausal physical influences, or any departure from standard probabilistic dynamics; it simply provides an intuitive backdrop for attractor-based descriptions of learning and self-regulation. Informally, agents are treated as systems whose histories are shaped simultaneously by prior conditions and by convergent end-states, with informational updates steering $\rho_A(t)$ toward stage-specific attractors σ_Z^κ.

Crucially, none of the empirical claims in this article depends on adopting a particular causal-symmetric ontology. The testable core requires only three elements: (i) the five-operator kernel (L,F,A,I,R) acting on an agent–environment system, (ii) diagnostic moderation of effects by a structured state taxonomy, and (iii) early-signature ordering in the composite divergence D^*. All predictions in Sections 5–9 remain valid in any framework that admits contractive informational updates in complex agents, independently of whether one endorses a causal-symmetric interpretation or not.

2.3 False Safety Signals

A central failure in substance education is the confusion between normalization and safety. Alcohol, nicotine, energy drinks, sedatives, stimulants, opioids, and painkillers can become normalized through law, advertising, prescribing, commerce, family culture, medical routine, school culture, sports culture, gaming culture, or habit. Normalization changes perception; it does not remove risk.

Alcohol is associated with celebration, relaxation, adulthood, and social bonding, yet it remains a major source of bodily, psychological, and social harm. Nicotine delivery systems differ in risk, but nicotine dependence remains central. Energy drinks are associated with performance, endurance, productivity, gaming, sport, and alertness, yet they remain pharmacologically active stimulant products whose developmental relevance may operate through sleep disruption, anxiety, cardiovascular activation, dose escalation, and commercial normalization. Prescription and over-the-counter status can create similar safety illusions. A medicine may be useful and necessary, but usefulness does not remove risk.

False safety signals are especially relevant for emerging adults. A substance may become newly accessible at the same time that social reward sensitivity, identity exploration, novelty seeking, performance pressure, sleep restriction, and peer belonging remain developmentally salient. For this group, the question is not whether autonomy exists, but whether autonomy is supported by realistic information, safe environments, and context-sensitive regulation.

Adult education matters as well. Adult autonomy is stronger when adults receive realistic information about dependence, toxicity, interactions, context, sleep effects, and long-term consequences. Autonomy is not strengthened by cultural denial.

2.4 Notation and licensing of symbols

To avoid category errors, we explicitly distinguish formal operators from traditional emblems. Formal symbols

(L,F,A,I,R, $\rho_A(t)$, σ_Z^{κ}, δI_Q,D)

belong to the mathematical model developed in this paper. They denote abstract operations, state distributions, attractors, and divergences within an informational description of agent–environment dynamics.

By contrast, traditional symbols—glyphs, talismans, deity-names, ritual diagrams, postures, and similar emblems—are treated purely as carriers within the symbolic mediation and context channels *L* and *C*. No physical claim is made about the emblem as an object. Any causal role it has in this framework is mediated through its informational function in the agent's representational loop: how it is interpreted, how it shapes expectations, and how it constrains action policies.

This licensing separates metaphysical claims about symbols from their operational role in the model. It allows rigorous testing of signature-practice protocols as informational interventions without committing to specific ontological positions about the ultimate nature or "power" of the emblems themselves.

3. Independent Evidence and Convergence

A central competing explanation treats reported practice effects as products of context, expectancy, and generic predictive processing. Such accounts can plausibly explain global shifts in experience or motivation, but they do not predict stable stage-specific ordering, early divergence effects under matched context, or threshold behavior tied to lineage fidelity. The present framework is designed specifically to distinguish these cases.

Multiple scientific literatures report mechanisms that align with a lawful informational account of signature practice. None of these streams alone proves the full model, but together they motivate the five-operator kernel as a minimal candidate that must still pass the discriminative program outlined in Sections 8 and 9. The key claim is process-level convergence: independently developed accounts of ritual, predictive processing and active inference, meaning response, meditation, and semiotic information processing describe mechanisms that can be mapped onto the same operator structure (*L,F,A,I,R)* and the associated divergence dynamics.

3.1 Ritual Psychology

Research on ritual demonstrates that highly structured sequences of action can regulate emotion, stabilize performance and goal states, and strengthen social connection through repeatable action patterns, synchrony, and formalized meaning [1]. Controlled laboratory work further shows that even arbitrary action sequences, when framed as rituals, increase engagement and perceived control compared to matched non-ritual sequences [8]. The critical point is that the additional effect derives from the *formalization and framing* of the sequence rather than from its specific material content.

Within the present framework, these findings map directly onto Attentional Stabilization *A* and stagenorm enforcement via invariants I_κ. Repetition of formally specified acts under shared meaning frames corresponds to a contractive attentional operator A that reduces wandering in state space and enhances stability of trajectories. At the same time, ritual prescriptions encode implicit or explicit invariants I_κ that define what counts as appropriate emotion, behavior, and relational stance at a given developmental stage. Ritual psychology thus supplies empirical support for the idea that structured, symbolically framed action sequences can implement both stabilizing dynamics and stage-specific constraints—two components the operator model treats as necessary for signature practice.

3.2 Predictive Processing and Active Inference

Under the Free-Energy Principle, perception and action are described as processes that minimize prediction error—or, more formally, variational free energy—by selecting policies that reduce expected surprise relative to a generative model [6,7]. Agents do not passively register sensory input; they actively sample the world and update internal states so that incoming signals become increasingly consistent with hierarchically structured expectations. In this view, behavior is organized around reducing the mismatch between predicted and observed states.

Ritualized protocols can be interpreted as constrained policy families that stabilize sensorimotor routines and encode shared priors about what should be perceived, felt, and enacted in a given context. When such a protocol is congruent with the practitioner's diagnostic state and the relevant stage-attractor structure, repeated engagement is predicted to produce contractive divergence $\Delta D < 0$, as the state distribution $\rho_A(t)$ is pulled closer to the stage-specific attractor σ_Z^κ. In the operator language, this corresponds to a correspondence map F_κ that selects policy sequences favoring convergence, together with an attentional operator A that reduces the volatility of trajectories.

Conversely, if a protocol is poorly matched to the diagnostic state—e.g., by imposing stage-inappropriate invariants or conflicting priors—the same machinery predicts drift, instability, or non-durable change. Active inference thus provides a process-level mechanism for F_κ-licensed convergence rather than drift: properly calibrated signature-practice protocols are those whose induced policy and attention patterns reliably decrease $D(\rho_A \parallel \sigma_Z^\kappa)$ over time under audit R, whereas miscalibrated or purely context-driven routines fail to produce such contractive dynamics.

3.3 Meaning Response

Meaning-response theory demonstrates that outcome shifts can occur independently of the material properties of an intervention once symbolic meaning structures and relational frames are fixed [3]. Identical carriers—such as pills, gestures, or verbal formulas—can produce markedly different effects depending on how they are explained, by whom they are administered, and within which narrative context they are embedded. The crucial determinant is not the inert substrate, but the pattern of meaning and expectation that the agent integrates into their representational and action loops.

Within the present framework, this supports a strict functional separation between context information C and signature information δI_Q. Context C captures non-specific contributions from expectancy, trust, group involvement, and background narrative. Signature information δI_Q denotes the additional structured, diagnosis-targeted content that a protocol introduces through the operator sequence (L, F_κ, I_κ). Meaning-response findings imply that carriers can be inert or causal depending on whether δI_Q is present and appropriately targeted: the same carrier and context may yield only generic meaning effects in one configuration, but a specific, stage-structured contraction in divergence in another.

In other words, meaning-response theory justifies treating δI_Q as an empirically necessary construct rather than a metaphysical add-on. It formalizes the intuition that some practices produce only context-level benefits, while others introduce a distinctive, structured informational component that changes the ordering, magnitude, and durability of outcomes when diagnostics and stage invariants are correctly aligned.

3.4 Neural Effects of Meditation Practice

Neuroscientific research on meditation provides direct evidence that sustained practice can reshape attentional and affective dynamics. Focused-attention training strengthens the capacity to maintain attention on a chosen object and modulates salience and affective networks in ways that increase the stability of cognitive and emotional trajectories [2]. Longitudinal and cross-sectional studies report reduced variability in attentional performance, more efficient recruitment of control networks, and altered patterns of baseline activity associated with enhanced regulation.

Within the present framework, these findings instantiate the attentional stabilization operator A as a measurable, contractive process. Repeated engagement in focused-attention practice corresponds to iterative applications of A with an effective contraction constant $c_A < 1$, such that fluctuations around the intended focus decrease over time. This is not merely a metaphor: empirical measures such as variance decay in sustained-attention tasks, reduced trial-to-trial reaction-time variability, and increased resistance to distraction can be used to estimate c_A in concrete protocols. Meditation neuroscience therefore supplies an operational bridge between the abstract operator A and observable changes in attention and affect, supporting the claim that attentional stabilization is a lawful informational mechanism rather than an unspecified "mental factor."

3.5 Semiotics and Representational Causality

In Peircean and contemporary semiotic accounts, information is realized through sign processes: symbols exert causal influence only insofar as they are interpreted within an agent's system of expectations, habits, and actions [4,5]. A sign is not a causal agent by virtue of its material substrate alone, but by the role it plays in a triadic relation between sign, object, and interpretant. When symbols are integrated into cognitive and behavioral loops, they constrain how the agent anticipates, categorizes, and responds to the world.

This perspective licenses L as Symbolic Mediation without importing metaphysical premises about symbols themselves. In the present model, L maps elements of the state space S onto representational structures that can be composed, audited, and linked to action via F_κ. Emblems—glyphs, names, diagrams, ritual phrases—are causal only to the extent that they function as structured informational carriers in this mapping. Their effects arise from how they shape the agent's representational and policy space, not from any intrinsic physical property.

Semiotic information theory thus provides a principled grounding for treating ritual and esoteric symbol systems as components of an informational engineering scheme. It clarifies why changes in symbols, meanings, and interpretive frames can alter trajectories in $\rho_A(t)$ even when the physical environment remains constant, and it supports the core claim that signature practice operates by manipulating informational structure rather than by violating physical law.

Table 1 does not claim empirical confirmation of the proposed model. Its function is to demonstrate that independent research programs converge on the same process-level operators, thereby justifying the minimal operator set as a lawful descriptive kernel rather than an ad hoc construction.

Table 1: Evidence-to-operator mapping (process-level convergence).

Evidence stream	Core empirical finding	Operators mapped	Mechanistic link
Ritual psychology	Formal sequences regulate affect/goal/social states; ritual framing adds carrier-independent effect [1,8]	A, I_κ	Structured acts stabilize dynamics and enforce stage norms
Active inference	Prediction-error/free-energy minimization via policy selection [6,7]	A, F_κ, R	Protocol priors drive convergence; audits test fixed points
Meaning response	Outcomes track meaning structure not inert carrier [3]	L,C, δI_Q	Representations drive endogenous update; carrier equivalence
Meditation studies	Attention training yields measurable stability/contraction [2]	A	Contractive attentional operator with $c_A < 1$
Semiotic information	Signs constrain cognition/action through interpretation [4,5]	L, F_κ	Symbolic mediation plus bounded correspondence

Implications for the operator model

Given convergent process structure across independent literatures, we posit (L,F,A,I,R) as the minimal lawful kernel required for specific signature practice effects, with tradition-specific content entering through stage-indexed calibration of F_κ and I_κ.

4. Operator Model of Signature Practice

4.1 Proxy Divergence and Early Signatures

Deviation from a stage attractor is tracked via a preregistered composite proxy

$$D^* = w_1 D_{attn} + w_2 D_{aff} + w_3 D_{beh} + w_4 D_{inv} \quad (2)$$

with fixed weights w_i. Unless a preregistered pilot provides a stable calibration, the default choice is equal weights $w_i = 1/4$. Pilot-based weights are only accepted if sign-robustness holds: small perturbations (±10%) of all w_i must not change the sign of the estimated effects on D^*. This guards against overfitting the composite to a particular dataset.

D^* is the operational proxy for the theoretical divergence $D(\rho_A(t) \parallel \sigma_Z^\kappa)$ under a fixed, preregistered measurement battery. In this framework, $\rho_A(t)$ denotes a latent informational state of the agent and is not observed directly; all empirical analyses are carried out on D^* and its components, which are constructed from observable attention, affect, behavior, and invariant-adherence measures. Each component captures a distinct facet of practice-linked change:

D_{attn} estimates the contraction constant of the attentional operator A (e.g., via variance decay in sustained-attention tasks).

D_{aff} tracks affect stabilization, combining ecological momentary assessment and validated affect scales.

D_{beh} measures cross-context behavioral consistency implied by the correspondence maps F_κ (e.g., adherence to preregistered commitments across settings).

D_{inv} audits distance to the stage-invariant library I_κ, using blinded ratings on an explicit rubric.

By construction, decreases in D^* indicate movement of $\rho_A(t)$ toward the stage attractor σ_Z^κ. Early-signature analyses focus on ordered changes in the components of D^* over an initial time window, testing whether practice effects appear first in the components predicted for a given stage before coarse outcomes shift.

4.2 Portable Operators *L,F,A,I,R*

Building on the convergent evidence reviewed in Section 3, we describe signature practice in terms of five portable operators that can, in principle, be instantiated by different traditions while remaining formally comparable. In plain terms, these operators correspond to structured learning rules, attentional stabilization, representational framing, invariance constraints, and regulatory feedback:

L — Symbolic mediation.

$L: S \to Rep$ maps states in the agent's space *S* into a representational code Rep that supports well-formed, composable, and externally auditable inference. In practice, *L* is realized by symbol systems, narratives, and formal instructions that encode how states are named, categorized, and related.

F_κ— Compositional correspondence.

$F_\kappa: \ Rep \to Rep'$ links representational structures to one another and to action policies in a way that preserves composition and bounds invariant distortion by a stage-specific parameter η_κ. Intuitively, F_κ specifies how meanings, commitments, and rules combine and how they constrain behavior at stage κ.

A — Attentional stabilization.

A is a contractive update operator with constant $c_A < 1$, guaranteeing convergence of attentional trajectories under repetition. It captures practice-induced increases in the stability and selectivity of attention and related salience processes.

I_κ — Stage invariants.

I_κ is a stage-indexed constraint library. It contains explicit or implicit invariants that characterize admissible trajectories for stage κ: for example, preregistered ethical constraints (such as non-harm commitments), cross-context behavioral consistency rules, or minimal standards for self-report coherence. I_κ defines what must remain stable for a state to count as belonging to stage κ.

R — Reflexive fixpoint audit.

R implements independent adequation testing of putative fixed points. It comprises blinded assessments, cross-context checks, and pre-defined criteria that determine whether a practitioner's state has in fact reached and maintained the attractor region associated with σ_Z^κ, rather than exhibiting transient or narrative-only change.

Together, these operators provide a portable template for modeling signature-practice protocols as informational engineering schemes. Different lineages may instantiate *L*, F_κ, *A*, I_κ, and *R* with distinct symbols, rules, and practices, but they can be compared within a common formal vocabulary that tracks how protocols move $\rho_A(t)$ relative to σ_Z^κ.

4.3 Protocol Sequencing *Q*

A practice protocol is modeled as an operator sequence *Q* built from *(L, F, A, I, R)*. Its action on the practitioner's state is written as

$$Q(\rho_A(t)) = U_Q\big(\rho_A(t) \mid \delta I_Q, C\big) \quad (3)$$

where U_Q denotes the update map induced by the protocol, δI_Q is the protocol's signature information, and *C* is the context. In experimental tests, *C* is held fixed across arms, and only the signature content δI_Q

differs between congruent and mismatch conditions. This allows specific effects of δI_Q to be separated from context-level influences.

4.4 Worked Example: Instantiated Stage-κ Protocol

Consider a stage-κ protocol Q consisting of:

A: Daily focused-attention cycles yielding a measurable contraction constant c_A (estimated, for example, from variance decay in a sustained-attention task).

I_κ: A calibrated token set (e.g., formulaic invocations, diagrams, posture cues) that maps practice acts to a shared representational Rep_κ.

F_κ: A correspondence rule linking representational commitments to behavior (e.g., affect patterns → action obligations), with distortion bounded by η_κ.

I_κ: Explicit stage constraints defining admissible trajectories (ethical commitments, behavioral consistency rules, and other invariants characteristic of stage κ).

R: Blinded cross-context reassessment after η cycles, testing stability independent of local narrative expectation.

For a given initial state ρ_A, we define the signature injection:

$\delta I_Q = (\mathrm{R} \circ I_\kappa \circ F_\kappa \circ \mathrm{L} \circ \mathrm{A})(\rho_A) - \rho_A$	(4)

This quantity captures the net informational change induced by one full sequence of the protocol, after auditing, relative to the starting state.

To illustrate how the composite divergence D^* behaves under such a protocol, consider a schematic toy example (values chosen purely for ordering illustration, not as priors or effect-size expectations). Suppose the baseline proxy divergence is

$D_0^* = 1.00.$

After four weeks of a congruent protocol Q_c (diagnosis-matched invariants and correspondence), the composite divergence is

$D_c^* = 0.72$

with early shifts appearing first in the components predicted by the preregistered stage-specific ordering O_κ, (for example, initial reductions in D_{attn} and D_{aff}, followed by later reductions in D_{beh} and D_{inv}.

A mismatch arm Q_m —identical carriers and context but diagnosis-incongruent invariants and correspondence rules—yields

$D_m^* = 0.90$

with no ordered early-signature pattern. A context-only control C, in which carriers and framing are retained but structured signature content δI_Q is removed, also yields

$D_C^* = 0.90$

The signature add-on estimate, beyond context, is then

$\Delta D_{sig}^* = D_C^* - D_c^* = 0.18,$

while the mismatch arm remains at context level. In this toy example, attribution of effects to δI_Qrequires both (i) a context-locked contrast $D_c^* < D_C^* \approx D_m^*$ and (ii) the presence of ordered early signatures consistent with O_κ. The numerical values are purely illustrative and must not be used as priors for power calculations or effect-size expectations.

5. Why Signature Practice Works

5.1 Carrier-Equivalence rather than Carrier-Irrelevance

Carriers—words, gestures, physical objects, spatial settings—implement the representational and contextual channels L and C. In the present framework, carrier independence is an *equivalence-class* claim, not a denial of material implementation. Distinct carriers can realize the same signature input δI_Q once they are calibrated by L and constrained by the correspondence maps F_κ. What matters for specific efficacy is the informational pattern instantiated in the agent's representational loop, not a unique material substrate [3].

Meaning-response research shows that physically identical carriers can yield different outcomes depending on the explanatory frame, relational context, and symbolic meaning [3]. Conversely, physically different carriers can converge to similar outcomes when they implement the same structure of expectations and commitments. The appropriate notion is therefore carrier-equivalence: a set of carriers belongs to the same equivalence class if, under a fixed L and F_κ, it realizes the same δI_Q and produces the same ordered pattern of changes in D^*. Signature practice works, on this view, because it engineers carrier-equivalent configurations that reliably instantiate the required informational structure, rather than because a particular material form is privileged.

5.2 Diagnostic Moderation

If signature practice contributes a genuine add-on beyond context, its specific efficacy should depend systematically on how well the protocol is matched to the practitioner's diagnostic profile. Let E_{spec} denote the specific effect size beyond context and let S_{diag} be a quantitative index of diagnostic certainty. The central moderation requirement is:

$$E_{spec} = f(S_{diag}), \quad f'(S_{diag}) > 0 \tag{5}$$

In words, as diagnostic certainty increases, the expected specific effect of a correctly matched protocol must increase monotonically. Absence of a positive monotone dependence falsifies the claim that a signature add-on is present; it would indicate that protocol effects do not track diagnostic alignment and are therefore better explained by generic context or noise.

To implement this requirement, a dominant-node taxonomy $N = \{n_1, \ldots, n_M\}$ is first constructed in an exploratory pilot using preregistered multivariate structure discovery. A typical pipeline might involve exploratory factor analysis on the proxy battery, followed by clustering (e.g., HDBSCAN or Gaussian mixture models) on factor scores. The number of nodes M is selected by stability criteria under bootstrap resampling (1,000 draws), requiring bootstrapped Jaccard similarity of cluster assignments ≥ 0.7 and adjusted Rand index (ARI) cross-validation consistent with stable recovery, with minimal silhouette ≥ 0.2 on held-out resamples.

Once N is established, it is frozen before confirmatory testing. All subsequent moderation analyses treat node membership as fixed, avoiding circularity between diagnostic structure and outcome patterns. The diagnostic-certainty index S_{diag} is operationalized via inter-rater agreement on node assignments and the stability of marker clusters across time and measurement occasions. Under the signature model, correctly matched protocols Q_c should display increasing E_{spec} with higher S_{diag}, while mismatch protocols Q_m and context-only controls C should remain near context level regardless of diagnostic certainty.

5.3 Early-Signature Ordering

A genuine signature add-on is expected to appear first as an ordered pattern of changes in the components of D^*, before coarse outcomes shift. In other words, signature practice should leave a characteristic "early

footprint” in how attention, affect, behavior, and invariant adherence begin to change over time.
Ordering is stage-specific. Each stage cluster κ is associated with a preregistered partial order O_κ over the set $\{D_{attn}, D_{aff}, D_{beh}, D_{inv}\}$, allowing equality ($\leq$) where theory does not require strict priority. Stage clusters are defined *a priori* by lineage manuals and invariant libraries, not by outcome data, to avoid circularity.
For example:

- An early ethical stage might preregister
  $O_1: D_{inv} \leq D_{attn} \leq D_{aff} \leq D_{beh}$,

reflecting the expectation that basic invariant adherence and attentional stabilization shift before broader behavioral consolidation.

- A pragmatic consolidation stage might preregister
  $O_2: D_{beh} \leq D_{attn} \leq D_{aff} \leq D_{inv}$,

Emphasizing early behavioral regularization with later refinement of invariants.
Within lineage samples, ordering tests are conducted cluster-specifically for each preregistered O_κ rather than pooling all participants into a mixed order. The criterion for a signature add-on is that early changes in D^* respect the stage-specific ordering more than would be expected under a permutation or exchangeability null. Systematic failure of early-signature ordering, given adequate measurement, counts against the presence of a distinctive signature component and favors interpretations in terms of generic context effects or unspecific practice benefits.

5.4 Stage Constraints via I_κ and F_κ

Hierarchical training stages can be modeled as attractor chains $\{\sigma_Z^1, \sigma_Z^2, \ldots\}$, where each attractor σ_Z^κ represents a relatively stable region of agent state space characteristic of stage κ. Progression through stages is then described as movement of $\rho_A(t)$ along this chain under suitable protocols.
Each stage supplies its own invariant library I_κ and correspondence maps F_κ. The invariants $I_\kappa$specify what must remain stable—ethical commitments, behavioral regularities, minimal cognitive structures—for a trajectory to count as belonging to stage κ. The maps F_κ encode how representations and commitments at that stage translate into action policies and further representational updates.
Attempting to enforce higher-stage alignment while violating the invariants I_κ of the current stage predicts instability or non-durable change: the system may transiently approach regions associated with higher attractors, but without satisfying the lower-stage constraints it cannot maintain those states under audit R. In formal terms, protocols that target $\sigma_Z^{\kappa+1}$ without first securing adequate adherence to I_κ are expected to produce trajectories that either revert toward earlier attractors or wander without achieving a stable reduction in $D(\rho_A \parallel \sigma_Z^{\kappa+1})$. Stage constraints via I_κ and F_κ are therefore not optional embellishments, but necessary conditions for robust, stage-appropriate convergence.

6. Structurally Adequate Lineage as a High-Order Signature Reservoir

Within this framework, a high-fidelity lineage is defined not by secrecy or prestige, but by the availability, calibration, and transmissible competence of high-order signature information that is not functionally available in exoteric circulation. The central question is whether a given lineage preserves, refines, and can reliably teach:

- a calibrated operator kernel (L,F,A,I,R), and
- stage-appropriate invariant libraries I_κ with bounded correspondence distortion under F_κ.

An operationally adequate lineage in this sense is one that (i) maintains a coherent symbol system and mapping L that can be learned and shared, (ii) implements correspondence rules F_κ that reliably link representations to behavior with low distortion η_κ, (iii) cultivates attentional stabilization A through reproducible practices, (iv) articulates and enforces explicit stage invariants I_κ, and (v) subjects outcomes to reflexive audit R that is not reducible to internal narrative endorsement. Such lineages are predicted to function as high-order signature reservoirs, providing structured access to δI_Qconfigurations that generic or ad hoc practices cannot reproduce, and thereby serving as primary candidates for observing the full signature profile specified by the model.

6.1 Operational Adequacy Index A_u

We define an operational adequacy index A_u as the joint availability of three ingredients:

1. bounded-η symbolic calibration (audited low distortion in L–F_κ mappings),
2. invariant library coverage (explicit, stage-indexed I_κ constraints), and
3. a reflexive audit protocol R that is independent of local narrative priors.

In compact, audit-ready form:

$$A_u = v_1 \cdot 1[\eta_\kappa \leq \eta_{thr}] + v_2 \cdot \mathrm{Cov}(I_\kappa) + v_3 \cdot Rel(R), \tag{6}$$

with weights v_i fixed in preregistration and explicitly distinct from the divergence weights w_i used in D^*. The indicator term $1[\eta_\kappa \leq \eta_{thr}]$ encodes whether the symbolic calibration passes a preregistered distortion threshold η_{thr}. $Cov(I_\kappa)$ quantifies invariant library coverage (e.g., the proportion of preregistered invariants that are explicitly taught and behaviorally testable), and $Rel(R)$ quantifies the reliability of the reflexive audit protocol (e.g., inter-rater agreement and cross-context consistency of fixpoint assessments). The distortion threshold η_{thr} is set in a pilot as the 75th percentile of η_κ within a high-reference subset of mappings and then frozen pre-study. This conservative cutoff is chosen to minimize false positives and to control Type-I error inflation when stratifying lineages by A_u-defined adequacy level. In empirical tests, A_u is used to stratify lineages into adequacy bands (for example, high-A_u versus low-A_u systems). The model predicts that the full signature profile—including diagnostic moderation and early-signature ordering—will be observed primarily in high-A_u systems within staged signature-practice traditions, whereas low-A_u systems are expected to remain at context-level effects even if they emulate external forms.

6.2 Procedure for A_u

To make A_u empirically usable, we outline an audit-ready procedure:

1. Preregister the reference kernel.

Define a lineage-specific reference kernel consisting of explicit, stage-indexed invariants I_κ^{ref}, together with the calibrated representational map L^{ref} and correspondence rules F_κ^{ref} used by that lineage. This kernel is specified before outcome data are analyzed.

2. Elicit operational mappings.

Independently elicit the lineage's *operational* L and F_κ mappings through multiple instructor-elicitation rounds under a standardized protocol, with coders blinded to expected outcomes and lineage prestige. The goal is to capture how the lineage actually teaches and applies its symbol system and correspondence rules.

3. Define L^{ref} and F_κ^{ref} by consensus.

Specify the reference mappings via a preregistered consensus rule across elicitation rounds (e.g., median or majority mapping on coded categories), rather than by single-instructor assertion. This reduces idiosyncratic bias and anchors the reference to shared practice.

4. Compute mapping distortion η_κ.

Compute a preregistered divergence measure between empirical L–F_κ outputs and the reference kernel (e.g., Kullback–Leibler divergence on coded distributions or Wasserstein distance on continuous proxies). This yields η_κ for each stage κ, which feeds into the $1[\eta_\kappa \leq \eta_{thr}]$ term in A_u.

5. Score invariant library coverage.

Quantify $Cov(I^\kappa)$ as the proportion of preregistered invariants that are (a) explicitly present in teaching materials, (b) clearly articulated in instruction, and (c) behaviorally testable via observable criteria. Higher coverage indicates that the lineage provides a more complete and operationally accessible invariant library.

6. Evaluate reflexive audit R.

Assess $Rel(R)$ by requiring a blinded cross-context fixpoint check administered by an assessor not embedded in the lineage narrative, using a preregistered rubric. Reliability indices (e.g., inter-rater agreement, test–retest stability) are used to score how well R can detect genuine fixed points versus transient changes.

7. Optional cross-lineage robustness check.

If cross-lineage calibration data are available, preregister an additional robustness analysis comparing η_κ for a given lineage against a pooled multi-lineage kernel. This helps to situate each lineage's symbolic calibration relative to a broader reference set.

8. Lock A_u strata and stage centroids.

Before testing the effects of congruent, mismatch, and context-only protocols $(Q_c/Q_m/C)$, lock the $A_u$strata (e.g., high, medium, low authenticity) and finalize stage reference centroids σ_Z^κ based solely on structural criteria and the procedures above. No outcome data from protocol arms are used at this stage. Subsequent analyses then evaluate whether high-A_u lineages indeed exhibit the predicted signature patterns, while low-A_u lineages remain at context-level effects, as specified by the model.

7. Threats to Validity, Scope, and Limitations

Several classes of threats must be addressed if the proposed framework is to be evaluated empirically rather than anecdotally. These include invariant availability (whether a lineage actually provides a usable library I_κ), non-compositional regimes (settings in which the assumed operator factorization into L, F_κ, A, I_κ, R breaks down), reflexivity leakage (assessment procedures contaminated by local narratives), expectancy and demand effects, selection bias, social contagion, and metric sensitivity in the construction of D^*.

Mitigation requires standard tools of rigorous experimentation: preregistration of hypotheses and analysis plans, blinding of assessors and, where possible, participants, targeted ablation designs that remove or alter specific operators, and replication across lineages and contexts. Typical context-only null patterns include weak-framing ritual arms that show no benefit over carrier-matched controls despite high subjective engagement, and heterogeneous meditation outcomes in which changes track expectancy and demand characteristics rather than ordered early signatures in the components of D^*. The framework treats such patterns as important discriminative cases: they exemplify systems in which context effects are present but the full signature profile is absent.

7.1 Limitations

The model is explicitly restricted to transformational and cognitive–behavioral outcomes inside agent–environment loops. It offers no claim to decide questions about external miracles, paranormal causation, or violations of physical law. All attractors σ_Z^κ are operational constructs, defined by stable patterns in observable proxies and invariant libraries I_κ; their empirical validity depends entirely on whether they reliably predict practice-linked trajectories under audit.

A further limitation is that some contemporary systems may produce genuine benefits through context alone—for example, via supportive relationships, narrative reframing, or generic ritual structure—without implementing a distinct signature component. The present framework predicts that such systems will fail mismatch and early-signature tests: their effects should not depend systematically on diagnostic alignment, nor should they exhibit the stage-specific ordering patterns in D^* that define a signature add-on.

Finally, the operator reduction to (L, F, A, I, R) is intentionally minimal. Actual traditions may contain additional, domain-specific operators that capture nuances of practice, symbolism, or pedagogy not included here. However, for such additions to enter the model, they must still be expressible as measurable informational interventions that can be linked to changes in $\rho_A(t)$ and to divergence dynamics under controlled conditions. The current framework should therefore be viewed as a baseline template for empirical discrimination, not as an exhaustive description of all possible mechanisms in signature-practice systems.

8. Falsifiable Predictions

The framework yields a set of concrete, testable predictions. Each prediction is stated so that it can, in principle, be rejected by empirical data.

P1 Diagnostic moderation.

With context C held fixed, the congruent protocol Q_c (diagnosis-matched invariants and correspondence) outperforms the context-only control C, while the mismatch protocol Q_m(diagnosis-incongruent invariants/correspondence under identical carriers and context) remains at context level:

$$Q_c > C \approx Q_m$$

Moreover, the specific add-on effect $(Q_c - C)$ increases monotonically with diagnostic certainty S_{diag}. If $(Q_c - C)$ does not grow with S_{diag}, the claim of a signature add-on is rejected.

P2 Early signatures.

For correctly matched protocols, stage-specific ordered early changes in the composite divergence, ΔD^*_{early}, occur before coarse outcome shifts and respect the preregistered partial order O_κ for the relevant stage. If early changes in the components of D^* do not show the predicted ordering (over and above what is expected under a permutation null), a signature component is not supported.

P3 Operator necessity.

Removing or degrading key operators, particularly attentional stabilization A or symbolic mediation L, sharply reduces convergence. In ablation designs, variants of the protocol that lack effective A or L should show attenuated or absent reductions in D^*, even when carriers and context are preserved. Failure of such ablations to reduce efficacy would argue against the proposed operator structure.

P4 Stage-bound limits.

Enforcing higher-stage alignment (targeting attractors $\sigma_Z^{\kappa+1}$, $\sigma_Z^{\kappa+2}$,…) without satisfying the invariants I_κ of the current stage yields instability or non-durable change. Empirically, protocols that push participants toward higher-stage content while I_κ is not adequately met are predicted to produce transient shifts in proxies that do not survive audit R, or to generate increased volatility rather than stable reductions in D^*.

P5 A_u-adequacy threshold.

Only high-A_u lineages—those with bounded symbolic distortion, substantial invariant library coverage, and reliable reflexive audit—exhibit the full P1–P2 signature profile (diagnostic moderation plus early-signature ordering). Low-A_u systems, including carrier-matched imitators, remain at context-level effects: they may produce subjective engagement and generic benefits, but they fail to show the characteristic interaction patterns of diagnostic alignment, stage-specific ordering, and robustness under mismatch tests.

9. Minimal Experimental Program

A preregistered, three-arm discriminative design that directly targets the core predictions of the framework is proposed. The three arms are:

1. Congruent signature protocol Q_c: diagnosis-matched protocol with stage-appropriate invariants and correspondence.
2. Diagnosis-mismatch protocol Q_m: identical carriers and context, but preregistered diagnosis-incongruent I_κ and F_κ replacements.
3. Context-only control C: carriers and framing preserved, but structured signature content δI_Q removed or neutralized.

The primary endpoint is the change in composite divergence ΔD^* over a preregistered time window. Early-signature ordering in the components of D^* serves as a secondary endpoint. The authenticity index A_u is used to stratify lineages according to the availability of invariant libraries I_κ and bounded-distortion correspondence maps F_κ, enabling tests of the authenticity-threshold prediction (P5).

9.1 Rival-Model Contrast

A key rival is a predictive-processing-only account H_{PP} that assumes context plus generic error minimization, but no structured stage-invariant libraries. Under H_{PP}, context and shared priors can produce non-trivial changes in outcomes, yet the model does not predict:

- a stable stage-specific ordering O_κ in early signatures,
- an authenticity threshold A_u , or
- a characteristic interaction profile involving ordering, authenticity, and mismatch conditions.

Formally, under H_{PP} the triple-interaction coefficient

$$\beta_{\mathrm{O}\times A_u \times M}$$

should satisfy $\beta_{\mathrm{O}\times A_u \times M} = 0$, where M indexes congruent versus mismatch arms. Once carriers and priors are matched, congruent and mismatch protocols are expected to converge to the same context-determined level:

$Q_c \approx Q_m \approx C.$

If data instead show that ordering effects and effect sizes depend jointly on diagnostic congruence, authenticity A_u , and mismatch status, the predictive-processing-only rival is disfavored in favor of a signature-add-on account.

9.2 Bayesian Moderation and Ordering Tests

For Bayesian moderation, let H_0denote a context-only model and H_1 denote a context plus signature-add-on model. Unless domain knowledge justifies otherwise, weakly informative priors set

$$P(H_1) = P(H_0) = 0.5.$$

Evidence for H_1 is accepted when the Bayes factor BF_{10} reaches a preregistered threshold, for example $BF_{10} \geq 10$. The key inferential target is the dependence of evidence on diagnostic certainty S_{diag}. The central requirement is

$$\frac{\partial}{\partial S_{diag}} log(BF_{10}) > 0. \tag{7}$$

meaning that evidence for a signature add-on must grow systematically with diagnostic certainty. If $log\ BF_{10}$ fails to increase with S_{diag}, the diagnostic-moderation prediction (P1) is not supported.

Early-signature ordering is tested using an order-restricted Bayesian model. Under the null H_0, the labels of early components (e.g., D_{attn}, D_{aff}, D_{beh}, D_{inv} are treated as exchangeable. To approximate this null, component labels are permuted within subjects across early-window shift vectors, holding each subject's multivariate early profile fixed. Permutations are implemented as, for example, 10,000 label-exchange draws.

The order-specific Bayes factor BF_{order} is computed as the ratio of posterior mass in the order-compliant region (as defined by the preregistered partial order O_κ) under symmetric priors across components to the corresponding mass under the permutation null. Stage clusters are evaluated separately under their respective O_κ, respecting the stage specificity of early-signature predictions.

9.3 Context-Locking and Failure Handling

Context matching is enforced through:

- carrier-identical protocols across arms,
- manipulation checks on expectancy and demand characteristics, and
- blinded assessment procedures for key outcomes.

If context matching fails—e.g., systematic differences in expectancy or perceived credibility are detected between arms—the study is declared non-diagnostic for the core predictions P1–P3. In such cases, results are reported descriptively, but no strong inferential claims are made about signature add-ons. This protects the interpretation of significant findings: any claimed signature effect must arise in a design where context has been successfully locked.

9.4 Sample-Size Logic

The primary evidential target is the three-arm contrast Q_c versus C, assessed via BF_{10} for a context-only versus context-plus-signature model. The moderation slope with respect to S_{diag} is secondary and analyzed in a hierarchical modeling framework that accounts for individual differences and lineage-level structure.

A balanced design with $N = 120$ participants per arm (total $N = 360$) is proposed to secure a high probability of decisive evidence (e.g., $BF_{10} \geq 10$) for the primary contrast under medium effect sizes, while maintaining adequate sensitivity to detect monotone moderation in $log\ BF_{10}$ as a function of S_{diag}. Detailed simulation studies for power and Bayes-factor behavior are specified and frozen in preregistration, ensuring that evidential criteria and analysis pipelines are fixed prior to observing the outcome data.

9.5 Ethics, Human-Subjects, and Data Governance

All empirical studies implementing this program require prior approval from an appropriate ethics or institutional review board (IRB), written informed consent from participants, and systematic monitoring of adverse events proportional to protocol intensity. Protocols must be risk-tiered as minimal-risk or more-than-minimal-risk according to local regulatory and institutional standards, with corresponding safeguards for screening, monitoring, and follow-up.

Preregistration of hypotheses, design, and analysis plans (for example on OSF or AsPredicted) is mandato ry. Upon publication, de-identified data and analysis code should be made available in an open repository, except where local regulations or legitimate privacy constraints prohibit full sharing. Where complete openness is not possible, authors should document the constraints and provide as much structured access (e.g., synthetic data, analysis scripts, or secure-access arrangements) as is feasible. These procedures are essential to ensure transparency, reproducibility, and independent audit of claims about signature practice.

10. Conclusion

Structured signature practice can be modeled as lawful informational engineering implemented through operator sequences that inject carrier-equivalent signature information into an agent's state space. The five-operator kernel (L, F, A, I, R) accounts for conditional efficacy (via diagnostic moderation), stage structure (via attractor chains and invariants I_κ), and stability under independent audit (via R and the composite divergence D^*.

Independent scientific literatures on ritual regulation, predictive processing and active inference, meaning response, meditation-based attentional training, and semiotic accounts of information and signs converge on the same underlying mechanisms: structured symbolic mediation, policy-constrained convergence, attentional stabilization, invariant enforcement, and reflexive evaluation. Within a single framework, these components explain why some practices yield durable, stage-structured change while others produce only generic context effects.

The model is empirically falsifiable. It predicts monotone diagnostic moderation of specific effects, stage-specific early-signature ordering in the components of D^*, characteristic mismatch profiles under carrier-identical but diagnosis-incongruent protocols, and an A_u adequacy threshold indexed by A_u. Failure to observe these patterns, given adequate design and measurement, would count against the presence of a distinctive signature component.

Under such tests, phenomena that are traditionally framed as "extraordinary" are reframed from claims about violations of physical law to experimentally decidable hypotheses about informational state engineering in complex agents. The question ceases to be whether extraordinary effects exist in principle and becomes whether particular systems instantiate the operator structures, invariants, and lineage-adequacy conditions required to produce the signature trajectories specified by the model.

11. Implications and Applications

The proposed operator framework treats signature practices as informational interventions that can be specified, audited, and experimentally contrasted. For research on ritual, meditation, healing practices, and meaning-driven anomalies, this allows a shift from vague global labels ("placebo," "belief," "energy") to testable operator components: symbolic mediation, correspondence rules, attentional training, invariant libraries, and reflexive audit. Experimental designs in areas such as anomalistic cognition, complementary and alternative medicine, contemplative training, and initiatory traditions can use the model to preregister stage definitions, diagnostic taxonomies, early-signature patterns, and adequacy bands defined by A_u. This enables discriminative tests between context-only explanations and genuine signature add-on effects, and between carrier-matched imitators and structurally adequate lineages. More broadly, the framework offers a common language in which qualitative reports, quantitative measurements, and case-based observations can be integrated into cumulative, audit-ready research programs on transformative and anomalous practices.

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