

# Intentional Integration as a Cross-Scale Principle in Neural and Organizational Systems

## *A Structural Homology Framework*

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Strategic Decision Frame

System Signals: Decision Integrity · Cognitive Load Distribution · Operational Coherence

Research Type: Translational Theoretical Research

Keywords: intentional integration, structural homology, distributed adaptive systems,  
cognitive load, decision coherence, organizational neuroscience

**ABSTRACT**

The present paper proposes a theoretical framework of structural homology between neural integration mechanisms and organizational decision architectures. Drawing on well-established findings in cognitive neuroscience regarding executive control, default mode network dynamics, salience processing, and dopaminergic novelty modulation, we argue that the conditions for intentional stability — distributed coordination, load balance, oscillatory coherence, and constraint-aware closure — are not biologically exclusive phenomena but scale-independent organizational requirements observable across complex adaptive systems. The framework, termed NeuroArt, does not assert biological equivalence between brains and organizations. Rather, it advances a mechanistic analogy at the level of integration dynamics: both classes of system exhibit parallel failure modes — premature closure, oscillatory imbalance, and synchronization collapse — when load distribution and coordination mechanisms degrade. The paper identifies three structural forces (Decision Transfer, Decision Distortion, and Coherence Fragmentation), addresses anticipated epistemological objections, presents an empirical research agenda, and concludes with a direct translation of the framework into executive system applications.

## 1. Introduction: The Translation Gap in Decision Systems Research

Contemporary neuroscience has substantially advanced the understanding of creativity, intentional action, and executive governance at the neural level. Neuroimaging modalities — including fMRI, PET, and SPECT — have identified distributed networks underlying executive control, imaginative simulation, salience detection, and novelty modulation. These contributions have enriched the cognitive sciences and produced a detailed map of the neural substrates of intentional behavior.

Yet a persistent methodological gap separates this body of work from the applied study of large-scale decision systems. Laboratory paradigms that isolate neural correlates of creativity and deliberation necessarily exclude the structural complexity, pressure asymmetries, and cross-agent coordination dynamics that characterize real-world organizational decision-making. As a result, the theoretical insights of cognitive neuroscience have remained largely sequestered within disciplinary boundaries, rarely translated into operational frameworks for understanding or improving organizational coherence.

This paper addresses that gap through the concept of structural homology. The claim is precisely defined: neural systems and organizational decision architectures constitute two instances of a broader class of distributed adaptive systems, and the integration constraints governing intentional stability in both cases share a common mechanistic structure. Where integration holds, stability emerges; where integration degrades, instability propagates. This is the foundational proposition of the NeuroArt framework.

The paper proceeds as follows. Section 2 reviews the neural foundations of intentional action. Section 3 develops the structural homology argument. Sections 4 and 5 examine cognitive load and pressure amplification as cross-scale instability variables. Section 6 synthesizes the three structural forces of the NeuroArt model. Sections 7 and 8 address epistemological limits and respond to anticipated critiques. Section 9 proposes an

empirical research agenda. Section 10 translates the framework into direct executive system applications.

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## **2. Neural Foundations of Intentional Action**

### ***2.1 The Multi-Network Architecture of Deliberate Cognition***

Intentional and creative acts are not products of isolated neural regions but emerge from coordinated interaction among multiple large-scale networks. The central executive network (CEN), anchored in the dorsolateral prefrontal cortex, subserves top-down goal maintenance, working memory operations, and behavioral inhibition. The default mode network (DMN), including the medial prefrontal cortex and posterior cingulate, supports internally directed cognition including prospective simulation and conceptual integration (Buckner et al., 2008; Raichle et al., 2001). The salience network (SN), centered on the anterior insula and anterior cingulate cortex, regulates the dynamic switching between CEN and DMN based on the perceived salience of incoming information (Menon & Uddin, 2010).

Dopaminergic modulation operates across these networks to regulate novelty sensitivity and motivational weighting, with dopamine transient signals encoding prediction errors that update action-selection policies. This system-wide coordination is what makes intentional behavior possible — and what makes it fragile under load.

### ***2.2 Oscillatory Balance Between Divergent and Convergent Processing***

Research converges on the view that creativity and intentional action depend on an oscillatory balance between divergent and convergent cognitive modes (De Dreu et al., 2014; Vartanian et al., 2013). Divergent processing — associated with DMN activation — involves broad associative search and generative ideation. Convergent processing — associated with CEN engagement — involves selective evaluation, error correction, and implementation. Neither mode is sufficient alone: exclusive divergence produces ideational drift without commitment; exclusive convergence produces premature closure and impoverished solution search.

Beaty and colleagues (2016) demonstrated, through fMRI-based functional connectivity analysis, that highly creative individuals show increased cooperation between DMN and CEN nodes during creative ideation — a pattern that in lower-creativity individuals is typically marked by antagonism between these networks. The governing principle is therefore not the dominance of any single network but the coordination capacity across them.

### ***2.3 Disruption Signatures***

When multi-network coordination degrades, characteristic failure patterns emerge. Executive dominance produces premature closure and fixation. Divergent overactivation produces fragmentation without implementation. Salience miscalibration impairs the switching mechanism that allocates attention appropriately between internal simulation and external demand. Network desynchronization — loss of coherent phase relationships between distributed nodes — produces output in which cognitive components fail to combine into integrated intentional action. These failure modes are structurally predictable consequences of specific integration breakdowns, which is precisely what makes the neural framework translatable to other scales.

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### 3. The Structural Homology Argument

#### 3.1 Defining Structural Homology

The concept of structural homology — borrowed from comparative biology and formalized in systems theory (Bertalanffy, 1968; Simon, 1962) — refers to the correspondence of organizational form or functional architecture across systems that share no direct material continuity. In this framework, two systems are structurally homologous with respect to integration if: (a) both consist of distributed functional components, (b) both require coordinated inter-component synchronization to produce coherent adaptive outputs, and (c) both exhibit analogous instability signatures when that synchronization degrades. This definition explicitly excludes any claim of biological equivalence or causal connection.

#### 3.2 Organizational Counterparts to Neural Disruption Signatures

The disruption signatures documented in neural multi-network research map onto well-characterized organizational pathologies. Table 1 articulates these correspondences, making explicit that the mapping is structural and functional — not biological.

Integration Failure Mode	Neural Manifestation	Organizational Counterpart
Executive hyperactivation	Premature closure; solution fixation	Hierarchical over-control; premature strategic lock-in
Divergent overactivation	Ideational drift; implementation failure	Strategic ambiguity; chronic reframing without execution
Saliency miscalibration	Chronic urgency; signal/noise failure	Permanent crisis mode; priority collapse
Network desynchronization	Fragmented cognition; incoherent output	Cross-functional fragmentation; execution incoherence
Dopamine dysregulation	Impaired novelty valuation; anhedonia or hypersensitivity	Innovation paralysis or chronic initiative overload

Table 1. Structural correspondence between neural integration failure modes and organizational pathologies.

Two clarifications are essential. First, these correspondences are structural analogies at the level of integration dynamics, not isomorphic mappings of mechanism. The neurobiological processes underlying executive hyperactivation differ entirely from the sociological and institutional processes underlying hierarchical over-control. What they share is the systemic consequence: in both cases, the control function exceeds its appropriate scope relative to generative processes, reducing the system's capacity for flexible, context-sensitive output. Second, organizational layers influence one another through authority structures, information flows, and incentive architectures — not electrochemical signals. The analogy does not presuppose a common mechanism; it identifies a common integration logic.

### 4. Cognitive Load as a Cross-Scale Instability Variable

#### ***4.1 Neural Evidence on Load-Induced Degradation***

Working memory limitations and stress-induced prefrontal impairment are among the most robustly documented findings in cognitive neuroscience. Arnsten (2009) demonstrated that even moderate acute stress activates signaling cascades that rapidly weaken synaptic connectivity in prefrontal networks subserving working memory and executive function. Importantly, this degradation precedes behavioral detection: decision variability increases and error-correction capacity diminishes before any external observer would identify performance impairment. Load-induced destabilization is latent — it accumulates below the threshold of visible failure.

Research on working memory capacity has established that the central executive has a fixed ceiling, beyond which task interference degrades primary task performance nonlinearly. The loss is disproportionate for complex decisions, because they require sustained integration across multiple representational modalities simultaneously — precisely the condition that characterizes strategic organizational choices.

#### ***4.2 Organizational Load Asymmetry***

Organizations exhibit analogous phenomena through load asymmetry: the uneven distribution of decision-processing demands across hierarchical layers and functional units. When decision volume concentrates at senior levels — through authority bottlenecks, escalation cultures, or insufficient middle-layer autonomy — the effective capacity of the decision system is constrained by the cognitive ceiling of its highest-load nodes. Research in organizational behavior documents the consequent pathologies: increased decision variability under time pressure (Eisenhardt, 1989), rework cycles driven by insufficient first-pass evaluation quality, and execution delays disproportionate to their apparent causes.

The cross-scale principle is this: load asymmetry destabilizes integration before performance is visibly impaired. The temporal gap between latent degradation and observable failure is precisely why load management is a strategic rather than merely operational concern.

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### **5. Pressure as Amplifier of Latent Structural Weakness**

Arnsten's (2009) research demonstrates that acute stress shifts neural processing toward faster, less integrative response modes. The prefrontal cortex — whose operation requires sustained, noise-resistant representations — is disproportionately vulnerable to stress-induced impairment, while subcortical structures mediating habitual and reflexive responses are relatively preserved. Under acute stress, behavior becomes more automatic, less flexible, and less sensitive to novel contextual information.

Organizational research supports an analogous pattern. Staw and colleagues (1981) documented threat-rigidity effects whereby organizations facing acute environmental threat demonstrate increased centralization, reduced information processing scope, and intensified reliance on established procedures — the organizational counterpart to stress-induced prefrontal inhibition. Organizations with poor load distribution and weak cross-layer synchronization are not merely disadvantaged under pressure; pressure actively amplifies their latent structural deficiencies. Pressure is therefore best understood as a diagnostic amplifier: it reveals pre-existing weakness rather than creating it de novo.

## 6. NeuroArt: A Structural Framework for Intentional Integration

### 6.1 Core Proposition

The NeuroArt framework proposes that intentional integration is a scale-independent organizational requirement: any distributed adaptive system that requires coordinated multi-component output will exhibit (a) a set of integration conditions necessary for stable coherent output, (b) characteristic failure modes when those conditions degrade, and (c) a temporal gap between latent integration degradation and observable performance impairment. This proposition applies equally to neural systems executing intentional behavior and to organizational systems executing strategic decisions.

### 6.2 Three Structural Forces

Three structural forces constitute the primary dimensions along which organizational integration can degrade or cohere. Decision Transfer refers to the effective distribution of decision-processing load across system layers; its failure mode is load concentration, the organizational analogue of working memory overload. Decision Distortion refers to the accuracy with which decision-relevant information is preserved across hierarchical transmission; its failure mode is systematic signal corruption, the analogue of oscillatory imbalance. Coherence Fragmentation refers to the degree to which coordinated action is maintained across organizational layers; its failure mode is cross-layer desynchronization, the analogue of neural network desynchronization.

These three forces are not independent. Load concentration increases informational demands on transmission pathways, amplifying distortion; distortion impairs the quality of coordination signals, accelerating fragmentation; fragmentation concentrates escalated decisions back onto overloaded nodes, closing the feedback loop. This interdependence makes early detection of integration degradation — before the loop closes — a high-leverage intervention point.

### 6.3 The Integration Model — Conceptual Diagram

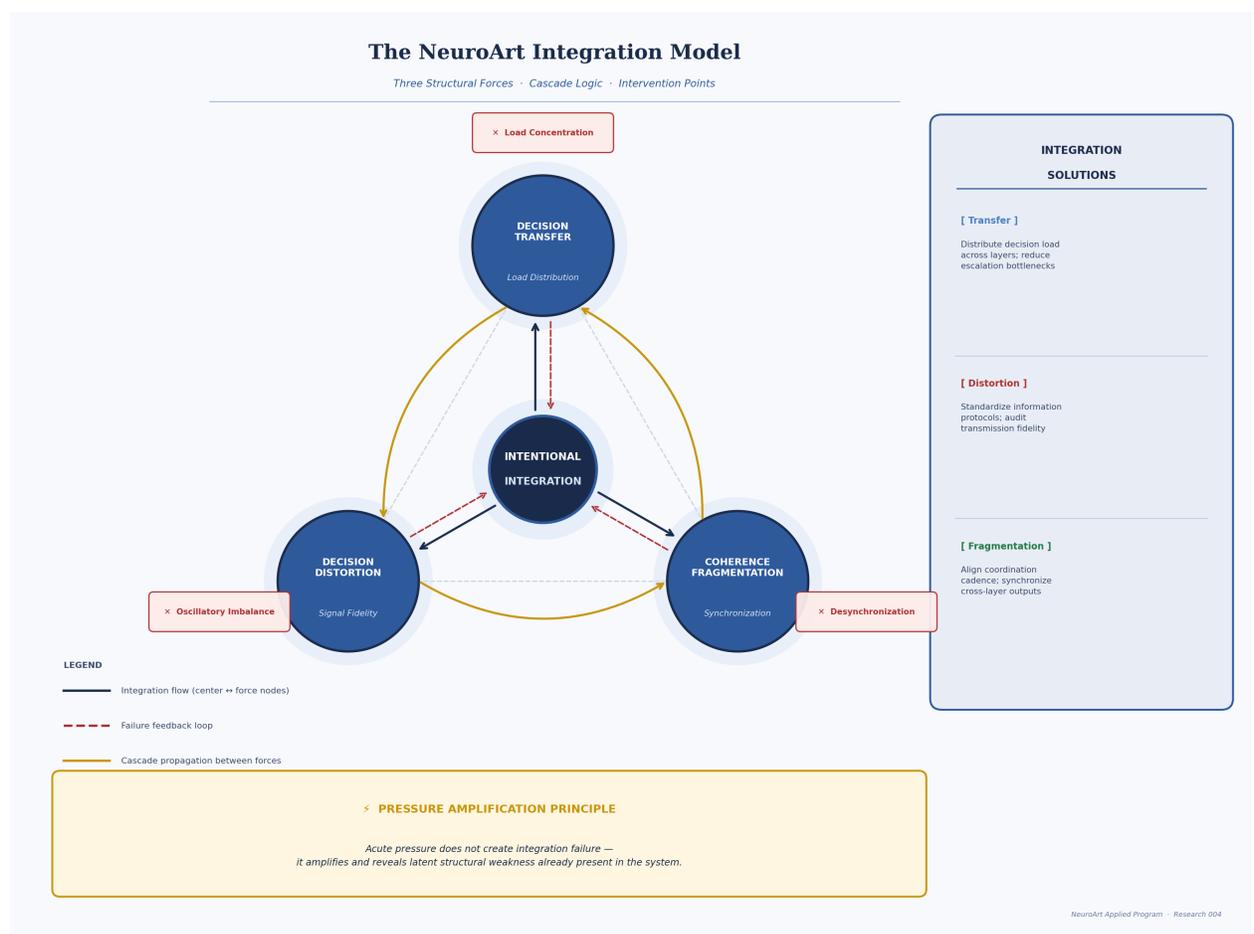


Figure 1. The NeuroArt Integration Model: three structural forces, cascade propagation logic, failure feedback loops, and concrete solution pathways. The Pressure Amplification Principle (bottom banner) applies system-wide.

### 6.4 The Brain as Prototype for Distributed Governance

The choice of the brain as the prototype for this framework is not arbitrary. Among known physical systems, the brain represents the most thoroughly studied instance of large-scale integration under constraint. Its architecture embodies general solutions to the problem of coordinating heterogeneous distributed components toward unified intentional output: functional specialization with integration hubs, dynamic routing through salience-based switching, and temporal synchronization through oscillatory coordination (Friston, 2010; Sporns, 2011). None of these solutions are biologically necessary in principle; they are convergent engineering responses to a common integration problem. Their organizational counterparts — functional specialization with coordination roles, priority-based escalation protocols, and meeting cadence alignment — solve the same problem at a different scale.

## 7. Epistemological Boundaries and Scope of Claims

The precision of this framework's claims requires explicit demarcation. The NeuroArt framework does not claim that organizations are biologically equivalent to brains, that neural imaging can predict corporate behavior,

or that causal biological determinism governs governance structures. It claims structural homology at the level of integration dynamics: that distributed systems governed by integration constraints exhibit parallel instability mechanisms when load distribution and synchronization degrade, and that this parallel is mechanistic rather than merely metaphorical.

The distinction between mechanistic analogy and metaphor is substantial. A metaphor attributes surface resemblance; a mechanistic analogy attributes correspondence at the level of causal structure. The claim here is the latter. The evidential status of the framework is that of a theoretically grounded hypothesis awaiting empirical validation — a defensible position in the philosophy of science (Kuhn, 1962; Lakatos, 1978). Theoretical frameworks establish the structure of possible explanations before empirical data can adjudicate among them.

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## 8. Response to Anticipated Critiques

### *8.1 The Overextension of Neuroscience Critique*

The most common objection to organizational neuroscience frameworks is that they overextend neurobiological concepts beyond their domain of validity (Satel & Lilienfeld, 2013). This critique has force when applied to frameworks that make direct causal claims from neural correlates to organizational behavior. The NeuroArt framework is designed to be immune to this objection: it uses integration theory — the abstract structural characterization of multi-component coordination requirements — as a template, not neuroimaging data as a causal source.

### *8.2 The Lack of Empirical Validation Critique*

This objection is correct as a description of the current evidence base but does not constitute a refutation of theoretical plausibility. Theoretical frameworks necessarily precede the development of instruments required to test them. The present paper's contribution is precisely to articulate the framework in sufficient structural detail to permit the construction of testable hypotheses and appropriate measurement instruments. The absence of current validation is a condition of the framework's developmental stage, not a defect of its conceptual architecture.

### *8.3 The Reductionism Critique*

This critique would apply if the framework attempted to explain organizational phenomena in terms of neural mechanisms. It does not. The framework explicitly operates at the level of integration dynamics, treating both neural and organizational systems as instances of a more abstract category. The organizational instantiation of integration dynamics is shaped by institutional, cultural, and political forces that have no neural analogue; acknowledging structural homology at one level of analysis does not commit to reductionism at another.

### *8.4 The Selection Bias in Analogy Construction Critique*

Analogies can always be constructed between sufficiently abstract characterizations of different systems — which may reflect abstraction level more than genuine structural correspondence. The response is that the present framework specifies the analogy at a level that generates non-trivial, falsifiable predictions: that load distribution asymmetry will predict decision instability with a temporal lag, that integration degradation will produce

characteristic failure signatures analogous to those in neural systems, and that pressure will amplify these signatures proportionally to pre-existing integration degradation. These predictions are specific enough to be disconfirmed — the criterion that distinguishes a scientific hypothesis from a vacuous analogy.

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## 9. An Empirical Research Agenda

Translating the NeuroArt framework from theoretical proposal to empirical science requires measurement instruments, experimental designs, and longitudinal data architectures appropriate to the claims being made. Five research directions are proposed.

The first and most foundational priority is the development of Decision Stability Indices (DSI): operationalized, psychometrically validated instruments measuring the consistency, reversibility rate, and cross-layer agreement of organizational decisions over time. Without valid measurement instruments, the empirical program cannot proceed.

The second priority is systematic measurement of cross-layer load distribution through behavioral and workflow data. Organizational workflow analytics and decision log analysis can provide proxy measures of load concentration at specific nodes, cross-validated against executive cognitive load instruments.

The third priority is longitudinal analysis of coherence degradation trajectories prior to documented organizational failure events. Retrospective analysis would permit identification of early-warning integration degradation signatures, testing the prediction that latent instability precedes observable failure.

The fourth priority is controlled organizational stress simulation: experimental designs in which decision teams face controlled pressure conditions while their decision patterns are measured against baseline, permitting direct testing of the pressure-amplification hypothesis.

The fifth priority is exploration of psychometric correlations between executive cognitive flexibility — measured through established instruments such as the Trail Making Test or the Wisconsin Card Sorting Task — and system-level organizational stability indices. If the structural homology hypothesis holds, executive cognitive flexibility should predict organizational integration quality above and beyond experience or general cognitive ability.

## 10. Why This Matters for Executive Systems

The preceding sections establish the theoretical and structural case for the NeuroArt framework. This final section translates that case into its direct implications for executive decision systems — the organizations, leadership structures, and governance architectures where these dynamics play out in practice. Three implications stand out as immediately actionable, and two as structurally foundational.

### *10.1 Organizational Fragility Is Architectural, Not Motivational*

The most consequential practical implication of this framework is also the one most frequently misdiagnosed: organizations under pressure fail because of how they are built, not because of how hard their people are trying. When a senior leadership team escalates every significant decision upward, when information loses fidelity as it crosses hierarchical layers, when the left hand consistently fails to coordinate with the right — these are not culture problems or engagement problems. They are integration architecture problems. Applying motivational or cultural interventions to structural failures is the organizational equivalent of treating a connectivity deficit with stimulants: it may produce short-term activity without addressing the underlying coordination breakdown.

#### **IMPLICATION 01**

##### **Redesign before you re-motivate.**

Before investing in leadership development, engagement initiatives, or performance culture programs, audit where decision load concentrates in your architecture. If the same three people make every significant call — regardless of their skill or commitment — the system will underperform its human capital. The constraint is structural.

### *10.2 Pressure Is a Diagnostic, Not a Cause*

The pressure-amplification principle reframes what organizational crises reveal. When a company navigates a regulatory challenge, a market shock, or an operational emergency and its decision architecture visibly fractures — escalation bottlenecks emerge, cross-functional coordination breaks down, decisions reverse themselves — the crisis did not cause these failures. It exposed weaknesses that were already structurally present. This means that post-crisis analysis should be directed not at the crisis itself but at the integration architecture that the crisis made visible. Organizations that treat pressure events as one-time exceptions will rebuild the same fragile structure.

**IMPLICATION 02****Use pressure events as integration audits.**

After any significant pressure event — a major product launch, a restructuring, a regulatory review, a leadership transition — conduct a structured analysis of where coordination failed and how load distributed across the system. These moments reveal the true architecture of decision-making, stripped of the routines that normally obscure it.

**10.3 The Temporal Gap Is the Strategic Opportunity**

One of the most practically significant findings from the neural research is the temporal gap between latent integration degradation and visible performance impairment. The system begins to fail well before anyone can see it failing. The same gap exists at the organizational level: load asymmetry accumulates, distortion compounds, synchronization weakens — and for a period, the dashboards still look acceptable. This gap is not a curse; it is a window. Organizations with the measurement infrastructure to detect early-stage integration degradation can intervene before the feedback loop closes, before fragmentation becomes visible, before the pressure event that will amplify everything.

**IMPLICATION 03****Measure integration quality continuously, not retrospectively.**

Decision variability, escalation rates, cross-layer reversal frequency, and execution coherence are measurable before they become crises. Organizations that track these signals as leading indicators gain the ability to intervene in the window that precedes visible failure. This is the organizational equivalent of monitoring prefrontal load before burnout.

**10.4 Load Distribution Is the Foundational Design Variable**

Of the three structural forces in the NeuroArt model, Decision Transfer — the distribution of decision-processing load — is foundational because its degradation accelerates the other two. Organizations that concentrate decision authority without designing effective load transfer mechanisms are structurally committed to distortion and fragmentation as scale increases. The question is never whether load will be distributed; it will be, informally and chaotically, through the workarounds that develop when formal structures fail. The design question is whether load distribution is architected intentionally — with appropriate decision rights, escalation protocols, and inter-layer coordination mechanisms — or whether it is left to emerge under pressure.

**IMPLICATION 04****Decision rights architecture is a cognitive infrastructure problem.**

Mapping where decisions are made, at what level, with what information, and under what time constraints is not an HR exercise — it is the equivalent of mapping cognitive load distribution across a neural network. Systems designed without explicit load-transfer architecture will develop pathological concentrations predictably, regardless of the quality of the individuals within them.

**10.5 Integration Is the Metric That Precedes All Other Metrics**

Revenue, execution speed, innovation rate, employee retention — these are outcomes. Integration quality is the upstream condition that determines whether a given organizational architecture can produce those outcomes consistently under varying conditions. A highly capable leadership team operating in a fragmented, load-asymmetric system will underperform a moderately capable team in a well-integrated one. Not occasionally, and not only under pressure: systematically, because the architecture determines how much of the available human capability can actually be converted into coordinated output. The practical consequence is that executive system performance measurement should include integration quality indicators as first-class metrics — the leading indicators that predict whether downstream outcomes are achievable at all.

**IMPLICATION 05****Treat integration metrics as leading financial indicators.**

The three structural forces — Decision Transfer efficiency, Decision Distortion rates, and Coherence Fragmentation indices — can be operationalized and tracked. Organizations that do so gain advance warning of performance deterioration that conventional metrics will not show until it is already expensive to correct. This is the applied version of the NeuroArt framework: not a theoretical model, but a measurement and governance practice.

**11. Conclusion**

This paper has proposed a theoretical framework of structural homology between neural integration mechanisms and organizational decision architectures. The central argument is that intentional action — understood as coordinated multi-component output directed toward a goal — is an integrative phenomenon governed by common architectural requirements across distributed adaptive systems of different substrates and scales. Both neural systems and organizational decision systems require distributed coordination, load balance, oscillatory integration, and constraint-aware closure. Both exhibit analogous failure modes when these requirements are not met. And in both, the transition from latent instability to observable failure occurs with a temporal lag that creates an intervention window — if the right measures are in place to detect it.

The NeuroArt framework does not reduce organizations to brains. It advances a mechanistic analogy at the level of integration dynamics, with sufficient specificity to generate falsifiable empirical predictions. Its current status is that of a theoretically motivated structural account awaiting empirical validation — which is, by design, an open question. What it offers in the interim is a coherent architectural vocabulary for diagnosing, measuring, and designing the integration conditions on which organizational intentionality depends.

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