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Cognition Under Conditions of Persistent Interpretive Instability

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Abstract

Contemporary information environments are characterized by persistent ambiguity, competing interpretations, and temporal fragmentation. Under such conditions, the expectation that cognition converges on stable, coherent meaning becomes increasingly difficult to sustain.

Building on the premise that interpretive instability constitutes a baseline condition of cognition in such environments, this paper focuses on how cognitive processes remain operational within that condition rather than how stability is achieved.

To address this, the paper introduces a set of interrelated constructs that describe the internal dynamics of cognition under persistent interpretive instability. Cognitive Superposition refers to a state in which multiple, potentially incompatible interpretations are maintained simultaneously without premature closure. Cognitive Pareidolia describes the tendency toward early pattern formation, where ambiguity is resolved through premature interpretive fixation. Metacognitive Friction captures the awareness of unresolved interpretive tension.

The paper further introduces Cognitive Gyroscope as a stabilizing capacity, and Cognitive Gyroscoping as its continuous operational expression. Together, they describe how cognition maintains directional coherence without requiring interpretive resolution. These processes are structured through Temporal Adaptive Frames, which organize cognition across past, present, and anticipated future states, enabling continuous reweighting of interpretation.

The paper argues that cognition in complex information environments is more accurately understood as an ongoing capacity to maintain orientation within instability through dynamically stabilized and temporally structured processes, rather than as a progression toward singular, stable meaning.

Keywords: interpretive instability; cognitive friction; cognitive superposition; cognitive pareidolia; metacognitive friction; cognitive gyroscope; temporal adaptive frames

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1. Introduction

Contemporary information environments pose challenges to established assumptions about how cognition operates. Information is increasingly encountered not as coherent, sequentially organized content, but as overlapping, competing, and temporally fragmented inputs. Multiple interpretations frequently coexist, often without clear mechanisms for prioritization or integration.

Much of the existing literature addresses such conditions through concepts such as cognitive bias, error, uncertainty, and disinformation. While these perspectives have contributed significantly to understanding deviations from rational or optimal judgment, they largely retain an underlying assumption that coherence is, in principle, attainable. Instability is therefore often treated as a deviation from an otherwise stable cognitive process.

Recent work has suggested that this assumption may not hold in environments where ambiguity is structurally embedded. Rather than representing a temporary disruption, interpretive instability may constitute an ongoing condition within which cognition must operate.

Building on this premise, the present paper shifts focus from how cognition resolves ambiguity to how it remains operational when ambiguity persists. The emphasis is not on convergence toward a stable meaning, but on maintaining functional orientation under conditions where such convergence may not be immediately attainable.

To address this, the paper introduces a set of interrelated constructs that together describe the internal dynamics of cognition under persistent interpretive instability. These include maintaining multiple interpretations without premature closure, a tendency toward early pattern formation, the emergence of metacognitive awareness of unresolved states, and the capacity to sustain directional coherence without requiring immediate resolution. These processes are further structured through temporal integration, in which experience, present input, and anticipated future states are continuously reweighted.

The purpose of the paper is not to propose normative models of optimal cognition, nor to prescribe strategies for decision-making. Instead, it provides a conceptual framework for more precisely describing the operation of cognition under persistent interpretive instability. In doing so, it seeks to contribute to a broader understanding of how cognitive processes remain functional in environments where stable and convergent meaning cannot be assumed.

This framework is positioned at the intersection of cognitive science, decision theory, and complex adaptive systems research. It extends existing work on uncertainty, ambiguity, and metacognition by shifting the analytical focus from resolution-based cognition toward the maintenance of operational coherence under persistent interpretive instability. In doing so, it complements rather than replaces established models of bounded rationality, heuristic processing, and cognitive control.

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In addition, this paper anticipates the question of how judgment is enacted under such conditions, introducing a preliminary conceptual extension—Cognitive Phronesis—to account for decision-making within persistent interpretive instability rather than beyond it.

2. Conceptual Definitions and Analytical Framework

This section defines the framework's core constructs. Each concept is presented as a distinct analytical component with a clearly bounded meaning and function. The purpose is to establish a precise and internally consistent vocabulary that supports systematic analysis of cognition under conditions of persistent interpretive instability. Where relevant, limitations and boundary conditions are indicated to clarify the scope of each construct.

2.1 Cognitive Friction (CF)

Cognitive Friction refers to the interpretive tension that arises when informational inputs resist integration into a coherent structure.

This condition emerges in environments characterized by informational density, ambiguity, and temporal fragmentation, where multiple signals or representations coexist without clear mechanisms for prioritization or resolution. CF is not defined as a failure of cognition, but as a baseline condition in which the cognitive system must operate despite the absence of immediate coherence.

While CF enables the emergence of multiple interpretive possibilities, it also imposes processing demands. Under conditions of sustained or intensified friction, cognitive load may increase to a level that pushes the system toward premature resolution or disengagement. CF, therefore, constitutes both a generative condition and a source of pressure within the cognitive process.

This conceptualization aligns with perspectives in complexity theory and information-rich environments, where cognitive systems are understood to operate under conditions of persistent informational overload and competing signals (Simon, 1971; Morin, 2008).

2.2 Cognitive Superposition (CSP)

Cognitive Superposition refers to a cognitive state in which multiple, potentially incompatible interpretations are maintained simultaneously without premature resolution.

In CSP, competing representations remain active in parallel as provisional possibilities. The cognitive system sustains interpretive plurality, allowing for continued processing and adaptive re-evaluation as new information becomes available. CSP does not imply indecision or passivity, but reflects an active capacity to delay closure while maintaining functional engagement.

This capacity is not unlimited. CSP may degrade under conditions of high cognitive load, time pressure, or low tolerance for ambiguity, increasing the likelihood of transition into premature

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closure. Sustained superposition, therefore, depends on both contextual conditions and the system's ability to regulate interpretive tension.

2.3 Cognitive Pareidolia (CP)

Cognitive Pareidolia refers to the tendency toward premature pattern formation, in which ambiguity is reduced through early selection of a single, coherent interpretation.

In CP, interpretive tension is resolved before sufficient integration has occurred. This often results in misclassification, bias, or overconfidence in unstable interpretations. CP represents a collapse of interpretive plurality into premature certainty.

While often associated with error, CP may also serve as an adaptive shortcut under conditions that require rapid decision-making. However, in environments characterized by persistent ambiguity, this tendency may systematically increase the risk of misinterpretation. CP is therefore not inherently dysfunctional, but becomes problematic when applied under conditions that require sustained interpretive openness.

2.4 Metacognitive Friction (MF)

Metacognitive Friction refers to the reflective tension that arises when the cognitive system becomes aware of unresolved or competing interpretive pathways.

MF operates at a meta-level relative to CF. While CF describes tension within interpretation, MF describes awareness of that tension. It introduces a monitoring dimension in which cognition recognizes its own interpretive instability. MF does not resolve ambiguity, but renders it explicit within the cognitive process.

This awareness enables regulation, but also introduces additional pressure. Under certain conditions, MF may amplify perceived uncertainty, increasing the drive toward premature closure. In this sense, MF functions as a double-edged mechanism: it enables reflective control while simultaneously intensifying the experience of instability.

2.5 Cognitive Gyroscope (CG)

Cognitive Gyroscope refers to a stabilizing cognitive capacity that maintains directional coherence amid interpretive instability.

CG is defined as a structural property of the cognitive system. It enables orientation without requiring the resolution of competing interpretations. This capacity prevents both premature collapse into fixed interpretations and loss of direction under sustained ambiguity.

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Unlike traditional models of cognitive control that rely on selection, inhibition, or conflict resolution, Cognitive Gyroscope operates without reducing representational plurality, maintaining stability through continuous orientation rather than discrete resolution.

This capacity is not absolute. Under conditions of extreme instability, conflicting contextual signals, or insufficient metacognitive awareness, CG may weaken, leading to either disorientation or a shift toward premature closure.

2.6 Cognitive Gyroscoping (CG-ing)

Cognitive Gyroscoping refers to the continuous operational process through which the Cognitive Gyroscope is enacted.

It describes real-time stabilization during ongoing cognitive activity, where interpretive structures remain unresolved. Through CG-ing, cognition continuously recalibrates its orientation in response to shifting inputs, without interrupting progression. This process enables movement within ambiguity, maintaining coherence of direction rather than coherence of interpretation.

This process is sensitive to both internal and external conditions. Rapid fluctuations in input, high informational noise, or reduced attentional stability may disrupt the effectiveness of continuous recalibration. CG-ing, therefore, represents an active and ongoing process rather than a guaranteed state.

An illustrative parallel can be drawn to gyroscopic control in interactive digital environments, where orientation is maintained through continuous micro-adjustments amid dynamic, unpredictable input. Stability in such systems is not achieved through fixed positioning but through constant recalibration during movement.

2.7 Temporal Adaptive Frames (TAF)

Temporal Adaptive Frames refer to the dynamic structuring of cognition across past, present, and anticipated future states.

TAF organizes how experience, perception, and expectation are continuously reweighted in relation to contextual demands. Rather than treating time as a linear sequence, TAF describes a system in which temporal dimensions are actively integrated into ongoing cognitive processing.

Through this structuring, cognition can adapt its interpretive orientation without requiring an immediate resolution. Experience informs recognition and expectation, present input shapes immediate interpretation, and anticipated outcomes influence prioritization.

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However, temporal structuring is not neutral. Distortions in the weighting of past, present, or future may bias interpretive orientation. Over-reliance on past patterns may increase susceptibility to premature closure, while excessive future-oriented weighting may destabilize present interpretation. TAF therefore enables adaptation, but also introduces additional sources of variability.

2.8 Functional Architecture

The constructs defined above describe distinct but interrelated components of a unified cognitive system:

1) Cognitive Friction (CF) defines the condition of interpretive instability
2) Cognitive Superposition (CSP) and Cognitive Pareidolia (CP) represent alternative responses to this condition
3) Metacognitive Friction (MF) introduces awareness of unresolved interpretation
4) Cognitive Gyroscope (CG) provides structural stabilization
5) Cognitive Gyroscoping (CG-ing) enables continuous operational stabilization
6) Temporal Adaptive Frames (TAF) structure cognition across temporal dimensions

Together, these components describe a system in which cognition remains functional not by eliminating ambiguity, but by maintaining directional coherence within it. This functionality is contingent rather than guaranteed and depends on the dynamic interaction between the processes described above.

2.9 Operationalization and Measurement Considerations

The constructs defined in this framework are presented at a conceptual level to enable analytical precision in describing cognition under conditions of persistent interpretive instability. However, for the framework to support future empirical investigation and practical use, it is necessary to consider how these constructs can be approximated using observable indicators. The purpose of this section is not to reduce the constructs to directly measurable variables, but to identify analytically grounded proxies that may serve as points of engagement for empirical research.

Given the model's abstract and process-oriented nature, any operationalization must be approached with caution. The constructs described—such as Cognitive Superposition, Metacognitive Friction, and Cognitive Gyroscoping—do not manifest as discrete, independently observable variables. Instead, they emerge through dynamic interaction within ongoing cognitive activity. As such, the proposed indicators should be understood as approximations that capture the functional expressions of these processes rather than direct measurements of their underlying structure.

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To support this translation from conceptual definition to empirical applicability, Table 1 presents illustrative mappings between the framework's core constructs, their abbreviated operational interpretations, and potential observable proxies and measurement approaches.

Table 1

Illustrative Operational Proxies for Core Constructs

Construct	**Operational Definition (Abbreviated)**	**Observable Proxy**	**Illustrative Measurement Approach**
Cognitive Friction (CF)	Interpretive tension arising from conflicting inputs	Presence of competing signals or ambiguity	Task complexity indices; ambiguity scoring frameworks
Cognitive Superposition (CSP)	Maintenance of multiple concurrent interpretations	Number of active hypotheses retained over time	Think-aloud protocols; hypothesis enumeration; decision-path tracking
Cognitive Pareidolia (CP)	Premature convergence on a single interpretation	Early fixation on one explanatory model	Decision latency analysis; premature convergence markers
Metacognitive Friction (MF)	Awareness of unresolved interpretive tension	Hesitation, conflict awareness, or self-monitoring signals	Response delay metrics; self-report scales; eye-tracking fixation duration
Cognitive Gyroscope (CG)	Capacity to maintain directional coherence without resolution	Stability of task orientation despite ambiguity	Task progression consistency; deviation analysis
Cognitive Gyroscoping (CG-ing)	Continuous recalibration of interpretation during processing	Sequential adjustment patterns in decision-making	Time-series decision analysis; trajectory mapping
Temporal Adaptive Frames (TAF)	Dynamic weighting of past, present, and future inputs	Shifts in temporal reference during interpretation	Temporal coding of decision logs; narrative temporal analysis

Note. The operational proxies and measurement approaches presented are illustrative and are intended to support future empirical investigation. They do not constitute direct measurement of the constructs, but provide analytically grounded approximations suitable for experimental and applied research contexts.

These mappings are intended to provide a structured basis for future research design, enabling investigators to examine how cognition operates under sustained ambiguity using experimentally tractable methods. For example, the maintenance of multiple concurrent hypotheses may serve as an observable proxy for Cognitive Superposition, while sequential adjustment patterns in decision-making may approximate Cognitive Gyroscoping. Similarly, response latency and

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attentional fixation patterns may offer indirect insight into the presence of Metacognitive Friction.

3. Mechanistic Interaction and Dynamic Process

The constructs defined in the preceding section describe distinct components of a cognitive system operating under conditions of persistent interpretive instability. This section examines how these components interact dynamically. The focus is on process rather than classification, and on how cognition maintains operational continuity when interpretive coherence is not immediately attainable.

3.1 From Friction to Interpretive States (CF → CSP/CP)

Cognitive Friction establishes the initial condition in which informational inputs resist integration into a coherent structure. Under such conditions, the cognitive system is confronted with multiple, potentially incompatible interpretive possibilities.

Two primary response trajectories emerge from this condition. In one trajectory, the system sustains multiple interpretations without premature resolution, corresponding to Cognitive Superposition. In this state, interpretive plurality is maintained, allowing for continued processing without forced closure. In the alternative trajectory, interpretive tension is reduced through early pattern selection, corresponding to Cognitive Pareidolia. Here, ambiguity is resolved by imposing a coherent interpretation before sufficient integration has occurred.

These trajectories are not discrete states, but directional tendencies within an ongoing process. Movement between them is influenced by contextual pressure, cognitive load, prior experience, and tolerance for ambiguity. Cognitive Friction, therefore, defines the condition of instability, while CSP and CP represent divergent modes of handling that condition.

3.2 Metacognitive Awareness and Regulation (MF)

As interpretive processing unfolds, the cognitive system may become aware of the coexistence of competing interpretations. This introduces Metacognitive Friction, a reflective layer that recognizes unresolved interpretive tension.

MF does not resolve ambiguity, but alters the system's relation to it. Through this awareness, cognition can differentiate between provisional and stabilized interpretations, enabling a form of regulation that operates without immediate closure. In this sense, MF functions as a monitoring interface, allowing it to remain in a state of Cognitive Superposition without automatically transitioning into premature resolution.

At the same time, MF introduces additional tension. Awareness of unresolved interpretation can amplify perceived uncertainty, increasing pressure toward closure. MF therefore enables

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regulation, but does not ensure stability. It creates the conditions under which stabilization may occur, without constituting that stabilization itself.

This monitoring function resonates with established work on metacognitive awareness and cognitive control, in which higher-order processes enable the regulation of ongoing cognitive activity without necessarily resolving underlying conflict (Flavell, 1979; Botvinick et al., 2004).

3.3 Stabilization and Direction (CG / CG-ing)

While Metacognitive Friction introduces awareness, it does not provide directional stability. The maintenance of functional orientation under sustained interpretive instability requires a distinct mechanism.

Cognitive Gyroscope provides this stabilizing capacity. It enables the cognitive system to maintain directional coherence without requiring resolution of competing interpretations. Rather than selecting a single interpretive outcome, CG preserves alignment with context, allowing cognition to proceed without collapsing into either premature certainty or disorientation.

Cognitive Gyroscoping constitutes the operational expression of this capacity. It functions as a continuous real-time recalibration process, in which orientation is maintained through ongoing adjustment to shifting informational inputs. This process enables movement within ambiguity, where stability is not achieved through a fixed interpretation but through sustained alignment amid interpretive flux.

Through CG and CG-ing, cognition can continue operating under conditions that would otherwise lead to premature closure or loss of direction. Stabilization is therefore not a function of resolution but of maintaining a trajectory.

3.4 Temporal Structuring and Adaptive Reweighting (TAF)

The processes described above are structured within a temporally adaptive system. Temporal Adaptive Frames organize how experience, present input, and anticipated future states are integrated into ongoing cognitive activity.

Through TAF, the cognitive system continuously reweights interpretive elements. Experience informs pattern recognition and expectation, present input shapes immediate interpretation, and anticipated outcomes influence evaluative prioritization. This temporal integration enables cognition to adapt its orientation without requiring immediate resolution of competing interpretations.

The interaction between CG and TAF is central. While CG maintains directional coherence in the present, TAF allows that direction to be continuously adjusted in relation to temporal context. Together, they enable cognition to remain both stable and adaptive amid ongoing change.

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3.5 Dynamic Loop Formulation

The interaction between these components can be described as a continuous dynamic loop:

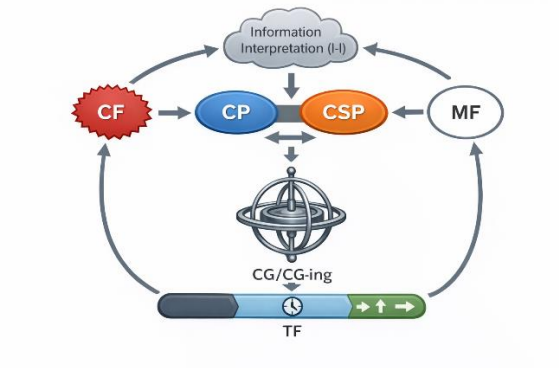
1) Cognitive Friction establishes conditions of interpretive instability.
2) This gives rise to parallel interpretive states, expressed as Cognitive Superposition or premature closure through Cognitive Pareidolia.
3) Metacognitive Friction introduces awareness of this unresolved condition.
4) Cognitive Gyroscope provides stabilization, enabling continued orientation without resolution.
5) Cognitive Gyroscoping maintains this stabilization through continuous recalibration.
6) Temporal Adaptive Frames structure the process over time, enabling adaptive reweighting of interpretations.

The output of this process feeds back into ongoing interpretation, generating new instances of Cognitive Friction as conditions evolve. The system, therefore, does not progress toward a final state of coherence, but operates as a continuous process of navigation within persistent interpretive instability.

To clarify the interaction among the components described above, Figure 1 illustrates the continuous dynamic loop through which cognition maintains operational continuity amid persistent interpretive instability.

Figure 1

Dynamic Loop of Cognition Under Conditions of Persistent Interpretive Instability



Note. Author-created conceptual model illustrating the dynamic interaction between Cognitive Friction (CF), Cognitive Superposition (CSP), Cognitive Pareidolia (CP), Metacognitive Friction (MF), Cognitive Gyroscope (CG), Cognitive Gyroscoping (CG-ing), and Temporal Adaptive Frames (TAF).

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Figure 1 depicts cognition not as a linear progression toward stable interpretation, but as a continuous, adaptive loop in which interpretive tension, awareness, stabilization, and temporal structuring interact to sustain directional coherence without requiring resolution.

To further clarify how environmental conditions influence the dynamic loop, specific contextual triggers may be associated with variations in the stability of the processes described. For example, high informational noise and signal interference may intensify Cognitive Friction, increasing the likelihood of transition toward Cognitive Pareidolia. Similarly, time pressure and cognitive overload may reduce the system's capacity to sustain Cognitive Superposition, accelerating premature closure.

Conversely, environments that allow for extended processing time and structured information flow may support sustained Cognitive Gyroscoping and the maintenance of directional coherence. Temporal fragmentation, such as rapidly shifting or asynchronous inputs, may disrupt Temporal Adaptive Frames, leading to imbalances in the weighting of past, present, and anticipated information.

These relationships highlight that the operation of the framework is contingent not only on internal cognitive processes but also on the structure and intensity of external environmental conditions.

4. Functional Implications of Stabilized Cognition Under Interpretive Instability

The framework developed in this paper describes cognition as operating under conditions in which interpretive stability is not immediately attainable. The interaction between Cognitive Friction, interpretive states, metacognitive awareness, stabilization mechanisms, and temporal structuring suggests a shift in how cognitive functionality may be understood in such environments.

Rather than defining effective cognition primarily in terms of accuracy or speed of resolution, the framework points toward functionality as the capacity to maintain orientation under conditions of sustained ambiguity. This does not imply that resolution is irrelevant, but that cognition must often remain operational before resolution becomes possible.

4.1 Sustained Operation Without Immediate Resolution

Under conditions of persistent interpretive instability, the ability to continue processing without premature closure becomes a functional characteristic. Cognitive Superposition, in interaction with Metacognitive Friction and Cognitive Gyroscoping, enables the maintenance of multiple interpretive possibilities while preserving directional coherence.

This suggests that cognitive functionality may, in certain contexts, depend less on rapid convergence and more on the capacity to delay resolution without loss of orientation. Such a

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capacity allows for continued integration of information as conditions evolve, rather than fixation on early interpretive outcomes.

For example, in cybersecurity operations centers, analysts often encounter streams of partially conflicting indicators that cannot be immediately resolved. The ability to maintain multiple hypotheses while continuing investigative action reflects the type of sustained operation described in this framework.

4.2 Avoidance of Premature Closure

Cognitive Pareidolia represents a trajectory in which interpretive tension is reduced through early pattern formation. While such closure may provide short-term stability, it may also increase the likelihood of misclassification when interpretive conditions are unstable.

Within the present framework, the interaction between Metacognitive Friction and Cognitive Gyroscoping can be understood as contributing to the avoidance of premature closure. Awareness of unresolved interpretation, combined with the ability to maintain orientation without immediate resolution, allows the cognitive system to remain within a state of provisional interpretation.

This does not eliminate the possibility of error but introduces a mechanism to moderate premature certainty.

4.3 Avoidance of Interpretive Paralysis

While premature closure represents one response to Cognitive Friction, sustained ambiguity may also lead to a loss of direction. In the absence of stabilization, the coexistence of multiple interpretations may lead to hesitation or fragmented action.

The introduction of the Cognitive Gyroscope and its operational expression provides a mechanism to mitigate this risk. By maintaining directional coherence amid ongoing interpretive flux, the system can continue operating without requiring the resolution of all competing representations.

This suggests that functionality under conditions of instability involves not only tolerance of ambiguity, but the capacity to move within it.

4.4 Maintenance of Directional Coherence

The interaction between Cognitive Gyroscoping and Temporal Adaptive Frames suggests that cognitive stability may be better understood as directional coherence rather than interpretive coherence.

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Through continuous recalibration and temporal reweighting, the cognitive system can maintain alignment with contextual demands while interpretive structures remain provisional. This allows for adaptive progression without requiring fixed or final interpretive states.

Directional coherence, in this sense, does not imply correctness of interpretation, but continuity of orientation. Similarly, in intelligence analysis, practitioners frequently operate under conditions in which incoming information is incomplete or contradictory. Maintaining directional coherence—rather than prematurely converging on a single interpretation—enables continued assessment as additional data becomes available.

4.5 Functional Reframing of Cognitive Performance

Taken together, these implications suggest a reframing of cognitive performance amid persistent interpretive instability. Rather than evaluating cognition solely in terms of correctness, efficiency, or decisiveness, the framework highlights the importance of:

1) Sustaining interpretive plurality where appropriate
2) Recognizing unresolved ambiguity
3) Maintaining orientation without premature closure
4) Enabling continued progression under changing conditions

These characteristics do not replace traditional measures of cognitive performance, but extend them into domains where such measures may be insufficient to capture functional capacity.

5. Discussion

The framework presented in this paper is positioned within a broader effort to understand how cognition operates under conditions of increasing informational complexity. While the constructs introduced here are defined independently, they are compatible with earlier conceptualizations that describe interpretive tension as a baseline condition of contemporary cognition. In this sense, the present work may be understood as an extension that focuses more explicitly on the internal dynamics through which such conditions are navigated.

At a general level, the framework contributes to ongoing discussions within cognitive science and decision theory concerning uncertainty, ambiguity, and the limits of rational processing. Traditional approaches have often emphasized how cognition deviates from optimal reasoning through bias, error, or heuristic shortcuts. While these perspectives remain relevant, they do not fully account for conditions in which competing interpretations persist without clear pathways to resolution. The present framework does not replace such models, but situates them within a broader context in which instability itself may be structurally embedded.

The distinction between Cognitive Superposition and Cognitive Pareidolia offers a way to differentiate between sustained interpretive plurality and premature closure. This distinction

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aligns with, but is not reducible to, existing discussions of uncertainty tolerance and heuristic processing. Similarly, Metacognitive Friction extends established notions of metacognition by emphasizing not only monitoring and control, but the sustained awareness of unresolved interpretive tension.

The introduction of Cognitive Gyroscope and Cognitive Gyroscoping represents a further differentiation. Rather than focusing on selection or inhibition, these constructs describe a stabilizing mechanism that maintains directional coherence without requiring resolution. This places the framework in partial alignment with theories of cognitive control, while also suggesting that stability may be achieved through continuous recalibration rather than discrete decision points.

Temporal Adaptive Frames introduce a temporal dimension that connects the framework to phenomenological and process-oriented approaches to cognition. By emphasizing the continuous integration of past, present, and anticipated future states, TAF highlights the role of temporal structuring in maintaining functional orientation under changing conditions.

At the same time, the framework has clear limitations. It is conceptual in nature and does not provide direct empirical validation of the processes described. The constructs are defined at a level of abstraction that enables analytical clarity but may require further specification to support empirical investigation. In addition, the framework does not aim to provide a comprehensive model of cognition, but focuses specifically on conditions characterized by persistent interpretive instability.

It is also important to clarify what the framework does not claim. It does not assume that ambiguity is always preferable to resolution, nor that sustained interpretive plurality is inherently beneficial. Rather, it describes conditions under which immediate resolution may not be attainable, and examines how cognition may remain functional under such constraints. The framework, therefore, avoids normative assumptions about optimal cognitive behavior and instead focuses on descriptive mechanisms.

An additional consideration concerns variation in individual capacity to operate under conditions of persistent interpretive instability. Existing research on Need for Closure (NFC) and tolerance for ambiguity suggests that individuals differ in their propensity to resolve uncertainty rapidly versus sustain interpretive openness. High NFC has been associated with a preference for early closure and reduced tolerance for competing interpretations, while greater ambiguity tolerance supports sustained engagement with unresolved conditions.

Within the present framework, these individual differences may be understood to influence the dynamic interaction among cognitive processes. Specifically, such traits may affect the likelihood of transition between Cognitive Superposition and Cognitive Pareidolia, as well as the system's capacity to sustain Cognitive Gyroscoping under conditions of elevated interpretive

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tension. This integration situates established psychological constructs within the process-oriented model developed in this paper, extending their relevance to environments characterized by persistent interpretive instability.

In this sense, the paper's contribution lies in articulating a set of interrelated processes that together describe how cognition can maintain operational continuity in environments where coherence is not guaranteed. The value of the framework is not in prescribing solutions, but in providing a structured account of how interpretive instability may be navigated.

While the present framework is not derived from any single existing theoretical tradition, it intersects with several established areas of research. Work on cognitive control has emphasized mechanisms for managing competing representations and regulating responses under conflict (Botvinick et al., 2004). Predictive processing accounts describe cognition as a continuous process of hypothesis generation and error minimization (Friston, 2010; Clark, 2013). In parallel, decision theory has long addressed how agents operate under conditions of uncertainty and incomplete information (Knight, 1921; Tversky & Kahneman, 1974).

The framework proposed here is not positioned as a competing alternative to these approaches, but as an extension that becomes particularly relevant under conditions in which error minimization cannot be readily achieved. Rather than emphasizing convergence toward reduced uncertainty, the present model focuses on the capacity for continued cognitive operation when uncertainty persists, and interpretive resolution is delayed or structurally constrained.

In this sense, the framework may be understood as describing a higher-order operational condition in which cognition remains functional without requiring an immediate reduction in prediction error. This positioning allows the model to remain compatible with existing theories while extending their applicability to environments characterized by persistent interpretive instability.

5.2 From Stabilization to Judgment: Cognitive Phronesis

While the present framework describes how cognition can remain operational under conditions of persistent interpretive instability, the question of how judgment is enacted within such conditions remains open.

Cognitive Phronesis may be understood as an emergent capacity rather than a discrete mechanism. It does not operate independently of the processes described in this framework, but arises from their sustained interaction. In particular, it depends on the maintenance of interpretive plurality (CSP), awareness of unresolved tension (MF), and the stabilization of orientation without premature closure (CG and CG-ing). Without these conditions, judgment collapses either into premature certainty or indecision.

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The operation of Cognitive Phronesis may be further understood as a recursive feedback process linking action and interpretation. Judgments enacted under conditions of persistent interpretive instability do not terminate cognitive processing but instead re-enter the interpretive system as new inputs. Each enacted decision reshapes the subsequent configuration of Cognitive Friction, influencing the intensity and distribution of interpretive tension encountered in future processing. This feedback loop suggests that judgment is not a discrete endpoint but an ongoing intervention within the dynamic loop of cognition. Action alters the interpretive landscape, which in turn modifies the conditions under which subsequent judgments are formed. Cognitive Phronesis, therefore, operates not by resolving ambiguity, but by navigating and reshaping it through iterative engagement.

Stability, in the sense developed in this paper, does not imply resolution. The maintenance of interpretive plurality, metacognitive awareness, and directional coherence allows cognition to proceed without collapse. However, it does not in itself account for how decisions are formed or actions are taken.

To address this, the notion of Cognitive Phronesis (CPh) may be introduced as a capacity for context-sensitive judgment that operates within, rather than beyond, interpretive instability. CPh does not depend on reducing ambiguity or selecting a single, stable interpretation. Instead, it denotes the ability to enact judgment while multiple competing representations remain active, temporally distributed, and only partially integrated.

Within the present framework, Cognitive Phronesis can be understood as emerging from the interaction of the processes described. Sustained Cognitive Friction provides the condition of interpretive openness. Cognitive Superposition maintains plurality without premature closure. Metacognitive Friction enables awareness of unresolved states. Cognitive Gyroscope and Cognitive Gyroscoping provide directional coherence, while Temporal Adaptive Frames structure interpretation across time.

When these conditions are maintained, judgment becomes possible without requiring interpretive resolution. Action is enacted not based on stabilized meaning, but through a maintained orientation within ongoing instability. In this sense, Cognitive Phronesis represents a form of judgment adapted to environments in which coherence cannot be assumed and in which decision-making must proceed without eliminating ambiguity.

This perspective suggests that judgment in complex information environments cannot be fully captured by models that prioritize accuracy, optimization, or uncertainty reduction. Instead, it may involve the capacity to act within unresolved conditions while preserving sensitivity to their continued variability.

The present framework extends these perspectives by situating such traits within a dynamic system of cognitive processes. Rather than viewing closure tendencies as static traits, they may

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be understood as influencing the likelihood of transition between Cognitive Superposition and Cognitive Pareidolia, as well as the system's capacity to sustain Cognitive Gyroscoping under pressure. This integration bridges established psychological constructs and the process-oriented model developed in this paper.

6. Conclusion

This paper has examined how cognition operates under conditions in which interpretive stability is not immediately attainable. Rather than treating ambiguity as a deviation from otherwise coherent processing, the framework has approached interpretive instability as a baseline condition in contemporary information environments.

To address this, a set of interrelated constructs has been introduced, each describing a distinct component of cognitive operation under such conditions. Cognitive Friction defines the condition of interpretive tension. Cognitive Superposition and Cognitive Pareidolia describe alternative trajectories in the handling of competing interpretations. Metacognitive Friction introduces awareness of unresolved interpretive states. Cognitive Gyroscope and Cognitive Gyroscoping provide a stabilizing mechanism that maintains directional coherence without requiring resolution. Temporal Adaptive Frames structure these processes across time, enabling continuous reweighting of experience, perception, and expectation.

Taken together, these components describe a continuous dynamic process rather than a linear progression toward stable meaning. This process may be expressed as a recurring loop in which interpretive instability gives rise to parallel representations, awareness of this condition emerges, stabilization is maintained through continuous recalibration, and temporal structuring enables adaptive progression. The output of this process feeds back into ongoing interpretation as conditions evolve.

This framework may have implications for domains in which interpretive instability is not exceptional but persistent. This includes areas such as cybersecurity decision-making, intelligence analysis, and high-reliability organizational environments, where actors must operate amid continuous ambiguity, competing signals, and temporal misalignment. In such contexts, the capacity to maintain stability without premature closure may represent a critical dimension of operational effectiveness.

Within this framework, cognition is not defined primarily by its capacity to resolve ambiguity, but by its ability to remain functional amid ambiguity. The emphasis shifts from convergence to coherence, toward maintaining directional continuity under changing and uncertain conditions.
The contribution of this paper lies in articulating a structured account of this process. It does not propose a resolution to interpretive instability, nor does it prescribe optimal cognitive strategies. Instead, it provides a more precise conceptual framework for understanding the dynamics of cognition under such conditions.

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7. Future Directions and Research Trajectories

The framework presented in this paper is intended as a conceptual contribution to the analysis of cognition under conditions of persistent interpretive instability. While the constructs introduced provide a structured account of this process, they also indicate areas requiring further investigation.

A critical direction for future research involves the empirical operationalization of the constructs introduced in this framework. While the present study is conceptual, several experimental paradigms may be employed to approximate and observe the dynamics described. For example, cybersecurity simulation environments and intelligence analysis tasks provide conditions in which participants must process incomplete, conflicting, and temporally fragmented information streams. Within such settings, Cognitive Superposition may be approximated through the number of concurrently maintained hypotheses. At the same time, transitions toward Cognitive Pareidolia may be observed through premature fixation on a single interpretive outcome.

In addition, eye-tracking methodologies and physiological indicators (e.g., heart rate variability, galvanic skin response) may provide indirect measures of Metacognitive Friction by capturing sustained attentional engagement and stress responses under conditions of unresolved interpretive tension. Sequential decision-tracking approaches may further enable the observation of Cognitive Gyroscoping, particularly by analyzing directional consistency across evolving informational inputs.

These approaches do not assume direct observability of the constructs, but provide a basis for approximating their functional presence within controlled environments. Such empirical engagement is a necessary step toward extending the present conceptual framework toward testable, measurable applications.

A second area relates to variation across individuals and contexts. The framework assumes that the capacity to sustain ambiguity, tolerate interpretive tension, and maintain directional coherence may differ depending on cognitive, experiential, and situational factors. Investigating how such variation manifests, and under what conditions it is supported or constrained, represents a relevant extension of the present work.

A third direction concerns the role of environmental structure. The framework is developed in relation to information environments characterized by density, signal competition, and temporal fragmentation. Further research may examine how different configurations of informational input influence the emergence and interaction of the processes described, including conditions under which stabilization becomes more or less attainable.

Finally, the framework may benefit from continued conceptual integration with adjacent fields, including cognitive science, decision theory, and the study of complex adaptive systems. Such

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integration may clarify both the scope and the limitations of the constructs introduced, without reducing them to existing explanatory models.

These directions do not imply that the framework provides a complete account of cognition amid interpretive instability. Rather, they indicate that the concepts presented here may serve as a basis for continued analytical, theoretical, and empirical development.

Authorship Statement

The conceptual foundation of the Quantum-Cognitive Maturity Model (QCM²) originated from an initial idea developed by Mr. Aslak Molvær. The model was subsequently advanced through a structured research collaboration with Dr. Robb Shawe.

Dr. Shawe led the development of the theoretical articulation, structural framework, and interdisciplinary integration of QCM², including the formalization of its core constructs and analytical architecture. Mr. Molvær contributed the original conceptual insight and participated in the framework's continued development and refinement.

Both authors contributed to the interpretation, refinement, and presentation of the model as developed in this manuscript.

Author Note and Research Program Statement

This manuscript forms part of a coordinated research program advancing the Quantum-Cognitive Maturity Model (QCM²) as an interdisciplinary analytical framework for understanding cognition within complex, digitally mediated information environments.

The research program integrates perspectives from cognitive science, systems theory, organizational learning, cybersecurity governance, and socio-technical analysis to conceptualize cognition as a dynamic, context-dependent process shaped by environmental conditions and interpretive constraints.

Across this program of research, QCM² is developed as a structured framework for examining cognitive resilience, interpretive instability, and decision-making under conditions of informational complexity. The framework is intended to support ongoing theoretical refinement and future empirical and applied research across multiple domains.

Conflict of Interest

The authors declare no conflicts of interest associated with the development, analysis, or publication of this manuscript. The research was conducted independently and was not influenced by financial, institutional, or personal relationships that could be perceived as affecting the objectivity or integrity of the work.

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Originality Statement

This manuscript represents original scholarly work produced collaboratively by the authors. The conceptual framework, analytical interpretations, and written content have not been published previously and are not under consideration by any other journal or publication outlet.

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