

Cognitive Friction: Interpretive Tension in Complex Information Environments

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Abstract

This paper introduces the concept of Cognitive Friction as a baseline condition of contemporary information environments. Rather than treating interpretive difficulty as resulting from cognitive bias, error, or disinformation, the paper defines Cognitive Friction as the tension that arises when multiple informational inputs resist integration into a coherent structure. This tension is understood as a structural feature of the environment rather than a failure of individual cognition. The analysis examines the dynamics of Cognitive Friction, including variations in intensity and the persistence of unresolved interpretive tension. It then introduces the concept of cognitive pareidolia to describe how coherence may be imposed when it cannot be derived from available information. Finally, the paper considers the implications of these conditions for interpretation and decision-making, including the role of cognitive sustainability as the capacity to operate within ongoing ambiguity.

The paper is conceptual and analytical in nature. It does not present empirical findings, but develops a theoretical framework intended to clarify the conditions under which contemporary cognition operates. It aims to make visible a structural condition that underlies interpretation and decision-making in complex information environments.

Keywords: Cognitive Friction, Interpretive Tension, Information Environments, Socio-Technical Systems, Decision-Making Under Uncertainty, Cognitive Sustainability, Metacognitive Friction

1. Chapter 1: Introduction

Contemporary information environments are characterized by a level of complexity that challenges 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 coexist, often without clear mechanisms for prioritization or integration. Under such conditions, the expectation that individuals can

consistently derive stable meaning from available information becomes increasingly difficult to sustain.

Much of the existing literature approaches this difficulty through concepts such as cognitive bias and heuristics (Kahneman, 2011), bounded rationality (Simon, 1957), or sensemaking under ambiguity (Weick, 1995). These perspectives provide important insights into how individuals process information and construct meaning. However, they tend to assume that coherence is in principle available, even if not successfully achieved in practice. Interpretive difficulty is therefore often framed as a deviation from otherwise stable cognitive processes.

This study is positioned at the intersection of cognitive science, information systems, and socio-technical systems theory, contributing to an emerging body of work that examines how structurally complex information environments shape interpretive processes and decision-making. Moreover, this paper takes a different position. It does not begin from the assumption that coherence is available but distorted. It begins from conditions in which coherence is not readily available.

The concept of Cognitive Friction is introduced to describe the interpretive tension that arises when informational inputs resist integration into a coherent structure. Cognitive Friction is here conceptualized not as a failure of cognition, but as a condition produced by the environments in which cognition operates. It is treated as a baseline condition rather than an exception, reflecting the structural characteristics of contemporary information systems, as also suggested by broader transformations in the infosphere (Floridi, 2014) and the network society (Castells, 1996), as well as more recent analyses of information disorder and digitally mediated epistemic environments (Wardle & Derakhshan, 2017; Lewandowsky et al., 2020).

From this starting point, the analysis develops along three dimensions. First, it examines the internal dynamics of Cognitive Friction, including how variations in intensity and the persistence of unresolved tension shape interpretive conditions. Second, it introduces the concept of cognitive pareidolia to describe how coherence may be imposed when it cannot be derived from the informational environment. Third, it considers the implications of these conditions for interpretation and decision-making, including the role of cognitive sustainability as the capacity to operate within persistent ambiguity without premature closure.

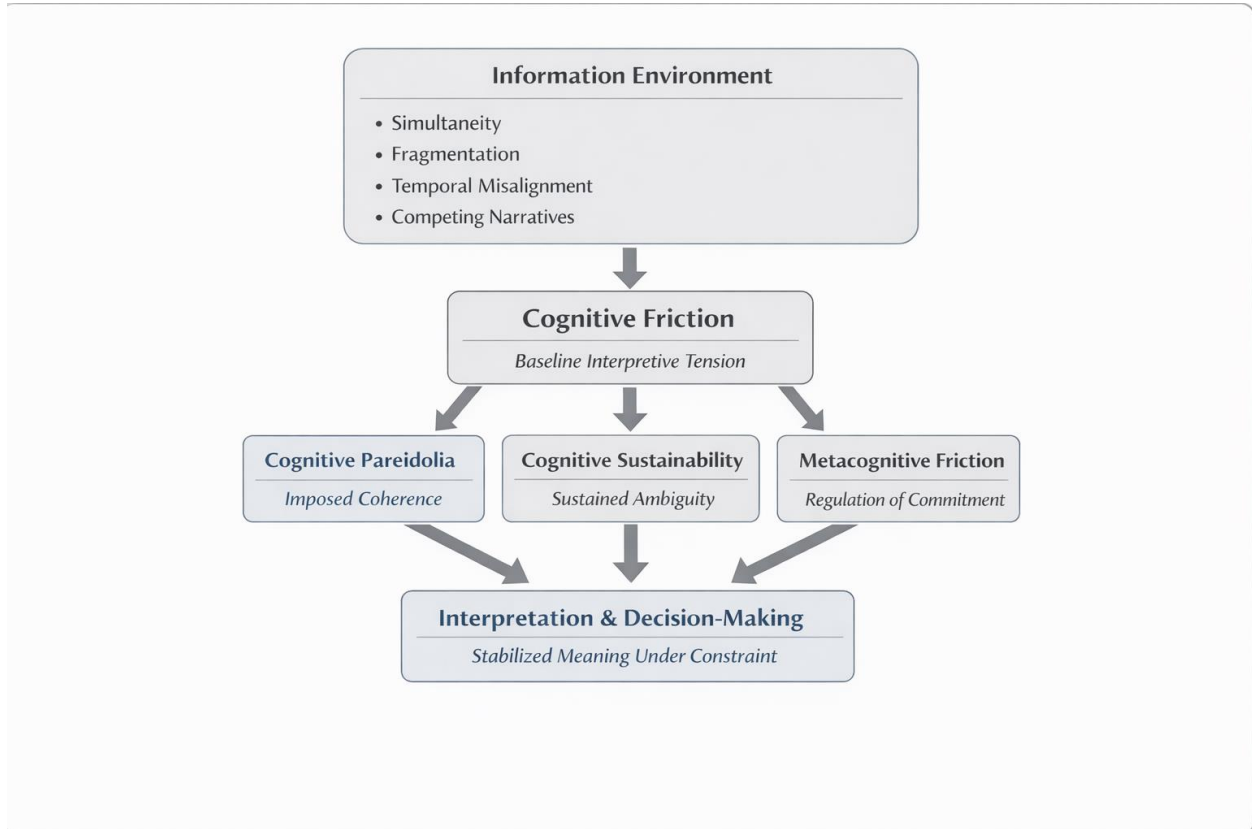
The purpose of the paper is not to propose solutions or interventions. Instead, it seeks to make visible a structural condition that underlies contemporary cognition and to provide a conceptual basis for discussing how meaning is formed in environments where coherence is not given. By reframing Cognitive Friction as a baseline condition, the analysis shifts focus from correcting individual cognition to understanding the environments that shape it. This study adopts a conceptual and theory-building methodological orientation, drawing on interdisciplinary literature across cognitive science, information theory, and sociotechnical systems research. Rather than empirical investigation, the analysis proceeds through structured conceptual

synthesis and analytical development to articulate Cognitive Friction as a baseline condition of contemporary information environments. This paper contributes to interdisciplinary scholarship in three primary ways. First, it reconceptualizes interpretive difficulty as an environmental condition rather than an individual cognitive limitation. Second, it introduces cognitive pareidolia and metacognitive friction as mechanisms that construct and regulate coherence under conditions of persistent ambiguity. Third, it advances the concept of cognitive sustainability as the capacity to maintain interpretive engagement without premature closure. Together, these contributions establish a framework for understanding cognition as operating within, rather than outside of, conditions of ongoing interpretive tension.

To clarify these relationships, the conceptual structure developed in this study is illustrated in Figure 1. This framework advances a novel theoretical lens for understanding cognition as operating within persistent interpretive tension, rather than as a system oriented toward stable coherence.

Figure 1

Cognitive Friction Framework: Environmental Conditions, Interpretive Responses, and Decision Pathways



Note. Author-created conceptual model illustrating Cognitive Friction as a structural condition of contemporary information environments and its primary interpretive response pathways.

As shown in Figure 1, Cognitive Friction emerges from structurally complex information environments and gives rise to multiple interpretive response pathways, each shaping how meaning is stabilized and decisions are formed under conditions of persistent ambiguity.

Chapter 2: Cognitive Friction as Baseline

Cognitive Friction is here understood not as an anomaly within human cognition, but as a condition produced by the environments in which cognition operates. While related to constructs such as cognitive load and epistemic uncertainty, Cognitive Friction differs in that it is not a property of individual processing capacity or knowledge limitations, but rather an emergent condition produced by structurally complex and competing information environments. It is not

treated as a disturbance or deviation from an otherwise stable interpretive state, but as a structural feature of contemporary informational conditions.

The term has previously been used within interaction design to describe effort arising from mismatches between user expectations and system behavior (Cooper, 1999). The present use diverges from this tradition. Here, Cognitive Friction refers to a structurally produced condition of interpretive tension within contemporary information environments, rather than usability challenges within discrete systems.

Contemporary information environments are characterized by simultaneity, multiplicity, and temporal compression. Information is no longer encountered as discrete, sequential streams, but as overlapping inputs that compete for interpretive priority. These inputs are often internally inconsistent, contextually fragmented, and temporally misaligned. Information does not arrive as a coherent narrative but as fragments, signals, claims, and representations, each carrying its own implicit logic and rarely aligning with others into a stable structure.

Under such conditions, cognition may operate differently from assumptions embedded in many classical models of reasoning. The expectation of coherence, consistency, and linear interpretation is not consistently supported. Instead, individuals continuously navigate competing interpretive possibilities without access to a single stable frame of reference.

Cognitive Friction can therefore be understood as the interpretive tension that arises when multiple informational inputs resist integration into a coherent structure. This tension does not reflect insufficient cognitive capacity, nor does it indicate a failure of reasoning. It reflects a structural property of the informational environment itself. The friction is not located solely within the individual, but in the relationship between the individual and the complexity of the inputs being processed.

It is therefore necessary to distinguish Cognitive Friction from concepts traditionally used to describe difficulty in reasoning. It is not reducible to cognitive bias, which presupposes deviation from rational judgment (Kahneman, 2011). It is not equivalent to error, which implies incorrect processing relative to an objective standard. Nor is it identical to cognitive dissonance, which describes tension arising from conflicting beliefs. Cognitive Friction operates prior to these. It defines the condition under which interpretation takes place when coherence is not readily available.

Cognitive Friction must be further distinguished from adjacent constructs frequently invoked in the literature. Unlike cognitive load, which refers to limitations in processing capacity, Cognitive Friction is not a function of individual constraint but of environmental structure. Similarly, while ambiguity tolerance describes individuals' capacity to remain comfortable under uncertain conditions, and epistemic uncertainty refers to limits in knowledge or knowability, Cognitive Friction operates prior to these as a structural condition that shapes how individuals encounter

ambiguity and uncertainty. This distinction positions Cognitive Friction not as a variation in cognitive response, but as a property of the informational environment itself.

This distinction has analytical consequences. Treating Cognitive Friction as a baseline condition shifts attention from correcting individual cognition to understanding the environments that generate persistent interpretive tension. The individual is not positioned as deficient but as situated within a context in which ambiguity and competition between meanings are structurally embedded.

Cognitive Friction is not primarily episodic. It does not arise only in moments of confusion or uncertainty. It is continuous, although its intensity may vary. At lower levels, it may appear as manageable ambiguity. At higher levels, tension becomes more pronounced as inputs increasingly resist integration and stable interpretive anchors diminish.

The presence of Cognitive Friction does not determine outcomes. It defines the conditions under which outcomes are formed. In some situations, it may support deeper reflection and more nuanced interpretation. In others, it may coincide with instability in meaning-making processes. These variations are not properties of Cognitive Friction itself, but of how cognition operates under such conditions.

Recognizing Cognitive Friction as a baseline condition reorients our understanding of contemporary cognition. Rather than assuming that clarity is the default and ambiguity the exception, this perspective acknowledges ambiguity, multiplicity, and interpretive tension as persistent features of modern information environments.

Cognitive Friction represents the manifestation of this condition within human cognition.

Chapter 3: Dynamics of Cognitive Friction

Cognitive Friction, as established in the previous chapter, is not a discrete event but a continuous condition. However, while its presence is constant, its intensity and structural characteristics are not. Cognitive Friction varies across situations, environments, and temporal contexts. It is therefore necessary to move from a static definition toward an understanding of its internal dynamics.

The degree of Cognitive Friction can be understood as shaped by the relationship between informational inputs and the interpretive capacity available to process them. This is not a simple matter of quantity. An increase in information does not necessarily produce greater friction, nor does a reduction guarantee clarity. Rather, friction emerges from the configuration of inputs, particularly when they are ambiguous, contradictory, or temporally misaligned in ways that resist integration.

At lower intensities, Cognitive Friction may remain within manageable bounds. Competing interpretations can coexist without destabilizing the interpretive process. Ambiguity is present, but it does not overwhelm the ability to maintain provisional coherence. In such conditions, friction may even contribute to expanded perspective, increased sensitivity to nuance, and a broader interpretive range.

As intensity increases, however, the structure of the interpretive situation begins to shift. Inputs may no longer merely coexist in tension, but can begin to interfere with one another. The possibility of integrating them into a stable frame diminishes. Interpretation becomes less a process of organizing meaning and more a continuous negotiation between incompatible representations. The individual may be required to hold multiple, partially conflicting interpretations without clear criteria for resolution.

A central feature of this shift is the emergence of unresolved Cognitive Friction. This does not refer to temporary uncertainty, but to situations in which no stable interpretive configuration is readily attainable. The system remains in a state of sustained tension. Importantly, this state is not passive. It places ongoing demands on cognitive processing, requiring continuous effort to navigate, reassess, and maintain orientation in an environment that lacks coherent structure.

Unresolved Cognitive Friction is not defined by confusion alone. The absence of resolution pathways defines it. Even highly capable individuals may encounter conditions where available information does not support a stable interpretation. In such cases, the limitation lies not in the individual but in the structure of the informational environment.

Temporal factors play a critical role in this dynamic. Information not only differs in content but also in timing. Inputs may refer to different temporal frames, outdated contexts, or projected futures, while being presented simultaneously. This temporal misalignment further complicates integration, as the individual must reconcile not only competing meanings but also competing temporal orientations. The result is a layered form of friction in which past, present, and anticipated futures intersect without clear alignment.

As Cognitive Friction persists without resolution, the interpretive system does not remain static. While the nature of this transition will be examined in subsequent chapters, it is important to note here that sustained unresolved friction alters the conditions under which interpretation operates. The demand for coherence does not disappear. It remains present, even when the environment does not provide the necessary structure to support it.

This creates a critical threshold condition. Not in the sense of a fixed boundary, but as a gradual shift in how cognition engages with the environment. The individual moves from attempting to derive coherence from available inputs to operating under conditions in which such derivation becomes increasingly unstable.

Cognitive Friction, therefore, is not only a condition but a dynamic field. Its intensity fluctuates, its structure evolves, and its persistence shapes the context in which interpretation unfolds. Understanding these dynamics is essential for examining how cognition responds when the environment no longer supports stable meaning-making processes.

Recent scholarship in digital cognition, information disorder, and complexity-informed epistemology further underscores the challenges of interpreting information in dynamic, high-volume environments (Wardle & Derakhshan, 2017; Lewandowsky et al., 2020; Bail, 2021). These perspectives reinforce the need to examine cognition not solely as an individual process, but as one shaped by structurally complex informational conditions.

Chapter 4: Cognitive Pareidolia and Synthetic Pattern Construction

As Cognitive Friction intensifies and remains unresolved, the interpretive system is not indefinitely sustained in a state of open tension. The demand for coherence does not diminish in the absence of structure. It persists. At a certain point, the relationship between available information and the need for interpretive stability becomes imbalanced. The environment no longer provides sufficient coherence to support interpretation, yet the cognitive system continues to require it.

It is within this condition that a qualitative shift may occur.

When coherence cannot be derived from the informational environment, it may instead be imposed upon it. Interpretation transitions from an attempt to organize meaning around available structure to a process in which structure is actively constructed to resolve tension. This process can be understood as a form of cognitive pareidolia.

The term pareidolia has traditionally been associated with perceptual phenomena, such as the tendency to perceive recognizable patterns in ambiguous sensory input. Faces in clouds or figures in noise are common examples. In this context, however, the concept is extended beyond perception and into higher-order cognition. Cognitive pareidolia refers to the imposition of interpretive patterns onto complex, ambiguous, or insufficiently structured information environments in order to restore coherence.

This is not a trivial misinterpretation, nor is it reducible to error or bias. It is a structural response to unresolved Cognitive Friction. The system is not failing. It is adapting under constraint.

Under sustained interpretive tension, the capacity to remain in an open, unresolved state is limited. The absence of stable meaning creates pressure within the system. Cognitive pareidolia can be understood as a compensatory mechanism that releases this pressure. Patterns are formed, connections are established, and coherence is reconstructed not because they are present in the environment, but because they are required for continued cognitive operation.

Importantly, the patterns produced through cognitive pareidolia are not arbitrary. They often draw on existing cognitive structures, prior experiences, cultural narratives, and available symbolic frameworks. What distinguishes them is not their origin, but the conditions under which they are formed. The environment does not sufficiently constrain interpretation, allowing internally generated structures to fill the gap.

This process alters the relationship between the individual and the informational environment. Interpretation is no longer primarily anchored in external coherence, but in internally stabilized patterns. The boundary between deriving meaning and assigning meaning becomes less distinct. The individual may experience a sense of clarity and resolution, even in the absence of a corresponding structure within the environment.

Cognitive pareidolia, therefore, represents a shift in how coherence is achieved. It does not eliminate Cognitive Friction, but transforms how it is managed. The tension is resolved, not by integrating competing inputs into a stable configuration, but by reducing the interpretive openness of the situation. Ambiguity is narrowed, complexity is compressed, and alternative interpretations are deprioritized or excluded.

The consequences of this shift are context-dependent. In some cases, the rapid construction of coherence may support decision-making under time or resource constraints. In other cases, it may lead to rigid interpretations that are resistant to revision, particularly when the imposed patterns are reinforced through repetition or social validation.

It is therefore necessary to maintain a distinction between the function of cognitive pareidolia and its outcomes. As a process, it is neither inherently beneficial nor detrimental. It reflects the system's capacity to stabilize itself under conditions in which the environment provides insufficient structure. Whether this stabilization supports or constrains adaptive cognition depends on the broader context in which it occurs.

Within the framework developed in this paper, cognitive pareidolia is not an isolated phenomenon. It is a natural extension of Cognitive Friction under specific conditions. It becomes visible when interpretive tension persists without resolution, and when the demand for coherence exceeds what the informational environment can supply.

Understanding this process provides a critical link between environmental complexity and cognitive response. It explains how meaning can become stabilized in the absence of sufficient external structure and how individuals navigate conditions in which interpretation cannot rely solely on what is given.

Cognitive Friction defines the condition.
Cognitive pareidolia reveals one possible trajectory.

Chapter 5: Friction in Contemporary Information Environments

Cognitive Friction does not arise in abstraction. It is inseparable from the environments in which information is produced, distributed, and encountered. To understand why Cognitive Friction constitutes a baseline condition, it is necessary to examine the structural characteristics of contemporary information environments.

These environments are increasingly characterized by simultaneity. Information is no longer encountered in discrete sequences, but as overlapping streams presented within the same temporal frame. Multiple narratives, interpretations, and representations are presented simultaneously, often without hierarchical organization or clear distinctions in credibility, relevance, or temporal origin. The individual is therefore often required to engage with a plurality of inputs that compete for interpretive priority.

This simultaneity is closely linked to the increasing role of algorithmic mediation. Information is not simply accessed; it is often curated, filtered, and continuously reorganized through systems that prioritize engagement, relevance signals, and behavioral patterns, often amplifying informational fragmentation and interpretive divergence (Pariser, 2011; Bakshy et al., 2015; Bail, 2021). Inputs are selected and presented based on criteria that do not align with the requirements of stable interpretation. As a consequence, individuals encounter information that is contextually fragmented, internally inconsistent, or temporally dislocated.

For example, in digitally mediated environments such as social media platforms, individuals are often presented with overlapping and conflicting narratives regarding the same event, each supported by selectively curated information streams. These narratives may differ in temporal framing, causal attribution, and evidentiary basis, yet are encountered simultaneously. Under such conditions, the difficulty of interpretation does not arise from individual cognitive limitation, but from the structural configuration of the informational environment itself.

Temporal fragmentation further intensifies this condition. Information originating from different points in time is presented as if it were contemporaneous. Past events, current developments, and projected futures are interwoven without explicit differentiation. This creates interpretive situations in which temporal context must be actively reconstructed, rather than passively received. The individual is required to determine not only what information means, but when it belongs.

In addition to simultaneity and temporal fragmentation, contemporary information environments are characterized by the coexistence of competing narrative structures. These narratives are not merely different perspectives on a shared reality, but often operate according to distinct internal logics. They frame events, assign causality, and define relevance in ways that may be mutually incompatible. The individual is therefore not only selecting between pieces of information, but between alternative systems of meaning.

Importantly, these characteristics do not represent a temporary deviation from a stable informational order. They reflect a structural transformation in the generation and distribution of information. The scale, speed, and interconnectivity of modern information systems ensure that ambiguity, multiplicity, and competition between meanings are persistent features rather than occasional disruptions.

Within such environments, the expectation of coherence must be reconsidered. Coherence is no longer a given property of the information landscape, but an outcome that must be actively constructed. The individual is positioned not as a passive recipient of organized knowledge, but as an active participant in assembling meaning from inputs that do not inherently align.

This shift has direct implications for the presence of Cognitive Friction. When information environments do not provide stable structures for interpretation, friction is not introduced from outside. The environment's internal configuration generates it. The multiplicity of inputs, their temporal misalignment, and their lack of hierarchical organization collectively produce conditions in which interpretive tension is unavoidable.

Cognitive Friction is therefore not an individual phenomenon that occurs within an otherwise stable environment. It is an emergent property of the interaction between cognition and structurally complex information systems. The individual does not bring friction into the environment. The environment produces conditions in which friction is inherent to the act of interpretation.

Recognizing this relationship is essential for situating Cognitive Friction within its proper context. It shifts the analytical focus from the limitations of individual cognition to the structural properties of the informational landscape. The question is no longer why individuals experience difficulty in achieving coherent interpretation, but how contemporary environments systematically generate conditions in which such difficulty is expected.

In this sense, Cognitive Friction is not only a cognitive condition, but an environmental one. It reflects the alignment, or lack thereof, between the structure of information and the requirements of interpretation. As long as information environments continue to exhibit simultaneity, fragmentation, and competing narrative structures, Cognitive Friction will remain a persistent feature of human cognition.

Chapter 6: Implications for Interpretation and Decision-Making

If Cognitive Friction is understood as a baseline condition within contemporary information environments, then interpretation and decision-making cannot be assumed to occur under conditions of inherent coherence. They take place within environments where ambiguity, multiplicity, and competing structures of meaning are persistent features. This has consequences not only for how information is processed but also for how meaning is stabilized and decisions are formed.

Interpretation, in this context, is no longer a process of uncovering coherence within a given informational structure. It becomes an activity shaped by the absence of such structure. The individual is required to navigate between competing inputs that do not converge toward a single, stable interpretation. Meaning is therefore not simply derived, but contingent upon how Cognitive Friction is engaged at a given moment.

This does not imply that interpretation becomes arbitrary. Rather, it becomes situated. The stability of any given interpretation depends on the configuration of available inputs, their temporal alignment, and the capacity to maintain engagement with unresolved tension. What appears as clarity may, in some cases, reflect the stabilization of meaning under constrained conditions rather than the presence of coherence within the environment itself.

Decision-making is similarly affected. Decisions are often assumed to result from sufficiently processed and integrated information. Within environments characterized by Cognitive Friction, this assumption is no longer tenable. Decisions may be made in contexts where integration remains incomplete, competing interpretations persist, and the informational environment does not provide a definitive basis for resolution, a condition increasingly observed in digitally mediated decision environments (Klein et al., 2010; Lewandowsky et al., 2020).

Under such conditions, the relationship between interpretation and decision shifts. Decisions do not necessarily follow from fully stabilized meaning; they may instead coincide with moments when interpretive tension is reduced to a level that allows action. This reduction does not require the elimination of ambiguity, but a temporary stabilization of meaning sufficient to support commitment.

The role of cognitive pareidolia becomes relevant in this context. As described in the previous chapter, the imposition of patterns can provide such stabilization when the environment does not supply it. In decision-making situations, this may lead to the rapid formation of coherent interpretations that enable action, even when underlying informational structures are ambiguous or incomplete.

However, not all stabilization arises through imposed patterns. It is also possible for interpretation to remain partially open, allowing decisions to be made without full closure. This introduces the notion of operating within Cognitive Friction rather than resolving it. In such cases, the individual engages with ambiguity as a persistent condition, rather than a temporary obstacle.

This capacity can be understood as a form of cognitive sustainability. It does not refer to resilience in the sense of recovering from disruption, but to the ability to maintain interpretive engagement under conditions where coherence is not readily available. Cognitive sustainability involves sustaining attention, evaluation, and orientation within an environment that does not resolve itself into a stable structure.

Within this framework, recognizing Cognitive Friction becomes analytically significant. It alters how interpretation and decision-making are understood. Rather than evaluating outcomes solely in terms of correctness or error, it becomes necessary to consider the conditions under which they were produced. The presence of unresolved tension, the absence of stable coherence, and the potential for imposed pattern construction all become relevant factors.

This does not lead to a prescriptive model of how decisions should be made. It does, however, reframe the context in which decisions are evaluated. Decisions are not made outside Cognitive Friction; they are made within it. Interpretation does not precede friction, but is shaped by it.

Understanding this relationship does not resolve Cognitive Friction, nor does it eliminate the dynamics described in previous chapters. It clarifies the conditions under which cognition operates in contemporary environments. In doing so, it opens the way for a more precise discussion of how meaning is formed, how decisions are taken, and how stability is achieved in contexts where coherence is not given.

Chapter 7: Toward a Reframed Understanding of Cognition in Complex Environments

The preceding chapters describe a shift in how contemporary cognition can be understood. Rather than operating in environments that provide stable structures for interpretation, cognition increasingly unfolds under conditions characterized by ambiguity, multiplicity, and temporal misalignment. Cognitive Friction emerges here, not as an exception, but as a baseline condition.

This shift has implications for how cognition itself is understood. Traditional assumptions position interpretation as a process oriented toward coherence, where ambiguity is treated as a temporary disruption. When Cognitive Friction is persistent, this assumption no longer holds. Coherence is not a given property of the informational landscape, but a contingent outcome. Interpretation does not begin with stability but with tension.

Recognizing this does not require redefining cognition in its entirety. It does, however, require adjusting how cognitive processes are situated. Cognition increasingly operates in environments that do not inherently support stable interpretation. The absence of coherence is not an anomaly to be corrected, but a structural feature to be acknowledged.

Cognitive Friction makes this visible. It captures the interpretive tension that arises when informational inputs resist integration and no singular structure of meaning is readily available. This tension is not reducible to individual limitations, but reflects the configuration of the environment itself.

Cognitive pareidolia clarifies how cognition may respond under sustained conditions of unresolved friction. When coherence cannot be derived, it may be constructed. This does not represent a simple departure from rationality, but a shift in how stability is achieved.

Interpretation moves from deriving meaning from external structure to imposing structure in order to restore coherence.

At the same time, the possibility of maintaining engagement without premature closure points to an alternative mode of operation. Cognitive sustainability, as described in the previous chapter, refers to the capacity to remain in interpretive tension without immediate stabilization. This does not eliminate Cognitive Friction, but allows cognition to operate without collapsing into imposed coherence.

Taken together, these elements describe a cognitive landscape in which stability, interpretation, and decision-making are contingent on conditions that differ from those assumed in simpler models of reasoning. Cognitive Friction defines the condition. Cognitive pareidolia illustrates one possible trajectory. Cognitive sustainability indicates a way of operating within it.

The purpose of this paper has not been to resolve these dynamics or propose mechanisms for their elimination. It has been to make visible a structural condition that underlies contemporary cognition. By articulating Cognitive Friction as a baseline and by examining its dynamics and implications, the paper establishes a basis for more precise discussion of interpretation and decision-making. Recognizing this condition does not provide solutions. It changes the terms of the conversation. When ambiguity, multiplicity, and interpretive tension are acknowledged as persistent features of the environment, cognition must be understood accordingly.

Cognition does not operate outside Cognitive Friction. It operates within it. This reframing establishes the conditions under which metacognitive regulation emerges, as examined in the following chapter.

Chapter 8: Metacognitive Friction

If cognitive friction describes the difficulty of forming coherent interpretations amid competing and unstable inputs, a second layer emerges when the mind reflects on its own interpretive activity. This layer can be described as metacognitive friction.

Metacognition is often presented as a corrective mechanism, a higher-order capacity that enables individuals to identify bias, reconsider assumptions, and arrive at more accurate conclusions. Within the context of cognitive friction, this characterization is insufficient. Metacognition does not operate outside the conditions that produce interpretive tension. It emerges within them, and it introduces a new form of tension rather than resolving the original one.

Under conditions of cognitive friction, the mind is exposed to multiple, partially incompatible interpretations. The pressure to reduce this tension often leads to rapid pattern completion, where coherence is established through the selection of a plausible interpretive frame. This process, closely related to cognitive pareidolia, allows for functional decision-making under uncertainty. It is not inherently erroneous. It is a structural response to informational pressure.

Metacognition enters at the point where this interpretive act becomes visible to the system itself. It is the moment at which the mind not only interprets, but also recognizes that it is interpreting. This recognition does not dissolve the tension. It reconfigures it.

Where cognitive friction creates difficulty in forming coherence, metacognitive friction creates difficulty in committing to it.

This distinction is critical. The presence of metacognition does not guarantee more accurate outcomes. Instead, it introduces a regulatory hesitation, a resistance to premature closure. The system is no longer only navigating between competing interpretations. It is also evaluating the act of choosing among them.

This introduces measurable costs.

Maintaining interpretive openness requires time. It increases cognitive load. It may delay decision-making beyond what is functionally optimal in time-sensitive environments. It may also carry social consequences, as hesitation can be interpreted as uncertainty or lack of competence in contexts that reward decisiveness.

At the same time, insufficient metacognitive engagement increases the likelihood of premature closure, where interpretations are accepted without sufficient evaluation of alternative possibilities. In such cases, the system becomes more vulnerable to distortion, manipulation, or misalignment between perception and underlying conditions.

The relationship between cognitive friction and metacognitive friction is therefore not linear. It is not a progression from problem to solution. It is a dynamic tension between two forms of constraint.

- Too little metacognitive friction leads the system to resolve ambiguity too quickly, whereas excessive metacognitive friction risks decision paralysis.

Between these poles, no stable equilibrium can be assumed. The system operates within a shifting balance, influenced by context, time pressure, prior experience, and environmental structure.

Metacognitive friction does not eliminate interpretive shortcuts. It modulates the conditions under which they are accepted, delayed, or rejected. In doing so, it reveals that the act of understanding is not only a matter of processing information, but also of regulating commitment to meaning under uncertainty.

Final Section: Cognitive Friction as an Open Condition

The concept of cognitive friction has been introduced here not as a deviation from normal cognitive functioning, but as a structural condition of contemporary information environments. The increasing density, simultaneity, and fragmentation of informational inputs make stable interpretive coherence more difficult to achieve, not because cognition has become deficient, but because the conditions under which it operates have fundamentally changed.

In this context, cognition cannot be understood as a system that reliably converges on a single, stable interpretation. Instead, it operates within a field of competing possibilities, where multiple interpretations may remain viable simultaneously, and where the process of selection is itself shaped by constraints rather than guided by clear resolution.

The introduction of metacognitive friction further complicates this picture. It shows that the regulation of interpretation does not resolve uncertainty, but redistributes it. The system is not only challenged by the difficulty of forming meaning, but also by the difficulty of deciding when meaning is sufficiently stable to act upon.

This leads to a central implication.

There is no inherent guarantee that increased reflection produces better outcomes. Nor is rapid resolution inherently inferior. Both operate as context-dependent responses to the same underlying condition. The distinction between adaptive and maladaptive responses cannot be determined in isolation from the environments in which they occur.

Cognitive friction, in this sense, is not a problem to be solved, but a condition to be understood. This reframing opens several lines of inquiry.

- Under what conditions does interpretive tension enhance rather than degrade decision-making?
- How does the capacity to sustain ambiguity vary across individuals, domains, and institutional settings?
- What role do technological systems play in amplifying or suppressing cognitive and metacognitive friction?
- To what extent can environments be structured to support productive forms of interpretive tension without overwhelming the systems that operate within them?

These questions point beyond the scope of the present analysis. They suggest that cognitive friction extends beyond individual cognition to organizational, technological, and societal domains.

Understanding this condition requires moving beyond models that assume coherence as a default state. It requires engaging with cognition as a system that operates under persistent tension, where meaning is neither given nor fully stabilized, but continuously negotiated.

Future research should explore empirical approaches to operationalizing Cognitive Friction across a range of contexts. This may include observational studies examining interpretive behavior in digitally mediated environments, experimental designs testing decision-making under conditions of structured ambiguity, and computational modeling of information environments characterized by fragmentation and simultaneity. Additionally, cross-domain studies may examine how Cognitive Friction manifests differently across sectors such as cybersecurity, emergency management, and organizational decision-making. Such approaches would enable the measurement, comparison, and validation of Cognitive Friction as a structural condition that influences cognition in complex environments.

In doing so, this study contributes a foundational conceptual framework for examining cognition under conditions of structural informational complexity, with implications for research across cognitive science, organizational systems, and digitally mediated environments.

Authorship Statement

The Quantum-Cognitive Maturity Model (QCM²) originated from an initial conceptual 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 concept and participated in the framework's continued development.

Both authors contributed to the refinement, interpretation, and presentation of the model 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. No external funding, sponsorship, or commercial support was received for this study. All interpretations, conclusions, and scholarly contributions reflect the authors' independent academic judgment and professional expertise.

Originality Statement

This manuscript represents original scholarly work produced collaboratively by the authors. The conceptual frameworks, 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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