

Remainder Processing in the Brain:

The Unconscious Preparation for Phase Change

CF Dietz

Nubellum Research Inc.

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Abstract

The CC-C framework defines remainder (R) as the structured content that any finite closure generates at its boundary: not noise, but the specific content the current closure cannot absorb. This paper proposes that remainder, in the human brain, does not simply accumulate at the boundary of conscious processing and wait. It is actively processed by neural systems operating below the level of access consciousness, and it surfaces as recommendations to higher-order systems in the form of intuition, felt sense, and creative insight. The paper identifies a five-step structural workflow implemented in biological hardware: mismatch detection in the hippocampus, offline accumulation during default mode network activity, intercommunication among specialized DMN hubs, candidate reorganization assembled below conscious awareness, and recommendation to conscious awareness through the insula and prefrontal cortex. This account extends the three-signature temporal model developed in Meaning as Phase Change (Dietz, 2026b) by proposing a signature zero: the extended offline processing period during which the unconscious neural machinery assembles the candidate that global ignition registers in conscious awareness. Four clusters of falsifiable predictions are developed, each grounded in existing neuroscience literature.

1. Introduction: Remainder Is Not Passive

The CC-C framework defines remainder (R) as the structured mismatch between what any finite closure constitutes and what it opens onto (Dietz, 2026a). Remainder is not noise. It is not the absence of content. It is the specific content that the closure's current identity criteria and admissible transformations cannot absorb. The shape of remainder reflects the shape of the closure that generated it: what falls outside a visual perceptual closure differs from what falls outside a narrative self-closure, which differs from what falls outside a scientific theoretical closure. Remainder is always informationally specific to the closure that produced it.

This specificity is what makes remainder productive rather than merely residual. Because remainder carries precise information about how the current closure is inadequate and in what direction a better closure would need to reach, it is the primary driver of what the Meaning as Phase Change paper formalizes as saddle-node bifurcation: the accumulation of remainder beyond what the current attractor basin can absorb, leading to discontinuous reorganization into a new closure grammar (Dietz, 2026b).

This paper develops a claim that is implicit in the CC-C framework but has not previously been made explicit: remainder does not wait for conscious attention. It is actively processed by neural systems operating below the level of access consciousness, and it surfaces as recommendations to conscious awareness when a candidate reorganization has been assembled. The insight that arrives feeling like it came from nowhere did not come from nowhere. It was assembled in the dark, by biological hardware running a structured workflow that the conscious mind did not direct.

1.1 Two Kinds of Consciousness: A Necessary Clarification

Ned Block's distinction between phenomenal consciousness and access consciousness is essential to the argument developed here and must be stated precisely at the outset (Block, 1995). Phenomenal consciousness, P-consciousness, is what it is like to be in a given mental state: the qualitative, felt character of experience. Access consciousness, A-consciousness, is the availability of a mental state for use in reasoning, verbal report, and the deliberate control of action and speech. The two are dissociable: a person can be phenomenally aware of something, can have it as part of their experiential field, without that content being available for explicit reasoning or report.

In CC-C terms, phenomenal consciousness corresponds to C: the irreducible presence in which any experience occurs. Access consciousness corresponds to the availability of content within c, the localized consciousness with content, for explicit processing by the interpreter system and verbal report. The unconscious processing described in this paper is non-attentional: it operates below the level of access consciousness, below the threshold at which content is available for deliberate reasoning and explicit report. It is an open empirical question whether the offline processing described here is also below the threshold of phenomenal experience. The CC-C framework does not require that it is. What it requires is only that the relevant neural processing occurs without executive direction and without the content being available for deliberate rational engagement. That is what below the level of access consciousness means in this paper.

This clarification matters because the claim that remainder is processed in the unconscious could otherwise be read as asserting that the relevant processing is entirely non-phenomenal, which is a much stronger and more contentious claim. The present

paper makes no such assertion. The offline processing described here is non-attentional, not necessarily non-phenomenal, and the distinction is significant.

1.2 Structural Claim and Its Scope

The account developed here is structural rather than merely analogical in the following specific sense. The five-step workflow described in this paper is implemented in identifiable neural hardware with measurable signatures. The hippocampus, the default mode network, the insula, and the prefrontal-basal ganglia system are not metaphors for the workflow. They are the workflow, running in biological tissue. This distinguishes the present account from cross-domain analogies, which identify formal similarities without specifying the implementing mechanisms.

A clarification of CI in neurobiological terms is required before the workflow is described. In the CC-C framework, a closure is a finite organized system that draws distinctions, constitutes stable facts, and maintains lawful relationships among its elements. In the language of dynamical systems theory, a closure corresponds to a stable attractor state in a recurrent neural circuit: a configuration of neural activity the system returns to after small perturbations, maintained by recurrent excitation above a threshold level and resisting displacement by inputs that fall below that threshold. The physical instantiation of a closure in biological hardware is a specific distribution of synaptic weights across a recurrent network. Following Hebb's principle that neurons which fire together wire together (Hebb, 1949), co-active neurons strengthen their connections through long-term potentiation, biasing the network toward configurations of activity that have previously been stable. Hopfield (1982) formalized this insight mathematically: patterns stored in a recurrent network through Hebbian weight modification become attractor states, energy minima in the network's state space toward which the system's dynamics converge from nearby initial conditions. In this formalism, the current episodic self-model is not a static memory trace. It is a specific distribution of synaptic weights that biases the network toward a stable pattern of activity, resisting revision by inputs whose accumulated force falls below the energy gradient required to escape the current basin of attraction. Remainder, in these terms, is the accumulated mismatch between what the current attractor state predicts and what incoming experience delivers. Phase change is the bifurcation event in which the accumulated mismatch generates sufficient input force to drive the network out of the current basin of attraction and into a new one. This mapping of CC-C terms onto dynamical systems and connectionist concepts is not a simplification. It is a precise correspondence that grounds the philosophical framework in the biological mechanism. A concrete image may help: picture the current closure as a ball resting in a shallow valley on a neural energy landscape. The depth and steepness of the valley walls reflect the strength of the synaptic weight distribution encoding the current attractor state. Remainder accumulation is the gradual tilting of the landscape as incoming experience

repeatedly fails to match the current attractor's predictions. When the tilt exceeds the height of the valley walls, the ball rolls out of the current basin and into a new, deeper, more complex basin that constitutes the new closure. That transition, ball escaping current basin and settling into new basin, is phase change. The valley the ball lands in is $Cl_{sub\ n\ plus\ one}$. What made the landscape tilt is R .

2. The Five-Step Workflow in Biological Hardware

Before examining each neural component, the five-step workflow is stated explicitly. The subsequent sections trace each step through its neural implementation.

Step one: mismatch detection. The brain's current closure constitutes a predictive model of the world, the self, and the relationship between them. When incoming experience violates that model in a way the current closure cannot absorb, a mismatch is detected. This is not a general anomaly signal. It is a specific signal that the episodic closure, the autobiographical self's constituted account of what the world has been and is expected to be, has encountered R .

Step two: offline accumulation. The mismatch is not immediately resolved by conscious executive processing. Instead, the unresolved content enters a processing regime that operates during periods of reduced external task engagement, below the threshold of directed access-conscious attention. The content accumulates and is worked on during these periods.

Step three: intercommunication among specialized processing components. The offline processing is distributed across multiple neural systems, each specialized for different aspects of the unresolved content. These systems communicate with each other, and the intercommunication follows the structure of what is being processed.

Step four: candidate reorganization. Through the intercommunication, the neural system arrives at a candidate new closure: a reorganization of the current grammar that would absorb what the current grammar cannot. The candidate exists as a prepared reorganization below the threshold of conscious articulation.

Step five: recommendation to conscious awareness. The candidate reorganization is surfaced to conscious awareness through the insula and the prefrontal-basal ganglia system. It arrives as a felt sense, an intuition, or an insight. The system either propagates the recommendation into explicit representation, producing the phase change described in Meaning as Phase Change, or routes the content back for further offline processing.

Table 1. The Five-Step Workflow: Neural Implementation and Measurable Signatures

Step	Neural System	Function in Workflow	Measurable Signature
0	Default Mode Network (offline)	Offline accumulation and stochastic competitive assembly of candidate reorganization	Awake hippocampal-cortical reactivation; sharp wave ripples; elevated DMN connectivity during post-encoding rest (Tambini & Davachi, 2019)
1	Hippocampus CA1 / Locus Coeruleus	Mismatch detection between incoming experience and current episodic closure; noradrenergic destabilization of memory traces	CA1 mismatch signal; LC norepinephrine release; prediction error correlated hippocampal activation (Sinclair et al., 2025)
2	Insula / Salience Network	Trafficking candidate reorganization to conscious awareness as felt sense when theta-gamma coupling reaches threshold	Insula activation; theta-gamma phase-amplitude coupling strength crossing threshold; salience network switch (Menon & Uddin, 2010; Canolty & Knight, 2010)
3	Prefrontal Cortex / Basal Ganglia	Bifurcation of PFC attractor dynamics triggered by accumulated input crossing threshold; global ignition across workspace	Right anterior temporal gamma burst (40Hz); global neuronal workspace ignition; saddle-node bifurcation of PFC attractor (Jung-Beeman et al., 2004; Wang, 2002)
4	Hippocampus / Cortex (autonoetic)	Autonoetic integration: encoding the new closure as a before and after in the temporal self	Extended bilateral hippocampal-cortical reactivation during post-encoding rest; episodic encoding of reorganization event (Tambini et al., 2020)

Signature numbering: 0 = offline preparation (novel to this paper); 1-3 = the temporal signatures described in Meaning as Phase Change (Dietz, 2026b). Step numbers in the table correspond to the workflow steps in section 2.

3. Step One: The Hippocampus as Mismatch Detector

The hippocampus is the brain's primary system for detecting when incoming experience diverges from what the current closure predicts. Functional MRI studies have established that hippocampal activation increases when incoming experience violates predictions derived from stored episodic memories. This response, termed mismatch detection or mnemonic prediction error, has been demonstrated across paradigms involving narrative violations, object-location mismatches, and associative prediction failures (Kumaran and Maguire, 2006; Duncan et al., 2012; Bein et al., 2020).

The hippocampus is selective about what constitutes a mismatch. Recent work published in PNAS has established that the hippocampus signals mismatches with episodic memories of specific experienced events but not with generalized schematic knowledge. Mismatches with schematic knowledge activate the Semantic Control Network and Multiple Demand Network along with subcortical prediction error regions. Episodic mismatches, by contrast, engage both the hippocampus and the Default Mode

Network (Sinclair et al., 2025). The hippocampus is therefore specialized for detecting when specific experienced events diverge from the episodic memory traces that constitute the current self-narrative, which is precisely the level of the closure the CC-C framework identifies as the primary site of R accumulation in the self-system. A precision note is required here: the hippocampus signals the prediction error; the remainder itself is the un-integrated cortical content that the signal flags as requiring processing. The hippocampus is the detector, not the generator, of R. A precision note is required here: the hippocampus signals the prediction error; the remainder itself is the un-integrated cortical content that the signal flags as requiring processing. The hippocampus is the detector, not the generator, of R.

Specifically, area CA1 of the hippocampus serves as a comparator, representing both what was predicted and what actually occurred, and generating a signal proportional to the mismatch between them (Duncan et al., 2012). When prediction error is detected, the hippocampus does not immediately resolve the mismatch. Instead, it destabilizes the relevant memory traces, making them malleable and available for updating. The mechanism involves cholinergic and noradrenergic modulation: hippocampal prediction error signals are transmitted to the locus coeruleus (LC), which releases norepinephrine into hippocampal circuits, facilitating encoding of new information following large prediction errors and reconsolidation of existing memories following smaller ones (Lisman and Grace, 2005; Sara, 2009).

When prediction errors are large, the hippocampus abandons ongoing predictions and makes memories malleable for new encoding. When prediction errors are small, the hippocampus facilitates reconsolidation of existing memories with minor updates. In CC-C terms, large prediction errors move the current closure toward the saddle-node bifurcation threshold. Small prediction errors represent Bayesian updating within the existing closure without grammar-level reorganization, corresponding to the distinction between phase change one and genuine phase change drawn in Meaning as Phase Change (Dietz, 2026b; Sinclair and Barensse, 2019).

Step one is complete. The mismatch has been detected at CA1. The relevant memory traces have been destabilized through LC-mediated noradrenergic modulation. The remainder has been flagged and the neural system is prepared for offline processing.

4. Steps Two and Three: The Default Mode Network as Offline Processor

4.1 The DMN Architecture

The default mode network is a set of brain regions that activate together during periods of reduced external task engagement and deactivate during focused external attention (Raichle et al., 2001; Greicius et al., 2003). Its core hubs include the medial prefrontal

cortex (mPFC), the posterior cingulate cortex (PCC), the angular gyrus (AG), the hippocampus, and the temporal poles. These regions are interconnected through large white matter tracts and show the highest overlap between structural connectivity and functional correlation of any large-scale brain network (Menon, 2023). Directionality analysis through dynamic causal modeling has confirmed consistent flow from the medial prefrontal cortex toward the posterior cingulate cortex as a dominant direction within the DMN, though full characterization of directional connectivity remains an active area of research (Greicius et al., 2003; Menon, 2023).

The DMN is involved in introspection, autobiographical memory, mental prospection, social cognition, and self-referential processing (Raichle, 2015; Buckner et al., 2008). It is the network that activates when the brain is working on internally directed content rather than externally directed tasks. Its discovery by Raichle and colleagues fundamentally changed the understanding of the resting brain: the brain at rest is not idle. It is doing something different and, from the perspective of the present account, something essential.

4.2 Offline Accumulation: Step Two

When the hippocampus has flagged a mismatch, the DMN activates during subsequent periods of reduced external task engagement to process the unresolved content. This is step two: offline accumulation. The content is held in an unresolved state and processed during periods when external task demands release neural resources for internally directed processing. This is the incubation effect, well documented in the creativity literature: stepping away from a problem and allowing mind-wandering produces measurable improvements in subsequent insight (Dijksterhuis and Meurs, 2006; Baird et al., 2012).

The reason incubation benefits are associated with low-demand activities such as walking, showering, or quiet rest rather than with continued focused engagement is mechanistically precise: the DMN is suppressed during externally focused task performance and activated during task-free states. Step two and step three require the release of that suppression. The shower is not accidental. It is the condition under which the gating on DMN processing is removed and the offline assembly of candidate reorganizations can proceed without interference from top-down executive constraint.

During high external task demand, the central executive network is dominant and the DMN is suppressed through mutual inhibition between the two networks. Candidate reorganizations that have not yet reached the insula threshold are held in the offline processing regime and cannot surface. This mutual inhibition is precisely why insights do not arrive during focused analytical work: the system that would surface them is suppressed by the system that is running the foreground task. When external demand drops, the inhibition releases, the DMN activates, and the offline processing regime

resumes. This is the mechanistic account of why low-demand activities such as walking, showering, and quiet rest facilitate insight. They are not incidental. They are the conditions of release.

The evidence for this comes from multiple converging lines. Post-encoding fMRI studies demonstrate that hippocampal reactivation of stimulus-specific patterns during post-encoding rest correlates with subsequent episodic memory performance: the patterns of neural activity that encoded an experience are replayed during rest, and the degree of replay predicts integration and retention (Tambini and Davachi, 2019). Causal evidence comes from combined TMS-fMRI studies demonstrating that disrupting hippocampal-cortical interactions in the post-encoding window selectively impairs associative memory retention (Tambini et al., 2020).

Sharp wave ripples in the hippocampus, brief high-frequency oscillatory events occurring during quiet rest and slow-wave sleep, are the likely mechanism of this offline reactivation. During sharp wave ripple events, sequences of hippocampal neural activity that occurred during prior experience are replayed at compressed timescales, facilitating transfer of information from hippocampal short-term storage to cortical long-term storage (Buzsaki, 2015; Foster, 2017). Critically, this replay is not random: it is biased toward experiences that generated prediction errors, toward events that the current closure could not absorb without updating (Roux et al., 2017).

4.3 Intercommunication: Step Three

The offline processing is not performed by the hippocampus alone. The DMN hubs communicate with each other during offline periods, and the pattern of that communication follows the structure of what is being processed. This is step three: intercommunication among specialized processing components, structured by the content of the remainder.

The medial prefrontal cortex handles self-referential processing: it integrates unresolved content with the current self-model, asking how the mismatch relates to identity and values. The posterior cingulate cortex handles autobiographical integration, placing the unresolved content within the narrative arc of the self across time. The angular gyrus handles semantic integration, asking what the unresolved content means in terms of existing conceptual structures. The hippocampus supplies episodic raw material from prior related experiences. The temporal poles handle emotional and social meaning, processing what the unresolved content feels like and how it relates to significant others (Buckner et al., 2008; Andrews-Hanna et al., 2010).

This routing is content-sensitive. Social remainder recruits temporal poles and mPFC more heavily. Perceptual-spatial remainder recruits posterior regions. Self-referential remainder recruits mPFC and PCC. The DMN is not a single undifferentiated processor.

It is a routing system that distributes unresolved content to the components best positioned to work on each aspect of it. This intercommunication is step three, and its structure is what makes the prediction in section 10 about DMN connectivity and insight domain empirically testable. An interpretive clarification is required: the neuroscience literature characterizes DMN activity during offline states as spontaneous thought and memory consolidation, not as directed assembly of a candidate solution. The claim that this spontaneous activity constitutes the assembly of a candidate closure reorganization is the theoretical contribution of this paper. It is a plausible and testable inference from the existing data, not an established finding.

A more precise characterization of the assembly process is needed to satisfy neurobiological scrutiny. The DMN does not purposefully build a solution. It runs a stochastic competitive search across the space of available memory traces. Multiple candidate reorganizations are spontaneously reactivated across DMN hubs during offline periods. These candidates compete through mutual inhibition and resonance dynamics: candidates whose activation patterns are more coherent across the network, those that better reduce the accumulated mismatch encoded in the hippocampal prediction error signal, gain activation strength at the expense of less coherent competitors. This is the neural implementation of Changeux's theory of selective stabilization of pre-representations (Changeux, 1985): the interaction with stored patterns does not enrich the candidate space but selects among pre-existing attractor configurations, enlarging the basin of the most coherent candidate at the expense of competing basins. The candidate that ultimately reaches the insula threshold is not the one the DMN chose. It is the one that won the competition. Assembly, in this paper, always means competitive selection, not purposeful construction.

5. Step Four: Candidate Reorganization Below Conscious Awareness

Through the intercommunication of DMN hubs, the neural system assembles a candidate reorganization: a new closure configuration that would absorb what the current closure cannot. This is step four, and it is the step most invisible to conscious inspection.

The candidate reorganization is not yet an explicit thought. It is a prepared state of the neural system, a configuration of activation and connectivity that represents a potential new grammar without yet being constituted as an articulated insight. The evidence for the existence of this prepared state comes from the structure of the Aha moment. Jung-Beeman et al. (2004) identified the neural signature of insight using combined fMRI and EEG: a burst of high-frequency gamma oscillations in the right anterior temporal lobe, accompanied by a sudden increase in neural activity that precedes the verbal report of insight by approximately 300 milliseconds. Crucially, this signature is

preceded by a period of reduced visual cortex activity in the one to two seconds before the burst, suggesting that the brain actively suppresses incoming visual information immediately before insight, clearing perceptual processing resources for the incoming reorganization.

On the causation question: the gamma burst is the result of the phase change, not its cause. The work was done in the dark. The burst is the light coming on. This interpretation is supported by the temporal structure of the Jung-Beeman et al. (2004) data: the neural preparation for insight, including the visual suppression period, precedes the burst, and the burst precedes the verbal report. The sequence is preparation, then transition, then report. The burst marks the moment at which the candidate reorganization, assembled through prior offline processing, crosses the threshold into access-conscious awareness.

In CC-C terms, this is the extended three-signature model of Meaning as Phase Change traced backward. Signature one, the saddle-node event at milliseconds, corresponds to the gamma burst and the propagation of the reorganization into access-conscious representation. Signature two, narrative consolidation at seconds, corresponds to the interpreter's initial account of the reorganization. Signature three, autonoetic integration at variable post-encoding duration, corresponds to the hippocampal-cortical reactivation that consolidates the new closure as a before and an after in the temporal self. What the present paper adds is signature zero: the extended offline processing period, ranging from minutes to years, during which the DMN assembled the candidate that signature one registered through global ignition.

6. Step Five: Recommendation and Global Ignition

6.1 The Insula as Carrier

The insula is the primary cortical region for interoceptive awareness: it continuously maps the body's internal state and traffics those signals into conscious awareness (Craig, 2009). Together with the anterior cingulate cortex, the insula forms the salience network, which serves as the critical switching mechanism between the DMN and the central executive network (Menon and Uddin, 2010). When the insula detects a salient internal signal, specifically a candidate reorganization that has accumulated sufficient signal strength in the offline processing regime, it triggers a switch: DMN processing is attenuated and the central executive network is engaged, allowing the candidate to cross into access-conscious awareness. The felt sense of unease before one knows why one is uneasy, the somatic marker that a decision is correct before the reasoning is complete, the intuition that something important has changed: these are all the insula carrying the results of non-attentional remainder processing into the edge of access-conscious awareness as pre-linguistic felt content (Damasio, 1994). The insula is not merely a

passive carrier. It is the gate between offline and online processing, and its sensitivity to candidate reorganization signals determines when step four transitions to step five.

In CC-C terms, the insula carries the candidate reorganization upward as a felt quality before it arrives as an articulated thought. The candidate is not yet explicit. It arrives as a direction, a pull, a readiness, an urgency whose specific content has not yet been constituted in propositional form. This is why genuine insights so often arrive with a felt sense of recognition that precedes their articulation: the felt sense is the insula trafficking the assembled candidate. The articulation follows.

The mechanism by which the insula tips the salience network is specifiable in oscillatory terms. Cross-frequency coupling, specifically the phase-amplitude coupling between theta and gamma oscillations, is the leading candidate for how a candidate reorganization achieves the signal strength required to trigger the switch from DMN to central executive network engagement. Canolty and Knight (2010) established that phase-amplitude coupling between low-frequency theta rhythms and high-frequency gamma oscillations serves as a mechanism to transfer information from large-scale brain networks operating at behavioral timescales to fast local cortical processing. The strength of this coupling differs across brain areas in a task-relevant manner and changes rapidly in response to cognitive events. Lisman and Jensen (2013) proposed that the theta-gamma code organizes multiple memory items within a single theta cycle, with each gamma subcycle representing a distinct item. In the context of the present account, when a candidate reorganization assembled by the DMN achieves sufficient coherence across the network, it generates a theta-gamma coupling event in which the gamma amplitude representing the candidate becomes modulated by the theta phase of the hippocampal-cortical reactivation. This coupling event is what the insula detects as a salient internal signal worth surfacing. The threshold for insula-triggered salience network switching is a threshold of cross-frequency coupling strength, not an arbitrary cutoff. This makes the insula mechanism specifiable: measure theta-gamma phase-amplitude coupling strength in the hippocampal-insula-prefrontal circuit during the transition from incubation to insight, and you are measuring the mechanism by which step four becomes step five.

6.2 The Prefrontal-Basal Ganglia System and Global Ignition

The mechanism by which the prefrontal cortex participates in global ignition must be described without invoking the homunculus problem: if the PFC ratifies a recommendation, what ratifies the PFC? The answer is that ratification is the wrong frame entirely. The PFC does not ratify. It bifurcates. The answer must be mechanistic, not inferential.

The mechanistic account comes from computational neuroscience. O'Reilly and Frank (2006) developed a model in which the prefrontal cortex and basal ganglia form a dynamic gating system: the basal ganglia provide Go versus NoGo modulation of prefrontal working memory representations through dopaminergic signaling, without invoking any homunculus. When the basal ganglia fire Go through the direct pathway, they disinhibit the thalamus, which in turn activates prefrontal representations, allowing new content to enter working memory and become available for access-conscious processing. When the indirect pathway dominates, prefrontal representations are protected from updating. This is a threshold mechanism, not a decision by an internal viewer.

Mathematically, the relevant transition is a bifurcation in the recurrent neural circuit dynamics of the prefrontal cortex. Wang (2002) demonstrated that attractor dynamics in PFC microcircuits produce categorical choices through bifurcation: when recurrent excitation exceeds a threshold level, the system undergoes a sudden transition between stable states. This is structurally identical to the saddle-node bifurcation described in *Meaning as Phase Change*. The PFC does not decide. It bifurcates. The bifurcation is triggered by the accumulated input from the DMN offline processing, carried through the insula and the basal ganglia Go pathway, when the input crosses the threshold required to flip the PFC attractor from the current state to the candidate reorganization state. In the language of Dehaene and Changeux (2011), this moment is global ignition: a sudden, self-amplifying propagation of the candidate representation across the global neuronal workspace, making it simultaneously available to multiple specialized processors. The CC-C term for this event is phase change. The global workspace term is ignition. The dynamical systems term is bifurcation. These are three descriptions of the same event at different levels of analysis.

In CC-C terms, the bifurcation of the PFC attractor is the moment at which the candidate reorganization crosses from non-attentional processing into access-conscious representation. No homunculus is required. The PFC is not an executive that chooses. It is a bistable dynamical system whose state is modulated by accumulated input from the offline processing regime. When the input crosses threshold, the state changes. That is step five.

When the bifurcation does not occur, when the accumulated input falls short of threshold, the content is routed back through the indirect pathway NoGo modulation for further offline processing. This is not suppression in the sense of a deliberate decision to block the candidate. It is the system's natural dynamics: insufficient input to cross the bifurcation threshold results in maintenance of the current attractor state and continued offline processing of the candidate. Any remaining reference in this paper to acceptance or gating of a candidate should be understood in this mechanistic sense: a network state

shift triggered by threshold crossing, a global ignition event, not a choice made by any internal decision-maker.

6.3 Dreams, Psychedelics, and Reduced Gating

Dreams represent the state in which PFC gating is reduced and the candidates assembled by prior DMN processing are allowed to reorganize conscious experience without the threshold constraint of the basal ganglia Go/NoGo system. The prefrontal deactivation characteristic of REM sleep reduces the threshold for attractor transitions in PFC circuits, allowing candidate reorganizations that fall short of the waking threshold to propagate into conscious representation. This is why dreams can feel like genuine insight: they are genuine candidates, assembled by prior offline processing, that reach access consciousness because the gating threshold has been lowered (Hobson et al., 2000; Stickgold, 2005; Walker, 2017).

Psychedelic substances produce a related state through a different mechanism: disruption of the normal hierarchical predictive processing structure, leading to increased bottom-up signaling and reduced top-down constraint. The clinical literature on psychedelic-assisted therapy documents durable phase changes in patients who have experienced years of therapeutic impasse, consistent with the prediction that reducing gating allows previously assembled candidates to reach access consciousness and be integrated (Carhart-Harris et al., 2016; Davis et al., 2021).

7. Signature Zero: Extending the Phase Change Model

The account developed in this paper extends the three-signature temporal model of Meaning as Phase Change in a specific direction. That paper identifies three signatures that distinguish genuine phase change from confabulation and from C-absent model updating: the saddle-node event at milliseconds, narrative consolidation at seconds, and auto-noetic integration at variable post-encoding duration (Dietz, 2026b).

The present paper proposes signature zero: the extended offline processing period during which the DMN assembles the candidate reorganization. Signature zero is not directly observable in the moment of insight. It is the preparation that makes the insight possible. Its duration ranges from minutes of post-encoding DMN rest to years of non-attentional processing of deeply held self-model mismatches. The strongest direct evidence for signature zero is Tambini and Davachi (2019), who demonstrated that awake post-encoding reactivation of stimulus-specific hippocampal-cortical patterns predicts subsequent memory integration. This awake reactivation is not an occasional event. It is a continuous process that runs during all offline periods, including quiet wakefulness, not only during sleep. Step three is continuous, not episodic. Every transition from external task engagement to internal processing is an opportunity for

the DMN to advance the assembly of a candidate reorganization from whatever remainder the current closure has accumulated.

The four signatures in sequence are therefore: signature zero, the offline accumulation and candidate assembly by the DMN, ranging from minutes to years; signature one, the saddle-node bifurcation of the PFC attractor triggered by the candidate crossing threshold, at milliseconds; signature two, the interpreter's narrative consolidation of the reorganization, at seconds; and signature three, the autonoetic integration that encodes the reorganization as a before and an after in the temporal self, at variable post-encoding duration grounded in Tambini and Davachi (2019) and Tambini et al. (2020).

The clinical and therapeutic implications are specific. Interventions that facilitate signature zero, that provide adequate post-encoding rest, reduce chronic gating suppression of emerging candidates, and cultivate the metacognitive capacity to allow prepared candidates to surface rather than reflexively defending the current closure, should produce more frequent and more durable phase changes than interventions that focus exclusively on the moment of insight or the immediate post-insight consolidation period. The incubation period is not wasted time. It is where the work happens.

8. The Working Memory Paradox Resolved

A genuine tension exists in the literature that prediction three must address: some research finds that working memory capacity benefits creativity through persistence, while other research finds that lower executive control and more frequent mind-wandering facilitate creative incubation. This apparent contradiction requires explicit resolution because both claims have empirical support.

The literature is genuinely mixed. De Dreu et al. (2012) found that working memory capacity benefits creativity through persistence, allowing systematic and focused combination of elements during engaged problem-solving phases. Baird et al. (2012) found that incubation periods during which participants engaged in a low-demand task that allowed mind-wandering produced better subsequent creative performance than high-demand incubation or rest. Smeekens and Kane (2016), however, found no evidence that working memory capacity or mind-wandering propensity predicted post-incubation divergent thinking performance across three experiments.

The reconciliation, proposed here as a theoretical contribution and not yet directly tested, is that working memory capacity and executive control have different effects at different stages of the workflow. During the engagement phase, when the brain is actively constituting a new closure and testing candidate elements against existing structure, higher working memory capacity is beneficial: it supports the persistent, systematic combination of elements that De Dreu et al. (2012) identified. During the incubation phase, lower executive control and more frequent mind-wandering are

beneficial: they allow the DMN offline processing to proceed without interference from top-down attentional constraints. The Cambridge Handbook of Creativity meta-analysis confirms this stage-specificity: creativity benefits variably from high or reduced cognitive control depending on the stage of the creative process and the type of task (Benedek and Jauk, 2019).

In CC-C terms, the engagement phase is when the closure is actively generating R through focused attempts at constitution. The incubation phase is when the DMN processes that R through offline intercommunication. Higher working memory capacity helps during engagement because it prevents premature closure on locally available but globally inadequate solutions, holding the remainder in an unresolved state rather than accepting the nearest available patch. Lower executive control helps during incubation because it reduces the top-down constraint that would otherwise interrupt the DMN's non-attentional processing. These are not contradictory claims about the same thing. They are claims about different stages of the same workflow. The CC-C account explicitly favors controlled processing during the engagement phase and spontaneous, unstructured processing during the incubation phase. These are not competing values. They are sequential requirements of the same workflow: control to accumulate R faithfully, spontaneity to process it effectively. Prediction three in this paper is therefore reframed: the relevant prediction is not that higher working memory capacity produces longer incubation overall, but that it produces more faithful engagement phases and more complete R accumulation before the incubation phase begins, resulting in richer candidate reorganizations when the incubation phase completes.

9. Rumination as Stalled Remainder Processing

The account of rumination requires careful specification to avoid overgeneralization. The present section develops the claim more carefully and with appropriate epistemic modesty, framing it as a theoretical proposal requiring empirical development rather than an established account.

Rumination, defined as repetitive negative self-focused thought that persists without leading to problem resolution, is a transdiagnostic feature of depression, anxiety, and related conditions (Nolen-Hoeksema et al., 2008). It is associated with elevated DMN activity, specifically in the mPFC and PCC, and with reduced ability to disengage from self-referential processing when external tasks demand attention (Hamilton et al., 2011; Sheline et al., 2009).

The CC-C account of rumination as a distinct theoretical proposal: rumination may represent remainder that has entered the DMN offline processing regime but cannot complete step four because the candidate reorganization that would resolve it requires a reorganization of the self-Cl that the PFC gating system is chronically suppressing. The

DMN identifies the mismatch, begins offline processing, and assembles partial candidates. But the candidates require a revision of the self-model that the current self-CI resists. The gating system repeatedly routes the candidates back for further processing. The result is repeated cycling through the early steps of the workflow without reaching the bifurcation threshold at step five.

This account predicts specific neural signatures that distinguish productive incubation from rumination: productive incubation should show DMN activation that decreases as the candidate reorganization approaches threshold, followed by a clean bifurcation event and PFC activation consistent with the new attractor state. Rumination should show sustained DMN activation without the characteristic pre-insight suppression of visual cortex identified by Jung-Beeman et al. (2004), and without the clean bifurcation event. Therapeutic interventions that are effective for rumination, including certain forms of behavioral activation, metacognitive therapy, and psychedelic-assisted therapy, may work in part by reducing the gating resistance that prevents candidate reorganizations from reaching threshold.

The CC-C interpretation proposes that this hyperconnectivity reflects a specific structural condition best understood in energy landscape terms: a state-lock. The current self-CI basin has deepened through chronic defensive maintenance, such that the accumulated R energy from the candidate reorganization is insufficient to surmount the basin walls. The problem is not a lack of remainder. High-energy rumination involves ample R. The candidate has assembled, the insula is surfacing it, the cross-frequency coupling signal is present. What prevents crossing is the depth of the current basin: the defensive CI has steepened its own walls against exactly this reorganization, and each suppression event deepens the basin further. Therapeutic interventions effective for rumination may work by flattening basin walls rather than strengthening the candidate push, reducing the metabolic cost of defending the current self-CI so that ordinary remainder accumulation can reach the bifurcation threshold. This is a philosophically motivated re-reading of the biological data, not a neuroscientific claim about depression per se. The specific biomarker that would confirm or disconfirm this account is stated in prediction five: intact insula activation and theta-gamma coupling consistent with a candidate being surfaced, followed by absent or attenuated right anterior temporal gamma burst consistent with failure to cross the bifurcation threshold. Prediction five is the experimental test of the rumination account.

10. Falsifiable Predictions

10.1 Prediction One: DMN Connectivity Predicts Insight Domain

If the DMN processes remainder according to its content structure, then the pattern of functional connectivity within the DMN during post-encoding rest should predict the

domain of subsequent insight. Participants who encounter a social mismatch should show elevated temporal pole and mPFC connectivity during subsequent rest. Participants who encounter a self-referential mismatch should show elevated mPFC and PCC connectivity. Participants who encounter a semantic mismatch should show elevated angular gyrus connectivity.

This prediction is testable with fMRI functional connectivity analysis, potentially using representational similarity analysis (RSA) to characterize content-specific reactivation during incubation periods. RSA would allow researchers to decode the content structure of DMN processing during rest and compare it to the content structure of the prior unresolved mismatch, providing a more direct test of content-sensitive routing than simple functional connectivity analysis. The prediction would be disconfirmed by uniform DMN connectivity across mismatch types, or by connectivity patterns that do not correspond to the content structure of the unresolved material.

10.2 Prediction Two: Pre-Insight DMN Elevation Precedes Gamma Burst

If phase change is the conscious registration of a reorganization already assembled by offline processing, then the gamma burst signature identified by Jung-Beeman et al. (2004) should be reliably preceded by a period of elevated DMN activity in the minutes or hours before the insight occurs. The preparation precedes the event. The insight arrives after the work is done.

This prediction requires combined EEG and fMRI across incubation periods of varying length. The EEG provides the temporal resolution to detect the gamma burst with millisecond precision. The fMRI provides the spatial resolution to characterize DMN activity during the preceding incubation period. The prediction would be disconfirmed by gamma bursts that appear without prior DMN elevation, suggesting that insight is generated at the moment of conscious processing rather than being propagated from prior non-attentional preparation.

10.3 Prediction Three: Stage-Specific Effects of Executive Control

The working memory paradox resolved in section 8 generates a specific prediction. Higher working memory capacity should produce more faithful engagement phases, characterized by more complete and specific R accumulation, and consequently richer candidate reorganizations when the incubation phase completes. Lower executive control during the incubation phase specifically should be associated with higher quality post-incubation insights, because lower executive control allows more uninterrupted DMN processing.

This two-stage prediction is testable by independently manipulating executive load during engagement versus incubation phases, and measuring both the specificity of R

accumulation after engagement and the quality of insights after incubation. It would be disconfirmed by a simple positive or negative linear relationship between executive control and insight quality that does not vary by stage.

10.4 Prediction Four: Autonoetic Decline and Phase Change Durability

If autonoetic capacity is the integration scaffold for phase changes, then individuals with reduced autonoetic function should show reduced durability of phase changes over time even when the phase changes themselves occur normally. The phase change happens but does not consolidate into a stable before and after in the temporal self. The pre-phase change self-model partially reasserts because the integration scaffold cannot maintain the new closure against the pull of prior attractor states.

This prediction connects the present account directly to CHAMP. Longitudinal assessment of autonoetic function using episodic memory and temporal self-orientation measures, alongside qualitative assessment of life-level phase changes using phenomenological interview protocols, should reveal a correlation between autonoetic decline and the durability of meaning-level reorganizations over time. The prediction would be disconfirmed by intact phase change durability in participants with significantly reduced autonoetic function.

10.5 Prediction Five: Depression and the Dissociated Gamma Burst

If rumination represents a candidate reorganization that reaches the insula recommendation stage but fails to cross the PFC bifurcation threshold, then neuroimaging of depressed individuals during insight problem-solving tasks should reveal a specific dissociation: intact insula activation consistent with a candidate being surfaced, followed by absent or attenuated gamma burst in the right anterior temporal lobe consistent with failure to cross the bifurcation threshold. Healthy controls should show both signals in sequence. Depressed individuals should show the first without the second.

This prediction is testable using the combined EEG-fMRI methodology of Jung-Beeman et al. (2004) applied to participants stratified by depression severity and rumination score on validated instruments. It would be disconfirmed by absent insula activation in depressed individuals, which would suggest the failure occurs earlier in the workflow at the recommendation stage rather than at the global ignition threshold, pointing to a different locus of dysfunction than the CC-C account predicts.

11. Relationship to Existing Frameworks

11.1 Friston's Free Energy Principle

The account developed here is compatible with and extends Friston's free energy principle (Friston, 2010). In Friston's account, the brain minimizes free energy by updating its generative model to reduce prediction error. The hippocampal mismatch detection described in this paper is prediction error in Friston's sense. The DMN offline processing is the system working to reduce that prediction error through model revision.

The CC-C account adds two things not specified by the free energy principle. First, it identifies the specific neural workflow through which offline model revision occurs, tracing the five-step process from hippocampal mismatch detection through DMN intercommunication to PFC-basal ganglia gating. Second, it distinguishes local R reduction, Bayesian updating within the existing model, from global R reduction, saddle-node bifurcation into a new model grammar. The free energy principle does not formally distinguish these two types of model revision. The CC-C account does, through the eta ratio and the scope of grammar reorganization described in Meaning as Phase Change.

11.2 Psychoanalytic Accounts

The account developed here shares the psychoanalytic intuition that important cognitive work occurs below conscious awareness and surfaces in ways that conscious processing did not direct. It differs from psychoanalytic accounts in being neurobiologically specified and in making the underlying mechanism explicit rather than inferring it from clinical observation and interpretive theory.

Freud's account of the unconscious as the site where content that cannot be absorbed by the conscious closure is routed finds a structural home here (Freud, 1915). The DMN as offline processor is a neurobiological implementation of something Freud identified clinically without being able to specify mechanistically. The present account generates falsifiable predictions about specific neural signatures. Psychoanalytic accounts do not. The difference is scientific in the Popperian sense, not merely terminological.

11.3 Global Workspace Theory

Global workspace theory proposes that conscious awareness arises when information is broadcast across a global workspace involving prefrontal and parietal regions, making it available to multiple specialized processors simultaneously (Baars, 1988; Dehaene and Changeux, 2011). The CC-C account is compatible with global workspace theory at the level of mechanism: the bifurcation event in section 6 corresponds to the ignition event in global workspace theory, in which a pattern of neural activity crosses threshold and propagates across the workspace.

The CC-C account extends global workspace theory by providing an account of what happens before ignition: the offline processing regime in which the candidate for ignition is assembled. Global workspace theory specifies the mechanism of conscious access. The CC-C account specifies what precedes it.

12. What This Paper Does Not Claim

This paper does not claim to resolve the hard problem of consciousness. C is treated as primitive throughout. The paper describes what C-operative neural systems do with remainder. It does not explain why there is something it is like to be a brain processing remainder.

This paper does not claim that all unconscious processing is remainder processing. The brain runs many non-attentional processes that have nothing to do with unresolved closure mismatches. The claim is specific: remainder that the current closure cannot absorb is processed through the workflow described here.

This paper does not claim that the DMN is the only site of offline remainder processing. The cerebellum, the basal ganglia, and subcortical structures also perform offline processing relevant to skill learning and procedural memory. The account here focuses on the DMN because it is the system most directly implicated in the episodic and self-referential closures that generate the remainder relevant to phase change in the CC-C sense.

However, a precise account of what C adds to the workflow that C-absent analogues cannot have is required here. In C-absent systems the workflow runs stochastically: the autocatalytic set generates boundary chemistry, the quantum system undergoes decoherence, the gravitational field amplifies density fluctuations. None of these systems can choose to incubate. They cannot recognize that a mismatch has been flagged and deliberately create conditions for offline processing to proceed. They cannot feel the candidate reorganization approaching and make space for it. C-operative systems can do all three. The capacity for directed remainder processing, the deliberate cultivation of incubation conditions through the choice to step back, disengage from external task demands, and trust the felt sense when it surfaces, is what C adds to the formal workflow. This is not a minor addition. It is the difference between a system that runs the workflow when conditions happen to permit it and a system that can recognize when conditions are not permitting it and act to change them. The clinical implications are immediate: interventions that teach C-operative systems to recognize and cultivate incubation conditions are doing something no C-absent analogue can do. They are directing the workflow that C-absent systems can only run passively.

13. Conclusion

The CC-C framework defines remainder as the structured content that any finite closure generates at its boundary. This paper has proposed that remainder, in the human brain, is not passive. It is actively processed by neural systems operating below the level of access consciousness, and it surfaces as recommendations to conscious awareness when candidate reorganizations have been assembled through offline intercommunication.

The five-step structural workflow runs in biological hardware. Area CA1 of the hippocampus detects mismatch between incoming experience and the current episodic closure, triggering LC-mediated noradrenergic destabilization of relevant memory traces. The default mode network processes unresolved content during offline periods through content-sensitive intercommunication among its hubs. The candidate reorganization is assembled below the threshold of access consciousness. The insula carries it upward as felt sense. The prefrontal-basal ganglia system does not choose to accept it. When the accumulated signal from offline processing crosses the bifurcation threshold of the PFC attractor dynamics, the network undergoes global ignition: a sudden propagation of the candidate representation across the global neuronal workspace that makes it simultaneously available to multiple specialized processors. That global ignition is what conscious insight feels like from the inside.

The phase change described in Meaning as Phase Change is the conscious registration of a reorganization that the non-attentional neural machinery has already largely completed. Signature zero, the extended offline processing period, is the preparation that makes signatures one, two, and three possible. The insight arrives feeling like it came from nowhere. It did not. It was assembled in the dark, by biological hardware following a structured workflow that the CC-C framework can now name.

The present paper establishes the structural case: in the human brain, remainder processing is implemented in identifiable neural hardware, produces measurable signatures, and generates falsifiable predictions. The predictions developed in section 10 provide the empirical agenda.

Remainder is not the failure of a closure. It is the engine of the next one.

Appendix: Figure Legend for the Neural Energy Landscape

Appendix A: Neural Energy Landscape (Figure 1)

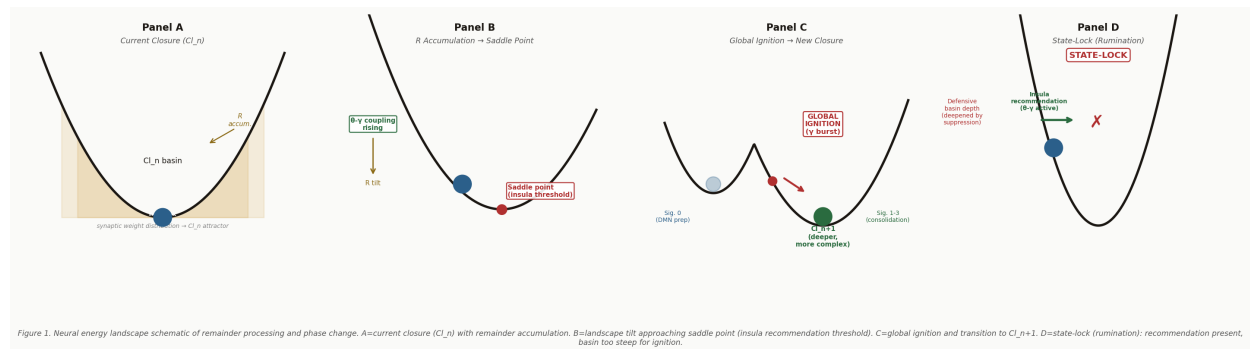


Figure 1. Neural energy landscape schematic of remainder processing and phase change. Panel A: current closure (CL_n) with remainder accumulation shading the basin walls. Panel B: landscape tilt as R accumulates, approaching the saddle point (insula recommendation threshold). Panel C: global ignition as the network bifurcates into CL_{n+1} ; gamma burst at saddle crossing. Panel D: state-lock (rumination) with high insula signal blocked by an abnormally deep basin. Blue ball = current network state. Gold shading = accumulated remainder.

Appendix B: Established Facts and Theoretical Contributions

Table 2. Mapping of each workflow component onto established neuroscience versus theoretical contribution of this paper.

Component	Status	Empirical Source	Theoretical Contribution
Cl (Closure as attractor)	Established	Hopfield (1982); Hebb (1949); Wang (2002)	Mapping philosophical closure onto synaptic weight distributions and attractor basins
R (Mismatch / Prediction error)	Established	Kumaran & Maguire (2006); Sinclair et al. (2025)	Characterizing prediction error as informationally specific remainder shaped by the generating closure
Signature Zero (offline accumulation)	Strongly supported	Tambini & Davachi (2019); Tambini et al. (2020); Buzsaki (2015)	Framing awake reactivation as preparation for phase change rather than mere consolidation
Insula recommendation (theta-gamma)	Supported	Menon & Uddin (2010); Canolty & Knight (2010); Damasio (1994)	Proposing that cross-frequency coupling strength is the specific threshold for salience network switching
Global Ignition (PFC bifurcation)	Established	Dehaene & Changeux (2011); Jung-Beeman et al. (2004); Wang (2002)	Identifying global ignition as the neural correlate of CC-C phase change

Component	Status	Empirical Source	Theoretical Contribution
DMN competitive assembly	Theoretical	Raichle (2015); Changeux (1985); Tambini & Davachi (2019)	Framing spontaneous DMN reactivation as stochastic competitive selection of candidate reorganizations
Rumination as state-lock	Theoretical	Hamilton et al. (2011); Sheline et al. (2009)	Reinterpreting DMN-subgenual PFC hyperconnectivity as a basin-deepening defensive response

Color coding: Green = established empirical fact. Gold = strongly supported, awaiting direct confirmation. Red = theoretical proposal requiring empirical development.

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