The Core Emotion Framework: A Unified Structural–Constructivist Architecture for Human and Synthetic Affect

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Abstract

Emotion science remains theoretically fragmented, with major models offering incompatible explanations of what emotions are, how they arise, and how they change. This lack of a unifying architecture has limited the field's ability to generate cumulative theory, integrate findings across levels of analysis, and develop coherent clinical or computational models of affect. The Core Emotion Framework (CEF) is proposed as a unified structural–constructivist architecture that integrates interoceptive physiology, computational operations, and mechanisms of therapeutic change into a single testable model. CEF conceptualizes emotional episodes not as discrete categories or linguistic labels but as dynamic sequences of ten functional operators distributed across three somatic centers—the Head, Heart, and Gut—with Accepting functioning as a global integrative capacity. These operators perform specific transformations on interoceptive signals, converting raw physiological inputs into structured affective states. By synthesizing evidence from diverse psychotherapy modalities, CEF identifies a cross-modal emotional ontology that unifies mechanisms of change across cognitive, behavioral, experiential, and relational approaches. The framework also provides a blueprint for synthetic affective systems by formalizing operator sequences as algorithmic modules capable of generating emergent affective dynamics in artificial agents. This article outlines the theoretical foundations, neurobiological substrates, computational formalization, and clinical implications of the Core Emotion Framework, and proposes it as a candidate for a unified theory of affect.

Keywords: affective science, theoretical psychology, structural-constructivism, interoception, computational psychiatry, synthetic affect, emotional operators, tripartite architecture.

1. Introduction

Emotion science remains deeply fragmented, with major theoretical traditions offering incompatible explanations of what emotions are, how they arise, and how they change. Basic emotion models emphasize biologically fixed categories, appraisal theories focus on cognitive interpretation, constructionist accounts describe emotions as emergent conceptual processes, and predictive approaches frame them as interoceptive inferences. Despite decades of progress, these perspectives have not converged on a unified architecture capable of explaining emotional episodes across physiology, cognition, behavior, and subjective experience. This persistent lack of integration has limited the field's ability to generate cumulative theory, develop coherent clinical models, and build computational systems that can reproduce or regulate affective states.

The Core Emotion Framework proposes that emotional episodes are generated by sequences of functional operations—"operators"—that act on interoceptive signals within a tripartite body–brain architecture. In this view, emotions are not fixed categories or abstract appraisals but dynamic transformations of bodily state, shaped by the coordinated activity of three neurobiological centers: the Head, which regulates uncertainty and prediction; the Heart, which governs relational and autonomic engagement; and the Gut, which organizes visceral valuation and somatic restructuring. Each center contributes a distinct set of operators, and emotional experience emerges from the ordered interaction of these operations over time. By identifying these operators and the architecture that organizes them, CEF aims to provide a unified account of how emotions arise, persist, and change across physiological, cognitive, and behavioral domains.

Basic emotion traditions emphasize evolutionarily conserved affective circuits (Ekman, 1992; Panksepp, 1998), while early physiological theories such as James (1884) similarly grounded emotion in bodily transformations. At the center of this architecture is a set of ten functional operators that describe the basic transformations the nervous system performs on interoceptive signals. These operators—distributed across the Head, Heart, and Gut centers—capture the core actions through which emotional states are initiated, amplified, stabilized, or resolved. Rather than treating emotions as fixed categories or diffuse appraisals, CEF frames them as sequences of these operators unfolding over time, each contributing a specific computational role. Identifying these operators provides the functional vocabulary needed to unify disparate theories, link subjective experience to measurable physiology, and explain how emotional episodes can shift

rapidly or become rigid and maladaptive. The remainder of this paper develops the theoretical foundations of this operator-based approach and outlines the architecture that supports it.

2. Theoretical Foundations: Structural Constructivism and Active Agency

The Core Emotion Framework is grounded in a structural–constructivist view of mind, in which emotional experience emerges from the dynamic organization of functional operations rather than from fixed categories or isolated appraisals. In this perspective, the nervous system continuously constructs meaning by transforming interoceptive and exteroceptive signals through recurrent patterns of action, prediction, and regulation. Emotional states are therefore not static entities but evolving configurations of operations that maintain coherence within a changing environment. This approach emphasizes that the fundamental units of emotion are the transformations themselves—the ways the system selects, amplifies, interprets, and reorganizes bodily signals—rather than the labels or concepts applied to them. By focusing on these underlying operations, CEF provides a principled foundation for explaining how diverse emotional phenomena can arise from a common set of functional mechanisms.

2.1 The Dynamic Nature of Psychological Structure

In traditional psychological theory, "structure" often implies a static or rigid entity (Mahoney, 1991). However, structural constructivism redefines structure as a dynamic process. This view posits that psychological stability is found within the context of process, not in opposition to it. A central metaphor for this concept is the human body, which is in a state of constant physical turnover and regeneration, yet maintains a sense of continuity and integrity over time (Mahoney, 1991). This perspective aligns with the view that bodily states play a constitutive role in emotional experience (Damasio, 1994, 1999), reinforcing the idea that emotional meaning emerges from transformations of interoceptive signals. Similarly, the Core Emotion Framework views emotional episodes as fluid, sequential configurations of operators rather than fixed mental states (Bulgaria, 2025). This perspective aligns with the work of Jean Piaget, who described the processes of assimilation and accommodation as the primary mechanisms through which organisms adapt to their environment (Piaget, 1936, 1970). In CEF, the ten operators function as the "tools" for this adaptation, transforming interoceptive inputs to maintain a state of internal equilibrium (Smith et al., 2021).

2.2 Proactive Agency and Autopoiesis

A fundamental tenet of structural constructivism is the concept of active agency

(Mahoney, 1991). Individuals are seen as "proactive" rather than purely "reactive" beings. This means that the drive to survive and thrive is fundamentally forward-looking; humans "anticipate" and "lean into life," shaping their reality through their internal models and predictive processes (Mahoney, 1991). This proactive drive is closely linked to the concept of autopoiesis—the capacity of a system for self-organization and self-renewal (Mahoney, 1991). Structural constructivism argues that humans organize their personal history and experience in highly idiosyncratic ways to protect and perpetuate their integrity (Mahoney, 1991). This organization occurs primarily at a "tacit" level, below conscious awareness, and is fundamentally driven by emotions. Emotions are viewed as powerful biological forces that direct attention, shape perceptions, and motivate the learning required for self-organization (Mahoney, 1991). The Core Emotion Framework formalizes this by organizing its ten operators around the "self" as the fundamental reference point for giving meaning to experience.

2.3 Integration of Cognitive, Social, and Cultural Strands

The "structural" aspect of structural constructivism also draws heavily on Pierre Bourdieu's concept of "genetic structuralism" (Bourdieu, 1977). Bourdieu emphasized the body as the locus of social influence, arguing that social structures are internalized and manifest as a "habitus"—a system of durable, transposable dispositions. This perspective bridges the gap between the individualistic focus of Piagetian cognitive constructivism and the socially situated focus of Lev Vygotsky's social constructivism (Piaget, 1936; Vygotsky, 1978). Structural constructivism integrates these views by recognizing that while the functional *mechanisms* of the mind (the operators) may be biological primitives, the *meanings* and *patterns* they generate are deeply embedded in a social-symbolic web (Mahoney, 1991; Berger and Luckmann, 1966). The Core Emotion Framework reflects this integration by proposing that emotional episodes are constructed through operator sequences that are both biologically grounded in the body and culturally shaped by social relationships (Bulgaria, 2025; Mahoney, 1991).

2.4 Why Functional Operators Are Required

Structural constructivism holds that psychological life is organized through ongoing transformations rather than fixed mental entities. If emotional episodes are dynamic configurations of meaning-making processes, then a complete account of emotion must identify the *functional units* that perform these transformations. Traditional theories describe emotions in terms of categories, appraisals, or predictions, but these constructs do not specify the underlying mechanisms that select, amplify, inhibit, or reorganize interoceptive signals as they unfold over time. Without such primitives, it is difficult to explain how emotional episodes emerge, why they vary across individuals and contexts, or how they can become rigid and maladaptive.

Within a structural–constructivist framework, functional operators serve as the minimal set of transformations through which the nervous system maintains coherence in the face of changing internal and external demands. They provide the “grammar” that organizes interoceptive inputs into structured affective states, much as linguistic rules organize words into meaningful expressions. Operators are therefore not metaphors or abstractions but biologically grounded processes that enact the adaptive work of emotion. By identifying these operations, the Core Emotion Framework translates the philosophical commitments of structural constructivism into a concrete, testable ontology. This establishes the foundation for the tripartite architecture described in the next section, where these operators are situated within the Head, Heart, and Gut centers that implement them.

3. The Tripartite Architecture: Head, Heart, and Gut

The Core Emotion Framework is organized into a tripartite architecture that reflects the functional neuroanatomy of the three primary neural centers of the human body (Bulgaria, 2025; Walia, 2019). These three centers—often referred to as the "three brains"—are the cephalic brain, the cardiac brain, and the enteric brain (Walia, 2019; Mayer, 2011).

3.1 The Head Center: Cognitive and Executive Intelligence

The Head Center corresponds to the cephalic brain, specifically the neocortex and the prefrontal cortex (Walia, 2019). It is responsible for logical thinking, information processing, and executive decision-making. In the context of emotion, the Head Center's primary goal is the reduction of uncertainty through the sensing and calculation of environmental and internal states (Seth, 2013; Friston, 2010). Neurally, the operators of the Head Center are implemented within the Central Autonomic Network (CAN), which includes the anterior insular cortex (AIC) and the anterior cingulate cortex (ACC) (Critchley and Harrison, 2013; Pollatos and Schandry, 2004). The AIC is the primary interoceptive cortex where top-down predictions of the body's state are compared with bottom-up afferent signals from the viscera (Barrett, 2017; Seth, 2013).

3.2 The Heart Center: Relational and Emotional Intelligence

The Heart Center is associated with the cardiac nervous system, which contains approximately 40,000 neurons communicating bidirectionally with the cephalic brain via the vagus nerve (Porges, 2001, 2023; Walia, 2019). The heart is a sensory organ sending more information to the brain than it receives. The operators of the Heart Center are grounded in the social engagement system described by Polyvagal Theory (Porges, 2001, 2007). This system focuses on relational intelligence—the ability to understand feelings,

manage boundaries, and align goals within a social context (Porges, 2001).

3.3 The Gut Center: Intuitive and Visceral Intelligence

The Gut Center is implemented in the Enteric Nervous System (ENS), containing between 100 to 600 million neurons lining the gastrointestinal tract (Furness, 2012; Mayer, 2011). The ENS is the largest and most complex unit of the peripheral nervous system and can operate independently of the cephalic brain (Gershon, 1998; Mayer, 2011). The Gut Center is the seat of intuitive intelligence and instinctive "gut feelings" (Mayer, 2011). Notably, 90% of the body's serotonin is produced in the gut, making it a critical regulator of emotional mood and visceral state (Bonaz et al., 2018; Gershon, 1998).

A visual summary of the operator distribution across centers is provided in Supplementary Figure S1.

4. The Ten Functional Operators: A Generative Grammar of Affect

The Core Emotion Framework posits that all emotional phenomena can be decomposed into ten functional operators (Bulgaria, 2025). Each operator performs a specific computational transformation on interoceptive inputs.

4.1 Head Center Operators

- **Sensing:** This operator increases interoceptive precision (Bulgaria, 2025). It functions as a sensory "gain" that brings internal bodily signals into sharper focus (Barrett, 2017; Seth, 2013).
- **Calculating:** This operator reorganizes cognitive appraisal (Bulgaria, 2025). It functions as a Bayesian engine that weights prior beliefs against incoming data (Seth, 2013).
- **Deciding:** This operator selects behavioral trajectories intended to maintain homeostasis or minimize free energy (Bulgaria, 2025).

4.2 Heart Center Operators

- **Expanding:** This operator increases relational openness and social vulnerability (Bulgaria, 2025). It corresponds to the activation of the ventral vagal complex (VVC) (Porges, 2001, 2007).
- **Constricting:** This represents the narrowing of focus and the setting of internal or external boundaries (Bulgaria, 2025). It involves the withdrawal of the "vagal brake" (Porges, 2001, 2025).

- **Achieving:** This operator aligns action with goals, providing the directional component of motivation (Bulgaria, 2025; Salamone and Correa, 2012).

4.3 Gut Center Operators

- **Arranging:** This operator restructures internal patterns at a visceral level, facilitating the restructuring of cognitive-somatic schemas (Bulgaria, 2025; Mahoney, 1991).
- **Appreciating:** This operator increases valuation and meaning (Bulgaria, 2025). Neurally, it is linked to activity in the medial prefrontal cortex (Fox et al., 2015).
- **Boosting:** This operator amplifies motivational energy and behavioral vigor (Bulgaria, 2025; Salamone and Correa, 2012).

4.4 Global Integrator

- **Accepting:** This meta-operator reduces resistance and integrates the outputs of the other nine operators into a coherent experience (Bulgaria, 2025).

4.5 Why These Ten Operators?

A central requirement for any unified theory of emotion is the identification of a minimal set of functional primitives that can account for the full diversity of affective phenomena without redundancy or theoretical inflation. The Core Emotion Framework proposes ten such operators, selected not as arbitrary categories but as the smallest set of transformations necessary to describe how interoceptive signals are selected, amplified, reorganized, and integrated into coherent emotional episodes. Each operator corresponds to a distinct computational action performed by the nervous system, and together they form a complete basis set for modeling affective change.

The ten operators meet three criteria for functional sufficiency. First, they are **non-overlapping**: each operator performs a unique transformation that cannot be reduced to the function of another. Second, they are **collectively exhaustive**: taken together, they span the full range of operations required to generate, maintain, and resolve emotional states. Third, they are **biologically grounded**: each operator maps onto identifiable neural circuits within the Head, Heart, or Gut centers, reflecting the distributed architecture of interoceptive processing. This grounding ensures that the operator set is not merely conceptual but anchored in measurable physiological mechanisms.

The operators also satisfy the constructivist requirement that emotional episodes be understood as sequences of transformations rather than static states. By defining the specific operations through which the nervous system modulates precision, reorganizes

appraisal, adjusts relational stance, restructures somatic patterns, and integrates competing signals, the operator set provides a generative grammar capable of producing the full range of human affect. This grammar is minimal—no operator can be removed without losing explanatory power—and extensible, allowing for the modeling of both typical and atypical emotional trajectories. In this way, the ten operators constitute the functional core of the CEF ontology and provide the foundation for the computational and clinical applications developed in subsequent sections.

5. Computational Formalization: Modeling Emotional Episodes

CEF utilizes the language of interoceptive inference and active inference to formalize emotional dynamics as transformations of internal bodily signals (Seth, 2013; Bulgaria, 2025). In this framework, emotions are not latent categories but emergent trajectories through interoceptive state space, shaped by sequences of operator-specific computations. This section defines the mathematical structure underlying these transformations and clarifies how operator sequences generate emotional episodes.

5.1 Interoceptive State Space

At any moment $\boldsymbol{t}$, the internal physiological condition of an organism is represented as an interoceptive state vector:

$$\boldsymbol{I_t} \in \mathbb{R}^{\boldsymbol{n}}$$

This vector encodes measurable physiological dimensions such as heart rate, respiratory depth, gastric tension, muscle tone, and metabolic load (Smith et al., 2021). The dimensionality $\boldsymbol{n}$ is not fixed; it reflects the granularity of the physiological model used. Emotional episodes correspond to structured trajectories through this state space, driven by operator-specific transformations.

5.2 Operators as Transformation Functions

Each operator O_i is defined as a transformation function acting on the interoceptive vector:

$$O_i(I_t) = f_i(I_t, \pi_i, \theta_i)$$

where:

- $\boldsymbol{\pi_i}$ is the *precision weighting* associated with the operator

- $\boldsymbol{\theta_i}$ is the set of *learned parameters* governing the operator's behavior
- $\boldsymbol{f_i}$ is the operator-specific transformation function

Precision Modulation (π_i)

Precision $\pi_i$determines the *gain* or *confidence* applied to interoceptive prediction errors. High precision amplifies the influence of bodily signals (e.g., Sensing), while low precision dampens them (e.g., Accepting). Precision modulation is central to emotional dysregulation: excessive precision can produce hypervigilance or panic, whereas insufficient precision can produce emotional blunting.

Operator Parameters (θ_i)

The parameter set θ_i encodes learned tendencies, priors, and habitual patterns associated with each operator. For example:

- In **Calculating**, θ_i includes prior beliefs and appraisal biases.
- In **Arranging**, θ_i includes learned somatic schemas.
- In **Achieving**, θ_i includes goal-value mappings.

These parameters allow the same operator to behave differently across individuals, contexts, and developmental histories.

5.3 Emotional Episodes as Sequence Compositions

An emotional episode $\boldsymbol{E}$ is defined as a composition of operator transformations applied to an initial interoceptive state:

$$\boldsymbol{E = O_n \circ O_{n-1} \circ \cdots \circ O_1(I_0)}$$

This formulation captures the sequential, dynamic nature of emotional experience. Different sequences produce different emotional trajectories:

- **Fear** may involve Sensing → Constricting → Deciding → Boosting
- **Grief** may involve Sensing → Expanding → Arranging → Accepting
- **Motivation** may involve Appreciating → Achieving → Boosting

The same operator can appear multiple times in a sequence, and the order of operations is essential: emotional meaning emerges from the *structure* of the sequence, not from any single operator.

5.4 Clinical Change as Operator Reconfiguration

Therapeutic progress is defined as the reconfiguration of operator sequences:

$$\Delta E = \Delta O$$

This change can occur through:

- **Parameter shifts** $\Delta\theta_i$ (e.g., modifying appraisal biases in Calculating)
- **Precision shifts** $\Delta\pi_i$ (e.g., reducing hyperprecision in Sensing during anxiety)
- **Sequence restructuring** (e.g., introducing Accepting earlier in the sequence)

In computational psychiatry terms, therapy alters the generative model that governs interoceptive inference (Stephan et al., 2015). CEF provides a structured vocabulary for describing these changes, enabling cross-modal integration of therapeutic mechanisms.

A full operator-vector lexicon (EL-1) used for computational modeling is provided in Supplementary File S2.

6. Integration with Evidence-Based Psychotherapy

CEF provides a cross-modal emotional ontology that unifies mechanisms of change across therapeutic modalities (Bulgaria, 2025). Each modality can be understood as selectively engaging specific operators, allowing diverse interventions to be described within a common functional language. This mapping clarifies why different therapies can produce similar outcomes despite using distinct techniques: they converge on shared operator-level transformations.

Table 1. Psychotherapy Modalities Mapped to CEF Operators

THERAPY MODALITY	PRIMARY OPERATORS ENGAGED	MECHANISM OF CHANGE (CEF INTERPRETATION)
CBT	Calculating, Deciding	Reweights priors, restructures appraisals, selects adaptive behavioral trajectories
ACT	Accepting, Expanding	Reduces experiential resistance, increases openness to internal states
DBT	Accepting, Expanding,	Enhances emotion regulation, restructures somatic patterns

	Arranging	
EMDR	Sensing, Arranging	Increases interoceptive precision, reorganizes traumatic somatic schemas
IFS	Appreciating, Arranging	Reorganizes internal parts-based schemas, increases valuation and meaning
MOTIVATIONAL INTERVIEWING	Appreciating, Achieving	Enhances goal-value alignment and motivational direction
SOMATIC EXPERIENCING	Sensing, Constricting, Expanding	Modulates autonomic activation and boundary regulation
POLYVAGAL-INFORMED THERAPIES	Expanding, Constricting	Targets vagal tone and relational engagement

By framing therapeutic change in terms of operator reconfiguration, CEF provides a unifying ontology that bridges cognitive, behavioral, experiential, and somatic approaches. This integration supports the development of transdiagnostic interventions and computational models of psychotherapy.

7. Testable Predictions and Future Directions

The CEF generates falsifiable hypotheses across physiological, behavioral, clinical, and synthetic domains. These predictions provide a roadmap for empirical validation and future research.

7.1 Physiological Predictions

- **Sensing** should correlate with increased Heartbeat Evoked Potential (HEP) amplitude, reflecting heightened interoceptive precision (Critchley & Harrison, 2013).
- **Expanding** should correlate with increased vagal tone and activation of the ventral vagal complex (Porges, 2001).

7.2 Behavioral Predictions

- **Constricting** should predict boundary-setting behaviors, reduced social gaze, and narrowed attentional focus.

- **Achieving** should predict increased goal-directed persistence and behavioral vigor, consistent with dopaminergic motivational pathways (Salamone & Correa, 2012).

7.3 Clinical Predictions

- Successful therapy should manifest as predictable shifts in operator activation probability (Bulgaria, 2025).
- Reductions in emotional rigidity should correspond to increased variability and flexibility in operator sequence composition.
- Treatment-resistant cases should show persistent hyperprecision in Sensing or rigid priors in Calculating.

7.4 Synthetic Predictions

- Artificial agents implementing operator sequences should exhibit emergent affective dynamics not explicitly programmed, demonstrating generative emotional behavior.
- Precision modulation in synthetic systems should allow simulation of emotional dysregulation (e.g., anxiety via hyperprecision; dissociation via hypoprecision).
- Operator-based architectures should outperform category-based models in tasks requiring adaptive emotional regulation.

These predictions highlight the framework's potential to unify research across neuroscience, psychotherapy, and artificial intelligence.

8. Discussion: Toward a Unified Theory of Affect

Psychological science has long lacked integrative theoretical frameworks capable of organizing findings across levels of analysis (Eronen & Bringmann, 2017). The Core Emotion Framework responds to this need by grounding emotion in ten functional operators acting on interoception. By grounding emotion in ten functional operators acting on interoception, CEF resolves long-standing tensions between basic emotion theories, appraisal models, constructionist accounts, and predictive processing frameworks. Rather than treating emotions as fixed categories or conceptual constructs, CEF frames them as dynamic sequences of biologically grounded transformations.

This operator-based ontology provides a generative grammar capable of explaining how emotional episodes arise, persist, and change across physiological, cognitive, relational, and behavioral domains. It also offers a principled foundation for computational modeling and synthetic affective systems, enabling the development of artificial agents

capable of adaptive emotional behavior.

8.1 Limitations

Several limitations warrant consideration. First, the granularity of the operator set may require refinement as empirical data accumulates; additional operators or sub-operators may emerge. Second, cultural and developmental variability in operator expression is not yet fully modeled, raising questions about universality. Third, measuring operator activation in vivo remains challenging, requiring advances in interoceptive neuroscience and computational psychiatry. Finally, synthetic implementations of operator sequences are still in early stages, and their ecological validity remains to be tested.

These limitations highlight the need for continued interdisciplinary research integrating neuroscience, psychology, computation, and artificial intelligence.

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Ethics Statement

This study did not involve human participants or animals and therefore did not require ethical approval.

Data Availability Statement

All datasets and technical specifications associated with the Core Emotion Framework are publicly available in the Zenodo community archive (030303) and the CEF Main Archive on Hugging Face.

Supplementary Material

Supplementary Figure S1. *The MIRROR TECHNIQUE diagram illustrating the mapping of the ten Core Emotion Framework operators across the Head (Cognition), Heart (Emotion), and Gut (Conation) centers. The diagram organizes operators into Reflecting, Balancing, and Outgoing phases, with Accepting functioning as a global integrative capacity.*

Supplementary File S2. *The EL-1 Emotion Lexicon (v1.0), containing 150+ emotion terms mapped to the ten Core Emotion Framework operators. Each entry includes symbolic operator composition, a 10-dimensional operator vector, and metadata for valence and arousal. This lexicon provides the computational grounding for operator-based emotional modeling described in Section 5.*

Author Contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of Interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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