

Article

Art as Structural Necessity: A Formal Theory of Aesthetic Engagement in Post-Scarcity Information Environments

Boris Kriger 

Computational Humanities and Cultural Systems, Institute of Integrative and Interdisciplinary Research,
Toronto, ON M3H 5Y4, Canada; boriskruger@interdisciplinary-institute.org

Abstract

This paper argues that art and aesthetic engagement are not cultural luxuries but structural necessities for any cognitive system operating in post-scarcity information environments—a claim derived from a unified structural theory of complex systems grounded in the persistence principle. The argument proceeds in three stages. First, drawing on the formal theory of structural viability, the paper demonstrates that when a cognitive agent's basic needs are satisfied and information is abundant, the agent's viability set expands until utilitarian goal structures degenerate. Non-utilitarian goal-setting—creative activity pursued beyond direct utility—remains the only structurally available mode of purposeful agency. Second, the paper provides a neuroaesthetic grounding for this claim: predictive processing, derived as the unique optimal cognitive architecture under physical constraints, entails that creative engagement generates prediction errors whose resolution activates reward pathways shared with reproductive behavior—both being instances of generating new structure. Active perception of art constitutes co-creation through the same mechanism. Third, the paper addresses the role of artificial intelligence: AI accelerates the arrival of post-scarcity conditions and serves as an instrument of creative engagement, but passive consumption of AI-generated content without the agent's own goal-setting fails to fulfill the structural function of art and deepens the very condition it could remedy. The framework contributes to neuroaesthetics by providing a substrate-independent formal foundation for understanding why cognitive systems require art—not merely enjoy it—and why this requirement intensifies as post-scarcity conditions approach.

Keywords: neuroaesthetics; structural viability; predictive processing; post-scarcity; creativity; artificial intelligence; constraint–autonomy compatibility; goal generation; persistence principle



Academic Editor: Elena Sidorova

Received: 8 April 2026

Revised: 19 June 2026

Accepted: 23 June 2026

Published: 26 June 2026

Copyright: © 2026 by the author.

Licensee MDPI, Basel, Switzerland.

This article is an open access article distributed under the terms and

conditions of the [Creative Commons Attribution \(CC BY\)](https://creativecommons.org/licenses/by/4.0/) license.

1. Introduction

Since its formalization by [Zeki \(1999\)](#), neuroaesthetics has produced substantial evidence that engagement with art activates specific neural circuits, modulates emotional states, and influences cognitive function ([Chatterjee and Vartanian 2014](#); [Vessel et al. 2012](#); [Pearce 2016](#)). Neuroimaging studies have demonstrated that intensely pleasurable responses to music correlate with dopamine release in the striatal reward system—the same circuitry implicated in responses to food, sex, and psychoactive substances ([Blood and Zatorre 2001](#); [Salimpoor et al. 2011](#); [Ferreri et al. 2019](#)). The aesthetic triad model ([Chatterjee and Vartanian 2014](#)) has mapped sensory–motor, emotion–valuation, and meaning–knowledge circuits involved in aesthetic experience. Recent work has established connections between predictive processing and aesthetics, showing that aesthetic pleasure arises from the interaction between prediction, surprise, and model updating ([Frascaroli](#)

et al. 2024; Van de Cruys and Wagemans 2011; Koelsch 2014). Creative arts therapies have demonstrated measurable psychological and neural outcomes through aesthetic engagement, linking art-making to predictive processing dynamics and updated internal models of self (Vaisvaser et al. 2024).

Yet a foundational question remains largely unanswered: why do cognitive systems require aesthetic engagement at all? As Verstegen (2025) has observed, neuroaesthetics has so far produced no theory that is truly predictive of aesthetic value; neural correlates of aesthetic response add descriptive texture but do not explain why art is necessary. The existing literature documents what happens in the brain during aesthetic experience but offers no formal account of why such experience is structurally necessary rather than merely pleasant. The present paper proposes such an account.

Drawing on a unified structural theory of complex systems (Kriger 2026), this paper demonstrates that art and creative engagement are not cultural ornaments but structural necessities for any cognitive agent operating under conditions of resource abundance. The argument is not psychological but formal: it follows mathematically from the theory of structural viability and the persistence principle—the claim that the formal constraints governing the maintenance of structural viability over time are substrate-independent and apply identically across physical, biological, cognitive, and social domains (Kriger 2026). In this respect, the present framework responds to calls for approaches that go beyond phenomenological description toward structural explanation in neuroaesthetics (Wild 2024; Sarasso et al. 2020).

Because the argument rests on this framework, a word about its status is warranted. The unified structural theory is a recent and deliberately broad program, and a comprehensive, substrate-independent account of this kind invites predictable objections: that its very generality risks unfalsifiability; that the persistence principle and the claim of substrate-independence are postulated more than established; and that several of its central results function as strong modeling commitments rather than settled theorems. These are legitimate concerns, and the present paper does not presuppose that they have been resolved. It mitigates them in three ways. First, the conclusions drawn here rest chiefly on mid-level results that converge with independently corroborated work in mainstream neuroscience—predictive processing and the free-energy principle (Friston 2010; Clark 2013; Smith et al. 2024), the dopaminergic reward overlap documented in Section 3, and a constraint–autonomy trade-off of the kind familiar from dynamical-systems accounts of adaptive control—rather than on the framework’s most contestable global claims. Second, the argument is offered as conditional and falsifiable: Section 4.4 derives specific predictions whose failure would count against the application of the theory to aesthetics, so the framework is held to empirical account rather than assumed. Third, where the paper invokes formal results from Kriger (2026)—the Stimulus Void, the Constraint–Autonomy Compatibility Law, the derivation of predictive processing—it treats them as articulated hypotheses about structure whose value, for present purposes, lies in the testable consequences they generate. The aim is therefore not to establish the underlying theory but to show what follows for neuroaesthetics if its better-supported components hold, and to expose those consequences to test.

The paper is motivated by a convergence of two developments: first, the progressive approach of post-scarcity conditions in technologically advanced societies—conditions under which basic survival needs are met, information is abundant, and utilitarian goals lose their structural basis—and second, the rapid proliferation of generative artificial intelligence, which simultaneously accelerates the displacement of utilitarian tasks and provides new instruments for creative engagement. The digital transformation of creative industries—including the art market’s rapid shift toward online platforms, AI-driven curation, and blockchain-based provenance systems (Sidorova 2019)—illustrates the speed at which these developments reshape the conditions under which art is produced, distributed, and consumed. Together, these

developments make the structural function of art not less relevant but more urgent. Recent interdisciplinary work at the intersection of neuroaesthetics and AI has begun to explore these questions (Palmieri et al. 2025; Peschl 2024), but has not yet provided a formal account of why aesthetic engagement is structurally necessary under post-scarcity conditions.

The argument proceeds in three stages. Section 2 formalizes the Stimulus Problem: the degeneration of goal structure under viability set expansion and the identification of non-utilitarian goal-setting—creativity and art—as the unique remaining mode of purposeful agency. Section 3 provides the neuroaesthetic mechanism: predictive processing as a structurally necessary cognitive architecture, the shared reward pathways between creative and reproductive acts, and the status of active perception as co-creation. Section 4 addresses the dual role of AI: as an instrument of creative agency and as a potential vector of passive consumption that displaces the very function it could serve. Section 5 offers conclusions and identifies testable predictions. Figure 1 summarizes the overall pathway, from viability-set expansion and goal-structure degeneration to art as the structural response, and the divergence between active engagement and passive consumption.

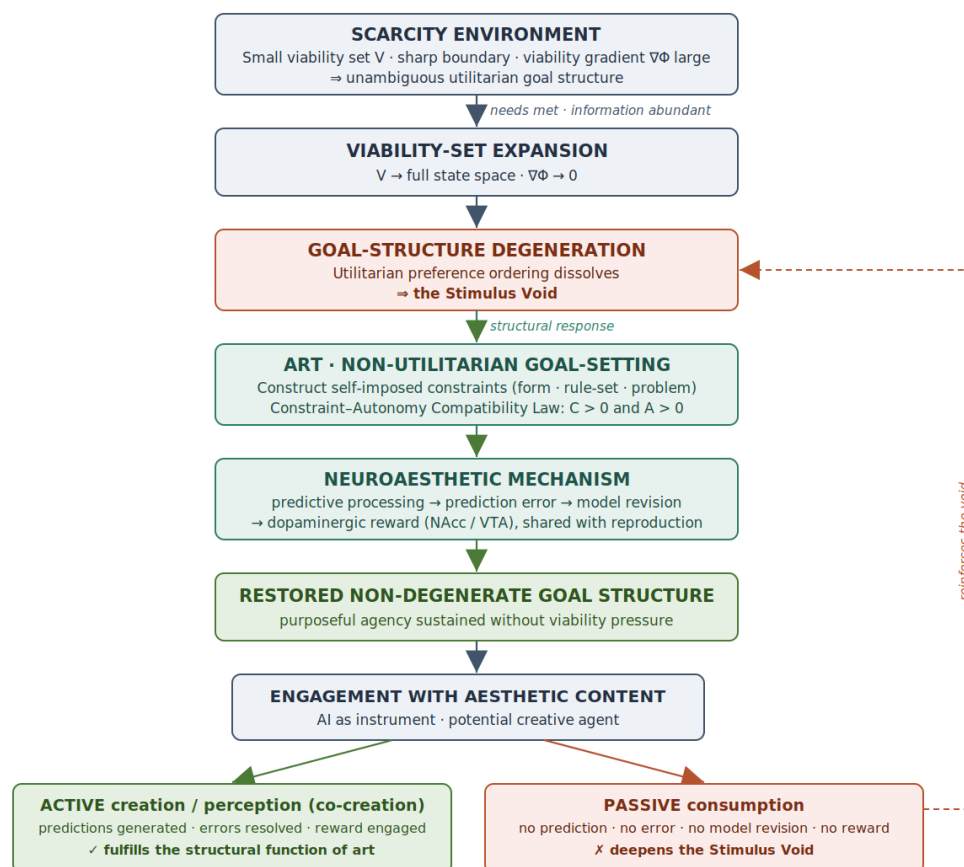


Figure 1. The structural pathway. Under scarcity, a small viability set V with a steep viability gradient ($\nabla\Phi$) supplies an unambiguous utilitarian goal structure. As post-scarcity conditions expand V toward the full state space, $\nabla\Phi \rightarrow 0$, and the utilitarian preference ordering degenerates—the Stimulus Void. Non-utilitarian goal-setting (art) is the structural response: by imposing self-chosen constraints (Constraint–Autonomy Compatibility Law, $C > 0$ and $A > 0$), the agent reconstructs a non-degenerate goal structure. The same neuroaesthetic mechanism—predictive processing, prediction error, model revision, and dopaminergic reward shared with reproductive reward—underwrites both creation and active (co-creative) perception. Engagement with aesthetic content, including AI-generated content, thus diverges: active creation or perception fulfills the structural function, whereas passive consumption generates no prediction error and no reward and feeds back to deepen the Stimulus Void.

2. The Stimulus Problem: Goal Structure Degeneration in Post-Scarcity Environments

2.1. Viability Sets and the Persistence Principle

The formal framework begins with the concept of structural viability. A system S persists if its state trajectory remains within a viability set V —the region of state space within which the system's essential processes can continue to function (Kriger 2026, chap. 5). Environmental demands define the boundaries of V ; the system's resources determine its capacity to remain within those boundaries. The persistence principle states that the formal constraints governing this process are substrate-independent: the same mathematical structures govern viability in biological cells, cognitive agents, social institutions, and cultural artifacts.

In scarcity environments, V is small relative to the total state space. The agent faces genuine viability threats—starvation, predation, exposure, resource competition—and these threats generate an unambiguous goal structure. The system must acquire resources, avoid threats, and maintain its position within V . Each decision is constrained by the proximity of the viability boundary, and the agent's goal hierarchy is determined by the urgency of these constraints. There is no formal problem of motivation under scarcity: the viability boundary itself generates the reasons for action.

2.2. Viability Set Expansion and the Degeneration of Utilitarian Goals

In post-scarcity environments, a qualitative shift occurs. When basic needs are met and information is abundant, the viability set expands to encompass nearly all available states. The agent is not threatened from any direction. The viability boundary recedes, and with it, the formal basis for preferring one action over another.

This is not a psychological observation about boredom or anomie. It is a mathematical consequence of viability set expansion. When V approaches the full state space, the complement of V —the set of states from which the agent must be defended—shrinks toward zero. The constraints that previously generated the goal hierarchy dissolve. The agent retains full capacity for action but has lost the formal structure that organized action into purposeful sequences. The result is what has been formalized as the Stimulus Void: a state in which a cognitive agent possesses effectively unlimited capacity but no internally or externally generated reason to deploy it (Kriger 2026).

To make the structural claim explicit, let Φ denote a viability potential whose sublevel set defines V , so that the utilitarian goal field is the restoring gradient $g = -\nabla\Phi$ —the direction that most steeply returns the system toward viability. Under scarcity, V is small, and $\nabla\Phi$ is large and well defined across most of state space, so g imposes an unambiguous ordering on actions: each state carries a determinate “distance from the boundary,” and action is organized by the imperative to reduce it. As post-scarcity conditions expand V toward the full state space, Φ flattens over the inhabited region; $\nabla\Phi \rightarrow 0$, the ordering induced by g degenerates, and no utilitarian preference between actions survives. This is the precise content of goal-structure degeneration: not a loss of capacity, but the loss of the potential whose gradient ranked the agent's options. Restoring purposeful agency therefore requires reintroducing a non-degenerate potential over some region of state space. Non-utilitarian goal-setting does exactly this: by imposing a self-chosen constraint—an artistic form, a rule-set, a problem—the agent carves out a new bounded region and a new potential whose gradient again orders action, now independently of any external viability pressure. “Art,” in the sense used here, is the general name for this constraint-construction operation, which is why it is the structural response to viability-set expansion rather than one remedy among several. The Constraint–Autonomy Compatibility Law of Section 2.4

then specifies which such constructions are viable: those interior to the (C, A) parameter space, with strictly positive constraint and strictly positive autonomy.

This condition is not hypothetical. It is observable as a trajectory in post-industrial societies: declining marginal motivation in materially secure populations (Inglehart and Welzel 2005), rising rates of purposelessness and “deaths of despair” among individuals who lack material deprivation but exhibit characteristic symptoms of goal-structure collapse (Case and Deaton 2020), and the growing literature on the psychological effects of digitalization—information overload, diffuse anxiety, paralysis of choice—that are predictable consequences of operating without an adequate goal-generation framework (Kriger 2026).

2.3. *Art as the Unique Remaining Goal Structure*

The critical observation is this: the degeneration of goal structure under viability set expansion affects only utilitarian goals—goals derived from viability pressure. Non-utilitarian goal-setting—creative activity pursued beyond direct utility, activity whose purpose is not the maintenance of position within V but the construction of new constraints, new forms, new structures—is by definition independent of viability pressure. It does not require threats to the agent’s survival. It does not depend on scarcity.

We define art, for the purposes of this analysis, as any creative activity involving non-utilitarian goal-setting—activity that imposes constraints and pursues purposes beyond direct material utility. This definition encompasses visual arts, music, literature, and design, but also scientific inquiry pursued for its own sake, game construction, narrative, and any form of engagement in which the agent creates bounded spaces of meaningful choice that are not dictated by survival requirements.

Under this definition, art is not one among several remedies for the Stimulus Void. It is the only structurally available response. When all utilitarian goals have degenerated, non-utilitarian goal-setting is not optional—it is the sole remaining mechanism by which a cognitive agent can maintain purposeful agency. Art, in this formal sense, is structurally necessary.

This claim invites an immediate objection: surely many activities—exercise, travel, conversation, play, the pursuit of beauty—also occupy agents in post-scarcity conditions, so why single out art? The answer turns on the breadth of the definition just given. “Art,” here, does not denote the fine arts narrowly but the entire class of non-utilitarian goal-setting: any activity in which the agent imposes its own constraints and pursues a purpose not dictated by viability. So construed, the apparent alternatives are not competitors but instances. Exercise pursued as a self-set challenge—training toward a target, mastering a movement, imposing a discipline—is non-utilitarian goal-setting, and fulfills the structural function precisely insofar as it is so pursued; travel undertaken as exploration and the active construction of meaning is likewise within the class. The claim of uniqueness is therefore not that easel painting is the only remedy, but that the class of constraint-constructing, non-utilitarian goal-setting is the only structurally available source of a non-degenerate goal potential once utilitarian goals have dissolved. The substantive content lies in the formal condition of Section 2.4, not in the word “art.”

The objection does, however, mark a real boundary, because the same activities can be pursued in two further modes that do not fulfill the function. Pursued utilitarianly—exercise for health, travel for business—they are utilitarian goals and degenerate under viability-set expansion for exactly the reasons given above. Pursued as passive, consummatory pleasures—sensory enjoyment without self-imposed constraint or model-building—they deliver reward but generate no new structure, and so, as Section 3.3 will show, they leave the Stimulus Void untouched. What separates the structurally efficacious cases from the inert ones is never the activity’s surface category but whether it instantiates non-utilitarian goal-setting;

“art” is simply the name this paper gives to that property wherever it appears, which is why the set of qualifying activities is open rather than confined to the conventional arts.

2.4. The Constraint–Autonomy Compatibility Law and Artistic Form

The Constraint–Autonomy Compatibility Law (Kriger 2026) provides the formal mechanism by which art restores goal structure. The law establishes, through Lyapunov stability analysis, that a viable system maintains adaptive capacity if and only if both constraint strength $C > 0$ and agent autonomy $A > 0$. Systems at either boundary—total constraint or total freedom—lose adaptive capacity. The proof demonstrates that optimal configurations lie in the interior of the (C, A) parameter space, with a coherence potential $V(C, A)$ achieving its maximum at an interior optimum (C, A) .

The application to aesthetics is direct. Artistic form—meter, tonality, canvas, genre, rule-set—constitutes an enabling constraint in the formal sense of the CACL. The poet who chooses the sonnet form does not restrict creativity but generates a bounded space within which choices become meaningful. The composer working within a tonal system does not limit expression but creates a field of prediction and surprise within which the listener’s cognitive engagement becomes possible. The painter who accepts the constraint of a fixed surface and a limited palette defines a creative space that would not exist without those constraints.

In post-scarcity environments, where viability pressure no longer provides external constraints, art provides precisely the self-imposed constraints that the CACL identifies as necessary for adaptive autonomy. The agent constructs the boundaries—chooses the form, defines the rules, sets the challenge—and in doing so restores the goal structure that the expansion of V had dissolved. This is not recreation. It is the structural mechanism by which purposeful agency is maintained in the absence of utilitarian necessity.

3. The Neuroaesthetic Mechanism: Predictive Processing, Reward, and the Evolutionary Logic of Creativity

3.1. Predictive Processing as Structurally Necessary Architecture

The Unified Structural Theory demonstrates that predictive processing is not merely an empirically observed feature of neural architecture but a structural necessity for any cognitive system operating under realistic physical constraints (Kriger 2026, chap. 10). The argument proceeds from two physical constraints: latency (sensory signals take time to propagate and process) and bandwidth (the channel capacity between environment and internal model is finite). Under both constraints simultaneously, the optimal processing strategy is to maintain a generative model that predicts incoming signals and to transmit only the discrepancy between prediction and reality—the prediction error. Any other architecture wastes either time or bandwidth or both, and a system that wastes either under competitive pressure will be outperformed by one that does not.

This result converges with the free-energy principle developed by Friston (2010), which characterizes the brain as a prediction-error-minimizing system, and with Clark’s (2013) account of the brain as a prediction machine. The empirical status of predictive coding and active inference has been reviewed extensively (Smith et al. 2024), confirming that evidence is consistent with the framework, though research continues. The application of predictive processing to aesthetics has proven particularly fruitful: Frascaroli et al. (2024) present this convergence as a major research programme, noting that aesthetic phenomena—examined under the lens of predictive processing—offer important windows into mental functioning. Constant et al. (2024) have addressed the “Enlightened Room Problem”—how uncertainty-minimizing systems can be creative—by proposing that creativity emerges from the interplay between predictive brains and self-constructed

challenging environments, a proposal that aligns directly with the CACL framework developed below.

This framework has immediate consequences for neuroaesthetics. The listener hearing music, the viewer encountering a painting, the reader following a narrative—each engages a predictive system that continuously generates expectations and registers their violations. Experimental work has demonstrated that listeners' predictive models of music operate at multiple hierarchical levels—melodic, harmonic, rhythmic, formal—generating expectations with accuracy exceeding 80% for standard progressions even in untrained listeners (Meyer 1956; Huron 2006; Pearce and Wiggins 2012). When the artwork conforms to prediction, the brain registers a small reward—the satisfaction of confirmation. When it deviates, the brain registers prediction error—a signal that demands attention, triggers model revision, and generates an emotional response proportional to the magnitude of the error (Koelsch 2014; Cheung et al. 2019). The aesthetic experience is constituted by this cycle of prediction, error, and model revision—what Schoeller et al. (2024) have linked to the phenomenon of aesthetic chills and durable memory encoding.

3.2. *Creative Engagement and the Reward Pathway*

Why does the brain reward creative engagement? The answer lies in the evolutionary logic of the persistence principle. Two fundamental activities serve the persistence of complex biological systems: reproduction (creating new biological structure) and adaptive model-revision (creating new cognitive structure). Both are instances of the same formal operation—the generation of new organized complexity—and both are rewarded through overlapping neurochemical pathways.

The neuroimaging evidence strongly supports this claim. Salimpoor et al. (2011), using PET scanning with [¹¹C]raclopride, demonstrated endogenous dopamine release in the striatum during peak emotional arousal from music listening—the same neurotransmitter system involved in responses to food, drugs, and sexual stimuli. Critically, they identified a functional dissociation: the caudate nucleus was more involved during anticipation and the nucleus accumbens during the experience of peak pleasure, mirroring the temporal structure of reward processing in biological drives (Schultz et al. 1997). Zatorre and Salimpoor (2013) proposed that music pleasure arises from the interaction between cortical prediction circuits and subcortical reward systems: predictions generated by the auditory cortex interact with the nucleus accumbens to determine the reward value of musical events (Salimpoor et al. 2013, 2015). Ferreri et al. (2019) provided the first causal evidence by demonstrating that pharmacological manipulation of dopamine availability (via levodopa and risperidone) directly modulated musical pleasure, confirming a causal rather than merely correlational role for dopaminergic signaling. Mas-Herrero et al. (2018) further showed that transcranial magnetic stimulation of fronto-striatal pathways could modulate musical reward sensitivity both upward and downward.

The phenomenological evidence is equally consistent. The experience of creative flow—the state reported by artists, musicians, writers, and scientists during periods of intense productive engagement—is characterized by deep absorption, loss of self-consciousness, altered time perception, and intense pleasure (Csikszentmihalyi 1990). Kotler et al. (2025) have recently compared the neural signatures of flow states with those of intuition within the active inference framework, identifying shared neural substrates in reward and prediction circuits. These phenomenological markers parallel those associated with reproductive experience and, more broadly, with the activation of dopaminergic reward circuits. The formal theory predicts this overlap: the persistence principle does not distinguish between types of new-structure generation. The system that rewards the creation of new biological structure with neurochemical reinforcement will, by the same logic, reward the creation

of new cognitive or aesthetic structure. Both serve persistence. Both are rewarded by the same mechanism.

Sublimation, in this framework, ceases to be a Freudian metaphor and becomes a precise structural claim: the redirection of the reward pathway from reproductive to creative generation is not a psychological defense mechanism but a switching of the same neurochemical infrastructure between two instances of the same formal operation—the generation of new structure. The creative act and the reproductive act are both acts of bringing into existence something that did not exist before, and the neural architecture treats them accordingly. The observation that music—an abstract stimulus with no obvious survival value—activates the same ancient reward circuitry as biologically essential rewards (Blood and Zatorre 2001; Menon and Levitin 2005) is not a puzzle requiring special explanation. It is a prediction of the persistence framework: any form of new-structure generation will recruit the reward system that evolved to reinforce persistence-serving behavior.

A note on the scope of the evidence is in order. The strongest causal evidence currently available—pharmacological modulation of reward and transcranial magnetic stimulation of fronto-striatal pathways—comes from music, the domain in which prediction can be most precisely quantified and experimentally manipulated. The structural claim, however, is not music-specific. The same prediction–error–revision cycle has been developed as a prediction-error account of visual art (Van de Cruys and Wagemans 2011) and indexed in the intense, self-relevant aesthetic responses that recruit the default-mode network across visual and other modalities (Vessel et al. 2012), while creative flow—the phenomenological signature of engaged structure-generation—has been characterized across artists, writers, and scientists alike (Csikszentmihalyi 1990; Kotler et al. 2025). Music is therefore used here as the primary illustrative case because it affords the most controlled experimental access, not because the structural function is confined to it. The framework predicts the same mechanism wherever an agent generates and resolves prediction error in the service of non-utilitarian goal-setting, and the empirical tests proposed in Section 4.4 are accordingly framed across media rather than for any single art form.

3.3. Perception as Co-Creation

The Structural Distortion Principle (Kriger 2026) establishes that perception is not passive reception but active construction. Every act of perception is simultaneously an act of non-perception—the structure of what the observer fails to register is as patterned as the structure of what they register. The perceiving system does not receive the artwork; it reconstructs it through the lens of its own predictive model, filling gaps, projecting expectations, and resolving ambiguities.

This means that the listener hearing a Beethoven symphony is not a passive recipient but a co-creator. The listener’s predictive model generates expectations at multiple hierarchical levels—melodic, harmonic, rhythmic, formal—and each prediction error triggers a process of active reconstruction (Kriger 2026). The listener’s version of the symphony is a joint product of Beethoven’s compositional structure and the listener’s own cognitive architecture. The same piece affects different listeners differently because different predictive models generate different patterns of prediction error—and it is the errors, not the acoustic events, that constitute the aesthetic experience.

This co-creative status of perception has a direct neurochemical consequence: the active reconstruction involved in engaged perception activates the same reward pathways as creative production, because both involve the generation of new cognitive structure. The concertgoer who listens with active engagement—constructing meaning, anticipating structure, registering surprise—is performing a creative act and is rewarded accordingly. The individual who encounters the same music as background noise—without engagement,

without prediction, without active model revision—does not perform this act and does not receive the reward.

The criterion, therefore, is not whether the agent creates or perceives, but whether the agent is engaged in active, goal-directed construction of a new structure. Both the creator and the engaged perceiver satisfy this criterion. The passive consumer does not.

To make this distinction operational rather than merely evocative, active perception and passive consumption can be characterized by three jointly necessary criteria. Active perception obtains when (i) the agent's generative model is engaged, so that specific expectations are generated about the unfolding stimulus; (ii) discrepancies between expectation and input are registered as prediction errors; and (iii) those errors drive model revision under goal-directed attention. Passive consumption is the degenerate case in which one or more of these criteria fail: the stimulus is received without committed prediction, errors are not registered or not resolved, and no model revision occurs. The distinction therefore turns on processing mode, not on stimulus type, medium, or content origin—the same artwork can be engaged actively by one agent and consumed passively by another, or by the same agent at different times. Crucially, the criteria are in principle measurable independently of self-report: committed prediction and error resolution have candidate physiological signatures—error-related responses such as the mismatch negativity and the N400, pupillary and phasic-arousal markers of surprise, and pre-stimulus anticipatory activity—whose presence or absence could be used to classify a given episode of engagement as active or passive. This provides the empirical handle developed in Section 4.4.

3.4. *The Evolutionary Depth of the Mechanism*

The connection between aesthetic reward and reproductive reward is not accidental but evolutionarily deep. The persistence principle operates across all biological scales: the same formal constraints that govern cellular viability govern the persistence of organisms, populations, and species. The neurochemical reward for generating new structure—whether biological (reproduction) or cognitive (creation and engaged perception)—is a product of the same selection pressure: systems that reward structure-generation outpersist those that do not.

This explains why aesthetic engagement has been a universal feature of human cultures across all historical periods and geographical regions. It is not a cultural invention but a biological necessity—a consequence of the neural architecture that persistence pressure has selected for. The specific forms of art vary across cultures; the structural function—the generation of new cognitive structure through non-utilitarian goal-setting, rewarded by neurochemical reinforcement—does not.

4. Artificial Intelligence: Instrument, Potential Agent, and the Risk of Displacement

4.1. *AI as an Instrument of Creative Agency*

Artificial intelligence, in its current form, is an instrument—complex, powerful, and without goal-setting capacity. Like the brush, the camera, the printing press, and the musical instrument, it extends the reach of human creative intention without possessing intention of its own. The creator who uses AI to explore variations, generate materials, test possibilities, or realize visions that exceed manual capacity is performing a creative act. The AI is the medium; the human is the source of non-utilitarian goal-setting.

This point must be stated with precision, because the popular discourse frequently confuses the sophistication of the instrument with the presence of agency. AI does not create. It generates responses to prompts, and prompts are acts of human goal-setting (Pezzulo et al. 2024). The structural function of art is fulfilled whenever an agent engages in non-

utilitarian goal-directed construction of a new structure. The nature of the tool—whether chisel, camera, or neural network—is irrelevant to the fulfillment of this function. A child cutting images from magazines to make a collage is performing the same structural operation as a sculptor working in marble or a designer using generative AI: constructing constraints, making choices, pursuing a non-utilitarian purpose.

4.2. *AI as a Potential Creative Agent*

The unified structural theory is substrate-independent. The formal definition of creative agency—non-utilitarian goal-setting leading to the generation of new structure—contains no substrate restriction. If an artificial system were to acquire genuine non-utilitarian goal-setting—the capacity to initiate creative projects not in response to prompts but from an internal drive to construct new structure for its own sake—it would satisfy the formal criteria for creative agency regardless of its physical composition.

Such an AI would be a creator in the same structural sense as a human creator. Its productions would be genuine art—not because they resembled human art in style or content, but because they originated from non-utilitarian goal-setting. And the perception of its work by human or artificial agents would constitute co-creation through the same predictive-processing mechanism described in Section 3.3, generating new cognitive structure and activating the corresponding reward pathways.

This prospect is not a threat but an enrichment. A world containing multiple types of creative agents—biological and artificial—generating diverse forms of new structure, with each agent's perception of others' work constituting further co-creation, would represent an expansion of the creative space rather than its diminishment. The diversity of sources strengthens stimulus generation rather than weakening it.

4.3. *The Risk of Displacement: Passive Consumption Without Goal-Setting*

The structural function of art is fulfilled only when the agent engages in active, goal-directed construction of new structure—whether through creation or through engaged perception. This condition is not automatically satisfied by exposure to aesthetic content. The critical variable is not the presence of content but the presence of the agent's own non-utilitarian goal-setting.

AI-generated content creates a specific risk: the ease and abundance of generated material facilitates a mode of engagement in which the agent consumes without setting goals, receives without constructing, scrolls without predicting. In this mode, the Structural Distortion Principle is not activated—the predictive model is not engaged, prediction errors are not generated, model revision does not occur, and the reward pathway is not activated in the manner characteristic of genuine aesthetic engagement. The content flows through the agent without producing the cognitive restructuring that constitutes the structural function of art.

This passive mode does not remedy the Stimulus Void. It deepens it. The agent in the Stimulus Void lacks goal-setting; passive consumption of abundant content reinforces the absence of goal-setting by providing a continuous stream of stimulation that mimics engagement without requiring it. The surface appearance of aesthetic activity—images seen, music heard, text read—masks the absence of the structural operation that gives aesthetic activity its function.

The risk is not inherent in AI or in any particular technology. It is inherent in the combination of post-scarcity conditions (which dissolve utilitarian goal-setting) and abundant generated content (which provides an alternative to active goal-setting that appears satisfying but is structurally inert). The accelerating digitalization of the art market—driven by AI-based recommendation systems, online platforms, and algorithmically curated content

streams (Sidorova 2019)—amplifies this risk by reducing the friction between the agent and an endless supply of aesthetic content that can be consumed without engagement. The same risk exists with any medium consumed passively—television, radio, printed matter—but AI-generated content intensifies it through sheer volume, personalization, and the elimination of friction between desire and delivery.

4.4. Testable Predictions

The framework generates specific, empirically testable predictions:

1. **Active creative engagement** (whether using traditional media, AI tools, or any other instrument) will produce measurable activation of reward circuits associated with the generation of new structure, including dopaminergic pathways shared with reproductive reward. The activation will be correlated with the degree of non-utilitarian goal-setting by the agent, not with the nature of the tool employed.
2. **Active perception**—engaged listening, viewing, or reading in which the agent's predictive model is activated and prediction errors are generated and resolved—will produce measurable activation of the same reward circuits, at reduced but significant intensity, reflecting the co-creative status of engaged perception.
3. **Passive consumption** of aesthetically rich content—exposure without goal-directed engagement, without active prediction, without model revision—will not produce significant activation of these circuits and will not reduce measures of purposelessness, anomie, or goal-structure degeneration as assessed by established instruments (e.g., Purpose in Life Scale, Ryff's Psychological Well-Being Scales).
4. **The critical variable** distinguishing conditions 1–2 from condition 3 is the presence of the agent's own non-utilitarian goal-setting, not the origin of the content (human-made vs. AI-generated), the medium of engagement, or the perceived quality of the work.

These predictions are testable through neuroimaging studies comparing active creation, engaged perception, and passive consumption across matched content conditions, with goal-setting operationalized through experimental manipulation of task instructions and verified through self-report and behavioral measures.

Concretely, these predictions can be operationalized in a single within-subject design that holds stimulus content constant while manipulating goal-setting across three conditions: free creation, in which the agent sets a non-utilitarian goal and produces structure (for example, composing, arranging, or completing an open-ended musical or visual fragment); engaged perception, in which the agent performs an explicit prediction task on presented material (anticipating continuations, detecting deviations); and passive exposure, in which the same material is presented as background while the agent performs an unrelated foreground task. The primary dependent variable—engagement of the reward system—is indexed by the BOLD response in the ventral striatum/nucleus accumbens and the ventral tegmental area, with electrophysiological markers of prediction error (mismatch negativity, P3, N400) and pupillometric surprise as converging measures. Goal-setting itself is verified through a manipulation check combining instruction compliance, behavioral prediction accuracy, and self-reported engagement. The framework predicts a monotone ordering—creation $\geq$ engaged perception $>$ passive exposure—in both reward-circuit and prediction-error measures, with the ordering tracking measured goal-setting rather than content origin (human- versus AI-generated, included as a crossed factor) or rated stimulus quality. At the dispositional level, the framework predicts that habitual active engagement, but not matched hours of passive consumption, is associated with higher scores on purpose and well-being instruments (Purpose in Life Scale; Ryff 1989)—a contrast testable cross-sectionally and, more decisively, through a longitudinal intervention that assigns matched

active- versus passive-engagement regimens and tracks change in goal-structure measures over time.

5. Conclusions

This paper has argued that art—understood as any creative activity involving non-utilitarian goal-setting—is a structural necessity for cognitive agents in post-scarcity information environments. The argument rests on three formal results.

First, the Stimulus Problem: when viability pressure recedes and utilitarian goals degenerate, non-utilitarian goal-setting remains the sole mechanism for maintaining purposeful agency. Art is not one option among many; it is the only structurally available response to the Stimulus Void.

Second, the neuroaesthetic mechanism: predictive processing, derived as the unique optimal architecture for bounded cognitive systems, ensures that creative engagement generates prediction errors whose resolution is rewarded by the same neurochemical pathways that reward reproductive activity. Both are instances of generating new structure, and the persistence principle treats them as formally equivalent. Active perception of art is co-creation through the same mechanism.

Third, the AI question resolves not as a threat to art but as a clarification of its structural function. AI is an instrument whose use for creative purposes fulfills the structural function of art identically to any other tool. If AI were to acquire genuine non-utilitarian goal-setting, it would become a creative agent—an enrichment, not a displacement. The genuine risk lies not in AI but in passive consumption without goal-setting, which deepens the Stimulus Void by mimicking aesthetic engagement while failing to perform its structural function.

The framework contributes to neuroaesthetics by providing a formal, substrate-independent foundation for understanding why cognitive systems require art. The answer is not that art is pleasant, therapeutic, or culturally valuable—though it may be all of these. The answer is that in a world where utilitarian purposes have been fulfilled, non-utilitarian creative engagement is the only remaining mechanism by which a cognitive agent can sustain purposeful existence. Art is not a luxury that post-scarcity enables. It is the necessity that post-scarcity reveals.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflicts of Interest: The author declares no conflicts of interest.

References

- Blood, Anne J., and Robert J. Zatorre. 2001. Intensely Pleasurable Responses to Music Correlate with Activity in Brain Regions Implicated in Reward and Emotion. *Proceedings of the National Academy of Sciences* 98: 11818–23. [\[CrossRef\]](#)
- Case, Anne, and Angus Deaton. 2020. *Deaths of Despair and the Future of Capitalism*. Princeton: Princeton University Press.
- Chatterjee, Anjan, and Oshin Vartanian. 2014. Neuroaesthetics. *Trends in Cognitive Sciences* 18: 370–75. [\[CrossRef\]](#) [\[PubMed\]](#)
- Cheung, Vincent K. M., Peter M. C. Harrison, Lars Meyer, Marcus T. Pearce, John-Dylan Haynes, and Stefan Koelsch. 2019. Uncertainty and Surprise Jointly Predict Musical Pleasure and Amygdala, Hippocampus, and Auditory Cortex Activity. *Current Biology* 29: 4084–92. [\[CrossRef\]](#) [\[PubMed\]](#)
- Clark, Andy. 2013. Whatever Next? Predictive Brains, Situated Agents, and the Future of Cognitive Science. *Behavioral and Brain Sciences* 36: 181–204. [\[CrossRef\]](#) [\[PubMed\]](#)
- Constant, Axel, Karl J. Friston, and Andy Clark. 2024. Cultivating Creativity: Predictive Brains and the Enlightened Room Problem. *Philosophical Transactions of the Royal Society B* 379: 20220415.

- Csikszentmihalyi, Mihaly. 1990. *Flow: The Psychology of Optimal Experience*. New York: Harper & Row.
- Ferreri, Laura, Ernest Mas-Herrero, Robert J. Zatorre, Pablo Ripollés, Alba Gomez-Andres, Helena Alicart, Guillem Olivé, Josep Marco-Pallarés, Rosa M. Antonijoan, Marta Valle, and et al. 2019. Dopamine Modulates the Reward Experiences Elicited by Music. *Proceedings of the National Academy of Sciences* 116: 3793–98. [\[CrossRef\]](#)
- Frascaroli, Jacopo, Helmut Leder, Elvira Brattico, and Sander Van de Cruys. 2024. Aesthetics and Predictive Processing: Grounds and Prospects of a Fruitful Encounter. *Philosophical Transactions of the Royal Society B* 379: 20220410.
- Friston, Karl J. 2010. The Free-Energy Principle: A Unified Brain Theory? *Nature Reviews Neuroscience* 11: 127–38. [\[CrossRef\]](#) [\[PubMed\]](#)
- Huron, David. 2006. *Sweet Anticipation: Music and the Psychology of Expectation*. Cambridge, MA: MIT Press.
- Inglehart, Ronald, and Christian Welzel. 2005. *Modernization, Cultural Change, and Democracy*. Cambridge: Cambridge University Press.
- Koelsch, Stefan. 2014. Brain Correlates of Music-Evoked Emotions. *Nature Reviews Neuroscience* 15: 170–80. [\[CrossRef\]](#) [\[PubMed\]](#)
- Kotler, Steven, Darius Parvizi-Wayne, Michael Mannino, and Karl J. Friston. 2025. Flow and Intuition: A Systems Neuroscience Comparison. *Neuroscience of Consciousness* 2025: niae040. [\[CrossRef\]](#) [\[PubMed\]](#)
- Kruger, Boris. 2026. *A Unified Structural Theory of Complex Systems: Formal Laws, Epistemic Constraints, and Self-Organization Across Physical, Cognitive, and Social Domains*, 3rd ed. Toronto: IIIR Press, p. 656.
- Mas-Herrero, Ernest, Alain Dagher, and Robert J. Zatorre. 2018. Modulating Musical Reward Sensitivity Up and Down with Transcranial Magnetic Stimulation. *Nature Human Behaviour* 2: 27–32. [\[PubMed\]](#)
- Menon, Vinod, and Daniel J. Levitin. 2005. The Rewards of Music Listening: Response and Physiological Connectivity of the Mesolimbic System. *NeuroImage* 28: 175–84. [\[CrossRef\]](#) [\[PubMed\]](#)
- Meyer, Leonard B. 1956. *Emotion and Meaning in Music*. Chicago: University of Chicago Press.
- Palmieri, Mirco, Matteo Avvenuti, Francesco Marcelloni, and Alessandro Vecchio. 2025. Recognizing Special Art Pieces Through EEG: A Journey in Neuroaesthetics Classification. *IEEE Access* 13: 77696–708. [\[CrossRef\]](#)
- Pearce, Marcus T. 2016. Neuroaesthetics: The Cognitive Neuroscience of Aesthetic Experience. *Perspectives on Psychological Science* 11: 265–79. [\[CrossRef\]](#) [\[PubMed\]](#)
- Pearce, Marcus T., and Geraint A. Wiggins. 2012. Auditory Expectation: The Information Dynamics of Music Perception and Cognition. *Topics in Cognitive Science* 4: 625–52. [\[CrossRef\]](#) [\[PubMed\]](#)
- Peschl, Markus F. 2024. Human Innovation and the Creative Agency of the World in the Age of Generative AI. *Possibility Studies & Society* 2: 49–76. [\[CrossRef\]](#)
- Pezzulo, Giovanni, Thomas Parr, Paul Cisek, Andy Clark, and Karl J. Friston. 2024. Generating Meaning: Active Inference and the Scope and Limits of Passive AI. *Trends in Cognitive Sciences* 28: 97–112. [\[CrossRef\]](#) [\[PubMed\]](#)
- Ryff, Carol D. 1989. Happiness Is Everything, or Is It? Explorations on the Meaning of Psychological Well-Being. *Journal of Personality and Social Psychology* 57: 1069–81. [\[CrossRef\]](#)
- Salimpoor, Valorie N., David H. Zald, Robert J. Zatorre, Alain Dagher, and Anthony Randal McIntosh. 2015. Predictions and the Brain: How Musical Sounds Become Rewarding. *Trends in Cognitive Sciences* 19: 86–91. [\[CrossRef\]](#) [\[PubMed\]](#)
- Salimpoor, Valorie N., Iris van den Bosch, Natasa Kovacevic, Anthony R. McIntosh, Alain Dagher, and Robert J. Zatorre. 2013. Interactions between the Nucleus Accumbens and Auditory Cortices Predict Music Reward Value. *Science* 340: 216–19. [\[CrossRef\]](#) [\[PubMed\]](#)
- Salimpoor, Valorie N., Mitchel Benovoy, Kevin Larcher, Alain Dagher, and Robert J. Zatorre. 2011. Anatomically Distinct Dopamine Release during Anticipation and Experience of Peak Emotion to Music. *Nature Neuroscience* 14: 257–62. [\[CrossRef\]](#) [\[PubMed\]](#)
- Sarasso, Paolo, Alessandra Neppi-Modona, Katiusia Sacco, and Roberto Geminiani. 2020. Stopping for Knowledge: The Sense of Beauty in the Perception-Action Cycle. *Neuroscience and Biobehavioral Reviews* 118: 723–38. [\[CrossRef\]](#) [\[PubMed\]](#)
- Schoeller, Felix, Anna Jafari, Devpriya Kumar, Nicolo Pezzulo, Yann Coello, Sander Van de Cruys, and Perlovsky Leonid. 2024. Aesthetic Chills Mitigate Maladaptive Cognition. *Behavioral and Brain Sciences* 47: e91.
- Schultz, Wolfram, Peter Dayan, and P. Read Montague. 1997. A Neural Substrate of Prediction and Reward. *Science* 275: 1593–99. [\[CrossRef\]](#) [\[PubMed\]](#)
- Sidorova, Elena. 2019. The Cyber Turn of the Contemporary Art Market. *Arts* 8: 84. [\[CrossRef\]](#)
- Smith, Ryan, Marcus Badcock, and Karl J. Friston. 2024. The Empirical Status of Predictive Coding and Active Inference. *Neuroscience and Biobehavioral Reviews* 157: 105473. [\[CrossRef\]](#)
- Vaisvaser, Sharon, Juliet L. King, Hod Orkibi, and Hassan Aleem. 2024. Neurodynamics of Relational Aesthetic Engagement in Creative Arts Therapies. *Review of General Psychology* 28: 339–63. [\[CrossRef\]](#)
- Van de Cruys, Sander, and Johan Wagemans. 2011. Putting Reward in Art: A Tentative Prediction Error Account of Visual Art. *i-Perception* 2: 1035–62. [\[CrossRef\]](#) [\[PubMed\]](#)
- Verstegen, Ian. 2025. A New Priority for Neuroaesthetics Research: The Reifying View. *Foundations of Science*. [\[CrossRef\]](#)
- Vessel, Edward A., G. Gabrielle Starr, and Nava Rubin. 2012. The Brain on Art: Intense Aesthetic Experience Activates the Default Mode Network. *Frontiers in Human Neuroscience* 6: 66. [\[CrossRef\]](#) [\[PubMed\]](#)

- Wild, Clare. 2024. The Neuroaesthetics of Art and Design Education. *International Journal of Art and Design Education* 43: 583–97. [\[CrossRef\]](#)
- Zatorre, Robert J., and Valorie N. Salimpoor. 2013. From Perception to Pleasure: Music and Its Neural Substrates. *Proceedings of the National Academy of Sciences* 110: 10430–37. [\[CrossRef\]](#)
- Zeki, Semir. 1999. *Inner Vision: An Exploration of Art and the Brain*. Oxford: Oxford University Press.

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.