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Article

Platonic Space as Cognitive Construct: Toward a Framework of Cognitive Platonism/Platonic Cognition

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Abstract

Classical Platonism posits a transcendent realm of ideal Forms, but this metaphysical stance is difficult to reconcile with naturalistic accounts of knowledge and cognition. At the same time, cognitive science and biology increasingly rely on abstract structures, such as internal models, morphological constraints, and predictive priors, to explain behavior and organization. This paper proposes a naturalized reinterpretation of Platonism, grounded in the idea that form functions not as a static blueprint but as a constraint within generative processes. Drawing from process philosophy, computational neuroscience, and developmental biology, it introduces the framework of Cognitive Platonism/Platonic Cognition: the view that abstract structure is real insofar as it organizes system dynamics as process of becoming. Forms are not external templates but emergent patterns encoded in systems memory, inference, and interaction. They shape perception, morphogenesis, and agency by narrowing the space of viable trajectories, offering a principled solution to the problem of form within a naturalistic worldview.

Keywords: platonic forms; platonic space; cognition; cognitive platonism; platonic cognition

Introduction

The status of abstract forms has been a problem in philosophy and science since antiquity. The Plato proposal that abstract forms possess explanatory priority over their material instances has influenced philosophical and scientific traditions for more than two millennia. In dialogues such as the *Republic* and *Phaedo*, forms are described as stable ideal structures underlying the intelligibility and identity of phenomena, while material objects are regarded as imperfect instantiations of these ideal patterns (Plato, 1997), (Cooper, 1997). Later thinkers extended and reinterpreted this insight. Aristotle reframed Forms as *formal causes*, distinguishing them from *efficient causes* grounded in physical forces (Aristotle, 1984). Kant internalized ideal structure into the conditions that make cognition possible, locating form not in a transcendent realm but in the organizing principles that shape experience (Kant, 1998). Husserl emphasized ideality as invariant structure disclosed through phenomenological analysis rather than metaphysical assertion (Husserl, 1913). Constructivist and enactive approaches later recast knowledge as emerging from the organization of experience by embodied cognitive systems (Piaget, 1952; Maturana & Varela, 1980; Varela, Thompson, & Rosch, 1991). Across this intellectual history runs a consistent insight: explanation depends not on the material particulars of phenomena, but on the abstract structures generated through cognitive processes, that constrain and organize them.

This constructivist insight, that abstract forms emerge through the organization of experience, finds a parallel in recent scientific research. Developments in theoretical biology, neuroscience, and computational modeling reveal that biological systems rely not only on physical interactions but on

informational architectures that guide behavior and development. These architectures do not represent fixed templates imposed from outside but arise as internally constructed, operational constraints that regulate system dynamics.

For example, research in regenerative biology shows that tissues appear to reference a target morphology—an internal representation of anatomical structure that persists even after injury. Michael Levin’s work demonstrates that this target is not genetically hard-coded but encoded in dynamic bioelectric networks, which function as distributed control systems (Levin, 2017, 2023). These internal guides act like cognitive constructs: they constrain and steer development toward viable outcomes by shaping the space of future states optimized through dynamic adaptation to environmental and internal constraints. Alterations to informational constraints can redirect developmental trajectories without modifying genomic content, indicating that ideal forms function as causal constraints that shape system dynamics.

Parallel developments in theoretical neuroscience conceptualize perception and action as processes of predictive inference guided by generative models that encode abstract expectations and minimize uncertainty (Friston, 2010). These models function as idealized structures that regulate behavior through constraint rather than through mechanistic pushing. In computational theory, Wolfram (2021) proposes that the space of possible computations, the *Ruliad*, constitutes a real structure that constrains laws of physics and mathematics. Tegmark (2014) embraces a Platonist outlook that ideal forms (mathematical objects) are real and fundamental, and he extends this to claim the entire physical cosmos and multiverse are manifestations of mathematical structures, making mathematics the ultimate reality itself. Theoretical accounts of constraint-based and teleodynamic causation argue that organization, rather than force, determines system trajectories (Juarrero, 1999; Deacon, 2011). Across these frameworks, abstract structures exert influence by restricting the space of possible states and guiding system behavior.

This paper advances the concept of Cognitive Platonism/Platonic Cognition, which interprets abstract forms as real in an operational sense: real insofar as they function as causally efficacious constraints implemented within cognitive generative architectures. On this view, what classical philosophy interpreted as a transcendent realm is understood as the result of cognitive processes that extract, stabilize, and externalize invariants across real-world experiences. Ideal structures appear transcendent because of their stability, generality, and independence from particular instances. However, their origin lies in the cognitive processes resulting from the interactions of cognitive agents with the world, rather than in a metaphysical domain. On this view, ideal structures function as attractors within generative models that organisms use to regulate interaction with the world, and their apparent objectivity arises from convergence across cognitive systems exposed to similar constraints.

This interpretation preserves the explanatory insights of Plato’s perspective while situating it within a naturalistic framework grounded in contemporary science.

In this framework, cognition is not confined to human-level reasoning or symbolic thought. Instead, it follows the view advanced by Maturana and Varela (1980), Stewart (1996), and others, that life is inherently cognitive. All living systems—from bacteria to human beings—exhibit forms of regulation, memory, and anticipatory behavior that satisfy the minimal criteria of cognition. On this view, cognition and life co-emerge: to live is to engage in adaptive, self-organizing interaction with an environment, guided by internal informational constraints. This broader definition grounds the proposal that abstract forms, or operational invariants, are not the exclusive product of human intellect but are enacted throughout biological systems.

The argument proceeds as follows. Section 2 reinterprets Plato’s theory of Forms through a cognitive lens, proposing that the “real world of ideal bodies” described in the *Republic* refers not to a transcendent domain but to a structured space of abstractions generated through cognitive processes. It traces a historical lineage from Plato through Kant, Husserl, constructivism, Spinoza, and Whitehead, demonstrating a progressive recognition that intelligibility emerges from the structuring activity of cognition. Section 3 examines contemporary scientific contexts in which

abstract forms are treated as causally real, including developmental biology, computational ontology, and predictive processing. Section 4 develops Cognitive Platonism as a conceptual framework that naturalizes the causal efficacy of forms in terms of constraint-based causation and generative modeling. Section 5 explores implications for philosophy of science, biological teleology, mathematics, and artificial cognition as well as future directions. Section 6 concludes by reframing the Platonic view that form precedes matter in explanation, through a naturalistic account of form as a cognitive construct.

By relocating Platonic space within the architecture of cognition while preserving the causal and explanatory role of abstract forms, this framework relates ancient philosophical intuition with contemporary scientific insight. It provides a conceptual foundation for understanding how minds construct and deploy ideal structures, not as illusions or transcendent realities, but as operational realities: constraints that enable living systems to survive and act in the world.

1. Reinterpreting Plato

Plato's doctrine of Forms (Plato, 1997; Cooper, 1997) was originally framed as a metaphysical solution to the problem of knowledge. For Plato, the empirical world presented through the senses is unstable and incomplete: objects change, perish, and differ from one instance to another. Yet human cognition grasps stable, universal truths, such as mathematical principles or ideal geometric shapes, that appear independent of any particular physical instantiation. To explain this, Plato posits the existence of a higher ontological domain: a realm of perfect, immutable Forms. These ideal entities, such as perfect circles or just actions, are more real than their sensory counterparts because they are causes rather than effects. In the *Republic* (Plato, 1997), the allegory of the cave dramatizes this distinction: the perceived world is only a shadow, and true reality lies outside the cave in the light of ideal objects.

Traditionally, interpreters, e.g., (Fine, 1999) have taken Plato's account to imply a radical dualism between the sensible and the intelligible, a metaphysical separation between the physical world and an ontologically independent space of abstract entities. However, such a reading leaves unexplained how human beings could access or interact with this assumed realm, and why the structure of human knowledge should mirror its structure. If Forms are transcendent and outside space and time, by what mechanism do they inform perception and reasoning? This metaphysical gap has historically been one of the central weaknesses of classical Platonism.

A different interpretation becomes available if we read Plato not as describing a supernatural domain, but as articulating a fundamental feature of cognition. On this view, the "realm of Forms" refers not to a metaphysical location, but to a structured space of idealized cognitive constructs that human minds generate through abstraction. The ascent from shadows to light in the cave allegory can be seen as the process by which cognitive systems extract invariants from sensory experience, compressing variation into stable structures that support prediction and reasoning. The "perfect circle", for example, does not exist in the external world; it exists as an attractor within conceptual space, a limit construction generated by the capacity to idealize and generalize based on perception.

Interpreted this way, the realism Plato attributes to Forms does not require locating them outside the physical universe. Instead, their reality consists in their causal and predictive efficacy. Ideal forms are real to the extent that they constrain reasoning, guide action, and enable reliable inference. In this operational sense, a form is real if it makes a difference, and functions as an invariant pattern structuring cognition and shaping behavior. Thus, the world of Forms is not separate from human minds, but emerges within them, yet not as subjective fantasies, but as compressed information shaped by the regularities of the world and stabilized by intersubjective communication.

This reinterpretation preserves Plato's insight that ideal structures are primary to understanding and explanation, while dissolving the metaphysical burden traditionally associated with them. It opens a path toward integrating Plato with contemporary theories of cognition, computation, and biological agency, in which abstract structures function as control constraints and generative models. On this reading, Plato was correct about the existence and causal power of forms but mistaken about

their location. The real world of ideal bodies is not beyond physical reality, but within the cognitive architectures through which living systems navigate.

2. Historical Lineage Toward Cognitive Platonism/Platonic Cognition

The reinterpretation of Platonic forms as cognitive constructs rather than metaphysical entities gains support when viewed through the trajectory of philosophical developments that followed Plato. Across more than two millennia, a recurrent theme appears: the recognition that the structure of reality as known to us is mediated by the structures and processes of cognition. Rather than discovering independent transcendent objects, cognition actively constitutes the form of what is intelligible. Against this background, Cognitive Platonism/Platonic Cognition can be seen not as a radical departure but as the consolidation of a long intellectual progression.

2.1. Kant: Forms as Conditions of Cognition

Immanuel Kant marks a decisive transformation (Kant, 1998; Bird, 2025; Williams, 2024) in the understanding of abstraction and objectivity. While rejecting the existence of a metaphysical realm of Forms, Kant preserves the idea that certain structures like space, time, causality, and substance, have a status more fundamental than empirical observation. For Kant, these are not features of things in themselves but a priori forms of sensibility and categories of understanding that make experience possible. Reality as we know it is shaped by the cognitive apparatus through which it is apprehended.

In Kant's framework, the distinction between noumena and phenomena parallels the Platonic distinction between real objects and their shadows, yet with a critical shift: the structure of experience reflects the mind's organizing activity, not access to transcendent ideals. The apparent objectivity and universality of mathematical and scientific knowledge arise from invariant cognitive structures shared by all rational agents. This move relocates the locus of universality from a metaphysical domain to a cognitive one, preceding the core tenet of Cognitive Platonism/Platonic Cognition. In sum, Kant's philosophy reshapes Platonic idealism into a transcendental idealism where the mind actively constructs experience, shifting the foundation of objectivity from metaphysical realms to epistemic structures.

2.2. Husserl and the Constitution of Ideal Objects

Husserl extends this line of thinking (Husserl, 1983) by examining how ideal objects are constituted within intentional consciousness. In his analysis of mathematical entities, Husserl argues that ideal structures do not exist independently of conscious acts, yet they exhibit objectivity through their reproducibility and intersubjective validity. An ideal triangle is not a physical object, nor an individual mental image, but a constructed invariant that remains accessible through iterative cognitive operations. Husserl thus provides phenomenological grounding for the view that abstract forms acquire reality functioning as stable structures across acts of cognition.

2.3. Constructivism and Enactivism

Unlike Plato who conceives Forms as metaphysically real, timeless, and existing independently of cognition or activity, twentieth-century constructivist thinkers reject the idea of independently existing forms. They hold that knowledge, including abstract invariants like shapes or categories, emerges through active sensorimotor engagement and cognitive organization. Rather than discovering pre-existing forms "out there," organisms *construct* meaningful invariants through ongoing interaction with their environment, which then function as causal and predictive regulators of behavior (Piaget, 1952; Maturana & Varela, 1980; Varela, Thompson, & Rosch, 1991). Biological organisms build internal models that guide adaptive interaction, and these models determine what counts as meaningful structure. Enactivism explicitly rejects the spectator view of cognition, proposing instead that organisms enact a world through sensorimotor engagement and

organizational closure. On this view, invariants are *constructed through activity* yet possess causal and predictive power precisely because they regulate that activity.

2.4. Spinoza: Dual-Aspect Monism and Structural Causality

Spinoza offers an important precursor (Spinoza, 1985) to a non-dualistic reinterpretation of Plato. Rejecting the separation between mind and body, Spinoza proposes that both thought and extension are attributes of a single underlying substance. On this view, ideas and physical processes are not fundamentally distinct kinds of entities but different aspects of the same underlying reality. Abstract forms can be understood as the formal aspect of organization within nature. Spinoza's monism thus anticipates the principle that structure and form have causal significance without existing in a transcendent domain.

2.5. Whitehead: Process Ontology and the Efficacy of Form

Whitehead extends this line of reasoning (Whitehead, 1978) into a full process ontology, arguing that the fundamental constituents of reality are not substances but events and relations. For Whitehead, form is not static but emerges from the dynamic patterning of processes. "Eternal objects," Whitehead's analogue to Platonic forms, provide the potential structures that constrain and shape actual occasions of experience. They are real insofar as they function as lures for becoming, guiding the organization of processes. This interpretation replaces Platonic essences with patterns of possibility that exert causal influence by limiting and structuring what can occur.

Whitehead's metaphysics, particularly his notions of eternal objects, prehension, and concrescence, offer a framework for understanding the causal efficacy of abstract forms in a way that aligns with Cognitive Platonism/Platonic Cognition. Whitehead describes eternal objects as potentialities for patterning actual occasions - formal possibilities that are not themselves instantiated but condition what can be realized in each process of becoming. This aligns closely with the operational definition of abstract forms as constraints or attractors guiding system behavior. Whitehead's processual account of reality centers on concrescence, the integration of diverse influences: past actualities, present data, and eternal potentials, into a unified *experiential* event. This can be interpreted as a model for generative cognition: each cognitive act is a concrescent synthesis of memory, sensory input, values, and ideal structures. *Prehension*, the mode through which an occasion takes account of others, echoes the information integration found in anticipatory systems and predictive models (Dodig-Crnkovic, 2025).

Whitehead's system thus avoids a dualism of matter and form. The process of becoming is inherently structured by form. The eternal objects do not cause by force, but lure each actual occasion toward particular patterns of realization. This parallels how ideal forms in biological and cognitive systems act not through direct efficient causation but by narrowing the field of viable futures - a cognitive equivalent of Whitehead's lures.

Consequently, Whitehead's philosophy provides a metaphysical grounding for the kinds of constraint-based causality described in contemporary science and formalized here as Cognitive Platonism/Platonic Cognition. Platonic space is not transcendent but immanent in the generative architecture of cognition and biological organization.

Together, Spinoza and Whitehead offer a framework in which abstract structures are real as relational and organizational constraints, not as separate substances. Their work provides philosophical grounding for understanding form as causally efficacious through constraint and organization which is an idea that aligns closely with contemporary process biology and anticipatory systems theory.

2.6. Section Summary

Viewed in historical continuity, the reinterpretation of Plato aligns with a larger philosophical trajectory. What begins as a metaphysical doctrine evolves toward a cognitive and operational

account of abstraction. The core insight retained from Plato: understanding depends on ideal structures rather than concrete particulars. What changes is the ontological location of those structures, shifting from a transcendent realm to the generative architecture of cognition.

This historical progression prepares the ground for integrating contemporary scientific developments in developmental biology, neuroscience, and computational theory, where abstract structures demonstrably exert causal influence. The following section turns to these scientific cases, focusing on recent work that implicitly relies on a Platonic conceptual vocabulary, yet can be made coherent only through a cognitive reinterpretation.

3. Contemporary Scientific Context

Recent work in developmental biology, computational theory, and theoretical neuroscience has revived concepts that resemble Plato's claim that ideal forms possess causal power. Researchers such as Stephen Wolfram, Max Tegmark, Karl Friston, and Michael Levin speak about the reality of abstract structures, computational possibility spaces, invariant patterns, and target forms as drivers of physical processes. These perspectives suggest that physics, mathematics and biology operate with reference to idealized end-states or structural constraints, not merely physical interactions. Yet these accounts often lack a clarifying ontology: what does it mean for an abstract form to be real, and how can something non-material exert causal influence? Interpreting these scientific developments through the framework established in earlier sections reveals a coherent explanation: abstract forms have operational reality as constraints encoded within cognitive generative systems. Their causal power derives from their role in shaping and predicting the behavior of physical systems.

3.1. Stephen Wolfram: *Computational Universe, the Ruliad and the Reality of the Possible*

Stephen Wolfram's work on computational universe introduces the concept of the Ruliad (Wolfram, 2021), which he describes as the space of all possible computations generated by all possible rules. For Wolfram, the Ruliad is not a theoretical abstraction but a real structure that underlies the universe; the laws of physics arise from observers embedded within this computational possibility space. In this view, mathematical entities are not human inventions but components of a real computational ontology; they exist whether or not humans think them.

However, the ontological status of the Ruliad remains unclear. If taken literally as an infinite computational object existing independently of minds, it reintroduces the difficulties associated with classical Platonic metaphysics: where does such a structure exist, and how is it causally connected to the physical world? Through the perspective of Cognitive Platonism/Platonic Cognition, the Ruliad can instead be understood as a maximal cognitive construct, a conceptual idealization that organizes scientific understanding by providing a unified framework for interpreting computation, physics, and mathematics. Its reality lies in its explanatory and predictive power: its capacity to constrain and guide reasoning across domains. In this operational sense, the Ruliad is a Platonic structure real as a constraint, not as a metaphysical entity.

3.2. Max Tegmark: *Mathematical Universe*

Max Tegmark extends this philosophical line into the realm of physics and cosmology with his Mathematical Universe Hypothesis (MUH) (Tegmark, 2007). According to Tegmark, the fundamental nature of reality is not merely described by mathematics but is itself a mathematical structure. This radical Platonism posits that all mathematical structures that exist mathematically also exist physically, forming a vast multiverse of all possible mathematical realities. In this framework, physical existence and mathematical existence are equated: every consistent mathematical object is a physically real universe. Observers, including conscious beings, are seen as self-aware substructures within these mathematical structures, experiencing what they perceive as a physical world.

Tegmark's eternal "forms" correspond to mathematical objects and structures that constrain and define the properties of universes, much like Platonic forms serve as eternal archetypes. However,

unlike static Platonic essences, these are mathematical structures that encompass all consistent possibilities and include the observer-dependent perception of reality emerging from complex mathematical patterns.

3.3. Michael Levin: Target Morphology and the Causal Power of Ideal Forms

Michael Levin's work on morphogenesis and bioelectric control in development provides a case in which abstract forms appear to govern physical processes. Levin argues that cells and tissues maintain representations of an organism's correct anatomical structure and use these internal models to guide growth, regeneration, and repair. The *target morphology*, the ideal anatomical form, is treated as a real causal object that constrains cellular behavior: tissues act to minimize the difference between current and desired anatomical states. Experiments in planarian regeneration (Lobo & Levin, 2015) and bioelectric reprogramming (Levin, 2017) demonstrate that altering informational patterns can change the body plan without altering DNA sequence. Levin frequently uses explicitly Platonic language, describing target forms as "goals," "memories of correct anatomy," and "desired morphological outcomes." On a classical metaphysical reading, this would imply belief in immaterial forms with independent existence.

In (Zhang, Goldstein, Levin, 2024), interpretation of morphogenetic control invokes a metaphysical realism about abstract forms, treating patterns and goal states as if they exist *independently* of the system that interprets or enacts them. However, if observer-dependence is taken seriously, the apparent agency of forms must be reframed: instead of Platonic structures "irrupting" into material processes, cognitive observers project, stabilize, and reify certain regularities as forms. The generative models used to describe or manipulate biological systems are themselves products of cognitive processes. On this view, the causal role of form arises not from metaphysical agency but from the way cognitive systems including scientists, organize, interpret, and interact with their environments. Platonic space, then, is a space of *expectation (or anticipation)*, enacted within observers' generative architecture. Within the framework of Platonic Cognition, the target morphology is understood as a cognitive construct instantiated in distributed control architecture, functioning as an attractor in the system's state space. It is real because it shapes outcomes, because it acts as a constraint that organizes matter and directs development.

From an info-computational (relational, process-based) perspective the form is enacted through computation: the iterative, state-sensitive interactions among agents that integrate past configurations and anticipate future outcomes (Dodig-Crnkovic, 2025). In this sense, the causal power of the target morphology does not lie in reified information outside the system but in the structured dynamics of a system actively computing its own viability.

Levin's experimental findings support a processual understanding of abstract form: the target morphology is real and efficacious not because it exists apart from the organism, but because it is instantiated through its ongoing computational dynamics, (Manicka and Levin, 2022).

3.4. Karl Friston: Predictive Processing and the Geometry of Generative Models

The predictive processing and free-energy frameworks in neuroscience (Friston, 2010) provide a natural bridge between abstract forms and internal cognitive architecture. In these models, perception, action, and learning are driven by generative models that predict sensory input and minimize prediction error. These internal models are not symbolic representations but high-dimensional geometric structures in neural state space. Abstract concepts, categories, and mathematical objects correspond to invariant patterns within these generative spaces. Their reality is measured by their stability, generalizability, and capacity to control behavior.

Within this framework, ideal forms possess causal power because they determine which actions are selected, which perceptions are prioritized, and which models survive. Abstract forms are not external to the mind but constituted through the internal dynamics of predictive control, functioning as attractors that organize inference and learning. Predictive processing thereby provides a

mechanistic account of how ideal forms are implemented biologically and why they exert operational causal influence.

3.5. Section Summary

Across contemporary computational theory, mathematics, biology, and neuroscience, abstract structures are treated as causally efficacious determinants of physical processes. Rather than interpreting this as evidence for metaphysical Platonism, these developments are better understood through the framework proposed here. Abstract forms are real as constraints implemented in cognitive generative systems that guide and predict the behavior of physical systems.

This sets the stage for a unified account of Platonic space as a cognitive construct, developed formally in the next section.

4. Mechanisms of Cognitive Platonism/Platonic Cognition

The preceding analysis motivates a reinterpretation of the classical Platonic claim that abstract Forms are real and explanatory, that they ground the identity and intelligibility of phenomena. Rather than locating forms in a transcendent metaphysical domain, Cognitive Platonism/Platonic Cognition proposes that abstract forms are real as causal and predictive constraints implemented within cognitive generative systems. Their reality is operational rather than ontological in the classical sense: forms are real because they structure behavior, development, reasoning, and perception. They make a difference. This pragmatic definition avoids both metaphysical dualism and eliminative nominalism, providing a naturalistic account of the status of abstract structures in science and cognition.

4.1. Defining Cognitive Platonism/Platonic Cognition

Cognitive Platonism/Platonic Cognition holds that Platonic space, the domain of abstract forms, is a structured space of idealized cognitive constructs generated by biological and cultural systems to model, predict, and control interactions with the world. Abstract forms are real insofar as they function as constraints that shape physical processes, guide action, and enable successful prediction. In this view, the reality of an abstract form is not a matter of independent metaphysical existence but of operational efficacy. A form is real if its presence or absence changes what happens. Its identity is not determined by material constitution but by its role in constraining possibilities and guiding trajectories. This framing is compatible with contemporary accounts of constraint-based causation and predictive control in living systems, and it offers a precise interpretation of the causal language employed by researchers such as Levin, Tegmark, Friston and Wolfram.

4.2. Operational Reality = Causal Efficacy

To say that an abstract form is real is to say that it shapes outcomes in a system. Operationally, a form is real if it exerts causal influence by constraining the space of possible states, enables accurate prediction and coordinated action, and persists across transformations and contexts. Under this definition, the reality of a form is measured not by material presence, but by capacity of making a difference. A mathematical principle, an anatomical blueprint, or a computational ideal is real to the extent that it systematically organizes behavior and dynamics. This relocates explanation from objects to patterns and from substance to organization.

4.3. The modalities of Platonic Space

Cognitive Platonism/Platonic Cognition identifies three interrelated modalities in which abstract forms exist and operate. All are cognitive, but each expresses a different dimension of implementation and effect.

Table 1. Modalities of Cognitive Platonism/Platonic Cognition.

Modality	Location	Description	Information for	Operational Reality
Ontological / Structural	Invariants of natural processes as modeled by cognition	Forms as optimal compressions of regularities	Information for systems that can observe them	Supports counterfactual generalizability
Biological / Neural	Dynamics of tissues, nervous systems, control architectures	Forms as attractors in generative models guiding behavior and development	Informational for the organism's regulatory architecture	Constrains action and inference
Symbolic / Cultural	Languages, shared practices	Forms as intersubjectively stabilized abstractions	Information for communities that share interpretive norms	Enables stable prediction and coordination

These modalities are projections of a single underlying cognitive process, not separate ontological realms. They appear distinct because they differ in scale and implementation, but they serve the same functional role: the extraction, stabilization, and deployment of invariants.

4.4. Causal Efficacy Without Metaphysical Transcendence

Cognitive Platonism/Platonic Cognition resolves the apparent paradox of causally efficacious ideal forms not by assigning them supernatural status, but by grounding their causal power in organizational and constraint-based causation. The causal force of a target morphology, a mathematical truth, or a computational invariant lies in its ability to exclude possibilities and direct processes toward particular outcomes. In biological systems, such constraints operate through predictive regulation and error-minimization; in mathematics, through deductive structure; in culture, through normative coordination.

Thus, forms cause without pushing. They act by constraining, not by exerting physical force. This conception is continuous with modern theories of self-organization, control, and anticipatory agency.

4.5. Resolving the Realism–Anti-Realism Problem

Cognitive Platonism/Platonic Cognition avoids the binary alternatives that have long structured debates about abstraction. It rejects classical metaphysical Platonism because it does not posit a separate realm of ideal objects. It rejects nominalism because it does not treat forms as arbitrary or merely subjective. It rejects reductionist materialism because it recognizes non-substantial causal structures.

Instead, it proposes a process-based, constructivist realism in which forms are real as constraints implemented through cognitive architectures that track, compress, and leverage world regularities. Abstract forms appear universal because cognitive systems converge on similar models when exposed to similar constraints.

4.6. *Virtual Machine as an Analogy for Platonic Cognition*

A useful way to understand how abstract structures can be real and causally efficacious without being material objects is through the idea of a virtual machine. In computer science, a virtual machine is not a physical device; it has no mass or physical components of its own. Instead, it is a layer of organized rules and processes that runs on top of physical hardware, using the underlying machine to implement its operations. A virtual machine can perform functions, run programs, and produce meaningful results, even though it is not itself made of physical substance. Its reality is functional and causal, not material.

This provides a helpful model for understanding the status of abstract forms such as mathematical structures, laws, norms, or internal models in cognition. These structures are not located in any single neuron or material object, and they are not reducible to a specific physical configuration. Instead, they exist as virtual causal architectures implemented across neural, embodied, and cultural substrates. Like a virtual machine, they shape and constrain the behavior of the underlying physical processes that support them. The causal power of such structures does not come from physical force, but from the organization of possibilities—from restricting what the system may do and guiding it toward certain stable outcomes.

Under this view, Platonic Space, the space of ideal forms such as geometric objects, numbers, or moral principles, is analogous to the virtual layer of a computational system. It is real, not in the sense of being a physical object or a transcendent metaphysical entity, but in the sense that it changes what happens. A legal rule, a mathematical proof, a goal state in biology, or an internal model in predictive cognition can redirect physical processes and actions, just as software can direct hardware. The forms are therefore virtual but causally effective, grounded in natural computation but irreducible to the material components themselves.

This analogy helps clarify how abstract forms can emerge from physical systems without being identical to them, and how they can exert causal influence without invoking supernatural metaphysics. Just as a virtual machine depends on the physical machine but is not identical with it, Platonic Space depends on biological and cognitive processes but constitutes a level of organization with its own dynamics and effects. This provides a naturalistic account of why ideal forms appear independent, universal, and authoritative: they are stable virtual constraints that organize lower-level processes.

4.7. *Section Summary*

Cognitive Platonism/Platonic Cognition reinterprets the reality of abstract forms in strictly operational terms. Forms are real because they shape processes, structure inference, and enable prediction; Platonic space is cognitive because such structures are implemented and manipulated within generative cognitive systems. This framework unifies ancient philosophical insight with contemporary science and prepares the ground for new theoretical approaches to agency, biology, and meaning.

5. Implications and Future Directions

Recasting Platonic space as a cognitive domain of causally efficacious constraints has implications across philosophy, biology, cognitive science, and the foundations of scientific explanation. By grounding the reality of abstract forms in operational causal and predictive terms, Cognitive Platonism/Platonic Cognition offers a framework that addresses long-standing conceptual problems while opening pathways for interdisciplinary synthesis.

5.1. *Philosophy of Science*

Cognitive Platonism/Platonic Cognition reframes the realism vs. anti-realism debate. Rather than asking whether scientific theories correspond to mind-independent reality or are merely useful fictions, it positions scientific models as cognitive constructions that derive their reality from their

capacity to constrain and predict phenomena. This perspective supports a form of constructive realism: theories and mathematical structures are real insofar as they successfully organize experience and guide intervention. Scientific progress therefore consists in the refinement of constraints encoded within cognitive generative models, not in approximating a metaphysically hidden world.

5.2. Teleology and Agency in Biology

The operationalization of abstract forms as control constraints provides a naturalistic account of teleology in biology. Target morphologies, regulatory goals, and preferred future states need not be dismissed as metaphorical, nor reified as metaphysical essences. Instead, they can be understood as informational constraints encoded in distributed control circuitry, functioning as attractors that regulate developmental and behavioral dynamics. This restores purposiveness and directionality to biological explanation without invoking supernatural or vitalist assumptions. Teleology becomes a feature of predictive control and anticipatory organization, not an external guiding force.

5.3. Foundations of Mathematics and Scientific Abstraction

Cognitive Platonism/Platonic Cognition offers a resolution to debates concerning the nature of mathematical objects. Rather than being eternal entities in a transcendent realm or arbitrary formal inventions, mathematical forms are understood as invariants discovered through cognitive compression of structural regularities. Their universality arises from the convergence of cognitive systems on optimal abstractions conditioned by shared constraints. Mathematical objects are therefore real as stable structures within cognitive and cultural generative spaces that successfully predict and organize phenomena across domains. This perspective explains both the apparent objectivity of mathematics and its deep applicability in physics and engineering.

5.4. Objectivity and Intersubjectivity

On this view, objectivity is not correspondence to an independently existing metaphysical structure but intersubjective stability, and the convergence of cognitive systems on shared abstract constraints that reliably generalize across contexts. Cultural evolution, formal notation, and institutional science function as mechanisms that stabilize and externalize cognitive constructs, enabling their transmission and refinement. Thus, the objectivity of abstract forms is grounded in collective constraint maintenance, not metaphysical transcendence.

5.5. AI and Artificial Agency

If abstract forms are real as constraints implemented in generative architectures, then artificial intelligence systems can also participate in Platonic space to the extent that they encode and manipulate such constraints. This suggests new perspectives on machine abstraction, generalization, and goal-directed behavior. It also implies that cognitively grounded teleology may be reproducible in artificial systems, not as symbolic programming but as emergent constraint dynamics.

5.6. Future Research: Morphogenesis as Generative Constraint Satisfaction

Algorithmic Development as Processual Form

One promising further development lies in bridging morphological computation and info-computational approaches to biological form. While Levin's work on regeneration highlights the causal role of target morphologies, a deeper integration with computational modeling may reframe these targets not as fixed blueprints but as dynamically emergent attractors within a constraint-satisfaction landscape.

Genomic Memory as Constraint Architecture

Within this distributed info-computational system, the genome plays a central regulatory role. Rather than encoding a blueprint, the genome can be seen as a distributed constraint system, a generative grammar that, in interaction with context, produces viable anatomical states. These are not fixed ideal forms, but context-sensitive attractors shaped by evolutionary and developmental constraints. This lends support to the idea that abstract constraints (informational structures) emerge from embodied computation.

This perspective reinterprets Platonic structures not as transcendent forms but as stabilized outcomes within computational morphospace, the product of iterative pattern completion, similar to solving a puzzle where missing parts are inferred from systemic constraints. Morphogenesis thus becomes a biological instance of Platonic cognition: the emergent realization of abstract regularities via embodied computation (morphological computing).

Geometry and Form in Development

The computational perspective on morphogenesis builds on earlier insights into the relationship between physical forces and biological form. In *On Growth and Form*, D'Arcy Wentworth Thompson (1917/1992) proposed that biological morphology can be explained through mathematical and physical principles, particularly geometry and mechanics. Thompson emphasized that the development of form is governed by general laws of transformation rather than by discrete genetic instructions, anticipating later views that see development as a dynamic process shaped by constraints. His approach, although pre-dating modern genetics and computational biology, aligns with the idea that form is not imposed from above but arises through the interaction of internal and external forces within a structured space of possibilities. This foundational work provides historical continuity for more recent views that interpret morphogenesis as a process of constraint satisfaction and computational unfolding.

5.7. Section Summary

Cognitive Platonism/Platonic Cognition yields a unified account of form, causation, and abstraction across disciplines. It resolves philosophical tensions by grounding the reality of abstract forms in causal and predictive efficacy rather than substance or subjective invention. It provides a naturalistic framework for teleology and agency in biology, reframes objectivity in science, and offers conceptual foundations for understanding abstraction in artificial intelligence. By relocating Platonic space within cognition while preserving its explanatory power, it opens a path toward a new synthesis between ancient philosophy and contemporary science.

6. Conclusion

The claim that abstract forms are real has historically been interpreted as a metaphysical thesis: that there exists a transcendent realm of ideal objects more fundamental than the empirical world. This classical Platonic perspective has influenced millennia of philosophical and scientific thought, yet its metaphysical commitments have remained ambiguous and difficult to reconcile with naturalistic explanation. By reinterpreting Platonic space as a cognitive generative domain of idealized constructs that function as causally efficacious constraints, we preserve the explanatory power of Platonic insight without invoking a separate ontological realm.

Reframing ideal forms as emergent structures within cognitive generative architecture, rather than as independently existing metaphysical entities, it becomes possible to explain the basis of Platonism by grounding it in naturalistic terms. Abstract structures as mathematical objects, morphological targets, or computational invariants, exert causal influence through constraint, shaping the trajectories of cognitive (biological and artificial) systems. Their reality consists in their ability to structure possibilities and generate behaviors.

The reinterpretation proposed here draws continuity across historical and scientific perspectives, linking Plato's and Aristotle's emphasis on form, Kant's transcendental grounding of structure, phenomenological accounts of invariant appearance, constructivist and enactive models of cognition, theories of teleodynamic and constraint-based causation (Juarrero, 1999; Deacon, 2011), predictive processing (Friston, 2010), contemporary research in morphological computation (Manicka and Levin, 2022) and computational and mathematical universe (Wolfram, 2021)(Tegmark, 2014). Across these domains emerges a transition from substance-based metaphysics to an understanding of organization, structure, process and constraint as the primary explanatory elements.

Cognitive Platonism/Platonic Cognition proposes that transcendence is not a metaphysical elsewhere, but an emergent achievement of cognitive architecture. Understanding how abstract constraints are formed, stabilized, transmitted, and transformed presents a continuing scientific and philosophical task, with implications for theories of agency, meaning, and artificial cognition.

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