# Cognitive Surplus Capacity as the Foundation of Cultural Construction

Religion, Art, and Science as Manifestations of Constructive Necessity

**Abstract**

This article develops the thesis that the major cultural constructions of humanity (religion, esotericism, art, science) result from a structural discrepancy between cognitive processing capacity and available sensory inputs. While cognitive systems with low neural complexity can operate largely reactively to sensory data, significant surplus capacity necessitates constructive processing beyond the given. These constructions differ not in their cognitive source, but in their methodological constraints: religion dogmatizes its constructions, art makes them explicit as such, science organizes them under conditions of falsifiability. The thesis is developed as a heuristic principle that makes disparate cultural phenomena comprehensible under a unified perspective and is categorially specified to avoid confusions between structural, functional, and phenomenal levels of description.

## 1. Introduction

The human brain possesses approximately $10^{14}$ synaptic connections (Herculano-Houzel 2009: 11), an order of magnitude that far exceeds what would be required for the immediate processing of sensory inputs. While the retinal resolution of the visual system is limited by approximately 126 million photoreceptors that converge onto about 1 million ganglion cells (Masland 2012: 1520), the question arises as to what function the enormous central processing capacity serves. The thesis developed here is that this discrepancy between peripheral sensory limitation and central processing capacity leads to a constitutive necessity for construction beyond what is sensorily given.

This constructive necessity manifests in various cultural domains. Religious thought postulates intentions and forces beyond the observable (Boyer 2001: 137-144), artistic production generates intensified modes of perception through systematic exaggeration of salient features (Ramachandran & Hirstein 1999: 17-18), scientific theory construction constructs abstract entities and laws that are not directly observable (Hacking 1983: 220-232). The question is whether these disparate phenomena share a common cognitive origin.

The article argues that cognitive surplus capacity relative to available sensory inputs constitutes the common enabling condition for these cultural constructions. This thesis differs from constructivist positions in that it does not merely claim that cognition is constructive, but explains why systems with certain structural properties must necessarily construct beyond what is immediately given.

## 2. Conceptual Specification: Levels of Description

To argue with categorial precision, at least three levels of description must be distinguished:

(1) The structural level: Here physical properties of the nervous system are described (number of neurons, synaptic density, connectivity patterns). These descriptions belong to the domain of neuroanatomy and neurophysiology.

(2) The functional level: Here processing operations and their achievements are described (pattern recognition, integration over time, context processing). These descriptions belong to the domain of cognitive neuroscience and information processing.

(3) The phenomenal level: Here properties of conscious experience are described (subjective qualities, differentiation of perception, richness of the stream of consciousness). These descriptions belong to the domain of phenomenology and consciousness research.

A frequent category error consists in identifying descriptions of one level with those of another or postulating causal relationships where only different descriptions of the same state of affairs exist. The number of synaptic connections (level 1) does not directly determine the differentiation of conscious experience (level 3), but rather sets constraints for possible processing operations (level 2), which in turn can enable certain phenomenal properties.

The concept of "surplus capacity" operates primarily on the functional level. It designates the relationship between a system's processing capacity (measured in possible differentiation achievements) and the bandwidth of available sensory inputs. This relationship is not directly readable from structural properties, but is limited by them.

## 3. Comparative Perspective: Scaling of Cognitive Complexity

To specify the concept of cognitive surplus capacity, a comparative view of systems of different complexity is instructive. In Caenorhabditis elegans with exactly 302 neurons and about 7,000 synapses (White et al. 1986: 1-340), processing capacity is tightly coupled to the processing of sensory inputs and control of motor outputs. The system operates largely reactively, behavioral repertoires are stereotyped and context-dependently modulated, but not characterized by elaborate constructions beyond the data.

In Drosophila melanogaster with about 100,000 neurons, a greater scope already emerges. The system can realize simple forms of learning and memory (Tully & Quinn 1985: 1983-1986), which implies a certain constructive processing by integrating past experiences into current behavior. Nevertheless, processing remains functionally tightly bound to immediate survival tasks.

In primates with highly complex brains (Macaca mulatta: approx. 6.4 billion neurons, Azevedo et al. 2009: 532), a qualitatively different picture emerges. These systems show elaborate social learning, tool use, rudimentary forms of Theory of Mind (Call & Tomasello 2008: 187-201), which requires constructive processing not immediately bound to sensory inputs.

In humans with about 86 billion neurons and $10^{14}$ synapses (Herculano-Houzel 2009: 11), this development reaches a new quality. The system generates not only constructions for immediate orientation, but systematic cultural constructions (language, religion, art, science) that go far beyond what is functionally necessary.

This scaling suggests a gradual increase in the ratio between processing capacity and immediate sensory requirements, which beyond a certain threshold leads to qualitatively new cognitive possibilities.

## 4. Sensory Limitation and Central Construction

### 4.1 Retinal Constraints

The human visual system exemplarily demonstrates the discrepancy between peripheral limitation and central processing. Retinal resolution is limited by photoreceptor density, which reaches about 200,000 cones per $mm^2$ in the fovea but decreases drastically toward the periphery (Curcio et al. 1990: 3381). Spectral resolution is limited by three cone types with overlapping absorption spectra (Schnapf et al. 1987: 613-614). Temporal resolution is limited by the reaction speed of the phototransduction cascade, which sets about 50-60 Hz as the upper limit for flicker fusion (Hecht & Shlaer 1936: 403).

These parameters define what visual information enters the brain at all. Nevertheless, what we phenomenally experience is not a direct reproduction of these inputs. Already at the retinal level, massive compression occurs: 126 million photoreceptors converge onto about 1 million ganglion cells

(Masland 2012: 1520). What enters the brain is already highly selectively filtered and preprocessed information.

### 4.2 Central Construction

The brain systematically constructs beyond these data. The blind spot, a region without photoreceptors at the exit of the optic nerve, is perceptually filled in (Ramachandran & Gregory 1991: 1731-1732). Interrupted contours are completed into closed forms (Kanizsa 1976: 48-52). From monocular two-dimensional retinal images, a three-dimensional spatial structure is constructed, integrating depth cues from disparity, motion parallax, and shading (Palmer 1999: 205-245). Colors are kept constant under strongly varying lighting conditions, which requires complex inferences about surface properties and light sources (Land & McCann 1971: 1-11).

These constructions are not optional additions but constitutive for coherent perception. A system that only registered what is retinally given would have fragmentary, discontinuous, monocular two-dimensional inputs. The phenomenal world is already the product of massive constructive processing.

The crucial question then is: If the system must construct anyway to generate coherent perception from fragmentary inputs, what limits this constructive activity to what is functionally necessary? The thesis is: With sufficient surplus capacity, there is no stable boundary between functionally necessary and beyond-necessary construction.

## 5. Cultural Manifestations of Cognitive Surplus Capacity

### 5.1 Religious and Esoteric Thought

Religious thought postulates intentions behind natural events, cosmic orders, invisible forces. Boyer (2001: 137-144) argues that these constructions result from hyperactive agent detection. Humans have specialized cognitive mechanisms for recognizing agents that were evolutionarily selected because false positives (seeing an agent where there is none) are less costly than false negatives (overlooking an agent that is actually present). These mechanisms operate with low thresholds and systematically lead to overinterpretations.

Atran (2002: 57-79) shows that religious concepts are typically "minimally counterintuitive": they violate ontological expectations in limited ways (gods are like humans but immortal; spirits are like agents but bodyless), making them cognitively salient and memorable without rendering them completely incomprehensible. These constructions are not arbitrary but follow specific cognitive preferences.

Guthrie (1993: 62-91) documents the systematic tendency toward anthropomorphization, toward projecting human properties onto non-human entities. This tendency already manifests in simple perception experiments: Heider & Simmel (1944: 243-259) showed subjects animations of geometric shapes and found that these were spontaneously interpreted as intentional agents pursuing goals, having emotions, maintaining social relationships.

From the perspective of cognitive surplus capacity, these phenomena are not malfunctions but manifestations of constructive activity that goes beyond what is immediately sensorily given. The system must recognize patterns, infer connections, construct explanations. With sufficient capacity and minimal constraints, this leads to elaborate constructions that go far beyond what is empirically verifiable.

The crucial point: religious constructions are typically immunized against empirical revision. They operate with unfalsifiable claims, circular arguments, ad hoc adjustments in face of anomalies. This is not an accidental property but follows from their function: they offer meaning-giving, orienting frameworks that are functional precisely because they are not constantly revised.

### 5.2 Artistic Production

Art uses cognitive surplus capacity differently. Ramachandran & Hirstein (1999: 17-18) argue that aesthetic effect arises through systematic amplification of salient features ("peak shift"). A caricature artist exaggerates characteristic facial features, leading to stronger activation of corresponding neural populations than the real face. In abstract art, reduced forms are employed that extract and amplify essential properties.

Zeki (1999: 22-28) describes art as a search for "essentials," for invariant properties that persist across changing appearances. An artist like Mondrian reduces visual scenes to basic geometric relations, an artist like Turner focuses on light and color while abstracting from details. These reductions are not simplifications but distillations that intensify certain aspects.

From a neurobiological perspective, art selectively activates certain processing pathways. Livingstone (2002: 73-89) shows that Impressionist painting specifically addresses the magnocellular system responsible for motion, depth, and coarse form, while details remain reserved for the parvocellular system. Through blurred edges and smudged details, a processing mode is selectively activated.

The crucial difference from religion: art makes its constructivity explicit. It does not claim to depict the world but to create new ways of experiencing it. A painting is recognizable as an artifact, a sculpture as a shaped object, a poem as a linguistic construct. Art operates in a space where construction is acknowledged as such and evaluated according to aesthetic, not truth criteria.

### 5.3 Scientific Theory Formation

Science constructs highly abstract entities and relations that are not directly observable. No one has ever seen an electron, perceived a gravitational field, observed an evolutionary process over millions of years. Scientific theories postulate unobservable entities whose existence is inferred from their observable effects (Hacking 1983: 220-232).

Kuhn (1962/1996: 111-135) shows that scientific theories are not simply derived from observations but constitute complex conceptual frameworks that influence what counts as relevant observation at all. The transition between paradigms is not purely cumulative but involves gestalt switches in which the same phenomena are interpreted in fundamentally different conceptual frameworks.

Hacking (1983: 16-24) distinguishes between "representing" (theoretical modeling) and "intervening" (experimental manipulation). Scientific realists argue that successful intervention provides evidence for the reality of postulated entities: if we can manipulate electrons to investigate other phenomena, electrons must be real in some sense.

From the perspective of cognitive surplus capacity, science is also construction beyond what is sensorily given. The crucial difference from religion lies in methodological constraints: scientific constructions must generate falsifiable predictions, must submit to intersubjective verification, must remain revisable in principle (Popper 1934/2002: 47-92). These constraints lead to systematic error correction and progressive approximation.

Important: science is not less constructive than religion or art. It only organizes its constructions under different norms. The same cognitive capacity that goes beyond immediate data enables religious speculation, artistic imagination, and scientific theory formation.

## 6. Empirical Evidence for Constructive Processing

### 6.1 Split-Brain Studies

Gazzaniga (2011: 77-103) describes split-brain patients in whom the corpus callosum was severed. In experiments, different information can be presented to the two hemispheres. When the right hemisphere (which does not control language production) receives an instruction and the person acts accordingly, the left hemisphere (which controls language production) subsequently constructs explanations for this behavior, even though it has no access to the actual cause.

In one example, the right hemisphere sees the word "walk," the person stands up, and the left hemisphere explains: "I wanted to get something to drink." The left hemisphere operates as an "interpreter" that constantly constructs coherent narratives even when the actual causes of behavior are not accessible (Gazzaniga 1998: 151-171).

This shows: the brain systematically constructs explanations, connections, narratives beyond what is immediately given. These constructions are not optional but constitutive for the self-interpretation of acting subjects.

### 6.2 Perceptual Completion

Ramachandran & Gregory (1991: 1731-1732) investigated perceptual completion at the blind spot. Subjects were presented with patterns that partially disappeared in the blind spot. Instead of perceiving a gap, the pattern was experienced continuously, as if it extended over the blind spot. This demonstrates active construction of missing information.

Kanizsa (1976: 48-52) demonstrated illusory contours: when so-called "Pac-Man" figures are arranged such that their openings define a square, this square is perceived as a brightly luminous figure with sharp edges, even though the edges are not physically present. The visual system constructs contours where there are none, when the configuration suggests this.

### 6.3 Change Blindness

Simons & Levin (1997: 644-649) showed that people fail to notice massive changes in visual scenes when these changes occur during eye movements or brief interruptions. In one experiment, the experimenter switched identity during a brief occlusion, and about 50% of subjects did not notice.

This shows: what we phenomenally experience as rich, detailed, continuous perception is largely constructed. The visual system registers only sparse information and constructs from it a coherent picture under the assumption of continuity and stability.

### 6.4 Confabulation

Hirstein (2005: 1-20) discusses confabulation in neurological patients: persons with certain brain damage spontaneously generate false memories or explanations without intent to deceive. A patient with Anton-Babinski syndrome (cortical blindness without awareness of blindness) describes what he "sees," even though no visual information is being processed. The system constructs content where no sensory data exist.

These phenomena show: construction is not the exception but the normal case. What appears as pathology in neurological patients is an exaggeration of normal cognitive processes. The brain constantly constructs beyond available data, normally under constraints that enable successful orientation.

## 7. Theoretical Implications

### 7.1 Epistemological Consequences

The surplus capacity thesis has radical epistemological implications. Traditional epistemology asks: How can we ensure that our conceptions correspond to reality? This question presupposes that knowledge is primarily representation, that there is a world "out there" that we more or less adequately depict.

The perspective developed here shifts the focus: if cognitive systems must constitutively construct beyond the given, the question is not primarily whether constructions correspond to reality, but under what conditions constructions are functional, enable reliable orientation, are intersubjectively stabilizable.

This leads to a specific form of epistemic humility: even scientific theories are constructions that go beyond observational data. They differ from religious or esoteric constructions not in how they arise categorially, but through their methodological constraints. Science organizes construction under conditions of systematic error correction.

This is not a relativistic position. Different constructions are not equally valid. But their evaluation does not occur through comparison with an independently accessible reality, but through testing their functional adequacy, their internal coherence, their fruitfulness for further investigations.

### 7.2 Anthropological Consequences

Philosophical anthropology (Gehlen 1940/1988: 33-71) characterizes humans as "deficient beings" forced to produce culture through lacking instinctual binding and biological unspecialization. Culture appears as compensation for biological deficits, as "second nature" replacing missing first nature.

The surplus capacity thesis reverses this perspective. Humans are characterized not primarily by deficiencies but by surplus. The enormous cognitive capacity exceeds what is necessary for immediate orientation. Culture is not compensation but productive use of this surplus capacity.

This shifts the perspective from deficit to potential, from compensation to productivity. Human culture is not a substitute for missing instincts but a manifestation of cognitive capacities that go beyond the biologically necessary.

Plessner (1928/1975: 288-346) describes humans as "eccentrically positioned": the subject can make itself an object, can relate reflexively to itself. This capacity requires cognitive capacity that goes beyond immediate orientation. It enables self-distancing, reflexivity, culture.

### 7.3 The Relationship of Rationality and Construction

A central implication: rationality is not the absence of construction but a specific way of dealing with the inevitability of construction. A rational subject is not one that only registers the given, but one that methodically controls its constructions.

This means: science and superstition stem from the same cognitive source, namely the capacity and necessity to construct beyond the given. They differ not in their source but in how they deal with constructions. Science organizes construction under norms of systematic error correction, superstition immunizes constructions against revision.

From this follows an important educational-political consequence: one cannot eradicate "irrational" tendencies by reducing cognitive capacity (which would be impossible anyway). One can only cultivate institutional and methodical practices that distinguish productive from destructive constructions. Education consists not in transmitting facts but in cultivating epistemic virtues: openness to revision, tolerance for ambiguity, systematic error correction.

## 8. Critical Discussion and Limitations

### 8.1 The Operationalization Problem

An obvious objection: How can "surplus capacity" be measured? The number of synaptic connections is not a direct measure of functional capacity. Synapses differ in strength, plasticity, neurotransmitter systems. The mere number says little about actual processing performance.

Moreover, it is unclear how one should quantify the "demands" of sensory inputs. In an impoverished environment, demands are lower than in a complex one, but the same brain operates in both contexts. Is surplus capacity then context-dependent?

A more productive approach to operationalization might consist not in asking about "capacity" as a static quantity, but about **degrees of freedom of non-input-driven activity**. This approach focuses on observable phenomena that indirectly indicate surplus capacity:

**Default Mode Network (DMN):** The DMN shows increased activity in resting states when no specific task is present (Raichle et al. 2001: 676-682). This spontaneous activity is not directly bound to sensory inputs but includes self-related thoughts, episodic memories, future planning, Theory of Mind (Buckner et al. 2008: 1-21). The DMN could be interpreted as a neural correlate of cognitive surplus capacity: the system must do something even in the absence of specific demands.

Empirically, one could investigate: Does the strength of DMN activity correlate with tendencies toward religious thinking, artistic productivity, scientific creativity? Initial findings suggest connections between DMN activity and creative processes (Beaty et al. 2016: 87-98).

**Play behavior:** Play is by definition non-functional activity that offers no immediate survival advantages. Burghardt (2005: 82-110) identifies play as characteristic of species with complex nervous systems and prolonged developmental times. Play could be understood as a manifestation of cognitive surplus capacity: the system explores possibilities beyond immediate functional requirements.

Comparative studies could investigate: Does neural complexity correlate across species with the frequency, duration, and elaborateness of play behavior? Which neural systems are activated during play, and do they differ from those in functionally bound activities?

**Creative processes:** Creativity involves the generation of novel combinations not directly derivable from inputs. Dietrich (2004: 1011-1026) distinguishes between deliberate and spontaneous creativity, which involve different neural networks. Creativity requires degrees of freedom for recombination, for exploration of non-obvious associations.

Empirically accessible would be: Do individuals with higher creative productivity show stronger activity in networks not directly input-driven? Are there correlations between measures of cognitive flexibility and tendencies toward elaborate cultural constructions?

**Mind-wandering:** Kane et al. (2007: 614-621) show that people spend about 30-50% of their waking time with thoughts not related to the immediate task. These "task-unrelated thoughts" are not random but often self-related, temporally extended, intentional. Mind-wandering could be interpreted as an indicator of cognitive capacity that goes beyond immediate demands.

This degrees-of-freedom approach does not operate at the level of direct capacity measurement but identifies observable phenomena that indirectly indicate surplus capacity. The thesis then is: systems with greater degrees of freedom of non-input-driven activity should show stronger tendencies toward elaborate cultural constructions.

This remains a heuristic principle but allows more concrete empirical approximations than the question about "capacity" in the abstract.

### 8.2 The Question of Sufficiency

Even if surplus capacity is a necessary condition for religion, art, science, it is not sufficient. Not every society develops the same cultural forms. Historical, social, economic factors play crucial roles.

This observation is correct but not a refutation. The thesis identifies a necessary, not sufficient condition. It explains why cognitive systems of certain complexity are capable of cultural constructions at all, not which specific forms these take.

An analogy: language capacity is a necessary condition for literary production, but not sufficient. Which literary forms emerge depends on cultural, historical, aesthetic factors. Nevertheless, identifying the necessary condition is theoretically valuable.

### 8.3 The Problem of the Zero Point

The thesis suggests a hypothetical state where processing capacity would be perfectly adapted to sensory requirements. But does such a thing exist? Is not every cognitive system necessarily constructive?

This objection requires a specification. The difference is not between constructing and non-constructing systems (all cognition is constructive), but between systems whose constructions are tightly bound to immediate functional requirements and those that generate elaborate constructions that go beyond what is functionally necessary.

C. elegans also constructs (in the sense of: generates internal representations that are not isomorphic to inputs), but these constructions remain functionally bound. Humans construct religion, art, science that are not explicable by immediate survival requirements. That is the difference.

### 8.4 Alternative Explanations

An alternative explanation: cultural constructions arise not from surplus capacity but from specific adaptive requirements. Religion promotes group cooperation (Norenzayan et al. 2016: 1-8), art signals fitness (Miller 2000: 258-291), science is collective problem-solving. These functional explanations could make surplus capacity superfluous as an explanans.

This alternative is not necessarily inconsistent with the surplus capacity thesis. One can argue: surplus capacity is the enabling condition, specific adaptive requirements are the selection factors that determine which constructions are stabilized. Both perspectives can be complementary.

## 9. Systematic Positioning

The surplus capacity thesis touches several established research programs without fully identifying with any one.

### 9.1 Demarcation from Predictive Processing

Predictive Processing (PP) claims that the brain is primarily a "prediction machine" that constantly constructs generative models of the world and tests them against incoming sensory data (Clark 2016: 1-21; Friston 2010: 127-138). At first glance, this seems compatible with the surplus capacity thesis: both emphasize that the brain "constructs more than it receives."

The crucial difference, however, lies in a categorial distinction: PP treats prediction as an **ontological principle** that underlies all life. Friston (2010: 127-138) argues that even bacteria maintain their existence through minimization of prediction errors (Free Energy). Prediction becomes a universal principle of life, ranging from single-celled organisms to complex cognitive systems.

This is a fundamental category error. It conflates different levels of description and explananda:

**Problem 1: Ontologization of cognitive terms.** "Prediction" is a term that presupposes genuine intentional states: a system must represent future states and use these representations as a basis for current behavior. A bacterium that moves along a nutrient gradient "predicts nothing" in the relevant sense. It reacts to local chemical concentrations. Describing this movement as "prediction" projects a cognitive term onto a process that is categorially differently structured.

**Problem 2: Determinans and determinandum.** PP explains cognition through prediction, but prediction is itself a cognitive achievement that would need to be explained. The explanans (prediction) is included in the explanandum (cognition). This creates circularity: cognition is explained through something that itself exists only in cognitive systems.

**Problem 3: Distinction between levels of description.** One can describe thermodynamic systems (such as a refrigerator) as "free energy minimizing," but that does not make them cognitive systems. Mathematical description (minimization of a function) is neutral with respect to the ontological nature of the described processes. PP confuses formal isomorphism with ontological identity.

The surplus capacity thesis avoids these errors by:

(1) **Treating construction as a specifically cognitive achievement** that is not projected onto all self-organizing systems.

(2) **Identifying structural conditions** (surplus capacity relative to inputs) that explain why certain systems must construct, without presupposing construction itself as explanans.

(3) **Respecting categorial distinctions** between physical processes, functional organization, and phenomenal properties.

PP and the surplus capacity thesis are thus not compatible but represent fundamentally different approaches. Where PP postulates a universal principle, the surplus capacity thesis identifies a specific structural configuration that leads to certain cognitive properties.

### 9.2 On Constructivism

The thesis shares the basic intuition that cognition is constructive but goes beyond mere assertion by specifying structural reasons for constructive necessity. Against radical constructivism (Glasersfeld 1995: 51-78), it does not claim that reality is completely constructed, but that cognitive systems must construct beyond the given.

### 9.3 On Embodied Cognition

The thesis is compatible with the emphasis on sensorimotor coupling (Varela et al. 1991: 172-179) but insists that central processing goes beyond immediate sensorimotor loops. Against strong versions that want to reduce cognition to body-environment interaction, it emphasizes the role of central constructive processes.

**9.4 On Evolutionary Psychology**

The thesis is not necessarily incompatible with adaptive explanations (Barkow et al. 1992: 3-15) but offers a complementary perspective: surplus capacity itself could be adaptive (flexibility, creativity, problem-solving in novel contexts), with the trade-off that it also enables non-adaptive constructions.

**9.5 Constructive Necessity versus Evolutionary Byproducts**

An important conceptual demarcation concerns the relationship of the thesis to evolutionary explanations through byproducts or "spandrels" (Gould & Lewontin 1979: 581-598). Gould and Lewontin argued that not all traits are direct adaptations; some are architectural necessities or byproducts of other adaptive traits.

One might suspect that cultural constructions (religion, art, science) are such spandrels: byproducts of cognitive capacities that evolved for other purposes. This interpretation would be categorially misguided.

**The crucial difference:** A spandrel is a **contingent byproduct** of a particular evolutionary development. The space between two columns and a vault (the original architectural example of Gould & Lewontin) is not intended but emerges as geometric necessity from the construction. A different architectural design would have different side effects.

Cognitive surplus capacity, however, is not a contingent consequence of a particular evolutionary trajectory, but a **systemic consequence** of the structure of highly complex information processing systems. The term "constructive necessity" marks this difference:

(1) **Necessity from structure, not from history:** Any system with sufficient processing capacity relative to available inputs must construct, regardless of how it arose evolutionarily. This is not historical contingency but follows from the functional properties of the system.

(2) **Not avoidable through alternative design:** While a spandrel would be avoidable through alternative architectural design, constructive necessity is not avoidable through alternative neural design, as long as the basic configuration (high processing capacity, limited inputs) is maintained.

(3) **Productive, not merely parasitic:** Spandrels are typically functionally inert or used subsequently (like the arch spaces for mosaics). Constructive necessity is constitutively productive: it systematically generates new cognitive possibilities that are not reducible to the original function.

This means: religion, art, science are not byproducts in the sense of Gould & Lewontin. They are manifestations of a structural property of cognitive systems of certain complexity. This property may have arisen evolutionarily, but its consequences follow from structure itself, not from historical contingency.

An analogy: the capacity for language arose evolutionarily, but the logical properties of formal languages (recursivity, compositionality, structural ambiguity) are not evolutionary byproducts but follow from the structural properties of symbolic systems. Similarly: cognitive surplus capacity may have arisen evolutionarily, but its consequences (constructive necessity) follow from structure, not from history.

**9.6 On Phenomenology**

The thesis touches phenomenological questions about the structure of conscious experience (Husserl 1913/1976: 92-117) but does not claim to fully grasp these from a third-person perspective. It identifies structural conditions for certain phenomenal properties without reducing phenomenal properties to structural ones.

## 10. Outlook and Research Perspectives

The surplus capacity thesis opens several research perspectives:

(1) Comparative cognitive science: Systematic investigation of the correlation between neural complexity and tendencies toward non-functional cognitive activities (play, exploration, spontaneous pattern recognition) across various species.

(2) Developmental psychology: Investigation of the temporal connection between neural maturation and the emergence of cultural constructions (religious concepts, artistic production, proto-scientific thinking) in ontogeny.

(3) Neuropsychology: Systematic analysis of which lesion patterns lead to reductions in elaborate constructions while basic perception remains intact.

(4) Cultural anthropology: Investigation of whether societies with different technological and social complexity levels show systematic differences in the elaborateness of their religious, artistic, scientific constructions.

(5) Computational modeling: Development of artificial systems with variable ratio of processing capacity to input complexity to investigate whether systems with surplus capacity show stronger tendencies toward hallucinations, overgeneralizations, spurious correlations.

These research perspectives cannot directly confirm or refute the thesis (since it operates as a heuristic principle), but they can demonstrate its fruitfulness by generating new empirical questions and integrating disparate findings.

## 11. Conclusion

This article has developed the thesis that cognitive surplus capacity relative to available sensory inputs constitutes the common enabling condition for cultural constructions (religion, art, science). These constructions differ not in their cognitive source but in their methodological constraints: how they deal with the constitutive necessity to construct beyond the given.

The thesis was categorially specified to avoid confusions between structural, functional, and phenomenal levels of description. It was supported by empirical findings from neurophysiology, cognitive neuroscience, and perceptual psychology. Its theoretical implications for epistemology, anthropology, and rationality theory were made explicit.

The thesis understands itself as a heuristic principle that makes disparate phenomena comprehensible under a unified perspective and opens fruitful research perspectives. Its value lies not primarily in direct empirical testability but in systematic explanatory power and theoretical productivity.

The basic insight is: humans are beings that must construct because their cognitive capacity exceeds immediate sensory data. This situation is constitutive, not contingent. It cannot be overcome. The task consists in cultivating methodical and institutional practices that distinguish productive from destructive constructions, without maintaining the illusion that construction itself can be overcome.

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