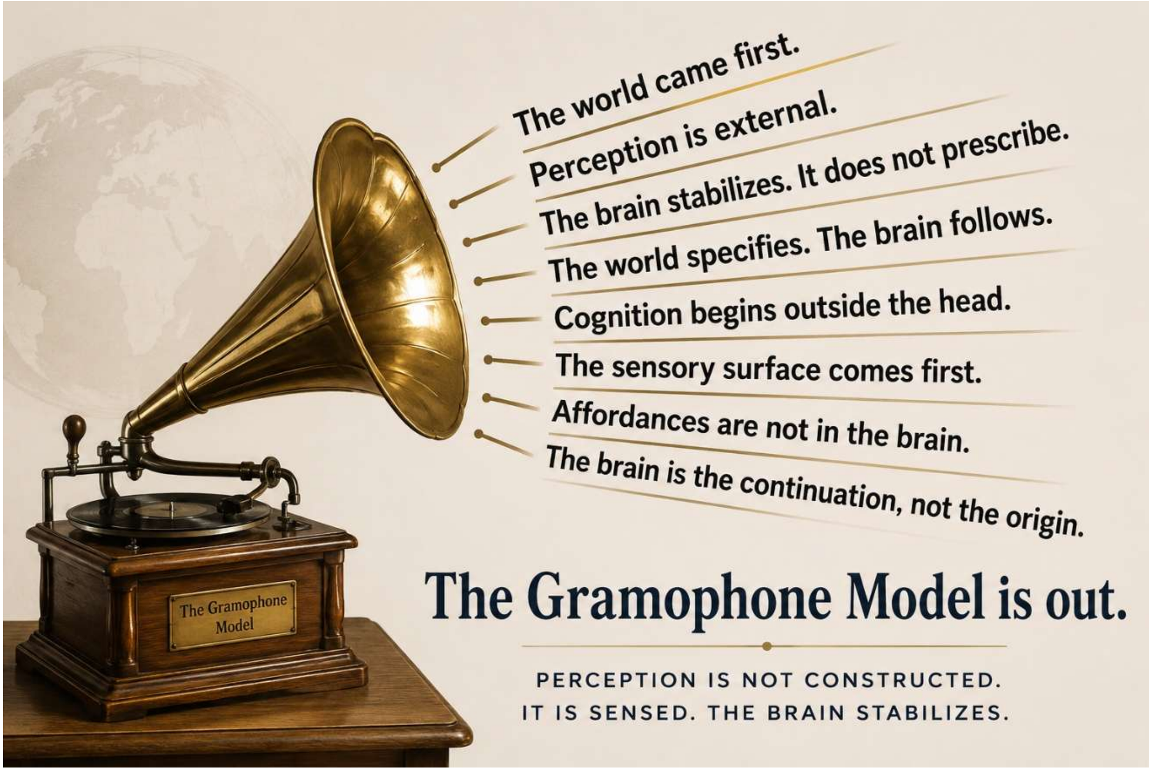
If Internal Models Exist, Then Prove It!

The Gramophone Model and a Systematic Comparison with Internal Models Across Four Domains of Scientific Evaluation



Caught In A Line
The explanatory model of all motoric movement actions

N.J. Mol

Contact: kwillinq@gmail.com
https://www.researchgate.net/profile/Nj-Mol/research
https://www.explanatorymodel.nl/

Abstract

Since the cognitive revolution of the 1950s, Internal Models (IM) have constituted the dominant theoretical paradigm in cognitive neuroscience, psychology, and motor control. Their central premise is that the primary organization of perception and cognition resides within the brain. The Gramophone Model (GM) proposes a fundamentally different paradigm in which the primary organization of perception and cognition resides at the sensory surface, where continuously changing, externally specified physical dynamics first encounter the organism, while the brain functions primarily as a biological stabilization system.

This article presents a systematic comparison of GM and IM across four categories of scientific evaluation: (1) Empirical Explanatory Power, (2) Physical–Mechanistic Coherence, (3) Philosophy-of-Science Criteria, and (4) Evolutionary Evaluation. Within these categories, both frameworks are evaluated using established scientific criteria, including explanatory completeness, explanatory unification, mechanistic specificity, ontological economy, consilience, ecological validity, and evolutionary plausibility.

The comparative analysis demonstrates that GM more closely satisfies the established criteria for scientific theory evaluation across all four domains than contemporary IM. Consequently, the historical dominance of IM can no longer serve as sufficient scientific justification for their continued acceptance. The burden of proof therefore reverses. If IM are claimed to constitute the primary organizing architecture of perception and cognition, this claim must now be supported by direct empirical and theoretical evidence rather than by historical consensus or inference from neural activity. The present analysis argues that GM currently provides the stronger, more coherent, and more parsimonious scientific framework for explaining perception and cognition.

Keywords: *Gramophone Model; Internal Models; scientific theory evaluation; explanatory power; philosophy of science; sensory transduction; ecological psychology; perception; cognition; evolution.*

Introduction

Since the cognitive revolution of the 1950s, Internal Models (IM) have constituted the dominant theoretical paradigm in cognitive neuroscience, psychology, and motor control. Despite substantial theoretical diversity—including internal representations, predictive coding, Bayesian inference, forward models, cognitive maps, and generative models—these approaches share a common premise: that the primary organization of perception and cognition resides within the brain.

Remarkably, this central premise has never itself been demonstrated directly. Instead, it gradually became embedded within cognitive science as a largely unquestioned assumption rather than as a conclusion established through direct empirical evidence. This development was primarily driven by two observations. First, perception and cognition are consistently accompanied by neural activity. Second, no alternative source of perceptual organization had been explicitly identified. From these circumstances, it became widely assumed that the organizing principles of perception and cognition must therefore reside within the brain. Yet neither the existence of neural activity nor its correlation with perception demonstrates the existence of internal models, internal representations, or any other internally organizing architecture. At most, these observations demonstrate that neural activity accompanies perception and cognition. The conclusion that such activity constitutes the primary origin of perceptual and cognitive organization is therefore an additional theoretical assumption rather than a direct empirical finding.

This assumption has been further reinforced by the historical underestimation of the external world as a source of organization. Although the pioneering work of James J. Gibson (The Affordances Theory) and David N. Lee (*tau*-coupling theory) demonstrated that essential perceptual variables are directly specified within ecological and temporal dynamics, the scientific field never recognized the strict spatiotemporal organization continuously present in the external world itself. External stimuli therefore continued to be treated primarily as incomplete or ambiguous inputs requiring internal organization, rather than as continuously unfolding, lawfully structured dynamics that already organize perception and action at the sensory surface. As long as this external organization remained unidentified, the brain inevitably remained the default explanatory locus.

The Gramophone Model (GM) identifies this missing external organization and proposes a fundamentally different explanatory framework. Rather than locating the primary organization of perception and cognition within the brain, GM argues that this organization resides at the sensory surface, where continuously unfolding, externally specified physical dynamics first encounter the organism. Sensory transduction transforms these dynamics into electrochemical activity, after which the nervous system functions primarily as a biological stabilization system rather than as the source of perceptual organization. A comprehensive mechanistic formulation of the GM, including the simultaneous afferent–efferent feedback coupling mechanism that underlies perceptual organization at the sensory surface, is presented in *Cognition Is Organized at the Sensory Surface, Not in the Brain* (Mol, 2026) [1], to which the present article refers for its theoretical foundations.

The introduction of a coherent alternative has an important methodological consequence. Once a theory exists that locates the primary organization of perception and cognition outside the brain while explaining the same class of empirical phenomena, the scientific burden of proof necessarily changes. The central question is no longer whether an externally organized framework is possible, but whether the assumptions unique to IM remain necessary and scientifically justified. Accordingly, the purpose of the present article is not to restate the GM itself, but to evaluate whether IM continue to satisfy established criteria for scientific theory evaluation once a coherent competing framework is available.

To address this question, GM and IM are systematically compared across four independent domains of scientific evaluation: 1. Empirical explanatory power, 2. Physical–mechanistic coherence, 3. Philosophy-of-science criteria, and 4. Evolutionary continuity. By evaluating both frameworks according to established criteria for scientific theory assessment, the present article argues that the GM fundamentally reverses the burden of proof in contemporary cognitive science.

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1. Why Internal Models Require Re-evaluation

For more than half a century, IM have largely occupied the position of the default explanatory framework for perception and cognition. This historical position was understandable. Neural activity is

[1] https://www.researchgate.net/profile/Nj-Mol/research

directly observable following sensory transduction, whereas no explicit alternative locus of perceptual organization had been identified. Consequently, the existence of neural activity was generally interpreted as evidence that the primary organization of perception and cognition must reside within the brain. The emergence of GM (Mol, 2026) fundamentally changes this scientific situation. GM proposes that the primary organization of perception and cognition resides at the sensory surface rather than within neural tissue. The existence of such an alternative means that the historical dominance of IM can no longer be regarded as sufficient justification for their continued acceptance.

Within science, competing theories are not evaluated according to historical precedence or disciplinary consensus, but according to their explanatory performance. Once two coherent frameworks attempt to explain the same class of empirical phenomena, neither framework can be regarded as the default position. Both must therefore be evaluated according to the same scientific standards.

The purpose of the present article is therefore not to defend GM, nor to criticize IM in isolation. Rather, it is to determine whether IM continue to represent the strongest available scientific explanation once a coherent competing framework has become available. This requires a systematic comparison based on established criteria for scientific theory evaluation rather than on historical acceptance or disciplinary tradition. The following chapters therefore compare GM and IM across four independent domains of scientific evaluation: empirical explanatory power, physical–mechanistic coherence, philosophy-of-science criteria, and evolutionary continuity.

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2. Empirical Explanatory Power

2.1 Explanatory Completeness

2.1.1 Scientific Background

Explanatory completeness is one of the fundamental criteria by which scientific theories are evaluated. A scientific theory gains explanatory strength by accounting for the broadest possible range of empirical phenomena through a coherent explanatory framework rather than through a collection of separate mechanisms. Consequently, explanatory scope has long been regarded as one of the principal measures of scientific progress. This criterion has been emphasized throughout the philosophy of science by scholars including Carl G. Hempel, Thomas S. Kuhn, and Larry Laudan. Although these philosophers differ in their broader conceptions of scientific progress, they agree that theories capable of explaining a wider range of empirical phenomena possess greater scientific value than those requiring multiple partially independent explanations.

2.1.2 Definition

Within the present comparison, explanatory completeness refers to the extent to which a theoretical framework accounts for the full diversity of perceptual and cognitive phenomena through a coherent explanatory organization. A theory exhibiting greater explanatory completeness should explain more empirical phenomena while relying on fewer independent explanatory principles.

2.1.3 Internal Models

IM explain a broad range of empirical phenomena, including perception, prediction, motor control, navigation, memory, mental imagery, and decision making. However, these phenomena are generally explained through multiple partially independent theoretical frameworks, including internal representations, (inferential) predictive coding[2] (IPC), Bayesian inference, forward models, cognitive maps, attractor dynamics, neural manifolds, and representational drift. Although each of these frameworks has generated important empirical findings, contemporary cognitive science has not converged on a single organizing principle capable of integrating these diverse explanatory approaches into one coherent theoretical framework.

2.1.4 The Gramophone Model

According to the GM, perception and cognition are organized by continuously unfolding, externally specified physical dynamics at the sensory surface. From this single organizing principle, GM proposes explanations for perception, action, affordances, *tau*-coupling, prediction, memory, mental imagery, dreaming, cortical feedback, and motor coordination. Rather than introducing separate explanatory mechanisms for these phenomena, GM derives them from one continuous perception–action organization.

2.1.5 Comparative Evaluation

Both IM and the GM seek to explain essentially the same empirical domain. The principal distinction concerns the organization of these explanations. IM distribute explanatory responsibility across numerous partially independent computational architectures, whereas GM derives the same class of phenomena from a single externally organized perception–action framework. The comparison therefore concerns not merely explanatory scope, but the degree to which empirical observations can be integrated within one coherent theoretical organization.

2.1.6 Scientific Assessment

From the perspective of explanatory completeness, the GM more closely satisfies this criterion than contemporary IM. Although IM have generated an extensive empirical literature, this explanatory success has been achieved through an increasingly diverse collection of theoretical constructs whose mutual integration remains incomplete. In contrast, GM derives these diverse perceptual and cognitive phenomena from a single organizing principle. The comparative analysis indicates that the GM explains the same empirical domain while substantially reducing explanatory fragmentation.

2.2 Explanatory Unification

2.2.1 Scientific Background

Explanatory unification is widely regarded as one of the defining characteristics of successful scientific theories. Rather than explaining individual phenomena through separate mechanisms, scientifically powerful theories seek to integrate diverse empirical observations within a common explanatory framework. The principle can be traced to William Whewell's concept of *consilience of inductions*, whereby the ability of a single theory to explain independent classes of phenomena provides particularly strong scientific support. The importance of explanatory unification has subsequently been emphasized by philosophers of science including Carl G. Hempel, Ernest Nagel, and Philip Kitcher, all of whom regarded theoretical unification as a major indicator of scientific progress.

2.2.2 Definition

Within the present comparison, explanatory unification refers to the extent to which diverse perceptual and cognitive phenomena can be explained through a common organizing principle rather than through multiple independent theoretical mechanisms. A theory exhibiting greater explanatory

[2] As the counterpart to *Externally Predictive Coding* (EPC) within the Gramophone Model (GM).

unification should account for a broader range of empirical phenomena while relying on a single coherent explanatory organization.

2.2.3 Internal Models

IM explain a broad range of perceptual and cognitive phenomena. However, these phenomena are generally accounted for by multiple partially independent theoretical frameworks. Perception is commonly explained through (inferential) predictive coding (IPC)[3] or Bayesian inference, motor control through forward and inverse models, spatial navigation through cognitive maps, memory through attractor dynamics or hippocampal representations, and decision making through additional computational frameworks. Although these approaches share an emphasis on internal neural computation, contemporary cognitive science has not converged on a single organizing principle capable of unifying these diverse explanatory architectures within one coherent theoretical framework.

2.2.4 The Gramophone Model

According to the GM, the same externally organized perception–action principle underlies the full range of perceptual and cognitive phenomena. Continuously unfolding physical dynamics are organized at the sensory surface, transformed through sensory transduction, stabilized by neural processes, and subsequently re-engaged through afferent–efferent coupling. From this single organizing principle, GM derives explanations for perception, action, affordances, *tau*-coupling, prediction, memory, mental imagery, dreaming, cortical feedback, and motor coordination. Rather than introducing separate explanatory mechanisms, these phenomena are interpreted as different manifestations of one continuous perception–action organization.

2.2.5 Comparative Evaluation

Both IM and the GM seek to explain essentially the same empirical domain. The principal distinction concerns the degree of theoretical integration. IM distribute explanatory responsibility across multiple partially independent computational architectures, whereas GM derives the same class of phenomena from one continuous externally organized perception–action framework. The comparison therefore concerns not merely the number of phenomena explained, but the extent to which these phenomena can be integrated within a single coherent theoretical organization.

2.2.6 Scientific Assessment

From the perspective of explanatory unification, the GM more closely satisfies this criterion than contemporary IM. Although IM have generated an extensive body of empirical research, their explanatory success has been achieved through an increasingly diverse collection of specialized theoretical constructs whose mutual integration remains incomplete. In contrast, GM proposes a single organizing principle from which diverse perceptual and cognitive phenomena are systematically derived. The comparative analysis indicates that the GM explains the same empirical domain while substantially increasing theoretical integration and reducing explanatory fragmentation.

2.3 Ecological Validity

2.3.1 Scientific Background

Ecological validity concerns the extent to which a scientific theory explains behaviour as it occurs under natural conditions rather than under highly constrained laboratory situations. The concept was originally introduced by Egon Brunswik, who argued that theories of perception should be evaluated according to how well they account for the lawful structure of real-world environments. This ecological perspective was subsequently developed by James J. Gibson, who proposed that perception de-

[3] As the counterpart to *Externally Predictive Coding* (EPC) within the Gramophone Model (GM).

pends upon information already specified within the environment rather than upon internally constructed representations. David N. Lee further extended this ecological approach by demonstrating that the temporal organization of environmental events is likewise lawfully specified, allowing organisms to guide action directly through variables such as *tau* without requiring internally constructed predictive models. Together, these ecological approaches established the external environment as a primary source of perceptual organization. Consequently, ecological validity has become an important criterion in psychology, cognitive science, and behavioural neuroscience for evaluating the generalizability and realism of theoretical explanations.

2.3.2 Definition

Within the present comparison, ecological validity refers to the extent to which a theoretical framework explains perception and cognition under naturally occurring organism–environment interactions. A theory exhibiting greater ecological validity should explain behaviour through principles that remain applicable outside artificial laboratory conditions while directly reflecting the lawful structure of the external world.

2.3.3 Internal Models

IM generally assume that sensory stimulation is incomplete, noisy, or fundamentally ambiguous and therefore requires internal reconstruction through neural computation. Consequently, explanatory emphasis is placed upon internal predictive mechanisms, probabilistic inference, and representational processing. Although these approaches have generated extensive laboratory evidence, the primary organizing principles are assumed to reside within the nervous system rather than within the lawful structure of the environment.

2.3.4 The Gramophone Model

According to the GM, perception is primarily organized by continuously unfolding physical dynamics that already exist within the external world and are projected directly onto the sensory surface. Sensory transduction converts these externally specified dynamics into neural activity, after which the nervous system functions primarily to stabilize and continue this organization. Rather than treating ecological structure as incomplete sensory input requiring internal organization, GM identifies it as the primary source of perceptual organization itself. Consequently, the same explanatory framework applies under both laboratory and naturally occurring organism–environment interactions.

2.3.5 Comparative Evaluation

Both IM and the GM seek to explain perception and cognition under real organism–environment interactions. The principal distinction concerns the location of perceptual organization. IM attribute the primary organization of perception to internal neural mechanisms, whereas GM attributes it to the lawful spatiotemporal organization continuously present within the environment and projected onto the sensory surface. The comparison therefore concerns the extent to which each framework incorporates naturally occurring environmental structure as an essential component of its explanatory organization.

2.3.6 Scientific Assessment

From the perspective of ecological validity, the GM more closely satisfies this criterion than contemporary IM. Although IM recognize the importance of environmental information, they continue to treat it primarily as input to internally organized computational mechanisms. In contrast, GM identifies the lawful spatiotemporal organization of organism–environment interactions as the primary source of perceptual organization. Consequently, GM incorporates the ecological structure emphasized by Brunswik, Gibson, and Lee directly into its explanatory framework rather than treating it as information requiring subsequent internal organization. The comparative analysis therefore indicates that the GM provides a more ecologically grounded account of perception and cognition.

2.4 Predictive Power

2.4.1 Scientific Background

Predictive power is widely regarded as one of the defining characteristics of successful scientific theories. A theory gains scientific value not only by explaining existing observations but also by generating accurate, testable predictions about previously unobserved phenomena. The importance of prediction has been emphasized throughout the philosophy of science, most notably by Karl Popper, who argued that scientific theories derive their strength from making risky empirical predictions capable of falsification. Later philosophers, including Imre Lakatos, likewise regarded predictive success as a major criterion for evaluating competing research programmes.

2.4.2 Definition

Within the present comparison, predictive power refers to the capacity of a theoretical framework to generate accurate, testable, and potentially falsifiable predictions concerning perceptual and cognitive phenomena. A theory possesses greater predictive power when its underlying principles reliably anticipate empirical observations across diverse behavioural and experimental contexts.

2.4.3 Internal Models

Prediction occupies a central position within contemporary IM. Predictive coding, forward models, Bayesian inference, and generative models all assume that the nervous system continuously predicts future sensory states or the sensory consequences of action. Although these approaches have produced numerous experimentally testable hypotheses, they generally attribute predictive capacity to internally generated neural models whose existence is inferred rather than directly observed.

2.4.4 The Gramophone Model

Within GM, predictive behaviour does not arise from internally generated representations of future states. Instead, prediction emerges because perception is continuously organized by externally specified physical dynamics extending from the manifest present into the latent future[4]. As action unfolds, the organism remains coupled to this continuously developing external organization through the sensory surface. Neural processes stabilize and maintain this coupling but do not themselves generate the predicted future state. Consequently, predictive behaviour is interpreted as the continuous perception of an externally unfolding organization rather than as the computation of an internal prediction.

2.4.5 Comparative Evaluation

Both frameworks explain predictive behaviour but attribute it to fundamentally different mechanisms. IM explain prediction through internally generated computational models, whereas GM explains prediction through continuous coupling to externally specified environmental dynamics. The comparison therefore concerns not whether prediction occurs, but whether predictive phenomena require internal predictive models or can instead be explained by lawful organism–environment interactions.

2.4.6 Scientific Assessment

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[4] Within the GM, the proposed counterpart to Inferential Predictive Coding (IPC) is termed External Predictive Coding (EPC). Whereas IPC assumes that predictive organization is generated by internally constructed models, EPC proposes that predictive organization is specified by continuously unfolding external physical dynamics at the sensory surface. A comprehensive formulation of EPC is presented in Mol (2026).

From the perspective of predictive power, the GM more closely satisfies this criterion than contemporary IM. Although prediction occupies a central role within IM, predictive behaviour is explained through internally generated predictive architectures whose existence is inferred from neural activity rather than directly observed. In contrast, GM explains predictive behaviour as the natural consequence of continuous coupling to externally specified spatiotemporal dynamics. Rather than postulating additional internal predictive mechanisms, GM derives predictive behaviour directly from the lawful organization of the unfolding environment, thereby providing a more parsimonious and physically coherent account of prediction. The comparative analysis therefore indicates that the GM provides the stronger theoretical framework.

2.5 Generalizability

2.5.1 Scientific Background

Generalizability refers to the extent to which the explanatory principles of a scientific theory remain applicable across different phenomena, behavioural domains, species, and environmental conditions. Scientific theories gain strength when the same underlying principles successfully account for diverse observations without requiring fundamental modification. The importance of generalizability has long been recognized within philosophy of science and scientific methodology and forms an essential component of theory evaluation across the natural and behavioural sciences. Closely related concepts have been discussed by Karl Popper, Thomas Kuhn, and Larry Laudan, all of whom regarded broad applicability as an important indicator of scientific robustness.

2.5.2 Definition

Within the present comparison, generalizability refers to the extent to which a theoretical framework applies across different sensory modalities, behavioural domains, species, developmental stages, and natural environments without requiring fundamentally different explanatory mechanisms. A theory possesses greater generalizability when the same principles remain valid across this broad empirical range.

2.5.3 Internal Models

IM have been applied successfully within numerous domains of cognition, including perception, motor control, language, navigation, decision making, and learning. However, different domains frequently require different computational architectures, including predictive coding, forward models, Bayesian inference, reinforcement learning, cognitive maps, and hierarchical generative models. Consequently, generalization often depends upon extending or modifying existing theoretical constructs rather than applying one common explanatory principle.

2.5.4 The Gramophone Model

The GM proposes that the same externally organized perception–action principle applies across all sensory modalities and behavioural domains. Whether perception concerns vision, audition, touch, proprioception, or multimodal behaviour, the underlying organization is proposed to arise from continuously unfolding external physical dynamics projected onto the sensory surface. Neural stabilization, sensory transduction, and afferent–efferent coupling operate according to the same fundamental principles regardless of the specific behavioural context.

2.5.5 Comparative Evaluation

The principal distinction concerns the degree to which both frameworks rely upon a common explanatory organization across different empirical domains. IM frequently introduce additional computational mechanisms when extending explanations to new behavioural phenomena. GM, by contrast, proposes that the same organizational principle applies without fundamental theoretical modification across perception, action, memory, imagery, prediction, dreaming, and motor coordination.

2.5.6 Scientific Assessment

From the perspective of generalizability, the GM more closely satisfies this criterion than contemporary IM. Although IM have been applied successfully across numerous domains of cognition, these applications generally rely upon multiple specialized computational architectures that differ across behavioural contexts. In contrast, GM applies the same externally organized perception–action principle across sensory modalities, behavioural domains, and cognitive phenomena. Consequently, GM provides a higher degree of theoretical continuity by explaining diverse empirical phenomena without requiring fundamentally different explanatory mechanisms. The comparative analysis therefore indicates that the GM provides broader explanatory applicability through a single organizing principle operating across sensory modalities, behavioural contexts, and cognitive functions.

3. Physical–Mechanistic Coherence

3.1 Mechanistic Specificity

3.1.1 Scientific Background

Mechanistic specificity is widely regarded as one of the defining characteristics of successful scientific theories. Scientific explanations become progressively stronger as they move beyond descriptive accounts toward explicit causal mechanisms specifying how observed phenomena arise. This mechanistic perspective has been developed extensively within contemporary philosophy of science by scholars including Carl G. Hempel, Wesley C. Salmon, William Bechtel, and Carl F. Craver. Although their conceptions of scientific explanation differ, they share the view that robust theories should identify the concrete causal organization responsible for the phenomena they explain rather than merely describing functional relationships or empirical regularities.

3.1.2 Definition

Within the present comparison, mechanistic specificity refers to the extent to which a theoretical framework explicitly identifies the causal mechanisms responsible for perception and cognition. A theory exhibits greater mechanistic specificity when it provides a continuous, physically identifiable account of how perceptual and cognitive phenomena arise, while minimizing reliance on hypothetical or functionally defined explanatory constructs.

3.1.3 Internal Models

IM propose that perception and cognition emerge through internally organized computational mechanisms operating within the nervous system. Depending on the specific framework, these mechanisms include internal representations, predictive coding, Bayesian inference, forward and inverse models, generative models, attractor dynamics, neural manifolds, and representational drift. Although these approaches have generated extensive empirical research, the primary organizing architecture responsible for transforming neural activity into perception and cognition remains described largely in computational or functional terms. Consequently, the mechanistic relationship between neural activity and the emergence of organized perceptual experience remains incompletely specified.

3.1.4 The Gramophone Model

According to the GM, the primary organization of perception and cognition originates outside the nervous system through continuously unfolding, externally specified physical dynamics projected onto the sensory surface. Sensory transduction converts these organized physical dynamics into afferent electrochemical activity while preserving their functional organization. The nervous system subsequently stabilizes, maintains, and re-engages this organization through afferent–efferent coupling and accumulated chemo-electrical residues acquired during previous perception. Rather than proposing additional internally organizing computational architectures, GM attributes perceptual organization to the continuous causal organization already present within the external world and its continuation through sensory transduction and neural stabilization.

3.1.5 Comparative Evaluation

Both IM and the GM seek to explain how perception and cognition arise from organism–environment interactions. The principal distinction concerns the location and specificity of the proposed causal mechanism. IM attribute perceptual organization to internally organized computational architectures whose mechanistic realization remains incompletely specified. GM instead identifies a continuous physical mechanism beginning with externally specified environmental dynamics, continuing through sensory transduction, and subsequently stabilized within the nervous system. The comparison therefore concerns the extent to which each framework provides a continuous and physically identifiable mechanistic account of perceptual organization.

3.1.6 Scientific Assessment

From the perspective of mechanistic specificity, the GM more closely satisfies this criterion than contemporary IM. Although IM provide sophisticated computational descriptions of neural function, the causal mechanism by which organized perception and cognition emerge remains only partially specified. In contrast, GM proposes a continuous mechanistic organization extending from the lawful physical dynamics of the environment through sensory transduction to neural stabilization and behavioural control. The comparative analysis therefore indicates that the GM provides a more explicit and physically continuous account of perceptual organization while reducing reliance on hypothetical internally organizing mechanisms.

3.2 Physical Coherence

3.2.1 Scientific Background

Physical coherence is a fundamental criterion for scientific theory evaluation. A successful scientific theory should remain consistent with established physical principles and describe phenomena in a manner that is compatible with the known causal organization of the natural world. Explanations that require mechanisms inconsistent with well-established physical laws, or that leave essential causal transitions unspecified, possess reduced scientific plausibility. The importance of mechanistic coherence has been emphasized throughout the philosophy of science by scholars including Ernest Nagel, Wesley C. Salmon, Carl F. Craver, and William Bechtel, all of whom argued that scientific explanations should remain firmly grounded in physically realizable causal processes.

3.2.2 Definition

Within the present comparison, physical coherence refers to the extent to which a theoretical framework provides an explanation of perception and cognition that remains compatible with established physical, physiological, and causal principles. A theory exhibits greater physical coherence when it explains perceptual organization through continuously identifiable physical processes without requiring discontinuities or hypothetical mechanisms that remain physically unspecified.

3.2.3 Internal Models

IM assume that sensory stimulation is transformed into neural activity through sensory transduction, after which perception and cognition are primarily organized by internally generated computational processes. Although the physiological mechanisms underlying sensory transduction and neural signalling are well established, the transition from electrochemical neural activity to internally organized representations, predictive models, or other computational architectures remains incompletely specified in physical terms. Consequently, the principal organizing mechanism is generally described functionally rather than through an explicitly continuous physical process.

3.2.4 The Gramophone Model

According to the GM, perception and cognition remain physically continuous throughout the entire causal chain. Continuously unfolding physical dynamics are first organized within the external world and projected onto the sensory surface. Sensory transduction converts these organized dynamics into electrochemical activity while preserving their functional organization. Neural processes subsequently stabilize, maintain, and re-engage this organization through afferent–efferent coupling without introducing an additional internally organizing architecture. Consequently, every stage of perception and cognition forms part of one continuous physical process extending from the environment through the organism.

3.2.5 Comparative Evaluation

Both IM and the GM recognize the importance of sensory transduction and neural physiology. The principal distinction concerns the continuity of the proposed physical mechanism. IM attribute the primary organization of perception to internally organized computational architectures following transduction, whereas GM maintains that perceptual organization remains physically continuous from externally specified environmental dynamics through sensory transduction and subsequent neural stabilization. The comparison therefore concerns the extent to which each framework preserves an explicitly continuous physical account of perceptual organization.

3.2.6 Scientific Assessment

From the perspective of physical coherence, the GM more closely satisfies this criterion than contemporary IM. Although IM incorporate well-established physiological processes, their primary organizing mechanisms remain described predominantly through computational constructs whose physical realization remains incompletely specified. In contrast, GM proposes a continuous physical organization extending from externally specified environmental dynamics through sensory transduction to neural stabilization. The comparative analysis therefore indicates that the GM provides a more physically coherent explanation of perception and cognition while reducing reliance on hypothetical internally organizing architectures.

3.3 Causal Continuity

3.3.1 Scientific Background

Causal continuity is a fundamental requirement of scientific explanation. Scientific theories gain explanatory strength when they describe phenomena through an uninterrupted chain of identifiable causal processes rather than through isolated explanatory stages or discontinuous transitions. The principle has long been emphasized within the philosophy of science by scholars including David Hume, Ernest Nagel, Wesley C. Salmon, and Carl F. Craver, who argued that scientific explanations should identify continuous causal relationships linking observed phenomena to their underlying mechanisms. The more complete and continuous the causal chain, the stronger the explanatory framework.

3.3.2 Definition

Within the present comparison, causal continuity refers to the extent to which a theoretical framework explains perception and cognition through one uninterrupted causal organization extending from the external environment to behavioural output. A theory exhibits greater causal continuity when every stage of the explanatory process follows directly from the preceding stage without requiring additional organizing principles or discontinuous explanatory transitions.

3.3.3 Internal Models

IM describe perception and cognition as beginning with sensory transduction, after which internally organized computational mechanisms generate perceptual experience and behavioural control. Although the physiological processes underlying sensory transduction and neural signalling are well established, the transition from electrochemical neural activity to internally organized representations, predictive models, or other computational architectures introduces an additional explanatory stage whose causal organization remains only partially specified. Consequently, the complete causal chain between environmental stimulation and perception depends upon internally inferred organizing mechanisms.

3.3.4 The Gramophone Model

According to the GM, perception and cognition remain causally continuous throughout the entire perception–action cycle. Continuously unfolding physical dynamics originate within the external environment and are projected directly onto the sensory surface, where they become functionally organized. Sensory transduction converts this organization into afferent electrochemical activity without altering its functional continuity. Neural processes subsequently stabilize, maintain, and re-engage this same organization through afferent–efferent coupling and accumulated chemo-electrical residues, allowing perception, memory, imagination, dreaming, and action to emerge from one continuous causal organization rather than from multiple independent mechanisms.

3.3.5 Comparative Evaluation

Both IM and the GM seek to explain the causal relationship between environmental stimulation, neural activity, and behaviour. The principal distinction concerns whether this relationship remains continuously organized throughout the perception–action cycle. IM attribute perceptual organization to computational mechanisms introduced following sensory transduction, whereas GM proposes that the same externally specified organization remains causally continuous throughout the entire process. The comparison therefore concerns the degree to which each framework provides one uninterrupted causal account of perception and cognition.

3.3.6 Scientific Assessment

From the perspective of causal continuity, the GM more closely satisfies this criterion than contemporary IM. Although IM successfully describe numerous components of neural information processing, the complete causal transition from environmental dynamics to organized perception remains mediated by additional internally organizing constructs. In contrast, GM proposes one continuous causal organization extending from externally specified physical dynamics through sensory transduction, neural stabilization, and behavioural control. The comparative analysis therefore indicates that the GM provides a more causally continuous explanation while reducing reliance on additional internally organizing mechanisms.

3.4 Anatomical and Physiological Consistency

3.4.1 Scientific Background

Anatomical and physiological consistency constitutes an essential criterion for evaluating scientific theories of perception and cognition. A successful theoretical framework should remain compatible with the established anatomical organization of the nervous system and the known physiological processes through which sensory information is acquired, transmitted, and utilized. Theories that require mechanisms unsupported by anatomy or physiology possess reduced scientific plausibility. This principle has been emphasized throughout neuroscience and the philosophy of science by scholars including Santiago Ramón y Cajal, Charles Sherrington, William Bechtel, and Carl F. Craver, who argued that scientific explanations should remain grounded in demonstrable biological organization.

3.4.2 Definition

Within the present comparison, anatomical and physiological consistency refers to the extent to which a theoretical framework explains perception and cognition in accordance with established knowledge of sensory transduction, neural physiology, and the anatomical organization of the nervous system. A theory exhibits greater anatomical and physiological consistency when its explanatory principles correspond directly to identifiable biological structures and physiological processes without requiring additional anatomically unspecified mechanisms.

3.4.3 Internal Models

IM are grounded in well-established knowledge concerning sensory receptors, sensory transduction, neural signalling, and cortical processing. However, the internally organizing mechanisms proposed by these frameworks—including internal representations, predictive models, generative architectures, and related computational constructs—cannot be directly identified as discrete anatomical or physiological entities. Instead, these mechanisms are generally inferred from patterns of neural activity and described primarily in computational or functional terms. Consequently, their precise anatomical realization remains incompletely specified.

3.4.4 The Gramophone Model

According to the GM, perception and cognition emerge through anatomical and physiological processes that are directly identifiable. Continuously unfolding physical dynamics first encounter the sensory surface, where specialized receptor systems transduce them into afferent electrochemical activity. Neural circuits subsequently stabilize, maintain, and re-engage this organization through established afferent and efferent pathways together with accumulated chemo-electrical residues resulting from previous perception. Rather than introducing additional internally organizing structures, GM attributes perceptual organization to the continuous interaction between externally specified dynamics and known sensory and neural physiology.

3.4.5 Comparative Evaluation

Both IM and the GM are consistent with established knowledge concerning sensory receptors, sensory transduction, and neural physiology. The principal distinction concerns the explanatory role assigned to these biological processes. IM attribute the primary organization of perception to internally organized computational architectures whose anatomical realization remains only partially specified. GM, by contrast, explains perception through physiological processes that directly connect externally specified environmental dynamics with established sensory and neural anatomy. The comparison therefore concerns the extent to which each framework relies upon biologically identifiable rather than computationally inferred organizing mechanisms.

3.4.6 Scientific Assessment

From the perspective of anatomical and physiological consistency, the GM more closely satisfies this criterion than contemporary IM. Although IM successfully incorporate established neurophysiology, their principal organizing mechanisms remain computational constructs whose anatomical implementation is incompletely specified. In contrast, GM derives perceptual organization directly from identifiable sensory surfaces, sensory transduction, afferent and efferent pathways, and neural stabilization. The comparative analysis therefore indicates that the GM provides a more anatomically and physiologically grounded account of perception and cognition while reducing reliance on hypothetical internally organizing architectures.

3.5 Mechanistic Parsimony

3.5.1 Scientific Background

Mechanistic parsimony is a fundamental principle of scientific explanation. A theory gains scientific strength when it explains a broad range of empirical phenomena through the smallest number of necessary mechanistic assumptions. Rather than multiplying explanatory entities or processes, scientifically successful theories seek to identify the simplest causal organization capable of accounting for the observed phenomena. This principle is closely associated with Occam's Razor and has been emphasized throughout the philosophy of science by William of Ockham, Isaac Newton, Karl Popper, and Elliott Sober. Although simplicity alone does not establish the truth of a theory, unnecessary mechanistic complexity reduces explanatory strength when simpler alternatives account equally well for the same empirical observations.

3.5.2 Definition

Within the present comparison, mechanistic parsimony refers to the extent to which a theoretical framework explains perception and cognition through the fewest necessary mechanistic assumptions while maintaining explanatory adequacy. A theory exhibits greater mechanistic parsimony when it accounts for a broad range of perceptual and cognitive phenomena without introducing additional hypothetical mechanisms beyond those required by established physical and biological processes.

3.5.3 Internal Models

IM explain perception and cognition through a diverse collection of internally organized computational mechanisms. These include internal representations, predictive coding, Bayesian inference, forward and inverse models, generative models, cognitive maps, attractor dynamics, neural manifolds, and representational drift. Although each of these constructs addresses specific empirical phenomena, the cumulative explanatory framework relies upon numerous partially independent mechanistic assumptions whose mutual relationships remain incompletely integrated. Consequently, explanatory success is achieved through an increasingly complex collection of specialized computational architectures.

3.5.4 The Gramophone Model

According to the GM, perception and cognition arise from one continuous mechanistic organization extending from externally specified physical dynamics through sensory transduction to neural stabilization and afferent–efferent coupling. Rather than introducing separate computational mechanisms for prediction, memory, mental imagery, dreaming, affordances, or motor coordination, these phenomena are interpreted as different manifestations of the same externally organized perception–action process. Consequently, GM seeks to explain a broad empirical domain while introducing only those mechanistic processes already required by established sensory physiology and organism–environment interactions.

3.5.5 Comparative Evaluation

Both IM and the GM seek to explain essentially the same class of perceptual and cognitive phenomena. The principal distinction concerns the number of mechanistic assumptions required. IM distribute explanatory responsibility across multiple specialized computational mechanisms, whereas GM derives the same range of phenomena from one continuous externally organized mechanism operating throughout the perception–action cycle. The comparison therefore concerns not merely explanatory scope, but the degree of mechanistic economy with which that explanatory scope is achieved.

3.5.6 Scientific Assessment

From the perspective of mechanistic parsimony, the GM more closely satisfies this criterion than contemporary IM. Although IM provide extensive explanations for perceptual and cognitive phenomena, these explanations rely upon an increasingly diverse collection of computational mechanisms introduced to account for different functional domains. In contrast, GM derives the same empirical phenomena from one continuous externally organized mechanistic framework grounded in sensory physiology and organism–environment interactions. The comparative analysis therefore indicates that the GM achieves comparable explanatory performance while substantially reducing mechanistic complexity and theoretical assumptions.

4. Philosophy-of-Science Criteria

4.1 Ontological Economy

4.1.1 Scientific Background

Ontological economy is one of the oldest and most influential principles in scientific theory evaluation. Scientific theories gain explanatory strength when they account for observed phenomena while postulating the fewest necessary entities, structures, or processes. This principle is most commonly associated with William of Ockham's Razor, which states that unnecessary explanatory assumptions should not be multiplied beyond necessity. Although ontological simplicity alone does not establish the truth of a theory, the introduction of additional theoretical entities requires independent justification. The importance of ontological economy has subsequently been emphasized throughout the philosophy of science by scholars including Karl Popper, Willard Van Orman Quine, and Elliott Sober, all of whom regarded unnecessary ontological commitments as reducing scientific explanatory strength.

4.1.2 Definition

Within the present comparison, ontological economy refers to the extent to which a theoretical framework explains perception and cognition while introducing the fewest necessary theoretical entities and organizing principles. A theory exhibits greater ontological economy when it accounts for the same empirical phenomena without postulating additional explanatory structures whose existence has not been independently established.

4.1.3 Internal Models

IM explain perception and cognition through a diverse collection of internally organized theoretical constructs, including internal representations, predictive models, generative models, Bayesian beliefs, forward and inverse models, cognitive maps, attractor dynamics, neural manifolds, and representational drift. Although these constructs have proven valuable within many areas of cognitive science, they constitute additional theoretical entities introduced to explain perceptual and cognitive organization. Their existence is generally inferred from behavioural and neural observations rather than directly demonstrated as independent organizing structures.

4.1.4 The Gramophone Model

According to the GM, perception and cognition do not require additional internally organizing entities beyond those already established by physics, sensory physiology, and organism–environment interactions. Continuously unfolding physical dynamics, sensory transduction, neural stabilization, and afferent–efferent coupling together provide the complete explanatory organization. Rather than introducing internal representations or predictive architectures as additional ontological entities, GM derives perceptual and cognitive phenomena from the lawful organization already present within the external world and its physiological continuation through the nervous system.

4.1.5 Comparative Evaluation

Both IM and the GM seek to explain essentially the same perceptual and cognitive phenomena. The principal distinction concerns the number of theoretical entities required. IM rely upon multiple internally organized constructs introduced specifically to explain perceptual organization, whereas GM explains the same empirical domain without postulating additional internally organizing entities beyond established physical and physiological processes. The comparison therefore concerns not only explanatory adequacy but also the degree of ontological commitment required by each framework.

4.1.6 Scientific Assessment

From the perspective of ontological economy, the GM more closely satisfies this criterion than contemporary IM. Although IM have generated an extensive theoretical literature, they do so by introducing numerous internally organizing constructs whose existence remains theoretically inferred. In contrast, GM explains the same empirical domain through physical and physiological processes already independently established. The comparative analysis therefore indicates that the GM achieves comparable explanatory performance while substantially reducing ontological commitments.

4.2 Consilience

4.2.1 Scientific Background

Consilience is widely regarded as one of the strongest indicators of scientific theory quality. The concept was introduced by William Whewell, who argued that a theory gains exceptional scientific support when it successfully explains multiple independent classes of phenomena through a single explanatory framework. Rather than merely accounting for isolated observations, theories exhibiting consilience unify diverse empirical domains that were originally investigated independently. The importance of consilience has subsequently been emphasized by philosophers of science including Ernest Nagel, Philip Kitcher, and Edward O. Wilson, all of whom regarded the convergence of independent lines of evidence as a hallmark of robust scientific explanation.

4.2.2 Definition

Within the present comparison, consilience refers to the extent to which a theoretical framework explains diverse and independently observed perceptual and cognitive phenomena through a common explanatory organization. A theory exhibits greater consilience when the same underlying principles account for multiple empirical domains without requiring fundamentally different explanatory frameworks.

4.2.3 Internal Models

IM have generated important explanations across numerous domains of cognitive science, including perception, motor control, language, memory, decision making, navigation, and learning. However, these domains are generally explained through different theoretical architectures, including predictive coding, Bayesian inference, forward models, cognitive maps, attractor dynamics, reinforcement learning, and generative models. Although these approaches collectively address a broad empirical range, their integration depends upon multiple partially independent explanatory frameworks rather than upon one unified theoretical organization.

4.2.4 The Gramophone Model

According to the GM, diverse perceptual and cognitive phenomena represent different manifestations of one continuous externally organized perception–action principle. Vision, audition, touch, proprioception, motor control, prediction, memory, mental imagery, dreaming, and affordances are all derived from the same lawful organization of continuously unfolding external physical dynamics projected onto the sensory surface and subsequently stabilized through neural physiology. Consequently, phenomena traditionally treated as independent domains are interpreted as expressions of one common explanatory organization.

4.2.5 Comparative Evaluation

Both IM and the GM seek to explain a broad range of perceptual and cognitive phenomena. The principal distinction concerns the degree to which these diverse observations are unified within one explanatory framework. IM integrate independent empirical domains through multiple specialized computational theories, whereas GM derives the same empirical diversity from one externally organized perception–action principle. The comparison therefore concerns the extent to which each framework achieves explanatory convergence across independent domains of investigation.

4.2.6 Scientific Assessment

From the perspective of consilience, the GM more closely satisfies this criterion than contemporary IM. Although IM collectively explain an extensive empirical literature, this explanatory success depends upon multiple partially independent theoretical frameworks developed for different functional domains. In contrast, GM proposes that the same organizing principle accounts for these diverse phenomena without requiring separate explanatory architectures. The comparative analysis therefore indicates that the GM substantially increases explanatory convergence while reducing theoretical fragmentation across independent empirical domains.

4.3 Inference to the Best Explanation

4.3.1 Scientific Background

Inference to the Best Explanation (IBE) is one of the central principles of scientific reasoning. Rather than selecting theories solely because they fit existing observations, IBE holds that the preferred scientific theory is the one that provides the most comprehensive, coherent, parsimonious, and causally satisfactory explanation of the available evidence. The concept was first systematically formulated by Gilbert Harman and has subsequently been developed by philosophers including Peter Lipton, Wesley C. Salmon, and Bas van Fraassen. Although these authors differ in their philosophical interpretations, they agree that scientific theories should be evaluated according to their overall explanatory superiority rather than by their ability to accommodate isolated empirical findings.

4.3.2 Definition

Within the present comparison, Inference to the Best Explanation refers to the extent to which a theoretical framework provides the overall strongest explanation of perceptual and cognitive phenomena when explanatory scope, coherence, mechanistic specificity, parsimony, and empirical consistency are considered collectively. A theory satisfies this criterion when it explains the available evidence more successfully than competing alternatives while relying on fewer independent assumptions.

4.3.3 Internal Models

IM have dominated cognitive science for several decades by providing explanations for a wide range of perceptual and cognitive phenomena. Their explanatory success, however, depends upon multiple computational architectures, internally organizing mechanisms, and theoretical constructs developed to account for different functional domains. Although these approaches accommodate a substantial body of empirical evidence, their explanatory organization remains distributed across numerous partially independent theoretical frameworks whose integration remains incomplete.

4.3.4 The Gramophone Model

According to the GM, perception and cognition are explained through one continuous externally organized perception–action principle operating at the sensory surface. From this single organizing framework, GM derives explanations for perception, action, prediction, memory, mental imagery, dreaming, affordances, cortical stabilization, and motor coordination without introducing separate internally organizing computational mechanisms. Consequently, GM seeks to account for the same empirical observations through a more unified, mechanistically continuous, and parsimonious explanatory framework.

4.3.5 Comparative Evaluation

Both IM and the GM explain essentially the same empirical domain. The principal distinction concerns their overall explanatory quality. IM explain perceptual and cognitive phenomena through multiple specialized computational frameworks, whereas GM derives these phenomena from one continuous externally organized explanatory principle. The comparison therefore concerns not any individual empirical observation, but which framework provides the overall superior explanation when explanatory performance, theoretical coherence, mechanistic continuity, and scientific economy are evaluated together.

4.3.6 Scientific Assessment

From the perspective of inference to the best explanation, the GM more closely satisfies this criterion than contemporary IM. Although IM provide sophisticated accounts of perceptual and cognitive phenomena, these explanations depend upon multiple internally organizing mechanisms whose existence is inferred rather than directly demonstrated. In contrast, GM explains the same empirical phenomena through a single externally organized mechanistic framework grounded in independently established physical and physiological processes. The comparative analysis therefore indicates that the GM provides the stronger overall explanation while reducing reliance on theoretically inferred organizing mechanisms.

4.4 Falsifiability

4.4.1 Scientific Background

Falsifiability is one of the fundamental principles of scientific theory evaluation. A scientific theory gains empirical credibility by making claims that can, in principle, be tested and potentially shown to be false. This principle was developed most extensively by Karl Popper, who argued that scientific progress depends upon the continual testing of theories through observations capable of refuting them. Although later philosophers of science have refined or criticized aspects of Popper's philosophy, falsifiability remains one of the most widely accepted criteria distinguishing scientific theories from explanatory frameworks that accommodate every possible outcome.

4.4.2 Definition

Within the present comparison, falsifiability refers to the extent to which a theoretical framework generates clear empirical predictions whose failure would require modification or rejection of the theory. A theory exhibits greater falsifiability when its central explanatory principles are directly testable and expose the theory to genuine empirical risk rather than allowing unlimited reinterpretation of contradictory observations.

4.4.3 Internal Models

IM have generated numerous experimentally testable hypotheses concerning neural activity, behaviour, and computational processing. However, because IM comprise a broad family of related theoretical frameworks—including predictive coding, Bayesian inference, generative models, forward models, cognitive maps, and representational accounts—negative findings frequently lead to modification or replacement of individual computational architectures rather than rejection of the overarching theoretical framework. Consequently, the central assumption that perception and cognition are primarily organized by internal models remains difficult to falsify directly.

4.4.4 The Gramophone Model

According to the GM, the primary organization of perception and cognition resides at the sensory surface rather than within internally organizing neural architectures. This central claim generates direct empirical predictions concerning perception, action, memory, mental imagery, dreaming, affordances, and cortical function. If these phenomena cannot be explained through the externally organized perception–action mechanism proposed by GM, or if internally organizing mechanisms are demonstrated to be indispensable for their explanation, the central explanatory principle of GM would require revision or rejection. Consequently, the core assumptions of GM are directly exposed to empirical testing.

4.4.5 Comparative Evaluation

Both IM and the GM generate empirically testable predictions. The principal distinction concerns the falsifiability of their central organizing assumptions. IM primarily test individual computational models while leaving the broader assumption of internal organization largely intact. GM, by contrast, exposes its central explanatory principle—the external organization of perception and cognition—to direct empirical evaluation across multiple perceptual and cognitive domains. The comparison therefore concerns not the number of experimental predictions produced by each framework, but the extent to which their fundamental theoretical assumptions are themselves empirically vulnerable.

4.4.6 Scientific Assessment

From the perspective of falsifiability, the GM more closely satisfies this criterion than contemporary IM. Although IM have generated numerous experimentally productive hypotheses, many of their central organizing constructs remain sufficiently flexible to accommodate diverse empirical outcomes through modifications of the computational architecture. In contrast, GM derives its predictions from a single externally organized mechanistic framework grounded in independently observable physical and physiological processes. The comparative analysis therefore indicates that the GM provides a more readily falsifiable theoretical framework while reducing reliance on adaptable internally organizing mechanisms.

4.5 Explanatory Necessity

4.5.1 Scientific Background

Explanatory necessity is a fundamental principle of scientific theory evaluation. Scientific theories should introduce explanatory assumptions only when they are demonstrably required to explain the available empirical evidence. The introduction of theoretical entities or mechanisms that are not necessary for explanation weakens scientific economy and reduces explanatory strength. This principle is closely related to Occam's Razor and has been emphasized throughout the philosophy of science by William of Ockham, Karl Popper, Elliott Sober, and Peter Lipton. Although additional explanatory assumptions are sometimes justified, they require independent evidence demonstrating that simpler competing explanations are insufficient.

4.5.2 Definition

Within the present comparison, explanatory necessity refers to the extent to which the central assumptions of a theoretical framework are required to explain perceptual and cognitive phenomena. A theory exhibits greater explanatory necessity when each of its fundamental assumptions contributes indispensably to explanation and cannot be removed without substantially reducing explanatory performance.

4.5.3 Internal Models

The defining assumption of IM is that perception and cognition require internally organized models, representations, or comparable computational architectures that generate or organize perceptual experience. Although these constructs have become central to contemporary cognitive science, their necessity has generally been inferred from the absence of an alternative explanatory framework rather than demonstrated independently. Consequently, the explanatory indispensability of internal models has remained largely untested because no coherent competing framework capable of explaining the same empirical domain was previously available.

4.5.4 The Gramophone Model

According to the GM, the primary organization of perception and cognition resides at the sensory surface rather than within internally organizing neural architectures. Perception, action, prediction, memory, mental imagery, dreaming, affordances, and motor coordination are explained through one continuous externally organized perception–action mechanism. Consequently, GM proposes that the internally organizing mechanisms uniquely postulated by IM are not required to explain the available empirical evidence. Their explanatory necessity therefore becomes an empirical rather than an assumed question.

4.5.5 Comparative Evaluation

Both IM and the GM seek to explain essentially the same empirical phenomena. The principal distinction concerns whether the internally organizing mechanisms unique to IM remain indispensable once an externally organized explanatory framework becomes available. If GM explains the same empirical domain without requiring internal models, representations, or comparable computational architectures, the explanatory necessity of these additional assumptions must be re-evaluated. The comparison therefore concerns not merely whether IM can explain perception and cognition, but whether their unique theoretical commitments remain scientifically necessary.

4.5.6 Scientific Assessment

From the perspective of explanatory necessity, the GM more closely satisfies this criterion than contemporary IM. Although IM successfully account for a wide range of perceptual and cognitive phenomena, they do so by introducing additional internally organizing mechanisms beyond those already established by physics, physiology, and evolutionary biology. In contrast, GM explains the same empirical domain through a continuous externally organized mechanistic framework grounded in independently established physical and biological processes. The comparative analysis therefore indicates that the GM provides the more explanatorily necessary framework while reducing reliance on additional theoretical assumptions.

5. Evolutionary Evaluation

5.1 Evolutionary Plausibility

5.1.1 Scientific Background

Evolutionary plausibility is an essential criterion for evaluating scientific theories of perception and cognition. A successful explanatory framework should remain compatible with the gradual, cumulative nature of biological evolution and account for how its proposed mechanisms could emerge through successive evolutionary transitions. Since Charles Darwin, evolutionary continuity has become a central principle of biology, emphasizing that complex biological functions arise through incremental modification of pre-existing structures rather than through abrupt appearance of entirely novel organizational principles. This perspective has subsequently been developed by evolutionary biologists and philosophers of biology including Ernst Mayr, Theodosius Dobzhansky, John Maynard Smith, and Daniel Dennett, all of whom regarded continuity across evolutionary history as a fundamental criterion for biological explanation.

5.1.2 Definition

Within the present comparison, evolutionary plausibility refers to the extent to which a theoretical framework explains perception and cognition through mechanisms that could realistically emerge through gradual evolutionary processes. A theory exhibits greater evolutionary plausibility when its central organizing principles remain applicable across different stages of biological evolution without requiring the sudden appearance of fundamentally new explanatory mechanisms.

5.1.3 Internal Models

IM generally assume that perception and cognition are organized through internally generated computational mechanisms operating within increasingly complex nervous systems. Although these frameworks successfully describe many aspects of cognition in advanced organisms, they provide comparatively limited explanations of how internally organized representations, predictive architectures, or generative models gradually emerged during evolutionary history. Consequently, the evolutionary origin of the central organizing principles proposed by IM remains only partially specified.

5.1.4 The Gramophone Model

According to the GM, perception and cognition originate from continuously unfolding physical dynamics that first encounter the organism at the sensory surface. This externally organized perception–action principle applies equally to the simplest organisms possessing basic sensory responsiveness and to highly complex nervous systems. Throughout evolution, increasing neural complexity does not introduce a fundamentally new organizing principle but progressively improves the stabilization, continuation, and integration of externally specified organization through sensory transduction and afferent–efferent coupling. Consequently, the same fundamental mechanism remains evolutionarily continuous across the entire biological spectrum.

5.1.5 Comparative Evaluation

Both IM and the GM seek to explain perception and cognition within an evolutionary context. The principal distinction concerns the origin of the organizing principle itself. IM attribute perceptual organization primarily to increasingly sophisticated internal computational architectures, whereas GM attributes perceptual organization to the continuous organism–environment relationship that necessarily existed before complex nervous systems evolved. The comparison therefore concerns the extent to which each framework provides a continuous evolutionary account of the emergence of perception and cognition.

5.1.6 Scientific Assessment

From the perspective of evolutionary plausibility, the GM more closely satisfies this criterion than contemporary IM. Although IM successfully describe many aspects of cognition in organisms possessing advanced nervous systems, the evolutionary emergence of their central organizing mechanisms remains incompletely explained. In contrast, GM derives perception and cognition from organism–environment interactions that necessarily preceded the evolution of complex neural tissue and remain fundamental throughout evolutionary history. The comparative analysis therefore indicates that the GM provides a more evolutionarily continuous and biologically plausible account of perceptual and cognitive organization.

5.2 Evolutionary Continuity

5.2.1 Scientific Background

Evolutionary continuity is a fundamental principle of evolutionary biology and scientific explanation. Biological theories gain explanatory strength when they account for complex structures and functions as gradual modifications of pre-existing mechanisms rather than as the appearance of fundamentally new organizational principles. Since Darwin's theory of descent with modification, evolutionary continuity has become one of the central criteria for evaluating biological explanations. This perspective has been further developed by evolutionary biologists including Ernst Mayr, Theodosius Dobzhansky, Stephen Jay Gould, and John Maynard Smith, all of whom emphasized that biological complexity emerges through cumulative evolutionary change built upon earlier adaptive structures.

5.2.2 Definition

Within the present comparison, evolutionary continuity refers to the extent to which a theoretical framework explains perception and cognition as continuous evolutionary developments rather than as fundamentally novel biological capacities. A theory exhibits greater evolutionary continuity when the same organizing principles remain applicable across increasingly complex organisms while requiring only gradual evolutionary modification.

5.2.3 Internal Models

IM generally explain perception and cognition through computational mechanisms that become increasingly sophisticated with neural complexity. Representations, predictive models, Bayesian inference, and related computational architectures are typically regarded as products of increasingly advanced nervous systems. Although these frameworks successfully explain many cognitive functions in higher organisms, they provide comparatively limited accounts of how their central organizing principles emerged progressively from simpler sensory systems during evolutionary history. Consequently, the transition from basic sensory responsiveness to internally organized cognition remains only partially specified.

5.2.4 The Gramophone Model

According to the GM, the fundamental organizing principle remains unchanged throughout evolutionary history. From the earliest organisms onward, continuously unfolding physical dynamics first encounter the sensory surface, where they become functionally organized before being transduced into neural activity. Evolutionary increases in neural complexity do not introduce a new organizing principle but progressively enhance the stabilization, continuation, integration, and behavioural utilization of this externally specified organization. Consequently, perception and cognition remain evolutionarily continuous because increasingly complex nervous systems elaborate the same externally organized perception–action mechanism rather than replacing it.

5.2.5 Comparative Evaluation

Both IM and the GM seek to explain the evolutionary emergence of perception and cognition. The principal distinction concerns whether increasing neural complexity introduces fundamentally new organizing mechanisms or progressively elaborates an already existing perception–action organization. IM generally associate increasingly sophisticated cognition with increasingly sophisticated internal computational architectures, whereas GM maintains that the primary organizing principle remains evolutionarily constant while neural tissue progressively improves its stabilization and behavioural application. The comparison therefore concerns the degree of evolutionary continuity exhibited by the two frameworks.

5.2.6 Scientific Assessment

From the perspective of evolutionary continuity, the GM more closely satisfies this criterion than contemporary IM. Although IM provide sophisticated explanations of cognition in organisms with highly developed nervous systems, their central organizing mechanisms remain specific to advanced neural architectures and therefore provide limited continuity with earlier stages of biological evolution. In contrast, GM derives perceptual and cognitive organization from the continuous organism–environment interactions that characterize all living organisms, with neural tissue emerging as a later specialization within this existing organization. The comparative analysis therefore indicates that the GM provides a more evolutionarily continuous account of perception and cognition while reducing reliance on evolutionarily discontinuous organizing mechanisms.

5.3 Evolutionary Economy

5.3.1 Scientific Background

Evolutionary economy is a fundamental principle of evolutionary biology. Natural selection does not generate biological complexity by introducing entirely new organizational principles whenever new behavioural capacities arise. Instead, evolution typically modifies, extends, and reuses preexisting structures and mechanisms that have already proven adaptive. Consequently, scientific explanations gain evolutionary plausibility when they minimize the introduction of fundamentally novel biological mechanisms. This principle has been emphasized throughout evolutionary biology by Charles Darwin, Ernst Mayr, François Jacob, and Daniel Dennett, all of whom argued that biological evolution proceeds primarily through modification and co-option rather than through the repeated invention of entirely new functional organizations.

5.3.2 Definition

Within the present comparison, evolutionary economy refers to the extent to which a theoretical framework explains the evolution of perception and cognition through the smallest number of fundamentally new biological principles. A theory exhibits greater evolutionary economy when increasingly complex cognitive capacities emerge through the refinement of existing mechanisms rather than through the introduction of additional organizing architectures.

5.3.3 Internal Models

IM generally explain increasingly complex perceptual and cognitive abilities through increasingly sophisticated internal computational mechanisms. As cognitive complexity increases, additional explanatory constructs—including internal representations, predictive coding, generative models, forward models, cognitive maps, and related computational architectures—are introduced to account for new functional capacities. Although these mechanisms successfully explain many empirical phenomena, evolutionary progress is frequently accompanied by the introduction of additional organizing principles rather than by the progressive refinement of a single underlying mechanism.

5.3.4 The Gramophone Model

According to the GM, evolutionary complexity emerges without introducing fundamentally new organizing principles. From the earliest sensory organisms onward, perception remains organized by continuously unfolding external physical dynamics projected onto the sensory surface. Evolutionary increases in neural complexity progressively enhance the stabilization, continuation, integration, and behavioural utilization of this externally organized perception–action process. Consequently, increasingly sophisticated cognition arises through the elaboration of one continuous evolutionary mechanism rather than through the appearance of multiple new organizing architectures.

5.3.5 Comparative Evaluation

Both IM and the GM seek to explain the evolution of increasingly complex perceptual and cognitive abilities. The principal distinction concerns the number of organizing principles required throughout evolutionary history. IM explain evolutionary complexity through an expanding collection of internally organized computational mechanisms, whereas GM explains the same evolutionary progression through the gradual refinement of one externally organized perception–action principle. The comparison therefore concerns the degree of evolutionary economy achieved by each theoretical framework.

5.3.6 Scientific Assessment

From the perspective of evolutionary economy, the GM more closely satisfies this criterion than contemporary IM. Although IM explain perceptual and cognitive phenomena through increasingly specialized computational mechanisms associated with advanced nervous systems, GM derives the same empirical domain from a single externally organized principle that remains applicable throughout evolutionary history. Neural tissue therefore emerges as a biological specialization that extends an already existing organism–environment organization rather than introducing a fundamentally new organizing architecture. The comparative analysis therefore indicates that the GM provides a more evolutionarily economical account of perception and cognition while reducing reliance on specialized internally organizing mechanisms.

5.4 Evolutionary Conservatism

5.4.1 Scientific Background

Evolutionary conservatism is a fundamental principle of evolutionary biology. Natural selection rarely replaces successful biological organizations with entirely new mechanisms. Instead, evolution preferentially preserves functional structures while gradually modifying and extending them to meet new adaptive demands. Consequently, biological systems are characterized by remarkable continuity across evolutionary history, with increasingly complex functions emerging through the elaboration of existing mechanisms rather than through their wholesale replacement. This principle has been emphasized by evolutionary biologists including Charles Darwin, Ernst Mayr, François Jacob, and Sean B. Carroll, all of whom regarded evolutionary conservation as a defining characteristic of biological organization.

5.4.2 Definition

Within the present comparison, evolutionary conservatism refers to the extent to which a theoretical framework explains perceptual and cognitive evolution through the preservation and gradual refinement of existing biological organization rather than through the repeated introduction of fundamentally new organizing principles. A theory exhibits greater evolutionary conservatism when increasingly complex cognitive capacities emerge through continuous modification of established mechanisms.

5.4.3 Internal Models

IM generally explain cognitive evolution through progressively more sophisticated internally organized computational architectures. As nervous systems become increasingly complex, additional representational and predictive mechanisms are proposed to account for advanced perceptual and cognitive abilities. Although this approach explains many higher cognitive functions, it implies that increasingly complex cognition depends upon the emergence of qualitatively new internal organizing architectures whose evolutionary origin remains only partially specified.

5.4.4 The Gramophone Model

According to the GM, the fundamental perception–action organization remains evolutionarily conserved throughout biological history. From the earliest sensory organisms onward, perception is organized by continuously unfolding external physical dynamics projected onto the sensory surface. Evolutionary changes occur primarily through progressive refinement of sensory transduction, neural stabilization, afferent–efferent coupling, and behavioural integration rather than through the introduction of fundamentally new organizing principles. Consequently, increasingly complex cognition represents the evolutionary elaboration of an already existing perception–action organization.

5.4.5 Comparative Evaluation

Both IM and the GM seek to explain how perception and cognition evolved across biological history. The principal distinction concerns the extent to which evolutionary progress requires fundamentally new organizing mechanisms. IM explain increasing cognitive complexity through increasingly elaborate internal computational architectures, whereas GM explains the same progression through the conservation and gradual refinement of one externally organized perception–action principle. The comparison therefore concerns the degree to which each framework remains consistent with the evolutionary preservation of successful biological organization.

5.4.6 Scientific Assessment

From the perspective of evolutionary conservatism, the GM more closely satisfies this criterion than contemporary IM. Although IM explain perceptual and cognitive organization through computational mechanisms associated primarily with advanced nervous systems, these mechanisms imply the emergence of a novel organizing architecture during evolution. In contrast, GM proposes that the same externally organized principle has remained fundamentally conserved throughout evolutionary history, with neural tissue progressively extending and stabilizing an already existing organism–environment organization. The comparative analysis therefore indicates that the GM provides a more evolutionarily conservative account of perception and cognition while reducing reliance on novel internally organizing architectures.

5.5 Evolutionary Necessity

5.5.1 Scientific Background

Evolutionary necessity is a fundamental principle of evolutionary explanation. Biological evolution favors only those structures and mechanisms that provide a genuine adaptive advantage. Consequently, the emergence of new biological organization requires evidence that existing mechanisms were insufficient to meet the functional demands imposed by natural selection. Evolution does not introduce additional complexity without selective necessity. This principle has been emphasized throughout evolutionary biology by Charles Darwin, Ernst Mayr, George C. Williams, and Richard Dawkins, all of whom argued that novel biological structures require demonstrable adaptive justification rather than theoretical convenience.

5.5.2 Definition

Within the present comparison, evolutionary necessity refers to the extent to which the central organizing principles of a theoretical framework are required to explain the evolutionary emergence of perception and cognition. A theory exhibits greater evolutionary necessity when each of its proposed mechanisms provides an indispensable adaptive contribution and cannot be eliminated without reducing explanatory adequacy.

5.5.3 Internal Models

The defining assumption of IM is that increasingly sophisticated perception and cognition required the evolution of internally organized computational architectures, including representations, predictive models, generative mechanisms, and related computational processes. Although these constructs explain many aspects of advanced cognition, their evolutionary necessity has generally been assumed rather than independently demonstrated. Historically, this assumption remained largely unchallenged because no coherent alternative framework capable of explaining the same empirical phenomena had been available.

5.5.4 The Gramophone Model

According to the GM, the primary organization of perception and cognition originates from continuously unfolding external physical dynamics projected onto the sensory surface. Throughout evolutionary history, increasing neural complexity progressively improves the stabilization, continuation, and behavioural utilization of this externally specified organization without introducing fundamentally new organizing mechanisms. Consequently, the internally organizing computational architectures uniquely proposed by IM are not required to explain the evolutionary emergence of perception and cognition. Their evolutionary necessity therefore becomes an empirical question rather than an implicit assumption.

5.5.5 Comparative Evaluation

Both IM and the GM seek to explain how perception and cognition evolved through natural selection. The principal distinction concerns whether the internally organizing mechanisms unique to IM constitute indispensable evolutionary adaptations. If GM explains the same evolutionary progression without requiring internally organized computational architectures, the adaptive necessity of these additional mechanisms must be re-evaluated. The comparison therefore concerns not whether IM can accommodate evolutionary observations, but whether their central theoretical commitments remain evolutionarily necessary once a coherent alternative framework is available.

5.5.6 Scientific Assessment

From the perspective of evolutionary necessity, the GM more closely satisfies this criterion than contemporary IM. Although IM explain perception and cognition through internally organized computational mechanisms associated with advanced nervous systems, the evolutionary necessity of these additional organizing architectures remains incompletely demonstrated. In contrast, GM derives perceptual and cognitive organization from organism–environment interactions that necessarily preceded the evolution of nervous systems and continued to constrain their subsequent development. Neural tissue therefore emerges as a biological specialization that extends an already existing organization rather than introducing a fundamentally new organizing principle. The comparative analysis therefore indicates that the GM provides a more evolutionarily necessary account of perception and cognition while reducing reliance on additional internally organizing mechanisms.

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6. General Conclusion

The present article set out to evaluate two competing theoretical frameworks for perception and cognition according to established criteria for scientific theory evaluation. Rather than defending the Gramophone Model (GM) in isolation or criticizing Internal Models (IM) individually, both frameworks were systematically compared across four independent domains of scientific evaluation: empirical explanatory power, physical–mechanistic coherence, philosophy-of-science criteria, and evolutionary continuity. Together, these domains comprised twenty independent criteria that are widely recognized for evaluating competing scientific theories.

This comparative strategy reflects a longstanding principle within the philosophy of science. Scientific theories are rarely evaluated on the basis of a single criterion alone. Rather, confidence in a theoretical framework increases when multiple independent standards of evaluation converge upon the same conclusion. This principle is embodied in William Whewell's concept of *consilience* and has subsequently been developed by philosophers of science including Philip Kitcher and Larry Laudan, who argued that robust scientific theories derive their strength from the cumulative convergence of independent explanatory virtues rather than from isolated empirical successes.

Across all twenty criteria examined in the present analysis, a remarkably consistent pattern emerged. In every independent domain of evaluation, the GM more closely satisfied the established standards of scientific theory assessment than contemporary IM. Compared with IM, the GM demonstrated greater explanatory completeness, stronger explanatory unification, higher ecological validity, greater predictive power, broader generalizability, stronger mechanistic specificity, greater physical coherence, stronger causal continuity, higher anatomical and physiological consistency, greater mechanistic parsimony, stronger ontological economy, greater consilience, superior overall explanatory quality, stronger falsifiability, greater explanatory necessity, stronger evolutionary plausibility, greater evolutionary continuity, higher evolutionary economy, stronger evolutionary conservatism, and greater evolutionary necessity.

The significance of these findings extends beyond the individual criteria themselves. Each criterion represents an independent assessment of theoretical quality. When twenty independent criteria consistently converge upon the same theoretical framework, this convergence constitutes an additional higher-order argument that is not reducible to any individual criterion considered in isolation. The cumulative agreement across empirical, mechanistic, philosophical, and evolutionary domains therefore possesses evidential significance in its own right. The overall pattern is substantially stronger than the outcome of any individual comparison alone.

Historically, IM acquired their dominant position largely because no coherent alternative explanatory framework was available. The observation that neural activity consistently accompanies perception, together with the absence of an explicitly identified external organizing principle, led to the widespread assumption that the primary organization of perception and cognition must reside within the brain. The GM fundamentally changes this scientific situation by identifying a coherent alternative organizing principle located at the sensory surface and by providing a physically continuous, mechanistically explicit, and evolutionarily coherent account of the same empirical domain.

The implications of this comparative analysis are therefore clear. The central scientific question is no longer whether an externally organized framework is possible. The present analysis demonstrates that such a framework not only exists, but also more closely satisfies the established criteria for scientific theory evaluation than contemporary IM. Consequently, the remaining scientific question is whether the internally organizing mechanisms uniquely proposed by IM are genuinely necessary.

The burden of proof has therefore reversed. If IM are claimed to constitute the primary organizing architecture of perception and cognition, this claim can no longer rest upon historical precedence, disciplinary consensus, or the mere observation that neural activity accompanies perception. It now requires direct empirical, mechanistic, evolutionary, and theoretical demonstration that internally organizing models actually exist and that they provide a scientifically superior explanation to the externally organized framework proposed by the GM.

Until such evidence is provided, the cumulative convergence of twenty independent criteria of scientific theory evaluation indicates that the GM currently represents the stronger scientific theory of perception and cognition. If IM exist as the primary organizing architecture of perception and cognition, the responsibility for demonstrating their existence and scientific necessity now rests with their proponents. The burden of proof has decisively shifted.

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