Review

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Natural Evolution at the Level of the Individual Mind

Arturo Tozzi

ASL Napoli 1 Centro, Distretto 27, Via Comunale del Principe 13/a 80145, Naples, Italy; tozziarturo@libero.it

Abstract

Current research in cognitive science tends to describe cognition in terms of adaptation or optimization rather than genuine evolution. We advance the hypothesis that the laws governing biological evolution can be meaningfully transposed to the dynamics of thought within the mind of a healthy human individual. We argue that the main mechanisms of natural evolution can be mapped onto mental counterparts that can be formally and mathematically characterized. For instance, genetic variation could correspond to the generation of new ideas through imagination and association; selection to the experiential retention of thoughts enhancing coherence or predictive success; inheritance to the stabilization of mental configurations through memory; mutation to conceptual transformation; recombination to the synthesis of ideas; migration to the assimilation of external information; drift to stochastic fluctuations in attention; adaptation to the progressive optimization of internal models, etc. We propose two theoretical applications: the use of the Hardy–Weinberg equilibrium to quantify cognitive homeostasis and the construction of a phylogenetic tree of thoughts to trace how ideas diversify and branch across an individual's development, revealing how early cognitive patterns generate increasingly complex and abstract forms of reasoning. Our hypothesis provides a unified vocabulary linking neural plasticity, conceptual change and psychological development within the same evolutionary logic. Our framework could guide clinical psychology by interpreting cognitive rigidity as deviation from equilibrium, education by mapping stages of conceptual diversification and consolidation, neuroscience by viewing learning as selection on neural representations, and AI by enabling systems that evolve ideas rather than optimize tasks.

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Introduction

Contemporary research in cognitive science, developmental psychology and theoretical neuroscience emphasizes that mental processes emerge from dynamic interactions among neural and environmental factors (Abbott 2008; Nielsen and Haun, 2016; Dikker et al., 2017; Li and Xu, 2018; Luppi et al., 2019; Lin et al., 2020; Yang et al., 2022; Shaw et al., 2023; Beffara et al., 2025). Yet, despite extensive work on neural plasticity, learning theory and predictive coding, most current models describe cognition in terms of adaptation or optimization rather than genuine evolution (Burke and Barnes, 2006; Arcos-Burgos et al., 2019; Hipólito et al., 2021; Kocagoncu et al., 2021; Tomov et al., 2023; Sumner and Lukasiewicz, 2023; Schilling et al., 2023; Shipp 2024; Keysers et al., 2024; Liao et al., 2025). Existing frameworks rarely include an explicit evolutionary logic linking the spontaneous generation of ideas, their selective reinforcement and their long-term stabilization. Meanwhile, evolutionary epistemology and cultural evolution theories have addressed how ideas propagate among individuals, but few of them examine how comparable mechanisms might operate within a single mind (Slijepcevic 2018; Stanford 2020; Saad 2020; Ermakov and Ermakov, 2021; Smolla et al., 2021; Carmel et al., 2023). We advance the hypothesis that the core laws of natural evolution can also govern processes within the individual mind.

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This mapping between biological laws and mental analogues allows imagination, reflection, learning and forgetting to be interpreted as specific instances of evolutionary mechanisms acting within a mental population. Within our perspective, the mind is understood as a self-organizing ecosystem in which ideas evolve through continuous feedback between internal constraints and external stimuli. The thought of every human individual thus becomes an evolving field balancing novelty and stability, driven by internal selection pressures and environmental challenges.

We will proceed as follows: first, we transpose the principles of natural evolution to the dynamics of individual thought; Next, we provide and effort to integrate developmental, psychological and neural phenomena under a single mathematical and conceptual framework, enabling the derivation of measurable patterns from the same laws that describe biological evolution. Then, we present the mathematical formulation of each evolutionary feature; next, we describe the theoretical implications and the construction of a phylogenetic tree of ideas; finally, we conclude with interpretive remarks on the broader meaning and scope of this framework.

Transposing the Principles of Natural Evolution to the Dynamics of Thought

The evolutionary organization of life is sustained mechanisms that regulate how novelty appears, is filtered by environmental constraints and is preserved across generations. We argue that, when viewed from a cognitive standpoint, these same principles could describe the continuous reshaping of mental life in a healthy human individual as ideas emerge, transform and stabilize like in a biological population. What follows is a theoretical transposition of the major features of natural evolution into their corresponding mental counterparts.

1. **Variation** would represent one of the primary sources of diversity in both biological and cognitive systems. In biology, it arises from genetic differences among individuals, ensuring that populations are never homogeneous (Paaby and Rockman, 2014). In the mind, it would correspond to the spontaneous generation of new ideas through imagination, associative recombination and small interpretive deviations occurring during recall or reasoning. Just as species survive environmental change through the presence of multiple genotypes, cognition would preserve its flexibility through the coexistence of competing representations. Mental variation could appear either as the spontaneous emergence of novel associations, alternative solutions to a problem or the creative blending of distant concepts. It would thus provide the raw material for learning and innovation, allowing the mind to answer to uncertainty not by rigidity, but by exploration of multiple possible forms.
2. **Selection** would determine which variants persist and which disappear. In biology, selection depends on the environment's capacity to reward advantageous traits with reproductive success (Ewens 2019; Cerca 2023). In the mind, a similar process would act through criteria like coherence, predictive accuracy, emotional satisfaction or social validation. Thoughts fitting experience and reducing uncertainty would be preferentially retained, while those generating inconsistency or discomfort would gradually weaken in the mental case. The adaptive criterion would therefore be epistemic and experiential rather than reproductive: mental states would persist in proportion to their coherence and usefulness. Over time, this selection would sculpt the individual's conceptual landscape, favoring representations that integrate successfully within memory and action.
3. **Inheritance** would provide continuity through time, preserving what has proven stable or useful. In biological systems, inheritance transmits genetic information, ensuring that adaptive variations are not lost (Tan, 2019; Xavier et al., 2019). In cognition, the corresponding process would occur through memory, particularly its long-term and procedural components. Memory would consolidate recurrent thought patterns through reinforcement and repetition, stabilizing neural or symbolic traces that encode experience. Each new idea would therefore emerge in a field already shaped by prior configurations, acting as the inherited substrate for further evolution. In this way, inheritance would maintain the continuity of identity and knowledge across the constant flow of change.

4. **Mutation** would constitute the mechanism of transformation and novelty. In biological organisms, mutation introduces random modifications in genetic sequences, occasionally producing new traits that selection may favor (Svensson and Berger, 2019). In the cognitive sphere, it would manifest as reinterpretation, recontextualization or analogical drift, i.e., small but cumulative shifts that alter the structure of meaning. No thought would ever reproduce itself identically: each recall or reformulation would introduce subtle variations. These deviations might arise from language, emotion or context, creating opportunities for conceptual innovation. While biological mutation is largely blind, mental mutation would tend to follow implicit goals and expectations, guiding transformation without determining its outcome.
5. **Recombination** would represent the synthesis of previously distinct ideas, mirroring the biological process by which new genetic constellations arise from parental material. In sexual reproduction, recombination ensures genetic diversity (Stetsenko and Roze, 2022; Burbrink et al., 2025); in the mind, it would ensure conceptual novelty. Human imagination would operate through this recombinative logic, fusing elements drawn from different cognitive lineages into new configurations. The formation of metaphor, analogy or abstract models would exemplify this process: distinct domains of experience would merge into unified conceptual structures, giving rise to hybrid thoughts that inherit properties from multiple sources. Creativity would therefore be the mental counterpart of recombination, allowing the mind to produce innovations retaining traces of their ancestral ideas while transcending their original context.
6. **Migration** would correspond to the movement of ideas between cognitive populations. In biological evolution, gene flow introduces diversity and prevents isolation (Lyu et al., 2022); in cognition, migration would take place through learning, communication, reading, imitation or social interaction. New information from other individuals, cultures or symbolic systems would enter the mental ecosystem, altering the internal distribution of ideas. These incoming variants could compete with, transform or reinforce existing representations, generating new selective pressures that reconfigure cognitive equilibrium, just as gene flow maintains the vitality of evolving species. The mind's openness to migration would thus be essential for cumulative knowledge, cultural integration and adaptability.
7. **Drift** would capture the stochastic component of mental evolution, the random fluctuations that alter the relative prominence of thoughts independently of their adaptive value. In biological terms, drift affects allele frequencies through chance events (Bourrat 2018); in cognition, it would manifest as spontaneous shifts of attention, associative leaps or changes in salience produced by mood, fatigue or distraction. These random dynamics would explain the unpredictable emergence of memories or intuitions that seem detached from immediate purpose. Drift would ensure that the evolution of thought remains open to contingency, allowing for unforeseen combinations and creative surprises beyond deliberate control.
8. **Adaptation** would represent the gradual tuning of the mind to its experiential environment. In biology, adaptation increases fitness by aligning organisms with ecological demands (Lenski, 2017; Mérot 2022); in cognition, it would take the form of refining internal models to minimize discrepancy between expectation and experience. Theories of predictive coding already describe how the brain continually adjusts its representations to reduce surprise, a process formally analogous to selection optimizing fitness. Through adaptation, the mind would integrate the outcomes of variation, selection and inheritance, achieving coherence between inner representations and external reality.
9. **Environment** would constitute the field within which mental evolution unfolds. For organisms, the environment defines the conditions of survival and reproduction; for the mind, it would be the totality of cognitive experiences. Every idea would exist in relation to this context, drawing reinforcement from experiences that confirm it and losing relevance when the environment changes. Bodily sensations, interpersonal relations and cultural frameworks would together form the selective landscape shaping cognitive survival. The environment would therefore not

merely influence thought but participate actively in its evolution, functioning as both constraint and catalyst of mental diversity.

10. **Equilibrium** would mark the temporary balance achieved when opposing cognitive forces like variation, selection and adaptation counteract one another. In biological systems, equilibrium corresponds to stable allele frequencies (Herring 2021); in the mind, it would correspond to psychological homeostasis, in which representations achieve internal consistency and minimal conflict. This cognitive equilibrium would not be static but rather dynamic, sustained by subtle, ongoing adjustments among competing ideas and emotions. During these periods, the mind would maintain coherence without suppressing variability, preserving the readiness to evolve again when new perturbations arise.
11. **Speciation** would represent the process by which mental lineages diverge and acquire distinct functional identities. In biology, speciation arises from reproductive isolation and environmental differentiation (Villa et al., 2019); in the mind, it would manifest as the gradual emergence of semi-autonomous subselves or cognitive modules (moral, emotional, analytical, aesthetic, linguistic, social) developing partial independence while remaining components of a unified system. Each of these subdomains would evolve its own representational rules, selection criteria and adaptive pressures, much like species adapting to distinct ecological niches. This internal diversification would enable the mind to manage complexity, allowing specialized subsystems to address different classes of problems while maintaining coordination through integrative networks such as consciousness or meta-awareness. The coexistence of differentiated mental lineages would therefore enhance flexibility and resilience, preventing any single representational strategy from dominating the entire cognitive ecosystem.
12. **Punctuated equilibrium** would describe the rhythm of cognitive evolution, alternating long periods of relative stability with brief episodes of radical transformation. In biology, these discontinuities reflect rapid speciation following environmental disruption (Manceau et al., 2020); in thought, they would appear as moments of insight, crisis or revelation, when accumulated tension, contradiction or novelty precipitates a sudden reorganization of conceptual structures. During these cognitive "bursts," the mind would restructure its representations, integrating previously incompatible elements into a new order. Though these transitions might be destabilizing, they would also serve as engines of creative evolution, producing higher-order coherence that cannot emerge through gradual refinement alone. Mental development, like natural evolution, would thus proceed through discontinuous leaps of reconfiguration.
13. **Coevolution** would express the reciprocal adaptation between mind and environment. In biological systems, species evolve together through continuous feedback (Agrawal and Zhang, 2021); in cognition, this process would manifest as the mutual shaping of thought and world. The mind would act upon its surroundings through behavior, language and interpretation, modifying the environment that in turn constrains and informs it. Perceptual learning, cultural participation and technological construction would form a continuous feedback loop through which experience and cognition co-adapt. Over time, this reciprocal modulation would blur the boundary between internal and external such that the environment would become a cognitive partner rather than a passive context.
14. **Exaptation** would capture the capacity of the mind to repurpose existing cognitive or neural structures for new functions. In evolutionary biology, exaptation refers to traits co-opted for purposes other than their original adaptive role, such as feathers first used for insulation later enabling flight (Tramacere et al., 2017; Brosius, 2019). In cognition, it would appear when old ideas, symbols or perceptual schemas are reinterpreted to serve new conceptual or practical goals. Metaphor, analogy and technological invention would all exemplify such exaptive reuses, in which structures originally evolved for perception, movement or language are redirected toward abstraction, problem-solving or creative expression. This mechanism would allow the

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mind to extend its repertoire without requiring the constant generation of entirely new structures, thereby maximizing efficiency through reconfiguration rather than replacement.

15. **Extinction** would close the evolutionary cycle by pruning obsolete, inefficient or maladaptive elements. In biological evolution, species disappear when they lose adaptive viability; in cognition, forgetting, inhibition or repression would perform an equivalent role. Ideas no longer integrating with current experience or contradicting the prevailing conceptual order would gradually fade from memory or become functionally suppressed. This process would not represent mere loss, but a basic mechanism of optimization: by eliminating redundant or conflicting representations, extinction would clear cognitive space for new configurations to arise. In this sense, forgetting would be essential to the self-regulation of mental life, maintaining balance within the ever-changing ecology of thought and preventing informational overload.

Overall, by grounding each mental process in a defined evolutionary principle, our framework portrays the mind as a system in which novelty, selection and stabilization interact according to lawful dynamics. Through these theoretical correspondences, the mechanisms governing biological evolution would acquire cognitive meaning. The equivalence is not metaphorical but structural, as each evolutionary feature fulfills the same logical function in sustaining adaptability, continuity and complexity within the domain of ideas.

Table. Theoretical correspondence between the evolutionary features discussed in the chapter and their cognitive analogues or mental counterparts.

Biological rule	Cognitive analogue	Functional description
Variation	Idea generation, imagination	Production of novel cognitive configurations ensuring flexibility and creativity.
Selection	Experiential validation, coherence, emotional reward	Preferential retention of thoughts that align with experience or yield coherence.
Inheritance	Memory consolidation	Stabilization of recurring mental patterns through learning and synaptic plasticity.
Mutation	Conceptual drift, reinterpretation	Gradual transformation of ideas through analogy, context or reframing.
Recombination	Metaphor, synthesis	Integration of distinct ideas into hybrid, creative constructs.
Migration	Learning, cultural intake	Incorporation of external information through education and communication.
Drift	Random salience fluctuation	Chance-driven shifts in thought prominence due to attention or mood.
Environment	Lived experience, context	The experiential field shaping which thoughts persist or fade.
Equilibrium	Cognitive homeostasis	Dynamic balance between novelty and stability in the mental system.
Adaptation	Predictive optimization	Progressive refinement of internal models to minimize uncertainty.
Speciation	Subself differentiation	Emergence of specialized cognitive lineages within the unified self.
Punctuated equilibrium	Insight, crisis	Sudden reorganization of mental structures following prolonged stasis.
Coevolution	Mind–world feedback	Reciprocal influence between cognitive processes and environmental change.
Exaptation	Cognitive reuse and creativity	Repurposing of existing concepts or neural circuits for new meanings.
Extinction	Forgetting, repression	Elimination of obsolete or maladaptive ideas maintaining mental efficiency.

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Mathematical Formulation of Cognitive Evolution

We provide here a formalism to assess the dynamics of a human individual's thought in terms of an evolutionary system. Thoughts are treated as evolving entities within a population, each competing for stability and relevance under the pressures of experience, memory and environmental feedback.

Representation of cognitive populations. Let the mind of a wealthy human individual at a given time t contain a set of K distinguishable cognitive variants or ideas, each denoted by C_i and represented by a normalized frequency variable $p_i(t)$. The vector

$$p(t) = [p_1(t), p_2(t), \ldots, p_K(t)]$$

describes the instantaneous state of the mental population, where $p_i(t) \geq 0$ for all i and $\sum_{i=1}^{K} p_i(t) = 1$. Each p_i represents the relative activation, prevalence or probability of idea i being dominant in consciousness or influencing current cognition.

Every cognitive variant possesses a **fitness function** $F_i(p, E, M)$, i.e., a scalar quantity describing its ability to persist or reproduce under current environmental conditions $E(t)$ and the structure of memory $M(t)$. Fitness depends on both intrinsic and extrinsic factors like its internal coherence, emotional resonance and contextual adequacy. The **average fitness** of the system is given by

$$\bar{F} = \sum_{i=1}^{K} p_i F_i(p, E, M),$$

which measures the overall stability of the cognitive ecosystem at time t.

The replicator–mutator equation. The temporal evolution of each cognitive variant follows a **replicator–mutator equation** extended to include mutation, migration, decay and stochastic drift:

$$\frac{dp_i}{dt} = p_i(F_i - \bar{F}) + \sum_j p_j \mu_{j \to i} - p_i \sum_k \mu_{i \to k} + m(r_i - p_i) - \delta_i p_i + \sigma_i \sqrt{p_i(1 - p_i)}\, \eta_i(t)$$

Each term represents a distinct cognitive process:

- $p_i(F_i - \bar{F})$: **selection**, the differential reinforcement of ideas whose fitness exceeds the average.
- $\mu_{j \to i}$: **mutation rate** describing the probability that idea j transforms into idea i, capturing conceptual drift or reinterpretation.
- $m(r_i - p_i)$: **migration**, representing the influx of external information (learning, imitation) with rate m, where r_i denotes the external distribution of incoming ideas.
- $-\delta_i p_i$: **extinction or forgetting**, representing the natural decay of unused or irrelevant ideas at rate δ_i.
- $\sigma_i \sqrt{p_i(1 - p_i)}\, \eta_i(t)$: **cognitive drift**, the stochastic fluctuation of idea salience due to attentional instability or spontaneous associative noise.

Here, $\eta_i(t)$ is a Gaussian white noise term with zero mean and unit variance (Zhou et al., 2021), while σ_i scales the amplitude of random cognitive fluctuation. The stochastic component ensures that thought evolution remains open to contingency and creativity, preventing the system from becoming entirely deterministic.

Structure of the cognitive fitness function. The fitness of an idea is determined by its interaction with the internal and external environment:

$$F_i(p, E, M) = U_i(E) + \sum_j W_{ij}(M) p_j - C_i(p_i) - \Gamma_i(E, p).$$

This formulation contains four key components:

1. **Contextual utility** $U_i(E)$: the degree to which idea i aligns with the current environmental or experiential context $E(t)$.
2. **Memory coupling** $W_{ij}(M)$: the reinforcement or inhibition between ideas i and j, determined by their co-activation history within memory M.

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3. **Cognitive cost** $C_i(p_i)$: a penalty term limiting excessive complexity or instability, ensuring that attention and processing resources remain bounded.
4. **Prediction error** $\Gamma_i(E,p)$: a measure of discrepancy between internal expectations and external feedback, representing cognitive dissonance or surprise.

Through these interacting terms, the fitness landscape becomes dynamic and self-modifying. Selection favors ideas that minimize prediction error while maintaining high contextual utility and manageable cognitive cost, leading to an adaptive balance between coherence and flexibility.

Dynamics of memory and inheritance. Memory provides the substrate for cognitive inheritance, preserving associations among ideas that frequently co-occur. The evolution of memory is described by a **plasticity equation**:

$$\frac{dM}{dt} = \alpha(pp^\top) - \rho M,$$

where M is a symmetric matrix encoding the associative strengths between ideas. The term $\alpha(pp^\top)$ reinforces connections among concurrently active thoughts, reflecting a Hebbian mechanism ("what fires together, wires together") (Munakata and Pfaffly, 2004; Remme et al., 2021; Lansner et al., 2023). The term $-\rho M$ introduces **forgetting**, a decay process that gradually weakens inactive associations.

This dynamic ensures that memory remains both stable and adaptive: associative structures are continuously reshaped by experience, maintaining coherence while allowing old or irrelevant connections to fade. The parameter α (learning rate) governs the speed of integration of new associations, while ρ (forgetting rate) controls the rate at which unused connections decay. The ratio α/ρ thus defines the **memory persistence index**, a quantitative measure of cognitive stability.

Environmental feedback and coevolution. The environment $E(t)$ is modeled as an interactive field rather than a fixed condition. It both constrains and is modified by cognitive activity, producing a feedback loop analogous to coevolution in ecology. The environment evolves according to:

$$\frac{dE}{dt} = G(E) + H\,a(p,E) + \xi(t),$$

where:

- $G(E)$ represents autonomous environmental dynamics.
- H is a coupling coefficient translating mental action into environmental modification.
- $a(p,E)$ is the behavioral or interpretive output of the current cognitive configuration.
- $\xi(t)$ is an exogenous stochastic term representing unforeseen external events.

This coevolutionary formulation formalizes the mutual dependence between thought and world: cognition adapts to its environment, but through interpretation and behavior it simultaneously reshapes that environment. Thus, mind and context evolve together in a recursive loop of constraint and transformation.

Equilibrium, stability and cognitive homeostasis. At equilibrium, when the right-hand side of each differential equation tends toward zero, the cognitive population reaches a state of **dynamic homeostasis**:

$$\frac{dp_i}{dt} = 0 \forall i, \frac{dM}{dt} = 0, \frac{dE}{dt} = 0.$$

In this condition, the inflow of variation, reinforcement and forgetting achieve balance, so that the relative frequencies of ideas remain approximately constant. The equilibrium is not static but continuously maintained through micro-adjustments among selective, mutational and environmental forces. Perturbations of the parameters such as sudden changes in $U_i(E)$ or in the connectivity of M may destabilize the system, leading to rapid reorganizations of cognitive structure analogous to **punctuated equilibrium** in biological evolution.

Local stability can be evaluated by linearizing the system around equilibrium and analyzing the eigenvalues of the Jacobian matrix of partial derivatives $\partial(dp_i/dt)/\partial p_j$. Negative real parts

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correspond to stable equilibria (cognitive stasis), while positive values indicate instability and the onset of conceptual restructuring.

Cognitive metrics and evolutionary interpretation. Several measurable quantities arise from this formalism:

- **Average cognitive fitness** $\bar{F}$: quantifies global coherence and efficiency of thought.
- **Cognitive entropy** $S = -\sum_i p_i \ln p_i$: measures diversity or richness of the mental population, analogous to genetic heterozygosity.
- **Innovation rate** $\dot{I} = \sum_{i \neq j} p_j \mu_{j \to i}$: captures the intensity of conceptual mutation and reinterpretation.
- **Resilience index** $R = \frac{\alpha}{\rho + \delta}$: expresses the ability of the system to recover coherence after disruption.

These parameters would provide operational links between the theoretical model and empirical observation through linguistic variability, neural activation diversity or behavioral adaptation rates.

In conclusion, the provided system of equations could unify the descriptive correspondences of evolution and cognition into a single mathematical structure. Our formulation portrays the mind as a living population of ideas subject to lawful dynamics. Its complexity arises not from static architecture but from the continuous interplay of differentiation and integration within the individual mind. Selection promotes coherence, mutation generates novelty, inheritance maintains continuity and drift introduces unpredictability. Environmental feedback ensures that thought remains open to the world it interprets. Equilibrium emerges as the transient balance of these interacting forces.

Theoretical Applications: Hardy–Weinberg Equilibrium and the Phylogenetic Tree of Thought

Our formal framework might acquire particular significance when two classical instruments of evolutionary theory, namely, the Hardy–Weinberg law and the phylogenetic tree, are transposed to the cognitive domain. Each could provide a distinct but complementary perspective on the evolution of thought: the first could quantify equilibrium and its deviations within the mental population, while the second could reconstruct the lineage of ideas through developmental descent. Together, they could convert the abstract laws of cognitive evolution into operational tools for analyzing mental structure and transformation.

The **Hardy–Weinberg equilibrium** represents in classical population genetics the f state of a biological system in which allele frequencies remain constant over generations, assuming the absence of mutation, migration, selection or genetic drift (Rogatko et al., 2002; Mayo 2008; Stark 2023; Saadat 2024; Neamatzadeh et al., 2024). It is the mathematical description of a population in perfect balance, a null condition against which evolutionary change can be detected. When transposed to the cognitive domain, the same equilibrium could express the state of *mental homeostasis*, where the relative prevalence of cognitive variants, standing for distinct but functionally equivalent ideas, remains stable in the absence of external or internal perturbations. Within this framework, thoughts could behave as alleles within a mental population, each variant corresponding to a particular interpretation, emotional response or conceptual stance. The mind, like a gene pool, could contain distributions of such variants whose proportions can remain constant if no transformative forces act upon them.

Let two complementary cognitive tendencies, A and a, possess respective frequencies p and $q = 1 - p$. Their joint expression within thought can be represented by the classical quadratic expansion

$$p^2 + 2pq + q^2 = 1,$$

where p^2 denotes purely A-type configurations (dominant cognitive inclinations), q^2 denotes purely a-type configurations (recessive or alternative tendencies) and $2pq$ represents *heterogeneous*

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mental states in which both tendencies coexist or alternate. In biological terms, this describes the proportion of homozygotes and heterozygotes; in the cognitive analogue, it might capture the distribution between pure and mixed modes of thinking, between conviction, ambivalence and synthesis. When this relation holds, the system is in *cognitive equilibrium*: the internal composition of thought types remains invariant over time, indicating that mental processes are neither producing nor eliminating variants faster than they stabilize.

This equilibrium could provide a quantitative criterion for cognitive homeostasis, the psychological condition of balanced ideational dynamics. In practical terms, it could correspond to phases of mental stability, when an individual maintains consistent patterns of reasoning, emotional regulation and conceptual coherence. During these states, internal representations could be reproduced with minimal distortion and the frequencies of dominant and alternative ideas could remain proportional to their established weights in memory and experience. The equilibrium condition $p^2 + 2pq + q^2 = 1$ thus might stand for a benchmark for identifying the absence of transformative cognitive forces: no learning-induced restructuring, no emotional destabilization and no influx of novel information could alter the balance between competing conceptual variants.

Deviations from equilibrium could signal the onset of mental evolution, revealing changes in idea distribution driven by selective reinforcement, mutation-like reinterpretation or informational migration. For instance, when new evidence favors one cognitive variant, its relative frequency p could increase at the expense of q, producing an observable shift in the composite terms. Likewise, emotional events or social interactions may alter the internal weighting of ideas, disrupting equilibrium and triggering adaptive reorganization. The degree of deviation, quantified by the difference between the observed and expected proportions of p^2, $2pq$ and q^2, could provide a direct measure of *cognitive adaptation intensity*. Just as geneticists infer evolutionary pressure from departures from Hardy–Weinberg expectations, cognitive scientists may interpret these departures as indicators of learning, creative restructuring or psychological transition.

In this sense, the Hardy–Weinberg law could become a diagnostic framework for quantifying mental stability and transformation. It allows us to distinguish phases of ideational equilibrium, where thought reproduces its existing configurations, from phases of evolutionary restructuring, when conceptual innovation or selective forgetting changes the composition of the mental population.

Overall, the Hardy–Weinberg equation defines the null condition from which evolution begins and to which it periodically returns. By measuring how far and in what direction the system diverges from this equilibrium, one could trace the rhythmic alternation of stability and change standing for the evolution of thought within the individual mind.

The second application concerns the **construction of a phylogenetic tree of thoughts**, a theoretical analytical instrument conceived to trace the descent, diversification and recombination of ideas across the temporal landscape of an individual's cognitive life. In biological contexts, a phylogenetic tree depicts the evolutionary branching of lineages from common ancestors, recording the paths by which species diverge, adapt and occasionally converge (Zhang 2016; Smith 2022; Janzen and Etienne, 2024; Steel 2025). When transposed to cognition, this structure becomes a diagram of conceptual ancestry: a formal reconstruction of how primitive, undifferentiated representations could give rise to increasingly specialized and abstract mental forms. Each node of the cognitive tree corresponds to a distinct conceptual variant C_i, while each branch represents a transformation path inferred from relations of similarity, temporal succession or causal dependence among thoughts. The resulting network provides not only a descriptive taxonomy of ideas, but also a quantitative reconstruction of their evolutionary history within the mind.

Mathematically, the genealogical structure of ideas can be derived from two central operators of our cognitive evolutionary model: the **transition matrix** μ_{ij} and the **co-activation matrix** M_{ij}. The transition matrix μ_{ij} is a $K \times K$ matrix where each element μ_{ij} represents the conditional probability that a cognitive variant C_i transforms into another variant C_j within an infinitesimal time interval. The normalization $\sum_j \mu_{ij} = 1$ ensures conservation of total probability, while diagonal elements μ_{ii} correspond to idea stability and off-diagonal terms μ_{ij} to transformation events. Asymmetry ($\mu_{ij} \neq \mu_{ji}$) captures the directional nature of reinterpretation or abstraction, where transitions from simple to complex representations are more probable than the reverse.

The co-activation matrix M_{ij} instead encodes associative relations, measuring how frequently two ideas are jointly active or contextually linked. If $a_i(t)$ denotes the activation of idea i, then $M_{ij} = \lim_{T\to\infty}(1/T)\int_0^T a_i(t)a_j(t)\,dt$. This symmetric matrix quantifies memory-based coupling: high M_{ij} values reflect strong conceptual association, while low values indicate independence. Over time, M_{ij} evolves through learning and forgetting according to $\frac{dM}{dt} = \alpha(pp^{\top}) - \rho M$, where α is the learning rate and ρ the forgetting rate.

To combine transformation and association, a **conceptual distance metric** is defined as

$$D_{ij} = -\log\left[(\mu_{ij} + \mu_{ji}) + \lambda M_{ij}\right],$$

where λ modulates the influence of associative coupling. Small D_{ij} values denote close conceptual kinship, i.e., ideas that frequently transform into or co-occur with each other, while large values signal divergence. The complete matrix D_{ij} forms the framework for reconstructing a phylogenetic tree of thoughts, where each node represents an ancestral conceptual form and branch lengths correspond to the magnitude of divergence.

This structure captures both the dynamic and structural aspects of mental evolution: μ_{ij} describes how ideas mutate across time, while M_{ij} preserves their co-activation history.

When used to assess individual development, the phylogenetic tree could become a map of the unfolding of cognition itself. It could reveal how early sensorimotor schemas and perceptual patterns, which dominate infancy, gradually branch into linguistic, symbolic and abstract domains during childhood and adolescence. Each branching event might represent a bifurcation in representational strategy: for example, the divergence between concrete object representation and symbolic manipulation or between procedural and declarative reasoning. Over time, these branches could proliferate, forming higher-order conceptual networks that underlie logical, aesthetic and moral cognition. In adults, the upper levels of the tree could encompass reflective and metacognitive structures, derived from but still connected to their earlier perceptual and emotional roots.

Convergent branches where two or more distinct cognitive lineages merge mark instances of **recombination or exaptation**, moments in which previously independent ideas fuse to form new constructs. These events could correspond to creativity, insight or analogical reasoning, when the mind reuses existing structures for novel purposes. For instance, a perceptual schema originally shaped by spatial navigation could be exapted to structure reasoning about abstract domains such as social hierarchy, ethical order, or conceptual distance. In this way, cognitive functions that evolved to guide movement through physical space would be redeployed to navigate symbolic or moral spaces, much as in biological evolution wings arise from forelimbs that once served for walking. Conversely, divergent branches might represent specialization or differentiation, where a single conceptual root splits into multiple subfunctions, such as the division of intuitive and analytical reasoning systems.

The **depth** of each branch in the tree could correspond to the temporal persistence or stability of its conceptual lineage: the longer a branch extends before diverging or terminating, the more enduring and robust that family of ideas. Branch terminations represent **extinction events**, indicating the fading or repression of obsolete cognitive forms that once occupied mental territory but no longer adapt to current experience. Periods of rapid branching correspond to intellectual expansion, often triggered by exposure to novel environments, education or emotional upheaval, whereas long, stable segments indicate phases of consolidation and equilibrium.

Beyond its descriptive power, the phylogenetic tree could provide a quantitative and visual synthesis of mental evolution, allowing researchers to infer the internal logic of idea diversification and identify the structural regularities governing conceptual change. When constructed longitudinally, from developmental or autobiographical data, it could portray the living history of a mind: how an individual's ideas originate, mutate, merge and sometimes disappear.

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Together, the Hardy–Weinberg equilibrium and the phylogenetic tree could represent the analytical core of our evolutionary hypothesis of thought. The first provides a static criterion for identifying equilibrium and its perturbations, defining cognitive stability in probabilistic terms. The second introduces an historical dimension, depicting the descent and diversification of ideas. In combination, they could transform the analogy between biological and cognitive evolution into a systematic framework capable of quantifying, mapping and explaining the lawful development of thought within the individual mind.

Comparison with Existing Approaches

Compared with existing approaches, our hypothesis differs in both scope and formulation. Classical cognitive frameworks such as Rumelhart & McClelland's connectionism and predictive coding describe learning and adaptation in probabilistic or dynamical terms, focusing on how neural and representational states minimize error or uncertainty (Pezzulo et al., 2022; Caucheteux et al., 2023; N'dri et al., 2025). In particular, Bayesian inference models formalize cognition as probabilistic reasoning under uncertainty (Aitchison and Lengyel, 2017; Parr and Friston, 2018; Lin and Garrido, 2022; Jin et al., 2023). While these paradigms capture short-term adaptation and optimization, they do not articulate a evolutionary logic of thought across an individual lifespan. Their architectures describe parameter adjustments within static structures rather than the branching, selection and extinction of ideas over time. Our approach extends these probabilistic frameworks by introducing a population-level description of cognition in which thoughts behave as evolving entities subject to variation, selection and inheritance.

Our formulation also connects to Donald Campbell's theory of blind variation and selective retention, which first articulated the epistemological parallel between thought and biological evolution and to Karl Popper's evolutionary epistemology, where knowledge progresses through conjectures and refutations analogous to selection pressures (Simonton 2010; Wettersten 2016; Simonton 2024). However, whereas Campbell and Popper focused on the logic of scientific discovery and knowledge accumulation, our formulation grounds these processes in the continuous microdynamics of individual cognition, making their principles empirically tractable.

Hints of our model can be found in Gerald Edelman's Neural Darwinism, together with Selfridge's Pandemonium, which proposed that neural groups compete for reinforcement through reentrant signaling (Edelman 1993; Grainger et al. 2008; Renier et al., 2014; Tozzi and Peters, 2018). Edelman's view anticipated an intra-individual selectionist framework but remained confined to synaptic and anatomical scales. Later developments by Jean-Pierre Changeux and Stanislas Dehaene extended these ideas toward cognitive architectures and consciousness, emphasizing global neuronal workspace dynamics (Mashour et al., 2020; Volzhenin et al., 2022). Our approach generalizes these biological insights beyond neural implementation, encompassing abstract representations, symbolic recombination and conceptual genealogy.

Theories of cultural evolution and memetics, beginning with Richard Dawkins' concept of the meme describe how ideas replicate across populations of minds (Braga and Wardil, 2023). Yet these theories primarily address inter-individual transmission (how cultural elements spread, compete and mutate socially) rather than the intra-individual selective dynamics shaping the evolution of thought within a single person. Our hypothesis fills this gap by shifting focus inward: each mind is viewed as an ecosystem of ideas.

From the standpoint of cultural-cognitive synthesis, our model is also related to Liane Gabora's theory of autocatalytic cognitive networks, which describes ideas as self-organizing structures evolving through associative activation (Gabora and Steel, 2017; Gabora and Steel 2020; Gabora et al., 2022). Yet Gabora's work emphasizes creativity and cultural innovation, whereas our framework seeks a general law of cognitive evolution applicable to all thought processes, not only creative ones. Similarly, Andy Clark's embodied predictive models and Karl Friston's free-energy principle define cognition as an inferential engine minimizing surprise (Ramstead et al., 2022), but they lack the genealogical and population-based representation of ideas central to our formulation.

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Finally, compared with dynamical systems approaches to cognition like Kelso's, which depicts thought as trajectories through continuous attractor landscapes (Kelso 2016; Zhang et al., 2020; Kelso 2021), our evolutionary model adds a historical and genealogical dimension. It traces the ancestry, recombination and extinction of discrete cognitive lineages rather than describing only instantaneous state transitions. Our approach, linking static and dynamic perspectives of mental evolution, positions cognition within a general evolutionary grammar shared by all adaptive levels, from neural assemblies and conceptual structures to cultural processes.

Conclusions

We propose that the laws governing biological evolution could be meaningfully extended to describe the internal dynamics of human thought. We treat cognition not as a sequence of independent computations but as an evolving population of ideas whose relative prevalence changes through processes of variation, selection, inheritance and extinction. The novelty of this perspective lies in formal tractability: each mental operation is mapped onto a specific evolutionary mechanism, allowing thought to be expressed as a quantifiable phenomenon. Its main advantage is explanatory integration: instead of treating psychological change, neural plasticity and epistemic development as unrelated processes, they become aspects of the same underlying dynamic. Thinking becomes the evolutionary activity of meaning: a process by which the mind continuously generates and selects representations to maintain coherence with its experiential environment. Our synthesis reframes mental evolution as a process of internal natural history, revealing that the same structure that sustains life could also govern the transformation of meaning.

Our heuristic model faces intrinsic limitations. Its abstraction compresses the richness of cognition into a finite set of mathematical variables, simplifying the affective and contextual dimensions contributing to real mental life. The representation of ideas as discrete variants neglects the fluid, overlapping nature of many conceptual processes. Furthermore, empirical validation remains challenging: estimating parameters like cognitive mutation or selection rates requires indirect measurement through behavior, neural activation or semantic networks. The analogy between genetic and cognitive evolution must therefore be understood as structural rather than literal. Unlike genes, ideas do not replicate through molecular mechanisms and their persistence depends on subjective, social and cultural reinforcement.

From a scientific standpoint, the potential applications of our approach are wide. In psychology, our model could quantify how internal equilibrium varies during problem solving, emotional adaptation or creative episodes. Making explicit the selective pressures acting upon ideas, our procedure allows quantitative prediction of which thoughts stabilize and which decay. In practical terms, this could provide a basis for the mathematical study of conceptual development, memory consolidation and cognitive resilience. In developmental psychology, our approach could provide a model for understanding how conceptual branching in children follows predictable evolutionary pathways from perceptual schemas to abstract reasoning. In educational settings, it could guide the design of learning sequences to balance variation and selection, optimizing the retention of meaningful content.

In neurocognitive research, it might allow modeling of synaptic competition, neural reuse and pruning as concrete correlates of selection and extinction. In neuropsychology, the temporal evolution of conceptual fitness may help to describe cognitive aging or recovery after injury, where the decay and reorganization of thought patterns follow identifiable selection laws. Future research should aim to parameterize these dynamics experimentally, for instance, by correlating brain connectivity patterns with shifts in idea prevalence during learning or by reconstructing "conceptual phylogenies" from longitudinal verbal data. In computational modeling, our evolutionary equations may generate artificial cognitive ecologies capable of self-directed conceptual growth. In artificial intelligence, our approach could guide the design of architectures that evolve ideas instead of merely optimizing fixed objectives, fostering systems capable of genuine creativity and open-ended conceptual growth.

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The central question, whether the evolutionary laws of life can account for the evolution of thought, finds here an affirmative answer. The same principles that govern biological adaptation appear to underlie the transformation of ideas, revealing a natural continuity between life and consciousness. Our model provides a backbone for merging the logic of Darwinian adaptation with modern theories of predictive processing and free energy, suggesting that evolution and inference are two facets of the same adaptive principle. The broader implication is methodological: rather than isolating cognition from biology, our approach situates it within the continuum of adaptive systems.

Declarations

Ethics approval and consent to participate. This research does not contain any studies with human participants or animals performed by the Author.

Consent for publication. The Author transfers all copyright ownership, in the event the work is published. The undersigned author warrants that the article is original, does not infringe on any copyright or other proprietary right of any third part, is not under consideration by another journal and has not been previously published.

Availability of data and materials. All data and materials generated or analyzed during this study are included in the manuscript. The Author had full access to all the data in the study and took responsibility for the integrity of the data and the accuracy of the data analysis.

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Authors' contributions. The Author performed: study concept and design, acquisition of data, analysis and interpretation of data, drafting of the manuscript, critical revision of the manuscript for important intellectual content, statistical analysis, obtained funding, administrative, technical and material support, study supervision.

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