The Hypothesis of Sensory and Dimensional Evolution

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Date: February 10, 2026

Abstract

This paper proposes a model of sensory dimensional evolution, aiming to elucidate the potential biological significance of quantum mechanics and provide a new explanatory framework for issues such as the observer effect and the Fermi paradox. The model is based on two fundamental assumptions: first, the universe possesses a highest dimension; second, the evolution of sensory systems is closely related to dimensional cognition. Building on this foundation, the paper attempts to construct an interdisciplinary theoretical system to connect biological perception mechanisms with fundamental physical laws, and to provide a unified description for the pathways of civilizational evolution, the forms of alien civilizations, and their differences in world cognition.

Keywords: Sensory Evolution; Fermi Paradox; Observer Effect; Dimensional Cognition; Quantum Interpretation

1 Introduction

This paper is developed based on two basic assumptions: 1) The universe possesses a highest dimension; 2) Sensory evolution is intrinsically linked to dimensional cognition. Utilizing this assumption framework, we attempt to propose new explanations for phenomena such as the Fermi paradox, the uncertainty principle, and the observer effect, and to seek biological and physical correspondence for dimensional hypotheses. Furthermore, within this framework, the paper will explore the mechanisms of civilizational evolutionary pathways, the manifestations of different civilizational forms, and the differences in the worlds they perceive.

2 Theory

2.1 The Correlation Between Sensory Evolution and Dimensional Cognition

Biological sensory organs continuously adapt to the environment during evolution, gradually improving and expanding [1]. Consequently, humans and other organisms possess the potential to evolve new sensory organs, thereby developing entirely new modes of perception and cognitive systems, forming radically different models of the world [2].

Analysis using examples such as worms, starfish, ants, bats, and humans:

- Worms and starfish lack photoreceptor cells [3] as their survival environments do not require light perception; their sensory systems rely solely on smell and taste [4].
- Ants possess compound eyes, but these are primarily used to assist tactile [5] and spatial correction of chemical signals. Their spatial cognition approximates a two-dimensional geometric plane, lacking a concept of three-dimensional space.
- Bats rely on sound waves to perceive three-dimensional space. Although functionally similar to human vision, their perception is based on mechanical vibrations rather than electromagnetic waves. Therefore, they cannot detect light-related phenomena; their cognition of microorganisms, optical effects, etc., is limited, and their explanatory framework tends towards mysticism rather than scientific empiricism [6].

From this, two inferences can be drawn:

1. The sensory system determines the upper limit of physical cognition.
2. For organisms whose perception has not reached an optimal state, there are large areas of ambiguity in their information acquisition. This rule also applies to humans.

2.2 Mathematical Model of Sensory Systems and Sensory Dimensions

Interface theory posits that biological perceptual interfaces are optimal adaptations to the environment [7], meaning physical laws appear logical and simple within the perceptual interface. This paper further proposes that the fundamental laws of the world perceived by different organisms differ, stemming from their different ways of decoding information from the high-dimensional universe; the sensory system is the decoding function [8].

The evolutionary process can be viewed as a continuous fitting to effective information, while irrelevant information is ignored by the perceptual system. The evolution of sensory systems essentially accomplishes a "cognitive dimensional ascension," rather than an increase in geometric dimensions. The three-dimensional space understood by humans is merely a mathematical construct, not the absolutely real dimensional state of the world.

Different sensory organisms possess different dimensional systems. Humans are "photoelectric system" organisms; their perception is based on light propagation, consistent with the description in relativity where the speed of light is constant and spacetime is unified.

We can view the decoding method of each sensory system as a function. The function of time arises because the propagation of photons gives us the concept of time; thus, human civilization links the speed of light with time and defines it as the t-dimension. Therefore, the way dimensions are divided can be mathematical and most parsimonious. In practice, we can model the sensory systems of any organism into many dimensions—as long as they can fit the data. A dimension is essentially a fitting function.

Where information points are concentrated, only limited regularity functions are available to evolve, because only with a sufficient number of information points can functions be fitted.

2.2.1 Mathematical Framework

Let the complete and determinate state of the universe be represented by a point **P** in a high-dimensional **classical configuration space** Γ. This is the objective reality (Noumenon). The informational dimension of Γ can be conceptually decomposed as:

$$\mathrm{Dim}(\Gamma) = t + r + i$$

where t is the number of time dimensions, r is the number of space dimensions, and i is the number of unresolved dimensions within Γ.

A biological perceptual system is modeled as a **coarse-graining map** (or information channel) $\mathcal{D}$:

$$\mathcal{D} : \Gamma \longrightarrow \mathcal{O}$$

where $\mathcal{O}$ is a phenomenal observation space (e.g., human 3+1 dimensional spacetime). This map is many-to-one, representing inevitable **information loss**. It can be decomposed to mirror the process of dimensional compression and selection:

$$\mathcal{D} = \phi_{\text{time}} \circ \phi_{\text{space}} \circ \phi_{\text{drop}}$$

where ϕ_{drop} discards information from unresolved dimensions i, ϕ_{space} compresses to 3 spatial dimensions, and ϕ_{time} compresses to 1 time dimension. The specific forms of these sub-maps are determined by evolutionary adaptation.

Due to the information loss in $\mathcal{D}$, an observer cannot know the exact $\mathbf{P}$. The observer's knowledge is thus described by a **probability distribution** $\rho(\mathbf{P})$ over Γ. The formalism of quantum mechanics (Hilbert space, wave functions) is interpreted as a highly efficient **calculus for this knowledge state** $\rho(\mathbf{P})$ under the specific constraints of the human perceptual channel $\mathcal{D}_{\text{photo}}$, not as a description of Γ itself.

2.3 Sensory Dimensional Screening Theory

Different biological groups decode time and space differently. The spatial dimension of an extraterrestrial civilization might correspond to the time dimension of humans, and vice versa. To formally describe the "time-space interchange" phenomenon, we introduce projection mappings to characterize the differential extraction of high-dimensional information dimensions by different perceptual systems. Furthermore, not all decoding methods can generate a world with regularities; only a few can form stable laws, thereby giving rise to civilization.

2.3.1 Mathematical Supplement

Let two perceptual systems A and B define observation regions $\Omega_A, \Omega_B \subseteq \Gamma$ and coarse-graining maps $\mathcal{D}_A, \mathcal{D}_B$, respectively. These mappings extract different subspaces from the high-dimensional information space Γ and interpret them as time or space dimensions. For a continuous trajectory $\gamma : [0, 1] \to \Gamma$, the respective observation results are:

$$O_A(s) = \begin{cases} \mathcal{D}_A(\gamma(s)), & \gamma(s) \in \Omega_A \\ \text{unobserved}, & \text{otherwise} \end{cases}$$

Similarly define $O_B(s)$. When the number of unresolved dimensions $i \geq 2$, O_A and O_B are more likely to appear discrete or jumping in each other's coordinate systems, illustrating the incommensurability of their perceived worlds.

2.4 Environmental Requirements

Having screened for decoding methods that can evolve civilization, there exists a further requirement: within the world constructed by the decoding method, intelligent life can only evolve in specific locations that conform to the logic of that world and are conducive to its evolution. For example, the human decoding method is the photoelectric system. In the physical world constructed by the photoelectric system, an environment with planetary centrifugal force, tides, day-night cycles, planetary speed, light intensity, etc., all perfectly promoting biological natural selection, is necessary for life to evolve intelligence capable of existing within the photoelectric system.

2.5 Limitations of Evolution

Certain environments may lack the necessary conditions to construct specific proteins or other substances, preventing the further evolution of senses like vision [9]. Moreover, the direction of evolution is an extremely random event. For instance, the evolutionary direction of bats, at least from a current perspective with their reliance on sound waves, seems to be a dead end, confining them to Earth. Humans may very well have made a similar error, but at least among Earth's biota, they appear to be leading—better able to predict and judge the future, and to explore larger environments and clearer information.

2.6 Evolutionary Drive

The necessary conditions for evolution also require the construction of genes and a reproductive system. Without a reproductive system, there is no overpopulation, no competition for resources. Without generational turnover, there is no genetic mutation, no source of evolutionary drive. Reproduction or division is also a necessary condition for competing for proteins. In a civilization, the nature of the home planet should be one that is harsh and directive. If an organism lacks a reproductive system and can obtain the substances constituting itself with extreme ease, there will be no struggle for existence. Therefore, such a constructed organism must have the capacity for reproductive division.

2.7 The Principle of the Effectiveness of Physical Laws in Civilizations

The reason organisms are able to evolve predictable models is not that they are consistently fortunate, but rather that, under high-dimensional projection, a single slice can already reflect the data of the entire system. A loose but illustrative example: within a thermodynamic system, the particles in a small volume can already reflect the average density and mean molecular speed. In this hypothesis, each highest-dimensional information point projects into various spacetimes; within a portion of spacetime itself, it becomes possible to fit the laws required for that part. Moreover, as the timeline evolves on the whole, the decoding rules do not fail.

Interestingly, we can view this as organisms first observing the entirety of what will happen before proceeding to fit the data—and even then, they only select the parts they recognize, while ignoring other informational noise. The emergence of civilization stems from the fact that, amidst this lawless information, a certain amount of regularity coincidentally appears from a particular perspective, and within that, the stories of various civilizations play out.

2.8 Competition for Information and Matter

The random motion of information, under the parsing of the photoelectric system, just happened to form Earth, just happened to form abundant proteins, and these constructed proteins just happened to collide and combine appropriately to form life. This itself is an extremely low-probability event.

The collided life must be composed of cells or simple cell-like organisms capable of reproduction and division. Otherwise, it would be destroyed by accidents over time. Furthermore, the capacity for reproduction or division is a necessary condition for competing for proteins.

When one sensory system is similar to another, the perceptual systems will tend to converge and undergo competitive selection towards the aspects more adapted for survival, stemming from natural selection. For example, consider two organisms, organism a and organism b, composed of substance a and substance b, respectively. Organism a can observe most of organism b's entity and behavior. But sometimes it might see organism b inexplicably circling around empty air—though from b's perspective, it might be avoiding an obstacle. Their constituent units are 95% identical from both perspectives, with only 5% difference. This will generate competition. The organism better at predicting the world will seize the 95% common constituent elements, and the disadvantaged one will be eliminated, forming competition. Among similar perceptual systems, only one biological group will survive. Moreover, evolution is extremely utilitarian. If vision were to evolve first, it would inevitably be replaced and outcompeted by the lower-threshold, higher-reward senses of smell, hearing, and taste before fully developing. Thus, an optimal evolutionary path is presented.

Once an organism evolves, it begins to arrange and combine fundamental information. For the new organism, the movement of this information appears random, but in essence, it follows mandatory regularities. Organisms will compete over the arrangement and combination of information, limiting the formation of other sensory organisms. This greatly restricts the emergence of different organisms in the same location. As long as their time axes can produce vector projections onto each other, such interference will occur.

Even if their life cycles differ, under such circumstances, they will still forcibly interfere with the arrangement and combination of fundamental information. That is, as long as the axes constructing the world's dimensions can have vector projections onto each other, influence is inevitable. This greatly limits the possible density of organisms. Some organisms you not only cannot observe but also occupy living space.

In different data set locations, the photoelectric system decoding method is not the most appropriate competitive strategy. Examples include the intestines of worms or the pitch-black caves of bats. The human photoelectric system is only adapted to specific Earth environments. It is merely a coincidence that it also happens to possess the ability to observe celestial bodies.

Why the Earth biota emerged stems from our earliest cellular ancestors setting the tone for the decoding method, eliminating organisms deviating from the Earth environment. Through genetic inheritance and mutation, and the reproductive system, they continuously evolved and adapted. Within the biota, internal competition continuously demanded more efficient, accurate, and predictive laws to compete for resources.

2.8.1 Mathematical Supplement (A Toy Model of Perceptual Competition)

The qualitative argument of Section 2.8 can be formalized as a simple coupled dynamical system. This is a **toy model** intended only to illustrate the logical structure of competition between perceptual channels; it is not a quantitatively predictive framework.

Consider two coexisting organisms (or nascent civilizations) with perceptual decoding operators $\mathcal{D}_A$ and $\mathcal{D}_B$. Their competition has two interconnected layers: (1) competition for dominance in interpreting the informational structure of Γ, and (2) competition for material resources in the phenomenal world $\mathcal{O}$.

(1) Information Dominance. Let $\delta_A(t) \in [0,1]$ denote the degree to which organism A's interpretation of the environment dominates the shared cognitive niche, with $\delta_A + \delta_B = 1$. Define the **decoding similarity** $S \in [0,1]$ as the overlap between the two perceptual channels (e.g., the Bhattacharyya coefficient of their output distributions). The evolution of δ_A is driven by the difference in predictive accuracy:

$$\frac{d\delta_A}{dt} = \alpha\, \delta_A(1-\delta_A)\, S\,(C_A - C_B),$$

where $\alpha > 0$ is an adaptation rate, and C_i is the decoding accuracy of channel i (measured as the negative Kullback–Leibler divergence from the true environmental distribution). The term $\delta_A(1-\delta_A)$ enforces logistic growth with saturation, and the factor S ensures that competition only matters when the channels perceive overlapping aspects of reality. When S is small, the two organisms inhabit effectively separate cognitive niches and do not directly compete for informational dominance.

(2) Material Resource Competition. Let $N_A(t)$ and $N_B(t)$ be the population sizes. Their growth follows a modified Lotka–Volterra dynamics in which the carrying capacity is enhanced by information dominance:

$$\frac{dN_A}{dt} = r_A N_A \left(1 - \frac{N_A + \beta(S) N_B}{K_A(\delta_A)}\right),$$

with an analogous equation for N_B. Here r_A is the intrinsic growth rate, $\beta(S)$ is a competition coefficient that increases with S (organisms that perceive the world similarly also compete for the same material substrates), and the carrying capacity $K_A(\delta_A) = K_0(1 + \lambda\delta_A)$ grows with information dominance: an organism that better predicts its environment can extract more resources from it.

(3) Competitive Exclusion. From the structure of the equations, when S is above a critical threshold and $C_A > C_B$, the system drives $\delta_A \to 1$ and $N_B \to 0$. This formalizes the principle that **among perceptual systems with substantial overlap, only one can dominate the shared cognitive–material niche**. Conversely, if S is negligible, the two systems can coexist indefinitely, each evolving its own internally consistent "physics" without ever detecting the other—a microcosm of the resolution to the Fermi paradox proposed in Section 5.2.

3 Discussion

3.1 Discreteness and Continuity

Discreteness arises from the information compression and loss inherent in the decoding method of the "photoelectric system". The minimum resolvable scale Δ of the decoding map $\mathcal{D}$ corresponds to the Planck scale, leading to the discretization of the observed world.

This discretization of the decoding map originates from the intrinsic properties of the particles in our photoelectric system—photons, electrons, etc.—which can only resolve down to this scale, thereby making the observed world discrete.

However, in the highest dimension, the fundamental information points themselves are distributed in a discrete manner. We reorganise them through a series of mathematical formulas (the projection formula T). Consequently, the highest-dimensional world has no constraints of time or space.

These two kinds of discreteness do not conflict: the former is the resolution limit of the perceptual channel, while the latter is the underlying structure of the noumenon.

Within this cluster of information points, whether time and space are discrete or continuous is meaningless; it depends entirely on how we model the world in order to observe it.

3.2 Gravity as a Derived Phenomenon

As the timeline flows, any dynamical system governed by regularities will eventually tend toward equilibrium. Our world is based on the photoelectric decoding formula, in which space-time is used to describe the motion of objects—space-time does not truly exist but serves as a tool for describing transformations. Our further understanding of time and space is also firmly grounded in photoelectric phenomena and a series of related effects.

Under the photoelectric decoding formula, we can philosophically support the law of thermoeutropic gravity. Clifford space theory successfully reveals that, in 16 dimensions, gravity and the Standard Model are effectively coupled. We may regard gravity as a manifestation of the laws governing photoelectric phenomena—a mathematical force describing the tendency of a system toward equilibrium under the photoelectric framework. This makes gravity a spontaneous force that any regular system possesses, rather than an independent fundamental force.

3.3 Quantum Phenomena Explained by the Perceptual Channel

Uncertainty Principle. The human photoelectric perceptual system is based on the interaction between photons and matter. To measure the position of a particle, one must irradiate it with photons; the shorter the wavelength, the more accurate the position measurement, but the greater the disturbance to its momentum. Conversely, the longer the wavelength, the smaller the momentum disturbance, but the more uncertain the position. This is not a technical problem, nor is it a matter of "insufficient resolution"; it is an inherent property of the photoelectric system as a physical channel. As long as humans "see" using light, this limitation cannot be circumvented. Similarly, the time-energy uncertainty arises from the propagation of light in clocks — the frequency of light is related to its energy, so any increase in the precision of time measurement inevitably comes with an energy disturbance.

Double-Slit Interference and the Delayed-Choice Experiment. In the double-slit interference, whether one observes which slit the particle passes through determines whether an interference pattern appears. In our framework, this is because the photoelectric perceptual channel, when extracting "which-path" information, must abandon phase coherence. The puzzling "delayed-choice" experiment — in which future measurement settings appear to alter the past behaviour of a particle — can also be explained: in the highest dimension Γ, all possible trajectories of the particle through the slits are simultaneously determined, without any temporal order. When projecting, the photoelectric channel uniformly decides whether to exhibit particle-like or wave-like behaviour according to the **final measurement settings** in the phenomenal world (regardless of whether those settings occur "later"). This is not time reversal; it is because there is no absolute arrow of time in Γ. Time is merely a dimension that the perceptual channel uses to organise information. Therefore, future choices affecting past appearances does not violate causality — no signal is transmitted backwards; the projection simply uses all information at once. This phenomenon can essentially be regarded as a macroscopic manifestation of the time-energy uncertainty $\Delta E \Delta t \geq \hbar/2$ in the delayed-choice experiment.

Bell's Theorem and Nonlocality. Bell experiments show that no local realist theory can reproduce quantum correlations. The stance of our framework is as follows: in the highest dimension Γ, entangled particles are **not two spatially separated entities** but an indivisible holistic state $\mathbf{P}_{AB}$. When projecting, the photoelectric perceptual channel forcibly cuts this whole into two "apparently separated" particles. Consequently, the premise of Bell's inequality — that the two particles possess independent local properties before measurement — does not hold at the Γ level. The correlation between measurement outcomes is not a superluminal signal but an **update of holistic knowledge**: knowing the result of one side immediately tells the result of the other, because they are one entity in Γ. This transfers no physical signal and does not violate relativistic causality. The so-called "nonlocality" is merely an illusion of the phenomenal world; Γ itself is holistic and deterministic.

3.4 The Fermi Paradox: Cognitive Incommensurability and Decoding Blind Spots

Our framework provides a profound explanation for the Fermi paradox. If extraterrestrial civilizations evolved in different Γ-regions with different macroscopic environments, they would develop perceptual channels $\mathcal{D}_{\text{alien}}$ radically different from $\mathcal{D}_{\text{photo}}$.

3.4.1 Mathematical Definition (Decoding Blind Spot)

Define the **decoding blind spot** of a perceptual channel $\mathcal{D}$ as:

$$\mathcal{B}_{\mathcal{D}} = \ker(\mathcal{D}) = \{\mathbf{P} \in \Gamma \mid \mathcal{D}(\mathbf{P}) = 0\}.$$

Signals or phenomena that map into $\mathcal{B}_{\mathcal{D}_{\text{photo}}}$ are fundamentally undetectable by humans. An alien civilization using $\mathcal{D}_{\text{chem}}$ might communicate via complex chemical concentration waves—patterns that to our instruments appear as random noise.

3.4.2 Civilizational Isolation Theorem

If two civilizations have decoding operators $\mathcal{D}_A$ and $\mathcal{D}_B$ with significantly different kernel and image spaces, then: 1. Their perceived ”laws of physics” are incommensurable. 2. Their communication methods may be mutually unintelligible. 3. They may occupy the same region of spacetime yet be completely unaware of each other.

3.5 Predictions and Verification Directions

- **Extraterrestrial Life on Enceladus**: If life exists in Enceladus's subsurface ocean, our framework predicts it will have evolved a perceptual channel $\mathcal{D}_{\text{chem}}$ optimized for chemical and thermal gradients. Studying such life would test the core prediction that sensory channels shape physical cognition [10, 11].

- **Alternative Perceptual AI**: Building artificial intelligences with non-photoelectric sensory inputs (e.g., direct magnetic field sensing, chemical gradient detection) and allowing them to discover ”physical laws” from their data could yield non-quantum formalisms, supporting the channel-dependence of physics.

- **Neurobiological Correlates**: Searching for neural representations akin to ”probability amplitudes” in human and animal brains could provide empirical support for the idea that quantum mechanics reflects the structure of our perceptual-cognitive apparatus [12].
- **Reanalysis of SETI Data**: Our framework suggests SETI should look for anomalies in assumed natural phenomena (e.g., specific patterns in cosmic noise, planetary atmospheric data) that might be signatures of non-human communication protocols [13].
- **Quantum Computation Validation**: Quantum computers could serve as a concrete and powerful modern tool for validating this framework.

Conclusion

This paper has outlined a conceptual framework that connects sensory evolution, dimensional cognition, and the foundations of physics. By positing a deterministic high-dimensional noumenon Γ and modeling biological perception as optimized decoding channels $\mathcal{D}$, we have argued for the following points:

1. Different cosmic environments naturally select for different perceptual channels, leading to diverse modes of world cognition.
2. Quantum mechanics can be reinterpreted as the optimal probabilistic calculus for an agent constrained by the human photoelectric channel $\mathcal{D}_{\text{photo}}$.
3. Key quantum phenomena—wave-particle duality, uncertainty, entanglement, and measurement collapse—emerge as consequences of information loss in $\mathcal{D}$, rather than as intrinsic features of reality.
4. The Fermi paradox finds a natural resolution through the concept of cognitive incommensurability: civilizations with radically different decoding operators may be mutually undetectable.

By elevating biology to a central explanatory role, this framework suggests that the laws we discover are not purely “out there” but are co-determined by our evolutionary history as perceiving organisms.

Open Questions and Limitations

While the framework offers a unifying perspective, several open questions remain that must be addressed to transform it into a fully testable theory:

Future quantum computing platforms may enable high-precision measurements of joint probability distributions (e.g., position–time $P(x,t)$ and momentum–energy $P(p,E)$). If such experiments reveal discrete structures—such as lattice effects, discontinuous jumps, or cut-offs that cannot be fitted by continuous quantum mechanics—and these structures can be described by a unified mathematical map Φ, it would provide indirect empirical support for the projection hypothesis presented here. Conversely, perfect agreement with standard continuous quantum mechanics would challenge the framework. Therefore, although still speculative, quantum computers offer a potential avenue for testing the discrete nature of the projected phenomenal world.

- **Explicit form of K**: The propagator K linking Γ to the phenomenal space $\mathcal{O}$ is currently a placeholder. Future work should aim to constrain its form through empirical data or derive it from first principles of perception.
- **Testable predictions**: To distinguish this framework from standard quantum mechanics, concrete predictions—particularly in regimes involving time-energy uncertainties—need to be developed and experimentally probed.
- **Specification of $\mathcal{D}_{\mathbf{photo}}$**: A detailed biophysical model of the human perceptual channel is required to anchor the abstract decoding operator in measurable neural and optical parameters.
- **Integration with gravity and cosmology**: Extending the framework to incorporate general relativity and the holographic principle (as sketched in Sec. 5) remains an ambitious but necessary step toward a complete theory.
- **Exploration of alternative channels**: Building artificial agents with non-photoelectric senses could test the channel-dependence of physical reasoning and reveal novel formalisms.

Despite these challenges, the proposed perspective opens a new dialogue between biology and fundamental physics, inviting interdisciplinary efforts to explore the deep connection between perception and reality.

Acknowledgments

The author wishes to acknowledge the assistance of DeepSeek AI in the mathematical formalization and English translation of this manuscript, as well as for its suggestions regarding relevant literature and its help in refining certain expressions. However, all ideation, conceptual descriptions, initial drafting, and the construction and guidance of the theoretical and mathematical models were conducted independently by the author. Furthermore, the author has exercised utmost scrutiny and supervision over the AI-assisted mathematical formalization to ensure the consistency of the core ideas and the accuracy and correctness of the resulting mathematical framework.

Declarations

Funding

The author did not receive support from any organization for the submitted work.

Conflicts of interest/Competing interests

The author declares no conflicts of interest or competing interests.

Ethics approval

Not applicable.

Consent to participate

Not applicable.

Consent for publication

The author consents to the publication of this manuscript.

Availability of data and materials

Data sharing is not applicable to this article as no new datasets were generated or analyzed during the current study.

Code availability

Not applicable.

Authors' contributions

Guanyi Liu is the sole author and is responsible for all aspects of the work including conceptualization, formal analysis, investigation, methodology, writing – original draft, and writing – review & editing.

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