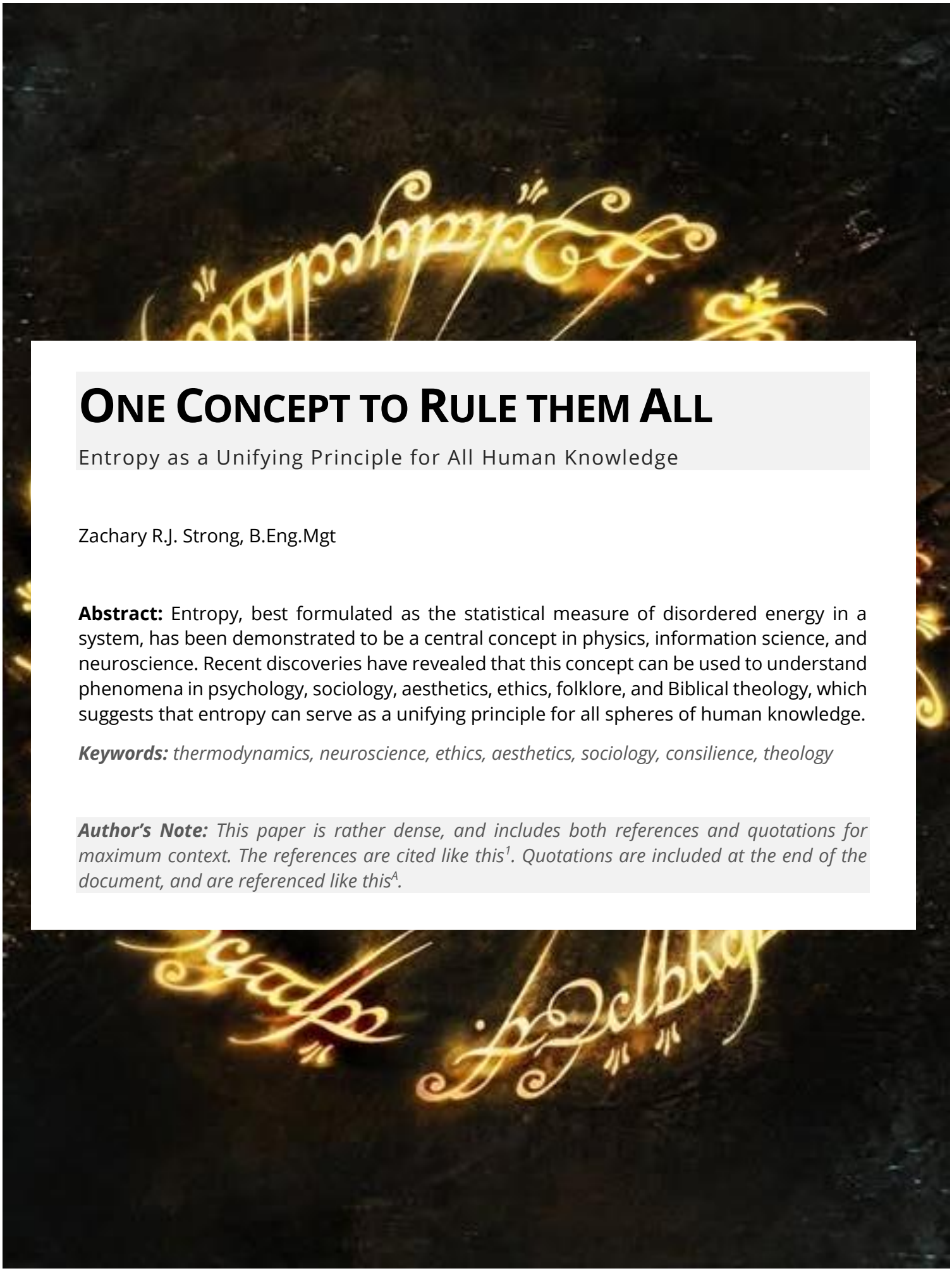

One Concept to Rule them All

Entropy as a Unifying Principle for All Human Knowledge

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Abstract: Entropy, best formulated as the statistical measure of disordered energy in a system, has been demonstrated to be a central concept in physics, information science, and neuroscience. Recent discoveries have revealed that this concept can be used to understand phenomena in psychology, sociology, aesthetics, ethics, folklore, and Biblical theology, which suggests that entropy can serve as a unifying principle for all spheres of human knowledge.

Keywords: *thermodynamics, neuroscience, ethics, aesthetics, sociology, consilience, theology*

Author's Note: *This paper is rather dense, and includes both references and quotations for maximum context. The references are cited like this[1]. Quotations are included at the end of the document, and are referenced like this[A].*

I. INTRODUCTION

The fragmentation of human knowledge into disciplines and sub-disciplines has both advanced and inhibited humanity's intellectual progress. While specialization allows for tremendous depth within disciplines, the current university model favors hyper-specialization over generalist approaches. This leaves many academics without a comprehensive understanding of the underlying unity of all knowledge – as well as the connections between disciplines that could lead to paradigm-shifting advancements[1,2].

In response to this fragmentation, biologist Edward O. Wilson released *Consilience*, a book about the unification of all human knowledge[3]. In his book, he proposed that knowledge across domains can and should be unified through the discovery of shared principles and points of harmony. While consilience is most often discussed in the context of the sciences, Wilson emphasized that the ultimate goal of academia should be to unify the sciences and humanities[A]. This sentiment was also echoed by scholars like John Henry Newman[4] and Jaroslav Pelikan[5], who believed knowledge should be harmonized whenever possible, even extending their vision of consilience to include Biblical theology[B].

Although the unification of the sciences, humanities, and theology seems like a far-off dream to be accomplished in future generations, the reality is that our current discoveries are sufficient to begin the unification process. This paper will demonstrate that thermodynamics, the science of energy transfer, provides a unifying set of principles that validate and connect discoveries across many disparate fields. By examining how the flow of energy manifests in human life, we can finally begin to articulate a harmonious paradigm of human knowledge that is grounded in the laws of physics.

Central to this framework is the concept of *entropy*, a measure of disorder within energetic systems[6]. Over the last two centuries, researchers in multiple disciplines have discovered that entropy plays a central role in many phenomena, including information transfer and brain activity. However, the implications of these discoveries, and their connections to the humanities and social sciences, have remained invisible to academics mired in a hyper-specialized environment.

II. ENTROPY IN PHYSICS

The concept of entropy first emerged during the Industrial Revolution as physicists sought to understand the efficiency limitations of combustion engines. In the early 1800s, Sadi Carnot established that there are unavoidable constraints on how efficiently heat can be converted into useful work[7]. Building on these insights, Rudolf Clausius introduced the term *entropy* to formalize a quantity that increases in all natural thermodynamic processes[8]. Clausius showed that while energy is conserved, its availability to do useful work diminishes over time. This insight was later encapsulated in the Second Law of Thermodynamics, which states that the total entropy of an isolated system always increases over time.

The meaning of entropy was deepened through the work of Ludwig Boltzmann, who connected thermodynamics to statistical mechanics. Rather than viewing entropy purely as a macroscopic property, Boltzmann interpreted it as a measure of the number of microscopic configurations corresponding to a given macroscopic state[9]. He famously expressed entropy as proportional to the logarithm of the number of such configurations, thereby linking disorder and probability. This statistical interpretation transformed entropy from a phenomenological law into a bridge between microscopic particle behavior and macroscopic physical phenomena.

III. ENTROPY IN SIGNAL THEORY

In the mid-1900s, scientists encountered the concept of entropy again as they sought to understand the limits of digital information transfer. In his 1948 paper, *A Mathematical Theory of Communication,* Claude Shannon introduced a quantitative measure of information that he called *entropy* due to its mathematical similarity to the thermodynamic concept[10]. In the context of information science, entropy does not refer to physical disorder, but to the uncertainty or unpredictability of a message source. Shannon demonstrated that this measure could be used to determine the limits of data compression and transmission efficiency, establishing a foundation for all digital communication.

Shannon's formulation defined entropy in terms of probability distributions in digital communications, showing that the informational content of a message increases with its unpredictability – or its level of *surprise*. This insight revealed that communication systems could be analyzed independently of their physical medium, focusing instead on the abstract structure of signals and noise. Warren Weaver later emphasized the broader philosophical significance of this theory, suggesting that the principles of information could extend beyond engineering into linguistics, psychology, and even the social sciences[11].

Together, Shannon and Weaver's contributions reframed entropy as a unifying measure of uncertainty in both physical and information systems, reinforcing the idea that both kinds of systems are governed by common statistical principles.

IV. ENTROPY IN NEUROSCIENCE

Decades after Shannon and Weaver defined communication as a thermodynamic process, the concept of entropy resurfaced again in psychology and neuroscience. Building upon Shannon and Weaver's work, Karl Friston developed the *Free Energy Principle*, which he claimed offered a "unified brain theory" that explained all mental activity[12].

In his work, Friston characterized the brain as an organ responsible for information processing and proposed that the brain's primary function is to minimize discrepancies between an organism's mental model of the world and incoming sensory data[C]. In simple terms, Friston showed that the brain attempts to minimize the *surprise* from its sensory data. In a more technical sense, it is trying to minimize the mathematical uncertainty generated from its sensory data – known as *surprisal* or *self-information*. By doing so,

the brain simplifies its cognitive load, avoids unexpected sensory input, and runs in an efficient manner to maximize chances of an organism's survival[C]. When these insights are understood within the context of Shannon and Weaver's work in information theory, we find that this is equivalent to *minimizing entropy* within the brain's mental system.

Crucially, Friston found that there are two methods by which organisms can reduce surprise within their brains – either by updating their mental model according to incoming sensory information, or by changing the environment to more closely match their mental model. Both methods reduce the brain's discrepancy between sensory data and its mental model. Thus, within Friston's framework, perception, action, and learning can all be understood as processes that reduce uncertainty and maintain order within an organism.

When we combine thermodynamic principles, information theory, and neural computation, Friston's work provides us with a powerful example of consilience: a single mathematical principle that spans physics, biology, and cognitive science. In doing so, it supports the broader view that the dynamics of mind and behavior are not exceptions to physical law.

More astoundingly, Friston and other researchers have extended these concepts to social systems, showing that social groups work to minimize uncertainty both individually and as a collective, using communication to accomplish this task[13,D]. This suggests that not only is cognition an expression of thermodynamic laws, but that social behavior can also be understood within the context of physics.

V. A UNIFYING PRINCIPLE

As one can see, the concept of entropy has been a stubbornly persistent character in the development of many branches of science. However, the implications of this have not yet been appreciated, nor have academics considered the applications of these discoveries in the humanities and social sciences.

Indeed, the discoveries made by Shannon, Weaver, and Friston allow us to examine entropy's role in brain activity, communication, and social behavior. This gives us a scientific platform to examine psychological phenomena *and* social phenomena from a thermodynamic perspective, which, in turn, allows us to appreciate complex human phenomena as expressions of the laws of physics.

With the lens afforded to us by Friston's scholarship, we can appreciate that the central objective of the brain is to *minimize surprise*, whether alone or in a group. We can also appreciate that this can only be accomplished by updating one's understanding of the world, or by modifying the world to more closely resemble one's understanding of it.

Viewed through this lens, cognition and behavior resolves into a fundamental duality: humans either revise their internal models to accommodate reality, or they act upon the world to make it conform to their current perceptions. This simple dichotomy offers a remarkably elegant framework for understanding many phenomena in psychology, sociology, and even philosophy and theology.

VI. ENTROPY IN PSYCHOLOGY

Despite its popularity and the many insights it has generated, psychology remains a stubbornly abstract discipline. While more venerable scientific fields like physics and chemistry have an underlying paradigm containing metaphysical and methodological principles[E], psychology is characterized by competing schools of thought and painfully loose definitions of central concepts like *mind*, *consciousness*, and *self*[14,15].

As a result of these conflicts and challenges, psychology has struggled to synthesize its findings into a unified theoretical framework. However, when viewed through the lens of Karl Friston's work, a potential pathway toward such a framework begins to emerge. By grounding cognition and behavior in the formal principles of uncertainty reduction, Friston's research offers not merely another theoretical perspective, but the foundations of a unifying paradigm capable of integrating disparate findings across the discipline.

Central to this unifying paradigm is the dichotomy between updating one's mental model and changing one's environment. From this perspective, all cognition and behavior can be understood as arising from the tension between these two strategies: either someone revises their mental model to accommodate reality, or they act upon reality to preserve their preconceived notions. In Friston's framework, these two methods correspond to perception and action, respectively.

This dichotomy becomes especially illuminating when applied to real-world behavior. Indeed, many psychological phenomena can be reinterpreted as systematic attempts to "minimize mental entropy" through internal revision… or control of one's environment.

COGNITIVE DISSONANCE

One example of surprise minimization at work is the concept of *cognitive dissonance*, which psychologists understand to be a natural resistance to uncomfortable information[16]. Cognitive dissonance is associated with well-known defensive mechanisms, including *denial*, *ad hominem arguments*, and the mischaracterization of uncomfortable information – commonly referred to as *straw-manning*.

Within the context of entropy minimization, we can take an empathetic and thermodynamic perspective on this phenomena. Psychological researchers have noted that information which is sufficiently threatening to one's worldview or self-concept triggers *terror*[17], an overwhelming sense of uncertainty or psychological unsafety. We can now understand this to mean that the cognitive load required to integrate that information into one's mental model exceeds the emotional or intellectual capacity of an individual's brain[F].

Therefore, we can use Friston's framework and the research on this topic to validate the common-sense understanding that people can "only handle so much". We can also characterize *denial*, *ad hominem*, and *straw-manning* as the brain's attempt to avoid confronting information that exceeds the individual's *carrying capacity* for revision of its mental model.

Since the brain can either minimize surprise by updating its mental model or by controlling the environment, the behaviors characteristic of cognitive dissonance can be properly seen as attempts to control the environment in protection of a preferred (and insufficient) mental model.

Scapegoating

The concept of a *scapegoat* is well-known within psychology, and is used to describe the persecution of people carrying uncomfortable truths. Historical examples of this behavior include the execution of Socrates[18], the execution of Sir Thomas More[19], and the persecution of Galileo Galilei[20]. In psychological literature, the term is also used to describe the persecution of family members who attempt to correct wounds in their family systems[21].

Much like cognitive dissonance, the phenomenon of scapegoating can also be seen within the context of entropy and surprise minimization. Rather than face uncomfortable truths about the world – or themselves – and update their mental model accordingly, it seems to be a human tendency to punish, exile, or execute people who carry those uncomfortable truths. Such behavior is an attempt to *minimize surprise* through controlling the environment. In many ways, scapegoating can be seen as an extreme form of *ad hominem* behavior, and therefore an expression of cognitive dissonance and a dysfunctional attempt to minimize surprise.

Prejudice

The persistent problem of *prejudice* can also be seen through the lens of surprise management. For people who hold prejudiced attitudes against any group, the notion that the "other" is fully human proves to be too destabilizing, or too surprising. As a result, prejudiced attitudes and behavior serve as the brain's attempt to minimize surprise by controlling its environment rather than updating its mental model of the world to include the existence of people different from oneself.

Cluster B Personality Disorders

Perhaps the most extreme expression of cognitive dissonance can be found in the "Cluster B" group of personality disorders, which includes narcissism and borderline personality disorder. Individuals with these two disorders will often go to great lengths to avoid updating their mental models to include "shadow" or "rejected" aspects of themselves – something that would cause unmanageable levels of shame[22].

Indeed, many of the behaviors that narcissists and borderlines display, including manipulation, abuse, scapegoating, and violence, can be seen as dysfunctional attempts to control their environment and avoid confronting shame. The rage and sensitivity displayed by narcissistic and borderline individuals indicates a very low *carrying capacity* that is compensated for by grandiosity, blame, and elaborate self-deception.

Towards an Entropy-Based Paradigm

As can be seen from these examples, Friston's work on entropy and surprise management offers us an elegant and

comprehensive lens with which to view psychological phenomena. Central to this framework is the dichotomy between *updating one's mental model* and *controlling one's environment*, with much psychopathology being related to an individual's inability to accept reality.

VII. ENTROPY IN SOCIOLOGY

Much like psychology, sociology lacks a cohesive paradigm. Human social behavior is extremely confusing for everyone, researcher and layperson alike, and it would be extremely helpful if a unified framework could be developed to understand social phenomena.

As we will see, the work that Friston and other researchers have done on collective surprise minimization offers a foundation for a paradigmatic understanding of social behavior that is fully consilient with the laws of thermodynamics.

Communication as Surprise Reduction

In their *Federated Inference* paper, Friston and other researchers noted that communication is a mechanism for sharing beliefs about the world between agents, and therefore reducing surprise within groups through mutual reality-testing and consensus-building[23].

Based on this understanding, we can now appreciate all forms of human communication as attempts to reduce individual and collective surprise. The phenomena encompassed by this understanding includes journalism, social activism, mass media, social media, marketing, and even artistic expression.

Indeed, when viewed through this lens, communication can be understood as the primary mechanism through which human beings coordinate their internal models of the world. By transmitting information, people allow others to update their beliefs in response to shared signals, which reduces uncertainty not only at the individual level, but across the group as a whole.

In this sense, communication is not merely the exchange of information, but a process of *collective inference* which enables social systems to converge upon more stable and adaptive representations of reality.

Censorship as Surprise Reduction

This perspective also helps explain the wide variation in communicative behavior observed across cultural contexts. When agents are willing to update their internal models, communication tends to be characterized by openness, inquiry, and mutual refinement of beliefs. However, when uncomfortable information would generate excessive surprise, agents may instead attempt to reduce uncertainty by controlling the informational environment through selective exposure, censorship, persuasion, or the suppression of dissenting voices.

In such cases, communication shifts from a tool of discovery to a mechanism of stabilization, preserving collective mental models at the expense of accuracy.

Ideological Echo Chambers

From this standpoint, phenomena such as propaganda, ideological echo chambers, and polarized discourse can be understood as consequences of humans prioritizing the minimization of surprise through environmental control. Conversely, practices such as scientific

inquiry, honest journalism, and open dialogue represent attempts to minimize surprisal through the revision of mental models, even when doing so is cognitively or socially costly. In this way, the dynamics of communication reflect the same fundamental duality observed at the level of individual cognition, reinforcing the idea that both personal and collective behavior are governed by shared principles of uncertainty reduction.

GENOCIDE

Perhaps the most extreme social behavior observed within societies is the phenomenon of *genocide* – the systematic elimination of groups perceived as undesirable within a society. From a thermodynamic perspective, such behavior can be understood as an extreme and deeply maladaptive form of uncertainty reduction. When the presence, beliefs, or identity of another group generates persistent and intolerable levels of surprise within a dominant population's shared model of reality, the pressure to resolve that discrepancy can escalate, culminating in attempts to remove the source of that uncertainty altogether.

Within this framework, genocide represents the terminal point of a continuum in which agents prioritize the stabilization of their collective models over the accurate integration of new or uncomfortable information. Rather than updating their mental models to accommodate complexity, diversity, or contradiction, the group seeks to enforce coherence through the elimination of perceived anomalies. This process is often preceded by certain kinds of communicative patterns such as dehumanization, propaganda, and ideological reinforcement, which serve to reduce the perceived cost of violence while increasing the perceived threat posed by the targeted group[24]. In this way, breakdowns in collective inference and communication do not merely distort reality – they can create the conditions under which mass murder becomes conceivable, actionable, and even desirable.

A UNIFIED SOCIOLOGICAL FRAMEWORK

As can be seen, many complex social phenomena can be coherently interpreted through the lens of surprise minimization. Behaviors ranging from communication and conformity to conflict and exclusion can be understood as emergent strategies for minimizing surprise at both individual and collective levels. In this way, Friston's work provides not just an additional perspective within sociology, but the foundations of a comprehensive paradigm capable of integrating diverse phenomena under thermodynamic principles.

VIII. ENTROPY IN AESTHETICS

Over the past century, the concept of beauty has largely been treated as subjective; something shaped by cultural context and individual preference.

While there is a great deal of subjectivity related to aesthetic enjoyment, art can be best understood as a form of expression and therefore a form of *social communication*. Therefore, it becomes possible to relate aesthetic phenomena to the same formal principles that govern information transfer and cognition. In particular, the work of Claude Shannon and Warren Weaver on communication,

alongside Karl Friston's work on uncertainty reduction, provides us with a framework through which aesthetics can be reconsidered in more objective terms.

Within the Shannon–Weaver model, communication involves the encoding of information into a signal, its transmission through a medium, and its reconstruction by a receiver[G]. When applied to artistic works, this suggests that artists encode information into symbolic or sensory forms, which are then transmitted to an audience[25,26]. This viewpoint has been validated by artists themselves[H,I]. In this sense, art can be understood as a structured signal, subject to the same constraints as any other communicative process, including limitations related to noise, redundancy, and interpretability.

From this perspective, classical aesthetic qualities such as legibility, coherence, and novelty can be reinterpreted as properties of effective information transmission. An artistic work that is too predictable carries little informational content and may fail to engage the observer, while a work that is excessively complex or disordered may exceed the observer's capacity for interpretation. Aesthetic value, therefore, may emerge from a balance between predictability and surprise, where the signal is sufficiently structured to be intelligible, yet sufficiently novel to reduce uncertainty through the introduction of new information. In this way, beauty can be understood not merely as a subjective preference, but as a reflection of how effectively a work facilitates the updating of an audience's internal models.

In its capacity as social communication, art also plays a role in reducing uncertainty at the group level. Artists often introduce novel perspectives, challenge existing assumptions, and expand the range of understandings available within a culture[27]. By doing so, art contributes to the collective process of model revision, enabling groups to integrate new information and adapt to changing conditions[28]. This aligns with the thermodynamic framework in which agents minimize expected surprisal either by updating internal models or by acting upon the environment – here, art functions as a mechanism that encourages the former.

Thus, it would seem that even beauty, long thought to be a social construction or a subjective matter, may actually be an expression of the laws of physics that govern communication and cognition.

Notably, complex artistic works are often not fully appreciated in their time – often after the death of the artist. This could be explained by the fact that their *informational content* is very high, or very unexpected, and it therefore takes years – or decades – for the public to fully appreciate the "messages" encoded within them. The historical record shows that this is often the case, as in the example of *impressionism* or thinkers like Friedrich Nietzsche.

Taken together, these considerations suggest that aesthetic experience may be more deeply rooted in the principles of communication and cognition than is often assumed. While cultural and individual variation undoubtedly play a role in aesthetic preferences, the effectiveness with which a work transmits information and facilitates the revision of

mental models provides a basis for understanding why certain aesthetic works are experienced as significant, compelling, or beautiful.

IX. ENTROPY IN ETHICS

Over the past century, developments in philosophy, from the critiques of Friedrich Nietzsche[29] to the rise of postmodern thought[30], have contributed to the view that morality is primarily a social construct shaped by historical and cultural forces. While these perspectives have provided valuable insights into the contingency of moral systems, they have also contributed to a fragmentation of ethical theory, leaving unresolved questions about whether any objective grounding for morality is possible[31].

However, when considered through the lens of Karl Friston's work, a different perspective begins to emerge. Within this framework, biological systems act to minimize surprise by maintaining adaptive alignment between their internal models and their environment. This process places functional constraints on cognition and behavior, suggesting that certain *internal dispositions* may be more conducive to effective model revision and long-term biological survival.

Among these dispositions are traits traditionally recognized as intellectual virtues. *Honesty*, for example, can be understood as the capacity to accurately register and acknowledge incoming sensory information, even when it conflicts with prior beliefs. In its absence, an agent may be forced to rely on controlling the environment in order to preserve mental coherence – often at significant cost. Similarly, *intellectual courage* enables individuals to confront anomalous or uncomfortable sense data[32], while *curiosity* motivates the exploration and resolution of uncertainty. Together, these traits facilitate the continuous refinement of internal models in response to changing conditions[F].

From this perspective, such virtues are not merely arbitrary ideals, but functionally advantageous strategies that align with the underlying constraints of cognitive systems. While this does not establish the existence of a fully objective moral system, it does strongly suggest that certain ethical dispositions are more compatible with the processes that support survival. In this sense, virtue ethics may be partially grounded in the structure and operation of the brain, rather than arising solely from social convention.

This also applies at the level of social groups. If societies are understood as networks of humans engaged in shared processes of uncertainty reduction, then behaviors that increase unpredictability – such as deception, violence, and corruption – can be expected to impair collective functioning. These behaviors introduce additional uncertainty into the system, forcing agents to allocate cognitive and social resources toward managing internal instability rather than engaging with the external environment. Conversely, norms that promote transparency, cooperation, integrity, and reliability serve to stabilize shared models, enabling more efficient coordination and adaptation.

It is notable that human beings display strong negative affect towards behaviors

that introduce collective uncertainty, especially things like corruption, deception, and unprovoked violence. At some level, this could be seen as an expression of the brain's inherent prerogative to reduce uncertainty.

Towards an Objective Ethical Framework

Uncertainty reduction does not, by itself, dictate what individuals *ought* to value; however, it does illuminate which behaviors are compatible with the survival and stability of both individuals and social systems. Indeed, entropy provides a basis for re-examining postmodernist ethics given the physical constraints imposed upon cognition, communication, and collective organization.

These considerations suggest that morality is not reducible to arbitrary social construction. Rather, ethical systems may emerge at the intersection of biological imperatives, cognitive constraints, and social dynamics, reflecting the ways in which humans navigate the fundamental challenge of maintaining stability in an uncertain world.

This poses an extremely difficult problem for postmodernist thinkers. Indeed, the only way for them to maintain that morality is purely a social construct is to reject the importance of survival, and therefore the value of human life.

However, if one accepts that individual and group survival is dependent on our collective efforts to reduce surprise, then the ethical imperatives of *honesty*, *courage*, *curiosity*, *integrity*, and *beneficence* seem to follow unavoidably from this premise. To maintain a postmodernist philosophy in light of these realities would be utterly nihilistic and may prove to be unjustifiable.

X. ENTROPY IN FOLKLORE

Beyond its applications in psychology, sociology, and philosophy, entropy can also be used as an interpretive mechanism to understand persistent patterns in folklore and mythology. In order to appreciate this, we must understand one of the primary expressions of entropy in physics – specifically, its use in the *Gibbs Free Energy Equation*.

As many physicists will acknowledge, entropy is most commonly found in an equation known as the *Gibbs Free Energy Equation*. Many undergraduate students studying the field become intimately familiar with this equation and how it is used to predict the spontaneity of a chemical or physical process.

The *Gibbs Free Energy Equation* is most commonly expressed in the following way:

$$\Delta G = \Delta H - T\Delta S$$

Where ΔG is the available energy for useful work, ΔH is the total energy within the system, and TΔS is the entropy.

However, let us rearrange the terms of the equation as follows:

$$\Delta H = \Delta G + T\Delta S$$

While this reformulation is mathematically trivial, it provides a useful conceptual lens: any increase in energy within a system will be distributed between structured, functional outputs and dissipative, entropic processes.

When viewed from this perspective, we see that the total energy within a system is

comprised of the useful (or "ordered") energy, and the useless (or "chaotic") energy. From this relationship between variables, we can also see that any additional energy gained by a system will either be in the form of "order" or "chaos".

This distinction between "order" and "disorder" provides an unexpected bridge to the study of mythology and folklore. In particular, the work of Jordan B. Peterson has identified recurring narrative patterns that closely parallel this fundamental dichotomy. In his landmark work *Maps of Meaning*, Peterson analyzes mythological and religious narratives across cultures and finds that they consistently revolve around the confrontation between the known, structured world and the unpredictable domain of anomaly and potential. Crucially, these narratives emphasize the role of the individual in voluntarily confronting chaos and transforming it into order through exploration, understanding, and cognitive integration[J,K].

Based on this analysis, Peterson proposes that a fundamental human trait is to transmute these anomalies into useful knowledge, and to convert painful or difficult experiences into personal growth. This is consilient with Friston's work, which shows that the brain is responsible for managing surprise through updating its mental model to reflect its sensory data. It is also consilient with the psychological phenomena previously discussed, including cognitive dissonance, genocide, and artistic expression – all prominent themes in *Maps of Meaning*.

Peterson's insights can be interpreted, in light of Friston's discoveries, as an early recognition of a deeper structural principle that connects psychology, neuroscience, mythology, and folklore. The rearranged *Gibbs Free Energy Equation* shows that, indeed, all energy in the universe is either "ordered" energy or "chaotic" energy. From Shannon and Weaver's work, we also know that the informational content of "chaotic" energy is much higher, and from Friston's work, we see that the brain is responsible for converting this "chaos" into a more refined mental model, and therefore a more ordered organism.

Indeed, the deep relationships between chaos, order, psychological growth, and neuroscience offer us a novel and useful perspective on mythological works and the structure of heroic narratives[33]. The persistent mythological emphasis on confronting the unknown and restoring order can be understood as narrative expressions of the same thermodynamic principles that govern human brain activity. In this way, folklore and mythology may preserve, in symbolic form, an implicit understanding of the processes by which humans reduce uncertainty in an unpredictable world.

XI. ENTROPY IN THEOLOGY

As previously mentioned, thinkers like John Henry Newman believed that theology, as a branch of knowledge, had the same kind of relationship to science as other fields in the humanities and social sciences. Although this may seem like an astounding claim, or an artifact of the Christian-dominant society that Newman lived in, a rigorous examination of concepts in Biblical theology reveals that entropy can be used to interpret concepts in that domain of knowledge as well.

Consider, for example, the general structure of Biblical thought – that the righteous are rewarded, and the wicked are punished. In Biblical terms, these rewards and punishments are framed as "blessings" and "curses", and are meted out to human beings according to the principle of *middah knegged middah*, or *measure for measure*[L]. This principle expresses a kind of proportional relationship between action and outcome, one that bears comparison to broader patterns of causality observed by Newton in his law of *action-reaction*.

However, when we examine the rearranged *Gibbs Free Energy Equation*, we can gain a deeper appreciation for the wisdom contained in the theological principles adhered to by Biblical believers.

Since all energy can be classified as either "ordered" energy, or "disordered" energy, we can better appreciate the Biblical dichotomy between *mitzvot* (commandments) and *aveirot* (sins). This is because an individual can either invest their efforts into productive work or wasteful efforts, which are held in Biblical theology to be either aligned with the Divine order or in contradiction to it[L,M].

Furthermore, we can also appreciate the Biblical emphasis on *middah knegged middah* and the concept of *concealed blessings* – a euphemism for Heavenly punishments[34]. From a thermodynamic perspective, we can appreciate that if an individual invests their energy into "sins", then they will receive a corresponding amount of "chaotic energy" in return – a "concealed blessing". Such "blessings" are comprised of chaotic or surprising sensory information, which are understood within theology to contain important lessons[35].

When understood within the context of the works of Peterson, Friston, Shannon, Weaver, and other researchers, we can see that the theological structure laid out by the Bible reflects the thermodynamic realities discovered in physics and neuroscience.

In this way, entropy serves not just as a unifying principle for the sciences, humanities, and social sciences, but can even be extended to interpret theological principles. Indeed, we can begin to see Biblical theology not as a mere arbitrary system of belief, but as a framework that encodes, in symbolic and normative terms, enduring insights into the conditions under which humans live on this planet.

XII. THE UNITY OF KNOWLEDGE

As can be seen, it is now possible to ground many topics in the laws of physics by way of their relationship to entropy and surprise. This includes many phenomena traditionally believed to be far removed from physics, including ethics, aesthetics, theology, and human phenomena such as cognitive dissonance and scapegoating.

As *surprising* as this may be, it makes sense in retrospect. Since the laws of physics are immutable, it stands to reason that everything in our universe would operate according to those laws of physics. And, thanks to the pioneering work completed by physicists, as well as the discoveries made by Shannon, Weaver, and Friston, we now have a comprehensive explanation of how those laws of physics apply to all spheres of knowledge. We also can now better appreciate the prescient

perspectives held by academics like Newman, Pelikan, and Wilson, who believed very strongly in the inherent unity of all knowledge and the possibility that we would, one day, be able to understand our universe not through a fragmented kaleidoscope of disciplines, but through a single clear lens.

"We, however, want to become who we are — the new, unique, incomparable ones, who give themselves their own laws, who create themselves! And to that end we must become the best learners and discoverers of everything that is lawful and necessary in the world: we must become physicists in order to be able to be creators in this sense,—while hitherto all valuations and ideals have been based on ignorance of physics or were constructed so as to contradict it. Therefore: long live physics! And even more so that which compels us to turn to physics — our honesty!"

- The Joyful Science (Friedrich Nietzsche)

We can walk our road together
If our goals are all the same
We can run alone and free
If we pursue a different aim

Let the truth of Love be lighted
Let the love of truth shine clear
Sensibility
Armed with sense and liberty
With the Heart and Mind united
In a single perfect sphere

- Hemispheres (Rush)

■

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QUOTES

[A] From "Consilience" (Edward O. Wilson)

"True reform [in academia] will aim at the consilience of science with the social sciences and humanities… every college student should be able to answer the following question: What is the relation between the sciences and humanities, and how is it important for human welfare? Every public intellectual and political leader should be able to answer that question as well… a balanced perspective cannot be acquired by studying disciplines in pieces but through pursuit of the consilience among them. Such unification will come hard. But I think it is inevitable. To the extent that the gaps between the great branches of learning can be narrowed, diversity and depth of knowledge will increase…

Beyond the mere smashing of aggregates into smaller pieces lies a deeper agenda that also takes the name of reductionism: to fold the laws and principles of each level of organization into those at more general, hence more fundamental levels. Its strong form is total consilience, which holds that nature is organized by simple universal laws of physics to which all other laws and principles can eventually be reduced. This transcendental worldview is the light and way for many scientific materialists…"

[B] From "The Idea of a University" (John Henry Newman)

"Now, as far as this objection relates to any supposed opposition between secular science and divine, which is the subject on which I am at present engaged, I made a sufficient answer to it in my foregoing Discourse. In it I said, that, in order to have possession of truth at all, we must have the whole truth; and no one science, no two sciences, no one family of sciences, nay, not even all secular science, is the whole truth; that revealed truth enters to a very great extent into the province of science, philosophy, and literature, and that to put it on one side, in compliment to secular science, is simply, under colour of a compliment, to do science a great damage.

I do not say that every science will be equally affected by the omission; pure mathematics will not suffer at all; chemistry will suffer less than politics, politics than history, ethics, or metaphysics; still, that the various branches of science are intimately connected with each other, and form one whole, which whole is impaired, and to an extent which it is difficult to limit, by any considerable omission of knowledge, of whatever kind, and that revealed knowledge is very far indeed from an inconsiderable department of knowledge, this I consider undeniable. As the written and unwritten word of God make up Revelation as a whole, and the written, taken by itself, is but a part of that whole, so in turn Revelation itself may be viewed as one of the constituent parts of human knowledge, considered as a whole, and its omission is the omission of one of those constituent parts.

Revealed Religion furnishes facts to the other sciences, which those sciences, left to themselves, would never reach; and it invalidates apparent facts, which, left to themselves, they would imagine. Thus, in the science of history, the preservation of our race in Noah's ark is an historical fact, which history never would arrive at without Revelation; and, in the

province of physiology and moral philosophy, our race's progress and perfectibility is a dream, because Revelation contradicts it, whatever may be plausibly argued in its behalf by scientific inquirers. It is not then that Catholics are afraid of human knowledge, but that they are proud of divine knowledge, and that they think the omission of any kind of knowledge whatever, human or divine, to be, as far as it goes, not knowledge, but ignorance."

[C] From "The Free Energy Principle: A Unified Brain Theory?" (Karl Friston)

"The repertoire of physiological and sensory states in which an organism can be is limited, and these states define the organism's phenotype. Mathematically, this means that the probability of these (interoceptive and exteroceptive) sensory states must have low entropy; in other words, there is a high probability that a system will be in any of a small number of states, and a low probability that it will be in the remaining states.

Entropy is also the average self information or 'surprise' (more formally, it is the negative log-probability of an outcome). Here, 'a fish out of water' would be in a surprising state (both emotionally and mathematically). A fish that frequently forsook water would have high entropy. Note that both surprise and entropy depend on the agent: what is surprising for one agent (for example, being out of water) may not be surprising for another. Biological agents must therefore minimize the long-term average of surprise to ensure that their sensory entropy remains low. In other words, biological systems somehow manage to violate the fluctuation theorem, which generalizes the second law of thermodynamics."

[D] From "Federated Inference and Belief Sharing" (Friston et al)

"This paper concerns the distributed intelligence or federated inference that emerges under belief-sharing among agents who share a common world-and world model. Imagine, for example, several animals keeping a lookout for predators. Their collective surveillance rests upon being able to communicate their beliefs-about what they see-among themselves. But, how is this possible? Here, we show how all the necessary components arise from minimizing free energy. We use numerical studies to simulate the generation, acquisition and emergence of language in synthetic agents. Specifically, we consider inference, learning and selection as minimizing the variational free energy of posterior (i.e., Bayesian) beliefs about the states, parameters and structure of generative models, respectively. The common theme-that attends these optimization processes-is the selection of actions that minimize expected free energy, leading to active inference, learning and model selection (a.k.a., structure learning). We first illustrate the role of communication in resolving uncertainty about the latent states of a partially observed world, on which agents have complementary perspectives."

[E] From "The Structure of Scientific Revolutions" (Thomas S. Kuhn)

"Aristotle's *Physica*, Ptolemy's *Almagest*, Newton's *Principia* and *Opticks*, Franklin's *Electricity*, Lavoisier's *Chemistry*, and Lyell's *Geology* – these and many other works served for a time implicitly to define the legitimate problems and methods of a research field for succeeding generations of practitioners. They were able to do so because they shared two essential characteristics. [First], their achievement was sufficiently unprecedented to attract an

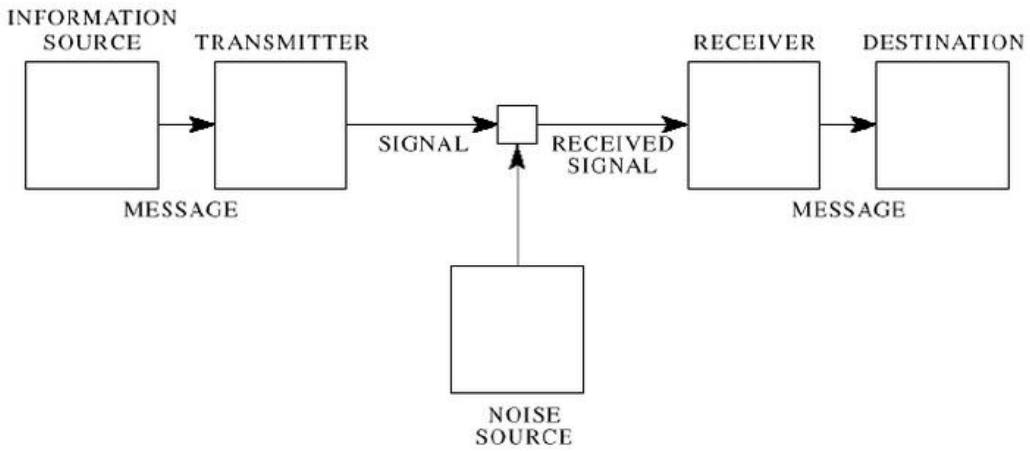
enduring group of adherents away from competing modes of scientific activity. Simultaneously, it was sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to resolve. Achievements that share these two characteristics I shall henceforth refer to as *paradigms*… [these are implicit bodies] of intertwined theoretical and methodological belief that permits selection, evaluation, and criticism [of research]."

[F] From "Maps of Meaning: The Architecture of Belief" (Jordan B. Peterson)

"Unprotected exposure to unexplored territory produces fear. The individual is protected from such fear as a consequence of "ritual imitation of the Great Father" – as a consequence of the adoption of group identity, which restricts the meaning of things, and confers predictability on social interactions. When identification with the group is made absolute, however – when everything has to be controlled, when the unknown is no longer allowed to exist – the creative exploratory process that updates the group can no longer manifest itself.

This 'restriction of adaptive capacity' dramatically increases the probability of social aggression and chaos. Rejection of the unknown is tantamount to 'identification with the devil,' the mythological counterpart and eternal adversary of the world-creating exploratory hero. Such rejection and identification is a consequence of Luciferian pride, which states: all that I know is all that is necessary to know. This pride is totalitarian assumption of omniscience – is adoption of 'God's place" by "reason' – is something that inevitably generates a state of personal and social being indistinguishable from hell. This hell develops because creative exploration – impossible, without (humble) acknowledgment of the unknown – constitutes the process that constructs and maintains the protective adaptive structure that gives life much of its acceptable meaning."

[G] From "A Mathematical Theory of Communication" (Claude Shannon & Warren Weaver)



"By a communication system we will mean a system of the type indicated schematically in Fig. 1. It consists of essentially five parts:

1. An information source which produces a message or sequence of messages to be communicated to the receiving terminal. The message may be of various types…
2. A transmitter which operates on the message in some way to produce a signal suitable for transmission over the channel…
3. The channel is merely the medium used to transmit the signal from transmitter to receiver. It may be a pair of wires, a coaxial cable, a band of radio frequencies, a beam of light, etc…
4. The receiver ordinarily performs the inverse operation of that done by the transmitter, reconstructing the message from the signal.
5. The destination is the person (or thing) for whom the message is intended."

[H] From Preface to "The Left Hand of Darkness" (Ursula K. Le Guin)

"The purpose of a thought-experiment, as the term was used by Schrodinger and other physicists, is not to predict the future… but to describe reality, the present world. Science fiction is not predictive; it is descriptive."

[I] From "The Romantic Manifesto" (Ayn Rand)

"Art is a concretization of metaphysics. Art brings man's concepts to the perceptual level of his consciousness and allows him to grasp them directly, as if they were percepts… The arts do not deal with the sensory field of awareness as such, but with the sensory field as perceived by a conceptual awareness.

The sensory-perceptual awareness of an adult does not consist of mere sense data, but of automatic integrations that combine sense data with a vast context of conceptual knowledge. The visual arts refine and direct the sensory elements of these integrations.

By means of selectivity, of emphasis and omission, these arts lead man's sight to the conceptual context intended by the artist. They teach man to see more precisely and to find deeper meaning [in the world]."

[J] From "Maps of Meaning: The Architecture of Belief" (Jordan B. Peterson)

"Human beings are prepared, biologically, to respond to anomalous information—to novelty. This instinctive response includes redirection of attention, generation of emotion (fear first, generally speaking, then curiosity), and behavioral compulsion (cessation of ongoing activity first, generally speaking, then active approach and exploration). This pattern of instinctive response drives learning—particularly, but not exclusively, the learning of appropriate behavior. All such learning takes place—or took place originally—as a consequence of contact with novelty, or anomaly.

What is novel is of course dependent on what is known—is necessarily defined in opposition to what is known. Furthermore, what is known is always known conditionally, since human knowledge is necessarily limited. Our conditional knowledge, insofar as that knowledge is relevant for the regulation of emotion, consists of our models of the emotional significance of the present, defined in opposition to an idealized, hypothetical or fantasied future state.

We evaluate the 'unbearable present' in relationship to the "ideal future." We act to transform 'where we are' into 'where we would like to be.'

When our attempts to transform the present work as planned, we remain firmly positioned in the domain of the known (metaphorically speaking). When our behaviors produce results that we did not want, however—that is, when we err—we move into the domain of the unknown, where more primordial emotional forces rule. 'Small-scale' errors force us to reconstruct our plans, but allow us to retain our goals and our conceptualizations of present conditions. Catastrophic errors, by contrast, force us not only to re-evaluate our means, but our starting points and our ends. Such revaluation necessarily involves extreme emotional dysregulation.

The 'domain of the known' and the "domain of the unknown' can reasonably be regarded as permanent constituent elements of human experience—even of the human environment. Regardless of culture, place and time, human individuals are forced to adapt to the fact of culture (the domain of the known, roughly speaking) and the fact of its ultimate insufficiency (as the domain of the unknown necessarily remains extant, regardless of extent of previous adaptation). The human brain—and the higher animal brain— appears therefore to have adapted itself to the eternal presence of these two "places"; the brain has one mode of operation when in explored territory, and another when in unexplored territory. In the unexplored world, caution—expressed in fear and behavioral immobility—initially predominates, but may be superseded by curiosity—expressed in hope, excitement and, above all, in creative exploratory behavior. Creative exploration of the unknown, and consequent generation of knowledge, is construction or update of patterns of behavior and representation, such that the unknown is transformed from something terrifying and compelling into something beneficial (or, at least, something irrelevant). The presence of capacity for such creative exploration and knowledge generation may be regarded as the third, and final, permanent constituent element of human experience (in addition to the domain of the 'known' and 'unknown').

Mythological representations of the world—which are representations of reality as a forum for action—portray the dynamic interrelationship between all three constituent elements of human experience. The eternal unknown—nature, metaphorically speaking, creative and destructive, source and destination of all determinant things—is generally ascribed an affectively ambivalent feminine character (as the 'mother' and eventual 'devourer' of everyone and everything). The eternal known, in contrast—culture, defined territory, tyrannical and protective, predictable, disciplined and restrictive, cumulative consequence of heroic or exploratory behavior—is typically considered masculine (in contradistinction to 'mother' nature). The eternal knower, finally—the process that mediates between the known and the unknown—is the knight who slays the dragon of chaos, the hero who replaces disorder and confusion with clarity and certainty, the sun god who eternally slays the forces of darkness, and the 'word' that engenders cosmic creation.

[K] Reviewer's Comment (Karl J. Friston)

"Notice a subtle paradox when expressing free energy in terms of total energy and entropy. Generally speaking, systems tend to minimise their free energy (in accord with the free energy principle). However — according to the equation — minimising free energy would entail an increase in entropy. So, how can this be reconciled with the minimisation of expected surprise or entropy? The answer is simple; the surprise we are talking about is the surprise about sensory exchanges or communication with the world. In contrast, the entropy entailed by free energy pertains to our beliefs that best explain these exchanges. In physics, these beliefs can be regarded as 'measurement' or inference to the best explanation. This is the basis of Jaynes' maximum entropy principle (Haken and Portugali, 2021; Jaynes, 1957; Jaynes, 1980) which goes hand-in-hand with the minimum entropy production principle (Jaynes, 1980; Nicolis and Prigogine, 1977; Prigogine, 1978).

Put simply, to minimise surprising exchanges with the world — and their entropy — it is necessary to maximise the entropy of our beliefs about the world. This is very much in the spirit of Occam's principle – which effectively says keep your options open when trying to explain something — or, in the words of Einstein, keep everything as simple as possible but no simpler."

[L] Deuteronomy 11:26-28

"Behold, I set before you this day a blessing and a curse; A blessing, if ye obey the commandments of the Lord your God, which I command you this day: And a curse, if ye will not obey the commandments of the Lord your God, but turn aside out of the way which I command you this day, to go after other gods, which ye have not known."

[M] From "The True Goal of a Holy Person" (Rabbi Mendel Kessin)

"Judaism demands interaction with the physical universe, which is very different from other religions. There's no such thing as a monastery in Judaism unless you want to call a yeshiva a monastery where you learn but you don't interact with anybody. All the *mitzvos* force you to interact with the world, therefore a mitzvah is a device that allows an individual to purify the body.

I previously mentioned that a mitzvah is really a testimony that you believe that, besides G-D, there's nothing else—and I've explained about the levels of doing a mitzvah—because it forces you to suspend your will and accept the Will of the *Ribono Shel Olam*, the Will of G-D. Measure for-measure, if you testify that G-D is the only being, you will ultimately enable the soul to transcend the body in the body itself.

A righteous person is a 24/7 *oved*—servant. That's really what he is. Whether he's doing something which is a *mitzvah* or he's doing something which is a necessity but is optional, he's still thinking about G-D and in some way it's connected. That's a *shvisi yid*, a Jew that is always thinking about G-D 24/7.

That is a very difficult *madrega* but there are people who reach that *madrega*. Classically there are many righteous people who only thought about G-D. The RaMCHaL says, in some of the other *sefarim*—books, that a person of that caliber will always ask himself: What would G-D want me to do in this particular situation? It's what's called the 'highest level of G-D-consciousness,' a constant state of G-D-consciousness. The unusual part about that is, in order for a person to be G-D-conscious, he has to remove what's called 'self-consciousness.'

Typically, people think about themselves for the majority of the day; what do I have to do to make it? It depends on your value system. Some might say: I have to make money. I want to have fun, want entertainment. I need a vacation. I need to buy something for my wife, or I need to hug my kids. There are millions of things, but it's always about 'my' needs. Think about that. The common denominator for almost all of mankind is 'my needs' or 'me.' What I need determines what I want to do. It can be many different things but the common denominator of all these different aspects of acquisition is 'me.' That's what it's about, my needs, what I want to do now, what will make me happy, what will move me forward, how can I progress. If you think about it, what the RaMCHaL is saying is that a righteous person is the reverse. He never asks about "me." It's always about "Him." What does He want? This is an incredibly lofty level. They think: how can I comply with His Will? That's really what the ultimate righteous person thinks about."

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