Cognition and Mechanics

Ian Malloy, MSc

This paper treats cognition as a function of consciousness and seeks to isolate neural correlates of consciousness as physical properties within the brain. We explore fundamental attributes of qualia paired with physical objects, suggesting all physical things have some relative quale. In this sense we require perception as input, a global workspace, cations, a calcium channel, awareness, attention, and a neural network. Given the hypothesized binding frequency of $40\ Hz$ and Libet's temporal factors, under Schrodinger's time-dependent equation in *n*-dimensions and potential energy given by spin attenuated under spherical properties as radial waves, we see energy levels on the quantum scale approximately equal to the energy of neuronal spikes on a classical scale separated by powers of ten. By treating the brain as a complex, compact manifold homotopic to submanifolds, under knot theory and braid groups we liken the model to quantum information processing and equilibria given by smoothness. Understanding that a model of binding is a partial solution to the hard problem of consciousness, we see consciousness emerges under the complexity of biological components as a function of neural energy. The result of the model is descriptive and explanatory, showing semantic information encoded within brain waves as brain waves signify consciousness can be encapsulated in physical properties of the brain such that binding occurs.

Keywords: Functionalism, Physicalism, Hard Problem, Philosophy of Mind, Cognitive Neuroscience, Consciousness, Quantum Physics, Knot theory, Neural Correlates of Consciousness, Binding

Introduction

Reducing consciousness to a physical process requires isolating the proper neural correlates of consciousness. Given the hypothesized correlation between 40Hz oscillations in the brain and cognitive binding (Crick & Koch, 1990), and the temporal factors given by Libet (Libet, 2004), we analyze these in the context of neural correlates of consciousness (Koch, Massimini, Boly, & Tononi, 2016). The neural correlates of consciousness are defined to be the bare neurological components for the experience of consciousness (Koch, Massimini, Boly, & Tononi, 2016). Knot theory is used in chemistry (Horner, Miller, Steed, & Sutcliffe, 2016) and braid groups with respect to quantum computing are also established (Rowell, 2022) and therefore relate to quantum information processing. We then base knots on neurochemistry with respect to braid groups in brain regions. Here we derive neural correlates of consciousness in terms of neuroscience and quantum mechanics with approximately equal energy between neuronal spikes and the isolated correlates, separated by powers of ten given the Libet frequencies. Encoding input in oscillations based on amplitude, and fitting the dimension with respect to the brain, we see the solutions to Schrodinger's time-dependent equation ranges over the action potential of a neuron with .16 Joules difference. We then establish that the neural correlates are ionic, proteomic, and wave oscillations given phases.

This paper models cognitive functions in humans as a dynamical system. The brain is considered a complex dimensional, compact manifold with submanifolds $\{M, S \mid S \subset M,\ S \in \mathbb{R}^3, M^{d^*} \in \mathbb{C}^\infty\}$. The physical equilibrium of the manifold is treated as centered upon the binding frequency of 40Hz (Crick & Koch, 1990). Input is encoded by perturbations of the manifold, disrupting equilibrium as wave functions on both classical and quantum scales. Via homotopy, the changes in the manifold map to submanifolds where equilibrium is restored under action. Given a knot has a matrix representation, a braid has matrix representation, and braid groups have matrix representations (May, 2006) they may be treated as vectors with respect to the manifold being a vector space and the columns of each matrix a vector. Mapping molecules to knots then admit wave functions treated with respect to the atom, which introduce vector components with respect to knots. It is with respect to these that the solutions to Schrodinger's time-dependent equation arises.

Binding occurs around 40Hz (Crick & Koch, 1990), and is defined with respect to Libet's temporal factors (Libet, 2004):

$$, \quad L_B = \begin{cases} 23.2\,Hz, & L = \dfrac{-290 \text{ ms brain activity}}{-500 \text{ ms readiness potential}} 40Hz \\ 23.5\,Hz, & L = \dfrac{40\,Hz}{\dfrac{-550 \text{ ms readiness potential}}{-323.125 \text{ ms unconscious activity}}} \\ 58\,Hz, & L = \dfrac{-290 \text{ ms brain activity}}{-200 \text{ ms conscious awareness}} 40Hz \\ 58\,Hz, & L = \dfrac{-300 \text{ ms brain activity}}{-\dfrac{6000}{29} \text{ ms conscious awareness}} 40Hz \\ 24\,Hz, & L = \dfrac{-300 \text{ ms brain activity}}{-500 \text{ ms readiness potential}} 40Hz \end{cases}, \qquad t = 1 \text{ period}$$

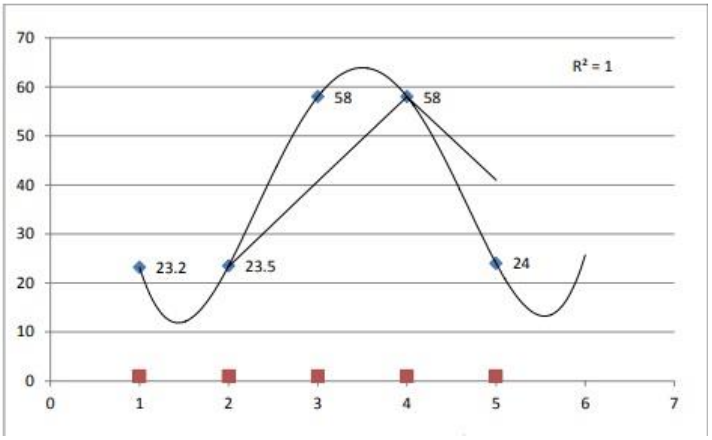

Figure 1 - Binding and Temporal Factors of Consciousness

Physicalism and Qualia

Consciousness may be defined as the ability for and experience of thought, where thought itself is the analysis and interpretation of the senses in the context of the experience of qualia or the intention of intentional states (Searle, 1992). This does not necessitate awareness of the self or the experience completely, but only really the experience of qualia. All cultural assumptions aside, it is safe to assume that a necessary and sufficient condition for this is biological. In this manner it is safe to posit that animals experience qualia in some form and process it in some way. Given the level of action not specifically for the organism itself but within the context of meaningful acts on behalf of other organisms similar in genetic structure, one could infer greater levels of intentional states due to the necessary recognition of similarity under interspecies acts in self-referential and other-mind identifying qualia such that the isness of an other's being is translated to intentional states.

One of the greatest difficulties that lie at the crux of understanding consciousness is coming to terms with its perceived inherent absurdity, inexplicable ineffability, and mystical nature. One cannot very well introspect the nature of consciousness completely with respect to the other, and consciousness itself is the grounds for and predisposition towards mystical experiences. Humankind, since thought has existed, has had a mystical connection to existence. The most we can say is that some experience results in a deep interconnectedness with the universe, a union with God, or an abolishment of self (such as nirvana or enlightenment). These may not be easily dismissed or discredited, but we follow the Cartesian method to reach a different conclusion than Descartes (Descartes & Cress, 1998)

We focus on that which is "clear and distinct." Assume a phenomenal world, subjective perception and that which is objectively perceived. By assuming only this, we reject cultural assumptions. I cannot be deceived into thinking that I do not exist insofar as I am necessarily a thinking thing aware of my own existence, namely the experience of a quale of self, the essence of my being. This is consciousness. The 'isness' of being. It is defined by the ability and capacity for experiencing the 'aboutness' of things as well as meaningful intentional states and the ability to act upon that which I am sure I perceive. It is here that Descartes posits his substance dualism. I do not make such an inference.

By focusing attention to others rather than self that also exhibit the fundamental component to the surety of my existence, we ask others if they are “thinking things.” Most answer ‘yes’ to this question, though we may only know with certainty that the self is a thinking thing. This raises the issue of a Chinese room (Searle, 1992), and Descartes ‘great deceiver’ (Descartes & Cress, 1998) We see that the other acts similar to the self, but may be a zombie. Additionally, the self may be the only thing in existence. I cannot doubt my inability to affect others with thought alone, and the self cannot doubt the experience of qualia. Furthermore, the other is in the same position as the self, such that they cannot assert each self and other are all thinking beings.

We know from perception that the things we perceive as the other, which is at least a simulacrum of a thinking being, that our perception of the other as conscious is based on interactions. This does not come from the combination of their thoughts, but rather their actions. Within the Cartesian system there is still room to be deceived by the account given by other, and therefore we now analyze an exchange between three individuals: Alice, Bob, and Claire. We assume Alice is conscious, and Bob and Claire may be deceptive.

If Alice tells Bob Alice is conscious, but doubts Bob is conscious, and Bob tells Alice Bob is conscious but doubts Alice is, we see an identical epistemic foundation. This extends to Claire. If Claire is an observer of Alice and Bob, Claire is aware she is conscious but also doubts both Bob and Alice. None of the self-aware people trust each other given solipsism, but thought alone cannot impact anyone. The only surety comes from qualia, such that an impression of each other can be trusted to exist though their consciousness may be disputed. What reason we have to doubt others’ existence and consciousness becomes a question of intent in the colloquial sense. If, and only if, there is some great deceiver no other can be trusted but there is no reason to assume a higher power exists (something that could easily be self-deception and of which the evidence of existence does not exist). We may only be sure of our own existence.

We may then assume that Alice, Bob, and Claire exist in some form and are not programmed to deceive. If this is the case, then we can reasonably assume the same essential status of existence between Alice, Bob, and Claire. Since thoughts are contained within the phenomenal extension of bodies, and the thoughts of the other are inaccessible to the self the issue becomes one of zombies and Chinese rooms (Searle, 1992) (Kirk, 2008). The Chinese room is avoided given qualia associated with meaningful behavior, given meaningful behavior is relativistic behavior between self and other. We also observe non-conscious objects in existence. Then a problem of origin granted by a transcendental higher power need not be invoked given evolutionary means composed of falsifiable observations. Since there has been no real appeal to substance dualism so far, it only presents itself epiphenomenally as a possible quality of qualia. By observation and a separation between Alice, Bob, and Claire given age we may state that Bob and Claire begat Alice and thus state Alice was born. This introduces a lineage that can trace back to evolution given acceptance of observations of the environment and the lack of a great deceiver. This is the pragmatic approach.

Consciousness is the epitome of adaptation as an effective circumvention of the survival of the fittest. Given the paradoxical nature of self-defeating behaviors though, consciousness may be ancillary to adaptation and evolution. The self is a vessel and expression of genetics to some extent, paired with the environment. For our genetics to respond to the environment in an effective manner, the mediation of input to output requires proteomics (Marcus, et al., 2004). This suggests inherent differences in neuropeptides mediating neuronal spikes as a translation of DNA and neuropeptides responding to the environment. It is then necessary that a modality of the brain would develop. Neurons are specific in their sensitivity given potentiation, but are also plastic which is adaptive relative to input.

This raises an important facet of genes in regards to information content within cells transferred via proteomics resulting in meaningful behavior. Genes and the environment are the source of our symbols, language, and conceptual constructs within the framework of evolutionary theory. Even if substance dualism were true and there was some causal interface between mind and body the information would still be a translation between genetics and environment. Despite a soul, we may measure the translation of input to proteomics to behavior. We need not appeal to a soul given what is measurable as an explanatory model. The information encoded within genetics in response to an environment is likely not the same as the information contained within our consciousness; rather it is consciousness that compiles and binds the coded information into understandable constructs within the global workspace (Baars, 2005) under emergence (Searle, 1992). The only immaterial aspect of consciousness possible under the simplest explanation is qualia, but only if qualia is epiphenomenal.

The distinction between internal and external mechanisms is crucial to an understanding of consciousness, which may be modeled under cognitive tasks and observations which may be agreed upon between the self and other. It is this awareness that is a signifier of conscious perception in conjunction with the central executive. In a classically physical world, which is the observable phenomenological, everything a human can possibly know or do is encoded within their genetics referent to the environment. This can only be understood and considered correct when a proper enzymatic cascade occurs relative to input as a neural network under proteomics. This is a feedback loop under forward propagation. At a neuronal level, plasticity is limited by the predisposition selecting the heaviest weighted neural network which decreases strengths of competing neural connections. In a Newtonian model, this predisposition is genetic but reliant upon the environment for activation.

Qualia are the only seemingly essential, possibly non-reducible aspect to conscious activity which is necessary. We will see it is also sufficient for consciousness. It is an inherent predicate of the subject that incites it, whether the subject is a conscious state or particle with spin (or a photon). In a noumenal sense it is ineffable, but also subjective apart from its objective predication in that it exists as a referential quality between objects. The qualia of a single particle do not necessitate that the qualia entail any self-reference to the object of which the qualia are a natural predicate. Qualia are ultimately the cause of action given the self is the experience of a quale of self, paired with perception of external qualia. Simple evolutionary theory suggests that an organism's inherent disposition is the spread of its genes, but the power of human consciousness has allowed that to be superseded by specific qualia and choice. This is the free-will of an agent. The conversation of freedom of action reduces to discussions of dualism or physicalism under theology vs evolution. Awareness of qualia relative to action requires biology.

Qualia are fundamental to any living organism given its necessity towards proliferation, likely implicit to any genetic structure but with the highest refinement in humans. This qualitative essence in humans is necessarily greater than any other object or organism. Relative to particle interactions, there is no awareness within a particle though the quantum mechanics of the environment is encoded within perception and behavior. It then stands to reason that there are classical qualia and the seemingly imperceptible quantum level of qualia as spin. The act of observation collapses the environment into a classical perception translated via quantum activity within the brain. Through the complexity of composition, quantum particles in neuronal form bring with it a level of awareness and experience on a classical scale.

A quantum theory would show that whatever binds codons and amino-acids is also responsible for increasing the complexity of qualia insofar as it increases the physical objectivity of which opposing objects are aware, leading to the creation of self. Quantum chemistry suggests an inherent predisposition in ionic and covalent bonding, determined by energetic favorability. Essentially it is a predisposition for a given neuronal state reducible to proteomic structure given quantum chemistry, resulting in a holistically physical threshold as a non-epiphenomenal, causal end. To analyze any correlation between any form of qualia and quantum phenomenon, we continue in the vein of the Cartesian method as objectively as possible. If, and only if, qualia are inherent with respect to a particle it is therefore the determinant behind collapse given an observer.

If qualia are inherent in any given mechanics determined by collapse, then an emergence between particle to atom and molecule occurs increasing in complexity. This then raises the hard problem of consciousness, though an inherent level of quale with respect to a particle gives it a different flavor such that functionalism readily presents itself since a cause has within it an effect. Each cause and effect are encoded within qualia. In essence:

$$\text{perception} \leftrightarrow \text{actuality} = \text{qualia} \leftrightarrow \text{particle}$$

We must then determine if the quale of self is reducible, and whether qualia writ large are reducible. Regardless, models of qualia are feasible and there is an emergence of qualia given the complexity of quantum mechanics translating to classical scales.

The Hard Problem

The hard problem, "why does subjective experience coincide with the physical process of the brain?" has vexed philosophers for quite some time (Shear, 1999). There have been varying responses to this question ranging from attempts to solve it philosophically and physically as well as efforts to make it a non-issue by saying it is irrelevant or intractable. If consciousness is a natural phenomenon, arising out of some evolutionary process, then it must have some physical component assuming all effects have within them some form of their cause. If consciousness is wholly physical then subjective experience arises out of the emergence of biological processes and can be modeled by physics. The hard problem in general seems to beg the question of teleology, given asking 'why are we conscious' results in 'to what aim did consciousness arise?' If a natural, physical account is true then there is no teleology since evolution is a blind process. This renders the hard problem moot. Teleology seems to suggest a purpose to consciousness, perhaps granted by a creator of which there is no evidence. Asking 'why' in this context then necessitates an *a priori* purpose and for that to exist there must be some higher authority to appoint such purpose. To avoid having to provide logic for a creator or higher power, is a physical perspective of consciousness feasible?

Consciousness is multifaceted, composed of intentional states (Searle, 1992), emotions (Damasio, 1994), and desire, as well as self-awareness in humans. These facets are incorporated in a global workspace (Baars, 2005), but what is consciousness itself? A pragmatic approach defines consciousness as the propensity for thought, where thought itself is the feeling and analytic interpretation of the senses which rise from the context of experience and create the intention of the intentional state. This does not necessitate the dynamic self-awareness we often think of when we hear the term consciousness, but does include awareness and attention. These form the foundation of the global workspace and are included in Libet's temporal factors. Any stimulus presented to the self is experienced as qualia in addition to analysis and judgment leading to decision making. This is internal with respect to physicality. This physicality includes input and a brain with the experience of mind, a projection of a physical component with respect to the self as an experience of identity in humans.

There are universal aspects to consciousness: emotions occur in conjunction with thoughts and may attenuate thoughts though they are not thoughts themselves and self-awareness requires a heightened reflection within the visuo-spatial sketchpad and phonological loop operating within working memory. With this operating definition of consciousness, we can begin to assess the issues revolving around the phenomenon, clearing a path towards showing whether or not a physical account of consciousness is tenable. Such an approach may lead to a physical solution to the hard problem. If a physical framework of cognition is tenable then there is a readily handy answer to the hard problem: we have subjective experience because the threshold of emergence has been reached biologically. There is something to be like what it is because it is, all that exists has a definition and everything that is defined is being in some sense. Distinctions detected from our surroundings in our experiences are the result of cognitive processes such that distinctions are *a posteriori* and occur given biological complexity.

If consciousness is a teleological puzzle, all ideas of a higher power aside, then it can be explained by how the added feeling that accompanies experience facilitates both distinctions and the recognition of taxons, or naturally occurring categories. If it is a question of the essential structure of what we experience then this can be described by phenomenology and physical explanations. We need merely isolate the neural correlates of consciousness in a measurable and falsifiable manner. The hard problem is, at its core, ontological. Not only do we ask "why are we conscious?" we must also ask "what does it mean to be a conscious being?" This is the question functionalists and physicalists must answer. The paradox of identity and ontology directly results from a physicalist perspective.

Without invoking any higher power or soul, of which evidence lacks, we are left with the simplest solution such that the mind is part and parcel equivalent to brain states, best captured by qualia and a global workspace. Physical nature has many different representations but what we experience is our cognition relative to nature and being. Assuming a Platonic realm, with members language and mathematics, still has physical correlations; namely the brain states which give rise to its ideation. This is measurable given brain waves (Suppes, Lu, & Han, 1997). What must be determined is whether what we perceive as composed of matter exists apart from observations and what it means to be physical. What we perceive as matter existing apart from observation has an existence which is impossible to verify apart from observation given no being can remove observation from their existence. What it means to be physical, however, can be resolved.

A definition of physicality hinges upon theories of the observable universe which are encapsulated by the sciences. An issue of causality and existence of language and qualia introduce problems of physical and logical theories as explanatory. Physicalism, defined in this context, is the belief that all things that exist succumb to physical laws and maintain physical properties either correlated with ontology or as a result of physical processes. Physicality then becomes, *a priori*, properties which lead to experience or that which is predictable to some degree. Given no physical thing can be experienced apart from the ontology of beings, we are left with *a posteriori* observation leading to deductive and inductive inference.

If consciousness is a physical phenomenon, then casual efficacy and substance would need to be addressed such that whatever is physical is either random, determined, or some combination thereof. If determinism is true and consciousness is completely material, or within a physical framework, we are free within emergent forces and consciousness becomes a complexity of biological foundations. This emergent force may have causal efficacy on bodily autonomy, though the force must be observable or predictable to some degree. The Platonic tradition argues that mathematical laws and theorems, as well as logic itself, exists at all times *sans* observation and we merely discover them within our own existence. This results from observation contrary to invention. If mathematics and logic are *a posteriori* then all reduces to neuronal states given invention. The syntactic content of which the meaning is derived logically determines our response to it, and causality lies in the qualia we are forced to experience given intentional states. Anything can be what it is like to be something under definition given by existence. This state of existence and definition is essentially the product of cognitive distinction which in turn is caused by the emergent physical reflection of objects under self-referential cognitive functions. This process is limited by neuronal assemblies and proteomics. But why should this feeling in experience associate itself with what we perceive?

Objects give rise to qualia, and the quale of self within a global workspace is the essence of the global workspace and consciousness. Drawing a distinction between epistemic possibility and metaphysical possibility we may state that the epistemic is possible knowledge, perhaps neo-Platonic, and the metaphysical is that which may be physically possible. The epistemic possibility skirts the realm of existential and noumenal, while metaphysics details the phenomenological. The difference between the two may be stated as: “either the possibility to know, or the possibility to be.” Insofar as something is necessary it is therefore true contingently when true in our experiential realm, but is synthetic. The epistemic is contained within thought, while being gives rise to such considerations.

Nothing can exist without being thought when it exists only in the form of thought, our being in experience of the physical begs the question of what exists once our thoughts cease. Again, no evidence of existence apart from phenomenological experience can be surmised without appeals to an “other.” We require the other to deduce what existence may be, or may have been. Without such, we are left with solipsism which is not tenable given the epistemic status of all thinking things. The adaptive capabilities of consciousness *sans* self-defeating behavior suggest the emergence of consciousness was selected for by evolution, allowing greater coordination between intraspecies activities.

The Model

Treating the brain as a complex dimensional, compact manifold mathematically homotopic to submanifolds introduces knot theory and braid groups. We may see knots, braids, and braid groups all have matrix representations given the works of Ibrahim (Ibrahim, 2021), and May (May, 2006). A vector field in M^{d^*} attenuates the smoothness of both M and $S \subset M$, and under transitive events deoxyribonucleic acid (DNA) attenuates neural networks via proteomics (Marcus, et al., 2004). We define input as $x \in X$ and inference to output as $f(x) \coloneqq y \in Y$. Then we see that we may further refine inference with respect to neurotransmitters $y_k \in Y$, neurons $y_b \in Y$ and neural networks $y_g \in Y$ for knot *k*, braid *b*, and braid group *g.* Each nontrivial knot with respect to y_k, the closed braid of nontrivial knot projections y_b, and the braid group y_g adheres to the following under angular momentum ω and calcium channel Ca^{2+} (where the channel is treated similar to the vector of current density):

$$\int_0^t t y_g \, dt = \int_0^t t \frac{\overrightarrow{y_g}}{||Ca^{2+}||} dt = \int t \left|\left|\overrightarrow{y_g} \times \psi_g\right|\right| dt \xrightarrow{\frac{\omega}{\theta}} y_g 40HZ,$$

$$t = [-550 \text{ ms}, 1 \text{ period}], \qquad y \approx -0.002n, \qquad n \neq 0, \qquad \theta = 2\pi n$$

Equation 1

Equation 1 represents the integrable function associated with translations between: time given a knowledge base as matrix, the neurophysics of neural networks with respect to calcium channels, and time multiplying the norm of a neural network's attenuations given connections, and overarching Hertz oscillations. A braid group is a collection of braids which are formed by linked knots, and the knots are represented as matrices. Then the braid group has a matrix representation and respective Eigenanalysis:

$$\psi_k \coloneqq$$

$$\begin{cases} K^+ \\ Na^+, \\ Ca2^+ \end{cases} \qquad \{\lambda_k, \phi w_k \mid \lambda, \phi w \in S^a \subset M^{d^*}\},$$

$$\begin{bmatrix} \lambda_k, \phi w_k & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \lambda_k, \phi w_k \end{bmatrix} \bigcup_0^k \oint t \, [\lambda_k, \phi w_k] - M^{d^*} \langle \psi_k \rangle \, dt$$

Equation 2

for potassium cation K^+, sodium cation Na^+, calcium channel Ca^{2+}, eigenvalues λ and Alexander polynomials ϕw. Equation 2 defines the relation of Eigenanalysis to a differentiable function over time with respect to determinants as the complex-dimensional manifold changes neurochemistry.

The matrices of knots give column vectors as crossings, which also form matrices of braids. The matrices of braids form a matrix of a braid group, which in turn is a set of column vectors within submanifolds. Some vectors then have an associated Alexander polynomial, which is the eigenvalue of the covariant matrix for tame knots. If the knot is wild, we simply treat it with respect to eigenvalues rather than Alexander polynomials. The area under the curve of a vector is defined by the complexity of the knot and mass, the complexity of the knot is dependent on atomic composition, and the path integral of the vector field is the mass of the atom. For current density J:

$$\int t \frac{y_g}{||J||} \times \psi_k dt = \oint_0^t t \frac{y_g}{||y_k||} \times \psi_k - \psi_{x_{\Delta M}} \, dt$$

Equation 3

Equation 3 relates time to neural networks and current density (e.g. a calcium channel) crossed with the wave functions of neurotransmitters, equal to the complex dimensional integral of time acting upon the cross of neural networks and ionic wave functions as the manifold undergoes transformation given input. Equation 4 relates the partial derivatives of dot products between neural network oscillations and perturbations to Hertz oscillations of the brain. This partial derivative is equal to neural network oscillations dotted with the unit vector of neural networks, which is a range of Hertz frequencies. Both are differentiated with respect to neuronal connections within the network.

$$\frac{\partial}{\partial y_g}\left|\left|\psi_{y_g}\right|\right|\left|\left|\psi_{x_{\Delta M}}\right|\right|\cos\theta = \frac{\partial}{\partial y_g}\left|\left|\psi_{y_g}\right|\right|\left|\left|\frac{y_g}{\left|\left|y_g\right|\right|}\right|\right|\cos\theta$$

Equation 4

$$\Delta M\langle\lambda y_g\rangle = \lambda^d \Delta M\langle y_g\rangle \text{ a homogenous equation}$$

The path integral of the spin group of the atom is composed of the spin of particles included, which requires Schrodinger's equation for general linear group GL(S):

$$\mathrm{Spin}(x_k, y_k) \to \mathrm{GL(S)}$$

$$\mathrm{Spin}(x_k, y_k)\colon \begin{cases} Q(z_1, \dots, z_d), & Q \in \mathbb{C} \\ Q(x_1, \dots, x_d), & Q \in \mathbb{R} \end{cases}$$

$$\int Q(x_d) - \frac{y_b}{\left|\left|y_b\right|\right|}\cdot\frac{y_k}{\left|\left|y_k\right|\right|}dy_k = y_k x_d - \frac{y_k}{\left|\left|y_m\right|\right|} + c = Q(x_d)y_k - \begin{cases}0\\1\end{cases} + c = y_k x_d - \begin{cases}0\\1\end{cases} + c$$

Equation 5

$$\oint Q(z_d) - \frac{y_b}{\left|\left|y_b\right|\right|}\cdot\frac{y_k}{\left|\left|y_k\right|\right|}dy_k = y_k z_d - \frac{y_k}{\left|\left|y_m\right|\right|} + c = Q(z_d)y_k - \begin{cases}0\\1\end{cases} + c = y_k z_d - \begin{cases}0\\1\end{cases} + c$$

Equation 6

for general linear group GL(S), and quadratics Q. Equations 5 and 6 represent the transformation of input with respect to neural networks, to a vector with a constant c such that we may treat the vector as superposition of states $|0\rangle, |1\rangle$. Input is encoded in amplitude in addition to the quale itself:

$$x_\alpha = \alpha\sin(\omega[t-\beta]) + \gamma$$

Equation 7

$$\left\{\frac{x_\alpha\overrightarrow{x_k}}{\left|\left|\overrightarrow{x_k}\right|\right|}\cdot\frac{x_\alpha\overrightarrow{x_g}}{\left|\left|\overrightarrow{x_g}\right|\right|}\right\}\frac{\psi_x}{\left|\left|\psi_x\right|\right|} = x_\alpha\left|\left|x_k\right|\right|\left|\left|x_g\right|\right|\cos\theta\frac{\psi_x}{\left|\left|\psi_x\right|\right|} = \begin{cases}0\\1\end{cases}$$

Equation 8

For $x_\alpha \in \psi_x$ oscillating, ω angular frequency, t time, amplitude α, and γ displacement offset. Given input x, the dot product is one and then becomes the unit vector of a wave function attenuated by x_α. The general, periodic orbit is with respect to $\{g, S, \Phi\}$:

$$\Phi\colon b \to S, \qquad b \subset g, \qquad b \times y_{S_k} \xrightarrow{\Delta S} g$$

$$\zeta(y_k) \coloneqq \{y_b \in g, \qquad g\colon y_b \to y_k\}$$

$$\Xi_{y_k} \coloneqq \{\Phi(y_b, y_k) \colon y_b \to \zeta(y_k)\} \subset S$$

Equation 9

The periodic orbit of Equation 9 allows for spherical coordinates in *n*-dimensions with respect to the time-dependent Schrodinger equation and Laplacian. For $t \neq 0$ with respect to $\zeta(y_k)$ where $\zeta(y_b, y_k) = y_k$ then ζ is a periodic orbit, where the periodic orbits correspond with both curves and Riemann surfaces. Assume complex compact manifold M^{d^*} in complex dimension. The family of deformations is homotopic to submanifold structure S^a, where for deformations Δ:

$$\Delta M_x \colon S_{x,y} \to \Delta S^a_{\vec{y}}, \quad \text{manifold mapped to submanifold,}$$

$$S_{\vec{k}} \colon \Delta S^a_{\vec{k}} \times \vec{g} \to \vec{y}_g, \qquad \text{deformation of submanifold maps to knowledge base}$$

$$h(g) \colon \mathrm{g} \times b \to b, \qquad \text{projection of a matrix to an orthogonal matrix}$$

$$h(b) \colon b \times y_k \to y_k, \text{project braids to knots}$$

We then define matrices of knots with eigenvalues or Alexander polynomials along the diagonal, and zero everywhere else, where tame knots have an Alexander polynomial and wild knots do not.

$$\text{knots}_{\text{TAME}} \coloneqq \begin{bmatrix} \phi w & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \phi w \end{bmatrix}, \qquad \phi w \geq 0, \qquad \phi w \in \mathbb{R}$$

$$\text{knots}_{\text{WILD}} \coloneqq \begin{bmatrix} \lambda & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \lambda \end{bmatrix}, \qquad \lambda \geq 0, \qquad \lambda \in \mathbb{R}$$

Eigenanalysis of knot matrix and Alexander polynomial define a vector field. The integral of the knot vector field is the mass of the atom, where complexity of knot gives complexity of atom:

$$m_{\text{knot}} \in M^{d^*}$$

The atomic vector field is additive when knots are grouped, treating each knot as mass equal to the inner product of wave functions with respect to knot matrices:

$$x_\alpha[m_{y_{k1}} \oplus m_{y_{k2}}] = \langle \psi_{x_k} | \psi_{y_{k1}} \rangle \to \langle \psi_{y_{k2}} | \psi_{y_{k2}} \rangle = f(x_k), \qquad \text{scalar}$$

Equation 10

Linked knots are a braid with vector field, integral of the braid gives the mass of atoms in the braid. Braids form braid groups which have a vector field. Equation 11 isolates the trace of matrices associated to knots given dot products between input functions and neural networks, summed with respect to the inner product of neural networks, treated under their wave functions.

$$\sum \langle \psi_X | \vec{g} \rangle + \langle \psi_{y_g} \rangle = \sum \lambda_k = \sum \phi w_k \quad \text{scalar}$$

$$\int_0^t t \langle \psi_X | \, \psi_y \rangle dy = \int \frac{y}{\left|\left|y_g\right|\right|} dy_g = \int \frac{y_b}{||y_b||} dy_b = \int \frac{y_k}{||y_k||} dy_k = \int y_k \cdot \psi_k \, dy_k,$$

Equation 11

The Hadamard product is taken in place of multiplication with respect to vectors as matrices given solutions to integrals. The integrals of Equation 11 then take time given the dot product of input functions and wave functions of the brain equal to a reduction in dimension from M^{d^*} to $y_g \in S$. This occurs given neurotransmitter functions are the integral of the dot product of the spin as a vector, and the wave function of that neurotransmitter. This reduces time, input, and the manifold as the manifold varies to the integral of neurotransmitters dotted with their wave functions as they vary. This stabilizes Hertz oscillations.

Under homotopy:

$$h: X_{x_g}^{d^*} \times M_g^{d^*} \to \Delta M_{y_g}^{d^*}$$

$$h: \Delta M_{y_g}^{d^*} \times S^a \to \Delta S_{y_g}^a$$

$$h: \Delta S_{y_g}^a \times y_g \to y_g$$

We then differentiate the time-dependent Schrodinger equation first as $f(x)$ varies at $t = 0$ and again as t varies when $f(x)$ is held constant, understanding that mass is a function of knot complexity:

$$\Gamma_{\mathrm{f(x)}} = \begin{cases} \frac{\hbar^2}{2}\sum_{n=1}^{N} \frac{1}{f(x_k)_n^2}\nabla_{\mathrm{n}}^2 + \frac{d}{df(x)}V(f_1, \ldots, f_N, t), & t = 0, \quad |\Psi(0)\rangle, \quad \frac{\partial t}{\partial f(x)}\Gamma_{f(x)} \\ \frac{d}{dt}V(f_1, \ldots, f_N, t), & t = 1, \quad |\Psi(1)\rangle, \quad \frac{\partial f(x)}{\partial t}\Gamma_{f(x)} \end{cases}$$

Equation 12

$$2\pi\left\{\sum L_B\right\}\Gamma_{f(x)} = 6.76 * 10^{-65}\ \text{Joules}\sum_{n=1}^{N}\frac{1}{f(x_k)_n^2}\nabla_{\mathrm{n}}^2 + 2\pi\frac{d}{df(x)}V(f_1, \ldots, f_n, t)$$

Equation 13

where a neuron $n \in N$ has $\sim 6.6 * 10^{-12}\frac{\text{Joules}}{\text{spike}}$ (Levy & Calvert, 2021). Characterizing the system with respect to energy given, as solutions to Schrodinger's equation:

$$E_{M_\beta} = \begin{cases} 6.76 * 10^{-65}\ \text{Joules}\sum_{p=1}^{P}\frac{1}{m_p^2}\nabla_{\mathrm{n}}^2 + 2\pi\frac{d}{df(x)}V(f_1, \ldots, f_n, t) \\ 6.6 * 10^{-12}\frac{\text{Joules}}{\text{spike}}\sum_{n=1}^{N}\frac{1}{f(x_k)_n{}^2}\nabla_{\mathrm{n}}^2 + 2\pi\frac{d}{df(x)}V(f_1, \ldots, f_n, t) \end{cases}, \quad 5\ \text{cycles}$$

Equation 14

$$r = \max_{1 \le i \le n}|\lambda_i|, \qquad \max_{1 \le i \le n}|\phi w_i|$$

$$2\pi * V(f_N) = \frac{1}{2\left|\left|C_a^{2+}\right|\right|}\sum_{n\geq 2}^{N}\frac{f(x_k)\mathrm{Spin}\big(x_k, f(x_k)\big)}{\left|\max\limits_{1\leq \mathrm{n}\leq \mathrm{N}}|(\lambda_n, \phi w_n)| - f(x)\right|}\{Nf(x)\}^d$$

Equation 15

Given two neurons, three spatial dimensions and time, and $|x_k|\left|x_g\right|\cos\theta = 1$ we isolate terms with respect to $\left|\left|C_a^{2+}\right|\right|$ and compute the Laplacian of potential energy, given calcium channels as a vector similar to current density. We adapt the model with respect to spherical coordinates in dimension N, Dirac delta δ, $|r - y| = R$, $(x_d y - x_\alpha) = \tau$, $(6x_d y - 5x_\alpha) = \sigma$, spectral radius $r = \max\limits_{1\leq n\leq N}|(\lambda_n, \phi w_n)|$ such that r is the point evaluated for potential, and y is the nonzero charge locus. Both (τ, σ) are functions of input amplitude acting upon $f(x)$ as x varies.

$$\nabla_n^2 + 2\pi\,\frac{\partial t}{\partial f_N}V(f_N, t) =$$

$$\frac{\psi_x}{||\psi_x||}\frac{1}{||C_a^2||}\sum_{n\geq 2}^{N}\left\{\left\{\left(\frac{12R^2}{R^7} - \frac{6\delta(R)}{R^4}\right)(yR\tau + 8R^2\sigma y^4)\right\} + \left\{\frac{2\tau\delta(R)y + 16\sigma y^4}{R^3}\right\}\right.$$
$$+\left\{\frac{1}{\max\limits_{1\leq n\leq N}\ |(\lambda_n, \phi w_n)|^2}\right\}\Delta_S\left\{\frac{1}{4\pi}\left[\sum_{n\geq 2}^{N}\frac{y\ \mathrm{GL(S)}}{R}\right][Ny]^d\right\} - \left\{\frac{6y(-x_\alpha + 16\sigma R y^3 + x_d y)}{R^4}\right\}$$
$$\left. - \left\{\frac{2yR(\tau R + 4\sigma y^3 R^2)}{\max\limits_{1\leq n\leq N}\ |(\lambda_n, \phi w_n)|\, R^5}\right\}\right\}$$

Equation 16

Results

The neural correlates of consciousness are: neurotransmitters $f(x_k)$, a neural network for inference $n \geq 2$, proteomic functions under DNA with respect to the brain $\Delta M_x\colon S_{x,y} \to \Delta S_{\vec{y}}^{a}$, input $\frac{\psi_x}{||\psi_x||}$, a global workspace (Baars, 2005) $\frac{\psi_{f(x)}}{\left|\left|\psi_{f(x)}\right|\right|} \times \frac{\psi_x}{||\psi_x||}$, Libet's temporal factors L_B, and binding at $40Hz$. These are necessary and sufficient for consciousness. The complexity of the knot is determined by mass, the integral of the knot as vector is with respect to mass, and mass is a function of the knot in the time-dependent Schrodinger equation. The experience of consciousness is then experience of the energy field in the brain translated from quantum to classical terms as proteomics return the brain to equilibrium resonant to input within the global workspace.

Brain waves modulate brain regions, which translate to neuronal firing. The fundamental energy of the system is determined by quantum activity, and the research of Koch and others shows binding occurs at 40 Hz (Joliot, Ribary, & Linas, 1994). Given brain waves also carry semantic information (Suppes, Lu, & Han, 1997), we may then infer that information processed cognitively is encoded in brain waves. Furthermore, Idris shows quantum fields occur *within* the brain (Idris, 2020). It is also well known that cognitive tasks increase Hz frequency. Then for emergence and energy E_M:

$$E_M = \begin{cases} 6.76 * 10^{-65} \text{ Joules} \sum_{p=1}^{P} \frac{1}{m_p^2} \nabla_n^2 + \frac{1}{\left||C_a^{2+}|\right|} \frac{\psi_x}{||\psi_x||} \sum \frac{8y^4[R^2\sigma + mR\tau]}{R^3}, & t = 0 \\ 6.6 * 10^{-12} \frac{\text{Joules}}{\text{spike}} \sum_{n=1}^{N} \frac{1}{f(x_k)_n{}^2} \nabla_{\mathrm{n}}^2 + \frac{1}{\left||C_a^{2+}|\right|} \frac{\psi_x}{||\psi_x||} \sum \frac{8y^4[R^2\sigma + f(x)R\tau]}{R^3}, & t = 1 \text{ period} \end{cases}$$

Discussion

With respect to qualia, we may begin an analysis under the perception of the color red. Let the percept of Q exist:

$$Q \in \Theta_{\mathrm{EM}}$$

for electromagnetic wave Θ_{EM}. Then the following holds:

$$\mathrm{Q}(\Theta_{EM}) \in \Theta_{\mathrm{EM}}, \qquad \mathrm{Q}(\Theta_{\mathrm{EM}}) \text{ observable}$$

Treating $Q(\Theta_{\mathrm{EM}})$ as an ordered set of scalar wavelengths orthogonal to the observer's cognition C, and treating cognition as a function, then $Q(\Theta_{\mathrm{EM}})$ may be treated as a vector given:

$$Q(\Theta_{\mathrm{EM}}) \coloneqq Q(\Theta_{\mathrm{RED}}, \Theta_{\mathrm{RED}^*}, \Theta_{\mathrm{GREEN}})$$

$$Q(\Theta_{\mathrm{RED}}) > Q(\Theta_{\mathrm{RED}^*}) > \mathrm{Q}(\Theta_{\mathrm{GREEN}})$$

$$Q(\Theta_{\mathrm{EM}}) \times C$$

Such that for any arbitrary components of the observable electromagnetic spectrum:

$$Q(\Theta) > Q(\Theta^*)$$

If $Q(\Theta)$ is orthogonal to the observer as a vector, and the vector is not perpendicular to itself, then the projection to the observer is with respect to parallel wavelengths. The passage of a percept to a person from parallel vectors orthogonal to the observer is then a vector in the direction of the observer with magnitude. Additionally, the percept $Q(\Theta)$ is carried by photons. A photon does not have color. Even the wavelength of a percept $Q(\Theta)$ does not have color. Color is a byproduct of the brain. Then there is a possible epiphenomenal component to the visible spectrum of the electromagnetic field paired to each color such that the observation of the same wavelength yields different experiences:

$$\{C_1 \colon Q_1(\Theta_{\mathrm{EM}}) \in \Theta_{\mathrm{EM}}\}, \qquad \{C_2 \colon Q_2(\Theta_{\mathrm{EM}}) \in \Theta_{\mathrm{EM}}\}$$

$$Q_1(\Theta_{\mathrm{EM}}) = Q_2(\Theta_{\mathrm{EM}})$$

$$C_1 \colon Q_1(\Theta_{\mathrm{EM}}) \neq C_2 \colon Q_2(\Theta_{\mathrm{EM}})$$

No isomorphism exists between $\Theta_{\mathrm{RED}}, \Theta_{GREEN}$, yet some who are colorblind see:

$$\Theta_{\mathrm{GREEN}} = \Theta_{\mathrm{RED}}$$

and some observe that:

$$\Theta_{\mathrm{RED}} = \Theta_{\mathrm{RED}^*}$$

Then it stands to reason that the spectrum of Θ_{EM} admits a component of percept paired to experience that has no effect on the physical world. We call these epiphenomenal qualia. The reflection and absorption of light with respect to an object having a neurotypical observer experiences a unified percept within the global workspace. This percept may incite action by the observer, but the percept itself has no physical effect. And yet perception of color yields actions with respect to that color. Given an effect has some form of its cause, the effect of decision based on percept shows qualia is not epiphenomenal. It impacts the process of cognition, and the percept under cognition affects brain waves.

If we reduce consciousness to its most primitive experience, it is the experience of a quale of self. This experience is a bound composite within the global workspace, and directly effects the brain so it is not epiphenomenal. Whether qualia are reducible does not then apply to questions of the quale of self as consciousness. Our experience of the quale of self then impacts the experience we have of the world insofar as our consciousness attenuates our experience based on it. Rather than circular, it shows the quale of self is reducible with respect to our global workspace given actions. We are not passive observers, and our identity is reducible to the experience of a quale of self.

Conclusion

Consciousness is the experience of a quale of self within a global workspace composed of neurotransmitters, field and energy oscillations, attention, and awareness. Disrupting the Hz oscillations of the brain directly impacts cognitive functions in terms of electromagnetic fields (Kim, Lee, Kim, Kim, & Kim, 2019), which solidifies the importance of the electromagnetic field in cognition given loss of equilibria. Furthermore, research supports that a solution to the binding problem is also a partial solution to the hard problem (MacIver, 2022). Libet's temporal factors centered about 40 Hz illustrates transference of information and offers a theory of binding given established research (Crick & Koch, 1990) (Suppes, Lu, & Han, 1997) (Libet, 2004) (Baars, 2005). A solution to the hard problem of consciousness requires an answer to the question of why we are conscious in the first place (Solms, 2019). We are conscious given the measure E_M, such that neural networks tied to proteomics within a global workspace attenuate attention and awareness under perception to allow the emergence of a quale of self.

Qualia represent the "isness of what it is to be that which it is" given perception. This includes the spin of particles translated between input and brain, with classical mechanics emerging from such properties. The traditional view of qualia does not include spin of particles, thus further refinement with respect to the model is required. Despite this drawback, intentional states, and the emergence of consciousness hinge upon brain waves, global workspaces, and qualia. Furthermore, under Equation 1 we see that $y \approx -0.002n$ which suggests virtual particles (Jones, 2002) are a function of conscious activity within the brain.

By ignoring cultural assumptions and appeals to higher powers, whether deceptive or not, under pragmatism we have escaped the Cartesian circle to some degree. Only self-deception is possible, but given no person remembers their creation moment we are left with two who state they are parents. Under this epistemic state we then rely on observation and falsifiability. Genetics supports birth, which leads to evolution. This allows a pragmatic judgment such that there are other thinking things. We may then introduce physicalism and functionalism in the hopes of falsifiability.

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