7. Evolving Useful Sensory Simulations of Reality

*The traditional dualism of mind and matter, which I regard as mistaken, is intimately connected with confusions. So long as we adhere to the conventional notions of mind and matter, we are condemned to a view of perception which is miraculous. We suppose that a physical process starts from a visible object, travels to the eye, there changes into another physical process, causes yet another physical process in the optic nerve, finally produces some effect in the brain, simultaneously with which we see the object from which the process started, the seeing being something “mental,” totally different in character from the physical processes which precede and accompany it. This view is so queer that metaphysicians have invented all sorts of theories designed to substitute something less incredible. But nobody notices an elementary confusion.1*

*—Bertrand A. W. Russell 1872–1970*

Phenomenal qualities are embodied spaciotemporal abstractions subjectively perceived by a conscious observer. Specific examples, i.e., qualia, include the color purple, the taste of chocolate, and the fragrance of a rose. The question of whether phenomenal awareness can be empirically understood forms one important facet of the “Hard Problem of Consciousness” (Chalmers, 1995, pp. 200–219). It is the position of this analysis that we will never understand why we experience sensory qualities in the manner we do until we first comprehend how they may have evolved in the very distant past.

This examination explores the evolutionary development of phenomenal experience. In so doing, it proposes that behind the mechanisms through which external stimuli interface with our sensory apparatus, there lies a long evolutionary process of standardization, approximation, and synchronization that has ultimately forged the close links between the two.

The consistent and efficient correlations that the resultant evolutionary links give rise to cumulatively generate conscious experience. There is a tight correspondence between our sensations and incoming stimuli, and this synchronous covariance is meaningful and functional; however, it does not result from a strict cause-and-effect relationship between the physical properties of external objects and our internal neurophysiology. As such, this investigation endorses Hoffman’s (1998, 2003, 2008, 2009) view that the external world is largely hidden from direct sensory evaluation.

The following enquiry utilizes Jung’s (1952) “Acausal Connecting Principle” to further explore the concept of complementary sensory phenomena as it may have originally been envisioned by Wolfgang Pauli. (Meier, 2001) This thesis, with respect to meaningful acausality and synchronicity, is first used to provide a plausible explanation for the initial genetic development of color perception, and then employed to examine the analogous evolutionary ties that ultimately engender all sensory modalities.

Without invoking the Quantum-Mind hypothesis, this paper supports the idea that our five senses are not direct, or true, or even approximate abstract representations of any underlying material properties of incoming stimuli; instead, they efficiently provide useful higher-order assumptions pertaining to the macro properties of spacetime, matter, and motion, as well as the causal-objective of all life. The overall investigation concludes that it is the structural categorization, hierarchical organization, and qualitative charictorization of this indirect presumptive meta-information that has engendered meaningful sensory experience, and all conscious thought over evolutionary time.

1 Russell (1927, p. 111).

**1. Introduction**

At the heart of any empirical approach to consciousness is a philosophical and scientific quandary that has yet to be satisfactorily addressed. At issue is the dilemma that David Chalmers (1995) calls the “Hard Problem of Consciousness” (pp. 200–219). The hard problem asks: How does the material brain—which is in some ways analogous to a modern digital computer—give rise to phenomenal experience? In other words, how do external physical stimuli become transformed into conscious sensory awareness? More specifically, how do the neural networks, which generate electrical patterns of stochastic information, integrate all this complex electrochemical activity, first into meaningful sensations and perceptions and then into emotion, feeling, language, logic, mathematics, and all manner of conscious experiences and behaviors?

Although the Nobel prize winner theoretical physicist Erwin Schrödinger (1887–1961) wrote extensively in the areas of quantum mechanics, he also published several essays and short books on what we would, today, describe as theoretical biology. In his posthumous 1967 combined volume titled, *What is Life? With Mind and Matter and Autobiographical Sketches,* in a chapter entitled “The Mystery of the Sensual Qualities,” Schrödinger (1967) expands on his belief that color is a percept (pp. 153–164). He argues that the notion of color as a physical property of matter is still very much open to debate. Schrödinger affirms that, “The sensation of colour cannot be accounted for by a physicist’s description of light waves.” (p. 154) In that chapter he asks, then answers, the following question:

Could the physiologist account for it, if he had fuller knowledge than he has of the processes in the retina and the nervous processes set up by them in the optical nerve bundles in the brain? I do not think so. (Schrödinger, 1967, p.154)

He continues by remarking that a subjective experience does not exhibit an absolute one-to-one correspondence with a visual stimulus. Schrödinger points out that light of wavelengths in the neighborhood of 590 nanometers produces the perception of yellow, whereas exactly the same sensation is produced by mixing infrared light having a wave-length of 760 nm (from which no color is perceived) with light in the frequency range of 535 nm (which is normally perceived as green). From this, he concludes that there is no numerical connection between the physical, objective properties of light waves and the color sensations that we consciously experience.

Schrödinger’s (1967) comments regarding color perception anticipate some of the same issues concerning the nature of phenomenal experience raised 30 years later by Chalmers (1995). In the more than 50 years since the publication of Schrodinger’s book, relatively little progress has been made in unraveling the mystery of sensual qualities.2 It is hoped that by concentrating on the initial evolutionary basis for color perception in particular, this analysis may shed light on the foundations of conscious experience in general. However, the time scales involved are so uncountably long and the number of intervening generations so unaccountably vast that there is little direct physical evidence to evaluate. Instead, the inquiry will utilize inference and deduction drawn from prior biological and mathematical studies, such as: Hamilton (1963, 1972), Williams (1966), Dawkins (1976), (Mark, Marion, and Hoffman 2010), Valiant (1984, 1994, 2006, 2009 & 2013), Hoffman (2019) and (Gigerenzer, 2000, 2004 & 2007).

2 Since Schrödinger’s death in 1961, a great deal of research has been published on the physiological generation of sensations; but as yet, no general theory provides a viable answer to the “Hard Problem” as posed by Chalmers (1995, pp. 200–219).

**2. Evolutionary Constraints and Peculiarities**

From an evolutionary perspective, due to predation and the instinctive need to propagate their species, certain primordial organisms began the process of adding complementary color percepts to their preexisting photosensitivity that responded only to the intensity of light. Over hundreds of millions of years, color came to be precisely assigned to the slim band of electromagnetic radiation that predominates on Earth when our sun is directly overhead, with wavelengths between roughly 400 and 700 nm.

At the high end of the visual spectrum, ultraviolet (UV) photons (from the Latin ultra, meaning “above”) have greater energy and shorter wavelengths and therefore a higher frequency than does the colorized light visible to humans. Conversely, under the lowest stratum of the visual spectrum, infrared (IR) photons (from the Latin infra, meaning “below”) have less energy, longer wavelengths, and therefore lower frequency than red light. UV light has waves of approximately 400 nanometers or shorter, whereas IR radiation is emitted across a wide range of wavelengths 700 nanometers or longer. Neither UV nor IR light are associated with a color percept, and as such they are invisible to humans, but when their photons strike exposed skin, the absorbed energy is experienced as heat; the same holds true for visible light.

According to the noted researcher of consciousness, artificial intelligence (AI), and artificial life (AL) Steven Grand: “It’s not visible light’s ‘predominance’ on Earth that makes this band ‘special,’ but its interaction with atoms and complex organic molecules, due to the wavelengths’ similar size” (Grand, personal communication, May 31, 2017). Grand states that,

Low frequency electromagnetic waves can wobble atoms, but do not carry enough Planck energy to do much more than that. Heat is one example of such things, i.e., individual atoms, being wobbled. Low frequency radio waves cannot wobble atoms very much, but they can wobble fluid seas of electrons and hence generate an alternating electrical current (which is how radio antennas work). At the other end of the spectrum, high frequency radiation tends to destroy things completely. Gamma waves can break atomic nuclei; ultraviolet light tends to break molecules. Neither of these extremes is biologically useful for sensing. (S. Grand, personal communication, May 31, 2017)

Grand goes on to say that,

Wavelengths of visible light wobble molecules in a more interesting way—neither transiently nor destructively but in a metastable way, either electrochemically or via atomic excitation. In particular, these middling wavelengths tend to be very differentially absorbed or reflected by different kinds of molecules, whereas others just pass right through. (S. Grand, personal communication May 31, 2017)

Grand then explains that,

The visual spectrum has a Planck energy content that is around the right level to make reversible yet somewhat persistent structural changes in complex organic molecules such as proteins. Given that life on Earth also happens to be made out of complex organic molecules, this is a more accurate explanation as to why visible light is important to us (S. Grand, personal communication, May 31, 2017).

*2.1 The Peculiarities*

The vast majority of people alive today do not bother to think about the objective constraints on the evolution of color perception. They simply assume that color is a physical property of matter, determined by the way its atomic structure absorbs, reflects, scatters, or generates visible electromagnetic radiation. The average woman or man, if she or he ponders color evolution at all, believes that color varies in proportion to the frequency of incoming light waves. They believe that colored spectra radiate from or are refracted to our eyes directly off the surfaces of objects. They also assume that within each color band, i.e., red, orange, yellow, green, blue, and violet, the brightest hues are associated with the highest frequencies and the darkest shades with the lowest.

But these common-sense suppositions, despite their great prevalence, are incorrect. Color is not an objective property of light waves; instead, it is an abstract percept that evolved to appear to be in sync with the energy levels and light distribution patterns of incoming electromagnetic radiation. What leads most people astray is that they do not realize that energy (E) and frequency (v) are directly proportional to each other, as specified by the equation E = hv, where h is Planck’s Constant. Thus, it is much the same thing whether one talks about “energy level” or “frequency” in the context of the visible light spectrum. The Planck-energy of a photon is another term for its frequency, which (because the two are directly proportional) is another word for its position within the electromagnetic spectrum.

The energy levels, i.e., wave frequencies, that humans distinguish have been extensively studied, as have their covariant color percepts. The correspondences have been documented and are presented in Table 1:

|  |  |  |
| --- | --- | --- |
| **Color** | **Wavelength interval** | **Frequency interval** |
| Red | ~ 700–635 nm | ~ 430–480 THz |
| Orange | ~ 635–590 nm | ~ 480–510 THz |
| Yellow | ~ 590–560 nm | ~ 510–540 THz |
| Green | ~ 560–490 nm | ~ 540–610 THz |
| Blue | ~ 490–450 nm | ~ 610–670 THz |
| Violet | ~ 450–400 nm | ~ 670–750 THz |

Table 1. The wavelength/color spectrum humans perceive.

Peculiar characteristics of physical phenomena, which do not exist externally in nature but are nevertheless consciously experienced, are referred to as qualia. Qualia, and its singular form quale, come from a Latin word meaning “what sort” or “what kind,” and is the modern term used by consciousness philosophers and other cognitive researchers to describe the subjective “feel” or quality of a conscious experience.

Qualia are not true representations, nor even close approximations, of the underlying essences or physical properties of external objects. However, there is an oblique correlation between the two, which American philosopher Roy Wood Sellars (1919), in his paper entitled, “The epistemology of evolutionary naturalism,” was the first to identify. The crucial concept is one that today we would define as a “synchronous covariance,” but he described it as a “differential correlation” between incoming stimuli and conscious experiences (Sellars, 1919, pp. 407–426).

The concept of a “synchronous covariance” applies to the physiological assignment of color to the visual spectrum. Though colors do not emanate from the physical properties of light waves directly, they are synchronistic qualia, in that—through evolution and experience—they have become abstract qualities that, seem to closely co-vary with the different energy levels and light destitution patterns that humans perceive.

**3. Critical Realism vs. Conscious Realism**

Our simplistic conceptions as to the nature of color fall within the realm of naive realism. This is the worldview holding that external reality is exactly as one perceives it. The vast majority of people in the world accept this is true without giving it a second thought. However, the prevailing view among most consciousness researchers and cognitive philosophers is not naive realism but critical realism.

On his website, egtheory.wordpress.com, mathematician and evolutionary game theorist Artem Kaznatcheev (2014) states that “in this paradigm, perception resembles reality but doesn’t capture all of it.” He goes on to state:

[I]f naive realism is a perfect photograph; then critical realism is a blurry picture. Or, to use a metaphor more familiar to scientific modelers, instead of models, our perception is a map of the territory that is reality. Our perception—like a map—distorts, omits many details, adds some labels and draws emphasis; but it largely preserves the main structure of reality. (Kaznatcheev, 2014)

Most mainstream scientists adhere to critical realism: They believe that complete empirical descriptions for the functioning of our sense organs were developed in the 20th century; they assume that our sensations and perceptions are close but not exact representations of the physical properties of the underlying stimuli, and that they result from a direct cause-and-effect relationship between the physical properties of external objects and our internal neurophysiology. The 2015 book, *Seeing Things as They Are:* A Theory of Perception, by American philosopher John Searle is a good example of this conventional point of view.

Critical realism: This broadly accepted orthodoxy among most consciousness philosophers and perceptual psychologists is not entirely supported by the available empirical evidence. Russell’s opening quotation and the research of Donald D. Hoffman provide strong epistemological counterpoints to this all-too-pervasive worldview. See (Mark, Marion, and Hoffman 2010) and Hoffman (1998, 2003, 2008, 2009 and 2019). According to Hoffman (2008):

[P]erceptual experiences do not match or approximate properties of the objective world, but instead provide a simplified species-specific user interface to that world. (p. 87)

Hoffman (2008) applies another term, conscious realism, to his ideas, and goes on to state that our sensory perceptions of the objective world:

… consists of conscious agents and their experiences; these can be mathematically modeled and empirically explored in the normal scientific manner. (p. 87)

Kaznatcheev, Montrey, and Shultz (2014) also assert that, for Hoffman, “perception is an interface that hides complexity that is irrelevant to the agent’s aims” (pp. 731– 736). Furthermore:

In the case of evolution, the “aim” is maximizing fitness, and thus perception does not need to be truthful, but has to provide an interface through which the agent can act to maximize its fitness. Mark et al. (2010) confirmed this [insight] with an evolutionary model showing that fitness is more important than “truth” to the agent. If perception is expensive, then the agent will tune it to reflect the fitness distribution—something that depends on the interaction between agent and objective reality. (Kaznatcheev, Montrey, & Shultz, 2014)

According to (Hoffman, 2019) our minds begin the process of generating abstract representations of real objects and events when our sense organs activate in response to physical stimuli emanating from the world around us. From a repeated sampling of external stimuli, our sense organs transduce this probabilistic data into corresponding electrical signals, and route the resulting stochastic impulses to the brain. The brain then reformulates this secondary information into a sensory abstraction of the actual entity or event and uses this—rather than direct information from the thing itself—to experience, plan and to make conscious judgments concerning external reality and our relation to it. Hoffman’s ideas are a modern interpretation Kant’s 18th century Transcendental Idealism.

Through computer modeling, (Mark, Marion, and Hoffman 2010), convincingly demonstrate that evolving sensory systems that truthfully depict every aspect of our external world would have been prohibitive to primordial organisms. Specifically, Hoffman’s position is that our macro sensations and perceptions eliminate the underlying complexity of reality that is not necessary in order for an observer to understand their relationship to external existence. So, the abstract manifestations of conscious qualia we experience: color-vision, sound, touch, taste and smell, do not have to be direct or true or even approximate representations of the underlying physical properties of external phenomena.

That said, the information we acquire through this indirect sensory experience is clearly a good (i.e., useful) fit with the actual spatiotemporal/causal-objective actions and events synchronistically unfolding in the perceived present. Given that our five classical senses do not directly represent the underlying physical properties of the environmental stimuli that they correspond to, and given that they, nevertheless, provide useful higher-order information about the external world we inhabit, then: how did our sensory modalities evolve to relate to external reality precisely in the manner they do?

In his 2019 book, *The Case Against Reality:* Why Evolution Hid the Truth from Our Eyes, Hoffman attempts to answer the forgoing question by invoking the Quantum-Mind hypothesis. In my opinion, interpreting his findings in that way is a grave error. Hoffman’s solid research concerning the evolutionary emergence of indirect perception does not need to be tied to the entirely questionable and utterly unverifiable ideas of quantum consciousness. A simple straightforward exposition is called for. 3

3 The referenced explanation begins in section four below and continues through the end of the chapter. While a corresponding meta-mathematical analysis in support of the initial sensory connections being acausal is presented in sections One and Two of Chapter Eight.

**4. Meaningful Acausality and Synchronicity**

This analysis puts forth a plausible evolutionary explanation for the subjective feel of conscious experience; while at the same time providing accurate meta-information about the natural world from indirect environmental sources. It does so by drawing on modern research that lends credence to the radical ideas presented in the controversial monograph, “Synchronicity: An Acausal Connecting Principle,” published in 1952 by the noted Swiss psychiatrist Carl Gustav Jung (1887–1961).

Jung initially articulated his concept of synchronicity in the 1920s, but these attempts were rather vague. Jung tried to empirically describe the unpretentious notion that under “certain interesting conditions,” humans may assign particular kinds of significance to near-simultaneous occurrences that are not causally connected, i.e., between which physical links are “nonexistent” (Jung, 1960). For Jung, acausal but synchronous events provide confirmation of a new and substantial understanding between the individual and the wider reality. Through this type of relationship, all events—be they emotional, physical, mental, spiritual, or societal—may bear personal significance, i.e., feeling and meaning, for the individual.

Jung never fully developed these concepts. For this reason, his unsophisticated ideas pertaining to meaningful acausality and synchronicity were considered trivial by most scientists in the mid-20th century. Additionally, his insistence that acausality and synchronicity could explain such decidedly nonscientific topics as the interpretation of dreams, psychic phenomena, spirituality, and religious experience further eroded any possibility of support.

However, due to his previous collaboration with the theoretical physicist and Nobel prize recipient Wolfgang Pauli (1900–1958), Jung’s ideas were later re-expressed in more scientifically rigorous terms (Atmanspacher & Primas, 2009). Like Jung, Pauli was searching for a unifying set of principles that would connect external objective reality to our internal meaningful physiological representation of it. In private letters to his friends and colleagues, Pauli expressed his belief that the established physical laws, including the new science of quantum mechanics, lacked the capacity to explain how the electrochemical processes of life lead to the phenomenal sensations and meaningful experiences that, while in a conscious state, one derives from nature.

In a letter sent to Marcus Fierz on January 7, 1948, Pauli wrote:

It seems to me—however, it is thought, whether we speak of “the participation of things in ideas” or of “inherently real things”—that we must postulate a cosmic order of nature beyond our control to which both the outward material objects and the inward images are subject. The ordering and regulating must be placed beyond the difference between “physical” and “psychical.” (von Meyenn, 1993, pp. 496–497, emphasis in original)

Pauli felt that modern science as a whole had not advanced to the point where it could adequately account for conscious phenomenal experience. Nevertheless, Pauli did believe that Jung’s concepts of acausality and synchronicity offered the best possible explanation for the physical reality one perceives. Synchronicity, as coined by Jung (1960), is the occurrence of two or more events that are meaningfully related but not causally connected. Jung believed that these random happenings occur infrequently at the macro world level, but that when they do, they are imbued with meaning and pathos by human observers due to their near-simultaneous occurrence in time.

Pauli preferred the term, “meaningful coincidences” when speaking of synchronistic events. He believed that synchronicity and acausality may be thought of as complementary processes, i.e., as dual phenomena that may be considered as opposites but are necessary for the complete description of a third physical process. He suspected that Jung’s ideas of acausality and synchronicity, if properly interpreted, might provide an empirical framework relating to how humans go about constructing a meaningful sensory world from a repeated sampling of external probabilistic phenomena. However, in order to bring Pauli’s insight to fruition, it will be necessary to expand Jung’s original thesis.

Aligning Jung’s ideas more closely with Pauli’s interpretation of them, it is proposed that acausal genetic qualitative characterizations and anticipatory mini-predictions about how nature relates to conscious observer, come together to cumulatively impart feeling and meaning to the macro world. The research of von Helmholtz (1866, pp. 1–37) and Gregory (1968a, 1968b, 1970, 1980, 1981, and 1997) supports this line reasoning. Furthermore, and again unlike Jung’s original view, it is also conjectured that different variations of these minute presumptive events are in constant occurrence at the synaptic level of brain function.

*4.1 Higher-Order Sensations*

Although there is a vast array of theories on phenomenal awareness, the representational theories may loosely be categorized into two types: first-order and higher-order. First-order theories hold that the initial representation of physical stimuli is directly experienced. For example, according to these theories, the absorption of the electromagnetic energy of photons, or the impact force of a large number of air molecules crashing against our bodies, triggers the neural net responsible for the experience of heat. The science writer Rita Carter (2002) states that it is the activation of this network that provides us with the first-order representation of heat and is responsible for the sensations of warmth we … experience (pp. 32–33).

By contrast, philosopher David Rosenthal’s higher-order thought theories state that the first representation—the initial synchronous firing of neural networks that correlates with the physical stimulus—requires a subsequent representation, and therefore a subsequent second neural event or series of events, in order to endow the initial representation with a subjective feel or qualitative meaning.

According to Rosenthal’s higher-order theories, a second neural event is brought about by the first, and it pushes the initial neural representation into conscious awareness. It is this second neural event or series of events, rather than the first, that brings about the sensation of warmth we feel as the result of the initial neural response to the mass of highly energetic air molecules or photons striking our exposed skin (Carter, 2002, pp. 32–33).

Higher-order theories do not specifically stipulate that the second neural event or series of events be directly connected to the first. Therefore, Pauli’s ideas of complementarity, when applied to acausality and synchronicity in conjunction with Rosenthal’s higher-order thought theories of brain function, could explain our color-vision as follows. The initial neural event is the transduction of retinal impulses accomplished by the excitation and firing of rods and cones. This event is triggered by photons striking the retina and involves the stochastic electrical reproduction of electromagnetic energy levels and spatiotemporal light distribution patterns through discrete but repeated sampling.

The second neural event or series of events involves the consistent and efficient assignment and correlation of emergent predictive abstract qualities and characteristics to external reality; thus, causing the synchronous visual perceptions and color sensations we consciously experience. It is necessary for this modified interpretation of the concept of acausality that the two physiological processes be considered causally distinct from one another but meaningfully connected through a consistent sensory covariance that is near-simultaneous. (Note: For a compilation of David Rosenthal’s collected works see https://www.davidrosenthal.org)

**5. Evolving Eﬃcient and Consistent Sensory Simulations**

In his book *Mind, Matter, and Quantum Mechanics*, physicist Henry P. Stapp (1993) had this to say concerning Pauli’s ideas:

Pauli apparently believed . . . that the synchronistic aspects of nature identified by Jung were sufficiently striking to place them beyond the bound of explanation in terms of pure chance. This judgment, if correct, would mean that behind the processes . . . that we already know and understand there lies another, which acausally weaves meaning into the fabric of nature. (p. 180)

The unexplained process that Stapp alludes to is most certainly evolution, for mutation in natural selection is not—as Charles Darwin erroneously believed—entirely the result of pure chance. Genes actively affect behavior; they also, after an initial random mutation event, purposefully shape the direction of evolution. The notion that genes affect behavior was popularized by ethnologist and evolutionary biologist Richard Dawkins. In his book *The Selfish Gene,* Dawkins (1976) advances concepts first developed by W.D. Hamilton (1963, 1972) and by George C. Williams (1966). Their thesis is that genes actively bring about altruistic behaviors that are beneficial to an organism and in that way increase the likelihood of those selfsame genes being passed on to the next generation.

The idea that genes strongly influence the timing and emergent order of ensuing mutations, i.e., the notion that bottom-up genetic activity can be accurately described using advantageous directed algorithms, was first proposed by (Cairns, Overbaugh and Miller 1988). The same premise has received solid reinforcement from (Gillis, 1991). The most resent support comes from: Livnat, A. (2013) and Valiant, L. G. (1984, 1994, 2009 & 2006). In his book, *Probably Approximately Correct* (2013), Valiant develops this hypothesis mathematically. He uses concepts borrowed from the fields of machine learning and Bayesian inference to show how genes may generate predictive algorithms about how nature works, which in turn affect the course of evolution.



Figure 12.1 Bayes theorem, formulated by Rev. Thomas Bayes (1701–1761) describes the probability of an event’s occurrence based on prior knowledge of conditions that might relate to the event, such as frequency.

Figure 1. P(A) = Probability of event A occurring. P(B) = Probability of event B occurring. P(A|B) = Probability of event A occurring given evidence that event B has already occurred. P(B|A) = Probability of event B occurring given evidence that A has already occurred

Valiant modified Bayes theorem (Figure 1.) by adding extra terms to account for genetic drift and to correct for genetic noise. With this new mathematical formulation, he asserted that purposeful bottom-up genetic predictions, based on previously accumulated random genetic knowledge, advance evolution by regulating the timing and the order of emergence of subsequent mutations. In conjunction with the phenotypic changes, these directed mutations also induce other genes to modify existing behavior.

The alteration of behavior (Dawkins, 1976) is necessary in order to test the robustness of the original genetic algorithms’ presumptions about the structure and function of external reality. If the new physical adaptations and behavioral modifications are useful to the species, the genes that bring them about are passed on to future generations. Those future generations of genes then continue making small corrections to the original random mutations by further standardizing and approximating the established mutation process.

Since accurately representing every aspect of external existence would have been prohibitive to primordial organisms (Mark, Marion, and Hoffman 2010), and because fitness was more important than truth, nature prioritized utility as opposed to an exact depiction of external reality. Wrong genetic mutations concerning the structure and function of external existence normally led to fatal results and so were not passed on.

 However, on rare occasions, incorrect genetic algorithms regarding primitive organisms’ sensory interpretations of external stimuli turned out to be useful to the species, and so they were kept, standardized, and approximated by future generations. Relating to the evolution of the visual spectrum: Based on preexisting genetic knowledge consisting of a physical sensitivity to opposite light intensity levels ranging in brightness from black to white, genes nurtured the development of erroneous predictive algorithms dictating that complementary, i.e., opposite, colors, exist analogously. These directed mutations, though wrong, led to genetic morphological and behavioral changes. Some of these proved beneficial to the species, so they were kept, passed on, and extended; in Valiant’s terms, they were standardized, approximated, and synchronized with incoming stimuli by future generations of genes. See: Hamilton (1963, 1972), Williams (1966), W. D. Dawkins (1976), (Mark, Marion, and Hoffman 2010), and Valiant (1984, 1994, 2006, 2009, 2013) in support.

As with color, in the beginning our other sensations were not direct, or true, or even close qualitative characterizations, of the material properties of external stimuli. However, the meaningful meta-information concerning the structure and function of external existence, in relation to the observer, that later evolved to be covariantly in sync and consciously expressed by these hypothetical sensory modalities, turned out to be a good fit with the actions and events occurring in the perceived present.

In his “Lecture to the Foreign People” (1953), where Pauli comments on the entangled relationship between an observer and the system being observed, his insights concerning evolution perfectly align with this modern interpretation of sense perception as being some type or form of directed approximation of initial acausal genetic assumptions. In that text Pauli states:

According to this hypothesis, which differs from both the Darwinian and the Lamarckian conception, we encounter here a third type of laws of nature which consists in corrections to chance fluctuations due to meaningful or purposeful coincidences of causally unconnected events.4

4 October 30, 1953, letter 1667 in von Meyenn (1999), pp. 327–340. Quoted from: Lecture to the Foreign People. Translated from the original German by Atmanspacher, H., & Primas, H. In: Pauli’s ideas on mind and matter in the context of contemporary science. In the Journal of Consciousness Studies 13(3), p. 36 (2006). See also (Atmanspacher et al. 1995, p. 326).

*5.1 Mini-Prediction*

In support for the aforementioned ideas: In his seminal 1866 essay “Concerning the perceptions in general,” Hermann von Helmholtz proposed that external objective information is not processed directly by the brain; instead, it is indirectly composed of countless unconscious inferences. As a result of his research on the neurological basis for vision, von Helmholtz came to believe that, in response to the limited data transmitted to the brain by the eyes, the perceptual properties of objects must be inferred from stored knowledge accumulated through previous experiences. (Please review Chapter Four)

These concepts have more recently been elaborated on by Richard L. Gregory. In (Gregory, 1968a, 1968b, 1970, 1980, 1981 & 1997), he argues that perception is a cumulative assembly of many small predictions of how nature works. These mini-assumptions are linked to internal stochastic data; they infer small physical properties, in relation to the observer, that are consistently exhibited by external reality. In this, Gregory’s ideas also comparable to the hypotheses of the scientific method.

According to Gregory (1997):

Following von Helmholtz’s lead, we may say that knowledge is necessary for vision because retinal images are inherently ambiguous (for example for size, shape and distance of objects), and because many properties that are vital for behaviour cannot be signaled by the eyes, such as hardness and weight, hot or cold, edible or poisonous. For von Helmholtz, ambiguities are usually resolved, and non-visual object properties inferred, from knowledge by unconscious inductive inference from what is signalled and from knowledge of the objective world. It is a small step (Gregory l968 a, b, 1980) to say that perceptions are hypotheses, predicting unsensed characteristics of objects, and predicting in time, to compensate neural signaling delay (discovered by von Helmholtz in 1850), so “reaction time” is generally avoided, as the present is predicted from delayed signals. This has recently been investigated with elegant experiments by Nijhawan (1997). Further time prediction frees higher animals from the tyranny of control by reflexes, to allow intelligent behaviour into anticipated futures. (p. 1122)

**6. Time-lags and Emergent Sensory Projections**

Further reinforcement comes by way of the paper, “Production of Threshold Levels of Conscious Sensation by Electrical Stimulation of Human Somatosensory Cortex” (1964, pp. 546–578). In this investigation Benjamin Libet and colleagues demonstrate that it takes between one-eighth and one-half of a second for the brain to completely process different perceptual stimuli and bring the accompanying sensations to conscious awareness. Later experiments establish that the brain coordinates distinct sensory time-lags and subconsciously “edits” them out of experience, making it seem as if we are simultaneously experiencing and consciously reacting to whatever is going on around us as if it is happening all at once in the present moment.

We tend to lose sight of the fact that direct perceptual information should not be experienced consciously in the perceived present until after it has been processed subconsciously, and that this direct processing takes time. Humans should not be able to perceive and react to an external stimulus more quickly than our nerve cells can categorize, hierarchically organize, and abstractly renormalize the different stimuli involved. But we do.

For example, it takes about one-tenth of a second for visual information to be brought to conscious awareness in humans. (De Valois & De Valois, 1991; Lennie, 1981; Manusell & Gibson, 1992; Schmolesky et al., 1998). Not only is the processing of visual information fast; it is also one-tenth of a second faster than the direct processing speed that would be required to perceive, in the present moment, the exact position of fast-moving objects (Changizi, (2009, p. 118).

The inability to accurately gauge the position of dangerous, fast-moving objects, or a delay of one-eighth to one-half second before meaningful conscious action can take place, would be a catastrophically maladaptive trait in any motile organism. Fortunately, evolution has overcome these two perceptual problems with a single, elegant solution. While it is not physically possible to move faster than the speed at which nerve cells transport, order, and hierarchically renormalize stochastic information, it is possible to circumvent the sensory time-lags that direct perceptual processing creates by initiating various mental, physical, and emotional reactions in advance.

*6.1 Anticipatory Heuristics*

In the brutal struggle for existence, any animal’s chances of survival would be greatly increased provided that it could weigh the positive or negative aspects of any developing situation, before that situation actually takes place. Anticipatory prediction does not eliminate the time-lags that necessitate having to wait one-eighth to one-half second before taking meaningful conscious action; instead, they become part the physiological process that enables an organism to quickly react, as projected events simultaneously unfold in the present moment. Consequently, it is proposed that, over the last several millennia, this ability has evolved to become an integral part of the physiological processes by which cognitive organisms produce meaningful phenomenal experiences from a repeated sampling of external stimuli, and it has come in the form of subconscious preemptive prediction.

From a regular reoccurring sampling of external stimuli, our sense organs generate corresponding stochastic information. It is proposed that the brain coordinates the statistical data with a series of hierarchal gamelike models of reality and their emergent mini-predictions of how nature relates to a conscious observer. These small assumptions are grouped together in accordance with pre-established rules derived from experience. As related predictive data sets are collected and combined, time-lags enable subconscious updates to be made and validated against subsequent incoming stochastic information.

The revisions are used to refine and further enlarge the original sensory predictions. These take the form of feed-forward heuristic vetting cycles which confirm that the more enhanced cognitive brain states, representing the larger projections, match the actions and events unfolding in external reality. The cycles have been assumed to take place every 30 to 70 milliseconds (Franck & Atmanspacher, 2009). Within these update cycles, both positive and negative feedback are vital to the end result. Negative feedback inhibits the propagation of incorrect mini-inferences, while positive feedback promotes the most accurate weighted assumptions, refining the system for future conscious implementation.

The synchronous macro simulations that result are higher-order heuristic constructs, “… whose goal is to provide efficient summaries of the [underlying] complexity ….” They “… simplify the description of the physical world significantly” (Manzotti & Owcarz, 2020 pp. 61 – 72). And by that means, greatly speed-up organic information processing. 5

5 An interesting adjunct to this investigation is that Hoffman’s “conscious agents” and Gigerenzer’s heuristics may know be understood as similar explanations for the same physiological process (e.g., Gigerenzer, 2000, 2004, 2007).



Figure 12.2 denotes a sensory percept comprised of hierarchically interconnected mini-assumptions emerging within a simplified gamelike model of reality. The model abstractly depicts three invariant macro properties of external existence: space/time, matter, and motion; all three abstract representations are entangled in holistic relation to the observer’s causal/objective, i.e., goal or intentionality, and feedback. Each mini-prediction maybe considered as being generated within a contextual subroutine of associated neurons.

Originating from a point in the recent past and based on the statistically weighted accumulation of multiple, updated vetting cycles (Franck & Atmanspacher, 2009, p. 215) (cf. Fetsch, Pouget, DeAngelis, & Angelaki, 2012) these large-scale emergent sensory qualia are timed so as to be consciously experienced as in synch with the events occurring in the temporal present. For this reason, the entire process can be described as “retro-prediction.” Although the resulting putative sensations are not direct, or true, or even close approximations of the material essences of incoming stimuli, they covariantly model the structure and function of overt reality in relation to the observer, and by that means simulate the outside world in conscious experience.

*6.2 More Empirical Evidence*

The three ideas developed here are: (1) Phenomenal sensations genetically evolved from hypothetical spatiotemporal characterizations of nature, acausally correlated with different external stimuli. (2) Our perceptions are meaningfully expressed via these abstract sensory modalities, and they consist of emergent anticipatory mini-predictions and larger heuristic-assumptions which depict more substantial correlations between external reality in relation to the conscious observer. (3) Both mini-predictions and the larger heuristics are learned and approximated through ongoing environmental, cultural, and familial interactions and are not based on the physical properties of the initiating stimulus.

There is abundant evidence for the third proposition, starting with the rods and cones of the retina found at the back of our eyes. Where the optic nerve connects to the eyeball, there are no photoreceptors. So, we ought to perceive a blind spot near the middle of our visual field; but of course, we do not. The question is, why? The standard answer is that the brain “fills in” the missing image using previously memorized macro sensory information supplied by the other eye, as incoming perceptual data from both eyes are merged into one complete image in the V5 area of the visual cortex. The blind spot of the right eye is covered by incoming visual information from the left eye and vice versa. But this explanation is in need of some adjustment. (Shimojo & Nakayama, 1990, pp. 69–80) point out that if a person completely covers one eye, they still perceive no blind spot in their visual field, even when looking at completely new, never-before-seen pictures.

This experiment rules out the possibility that the missing macro information is supplied from memory or from the other eye. And yet in every case, the participants were not aware of any blind spots. Their brains simply filled in the missing visual data with regard to color, perspective, and the occlusion of objects by other objects.

This is explained if we assume that perceptual processes always employ an immense number of small stochastic correlated mini-predictions; in turn, these come together to generate slightly larger heuristic descriptions of how nature relates to a conscious observer. Based on a limited amount of incoming visual data and the previously learned statistical regularity of external reality, the brain cobbles together a picture of what is likely to be taking place in the areas of the visual field hidden within the blind spot created by the optic nerve. It does this by using copious mini-assumptions embedded within hierarchically-linked gamelike models of reality and our immediate relation to it.

*6.3 The flash-lag Effect*

Another source of evidence that synchronous feed-forward retro-prediction is a major component of our conscious sensory experiences is provided by Romi Nijhawan. In his original “flash lag effect” experiment (Nijhawan, 1994), a stationary light was flashed just as a moving ball passed in front of the light-emitting mechanism. Volunteers observing the event uniformly report that the ball appears to be ahead of the flash; in other words, the flash seems to inexplicably lag behind the moving ball. Since its initial discovery, variations of the original flash-lag effect have also been observed to occur in audition and other sensory modalities (See: Alais, D., & Burr, D. 2003).

Writing about the results of this now-classic experiment, Changizi (2009) states that,

To perceive the present, we must be able to perceive (at time t) the true position (at time t) of the moving ball. The moving ball is predictable, and the brain can predict where the ball will be in a tenth of a second. The flash, however, is unpredictable, and so our perception of it occurs a tenth of a second after it happens. But in that amount of time the moving ball has moved past the flash. This means that, by the time you perceive the flash the moving ball is past the flash. (p. 118)

Cognitive scientist Steven Grand writes that primary perception is more top-down than bottom-up; that we generate sophisticated extrapolations about what we will experience in the immediate future, and use bottom-up sensory signals to fill any gaps in our predictions, that confirm, deny, merge or otherwise affect those extrapolations (S. Grand, personal communication, April 3, 2006).

Grand points out that most feed-forward signals enter the primary sensory cortex from higher areas within the cortex itself, rather than from the sense organs. In particular, primary sensory cortex regions receive signals from the cerebellum, the upper portion of the brain stem (known as superior colliculus), and the lateral geniculate nuclei (LGN) of the thalamus.

What this means is that indirect bottom-up signaling initiates the emergence of top-down predictive schemata that flesh out our conscious perceptual experiences. In a sense, Grand argues, primary perception is more top-down than abstract thought, such as language and mathematics, because every layer of the processing hierarchy is invoked in order to generate the sensory macro hypothesis that we experience as phenomenal awareness.

The most stunning aspect concerning the predictive abstraction of the senses is its accuracy. Though there are exceptions, the abstract sensory simulations generated by human perceptual systems seem to be perfectly in synch with the spatiotemporal actions and events unfolding in the temporal present. The amount of data processing required to produce this level of simultaneous accuracy is staggering, as are the depth and breadth of the interconnected mosaic-like mini-assumptions involved. The complementary aspects of this explanation give it a quantumlike character, but one need not call upon the collapse of wave function to invoke it (e.g., Hamerhoff & Penrose, 1996a & 1996b) and (Hoffman, 2019).

**7. The Problem at Heart of the Hard Problem**

From (Jung, 1952), (Jung & Pauli, 1955), Gregory (1968a, 1968b, 1970, 1980, 1981), Valiant (2013, 2009, 2006, 1994, 1984), and from von Helmholtz (1866, pp. 1–37) one may infer that acausal genetic characterizations of external stimuli and prior physiological experiences, with consistent external processes, are a prerequisite for the chaotic emergence of meaningful sensations and perceptions. The macro-world is learnable and comes with immutable spatiotemporal properties, an infinite number of recognizable patterns, and foreseeable cause-and-effect relations that are repeated over and over. Humans isomorphically map those invariant physical properties, to our internal gamelike mental models of reality; while the repeating patterns, regular cause-and-effect relations and our physical and emotive reactions, develop as higher-order anticipatory schemata within these models.

Most consciousness researchers strongly adhere to the idea that consistent and efficient correlation requires strict causality. As evidenced by the following quotation and short analysis, this belief in direct causation of phenomenal experience is deeply ingrained in the minds of most mainstream scientists and cognitive philosophers:

In Kant’s philosophy . . . the causal law is not an empirical assertion which can be proved or disproved by experience, but the very basis of all experience––it is part of the categories of understanding Kant calls “a priori.” The sense impressions by which we grasp the world would be nothing but subjective sensations, with no objective correlates, if there were not a rule by which certain impressions must follow from certain preceding ones. This rule, i.e., the existence of a strict relationship between cause and effect, must be presupposed if we wish to objectify our observations, if, indeed, we wish to assert that we have experienced any thing or process. (G. Herman, quoted in W. Heisenberg, 1971, p. 118)

The ensuing analysis encapsulates the hard problem of phenomenal awareness with respect to our dutiful acceptance in direct causation of color generation, specifically the color red.

Under normal circumstances, light with a frequency interval between 430 and 480 THz always results in our perception of red color. We may not know the exact causal chain that gives rise to this effect, but prior experience with reality leads us to believe that consistent and efficient correlation necessitates objective causality. So, we assume that the physical properties of the incoming light stimulus must directly bring about our perception of redness. And so long as one adheres to the conventional notion that consistent and efficient sensory correlation requires strict causality, the “Hard Problem”—how material brains generate conscious experience—is “hard,” not because it is a difficult problem for reductionist science to answer, but because it is undecidable within the specified cognitive framework erected to understand it. Nonetheless, if one acknowledges that consistent and efficient correlation implies causality but may not require it in all cases, then one has taken a significant first step toward understanding the true nature of phenomenal experience.

*7.1 Utility vs. Truth*

The idea that phenomenal experiences do not have to be true or even close representations of external stimuli, but simply useful, has a long and varied history within developmental psychology and quantum physics. The American philosopher and psychologist William James (1842–1910) was among the first to develop these ideas in two books: initially in his 1907 book, *Pragmatism:* A New Name for Some Old Ways of Thinking, and then in his 1909 book, *The Meaning of Truth:* A Sequel to “Pragmatism.” According to Henry P. Stapp (1993):

James argued at length [in The Meaning of Truth, pp. 217, 239] for a certain conception of what it means for an idea to be true. This conception was, in brief, that an idea is true if it works. (p. 58)

Stapp (1993) continued:

The only evidence we have on the question as to whether human ideas can be brought into exact correspondence with the essences of external realities, is the success of our ideas in bringing order to our physical experience. Yet the success of ideas in this sphere does not ensure the exact correspondence of our ideas to external reality.

Inasmuch as it is proposed that our conscious sensations and perceptions are highest-level higher-order abstractions, and that these abstractions may be thought of as being meaningful ideas in their own right, then the arguments of Jung and Stapp should also apply to them. With respect to the Hard Problem: because nature prioritized utility over truth, and despite their great success at providing useful information pertaining to the non-sensory world we inhabit, our sensory modalities never evolved to provide a direct and exact causal-representation of external existence.

 Irrespective of that fact, the vast majority of people in the world believe in direct causation of sensory experience. This view has everything to do with the synchronicity and covariance that evolved between external stimuli and our sensory apparatus, and relatively little to do with the actual physiology involved. What is being experienced is a higher-order simulation of reality and not reality its self. A deeper understanding of our evolved inexact perceptions of different colors provides strong support for the idea that the sensations we experience, are in fact, a conscious simulation.

*7.2 Light Stimuli and Color Qualia*

According to Steven Grand:

Most, but not all, humans evolved three kinds of cone cells in our retina, The three cone cells reacts to a wide range of frequencies, but each response peaks at a specific frequency. One reacts best to longer wavelengths, one to middling wavelengths, and one to shorter wavelengths. By convention, we call R (long), G (medium) and B (short) receptors. R stands for red, G for green and B for blue, but do not be misled by this! Light is never red, green or blue.

The colors we see are determined by the ratio of the responses of all three receptors. If we shine monochromatic long-wave light at the eye, all three types of cones will fire, but the R cones will fire a lot and the G and B cones will fire less often.

The brain measures the ratio, i.e., the differences between all three firing rates, and we see red. Exactly how the brain measures this ratio is complex and would add unnecessary confusion to my description. But the key point is simply that the brain compares these three signals, and so it is not direct causation. (Grand, personal communication, December 15, 2021)

Grand states that,

We can utilize a monochromatic light source that is shorter than the longest wavelength we can see, but longer than the medium wavelength. We’ll call it Y, for yellow. If we shine Y light at the retina, the R cones will respond a lot, although not as much as they do to longer wavelengths. And the G cones will react a lot, but not as much as they do to middle wavelengths. Because the R and G cones are responding about equally and the B cones are not reacting very much, we see this as yellow.

But there is a completely different way to produce the sensation of yellow. One that does not require any Y light at all. If we shine polychromatic light at the retina that contains two pure wavelength – long and medium – we do not see a mixture of redness and greenness; we see yellow (e.g., Schrödinger, 1967, pp. 154 – 164).

This is because the ratio of responses is very similar in both cases: the R and G cones will both react about equally and the B cones will respond less often than both. In the first case they respond equally because their peak response wavelengths are about equidistant from that of the actual monochromatic yellow light they are receiving. In the second case, they are both detecting light they are perfectly tuned to – the R cones react strongly to the long wavelength light, and the G cones respond strongly to the medium wavelength light. Since in both cases these two cones are reacting equally, we see the same color both times. And once again we do not have a direct physical response or actual frequency covariance. (Grand, personal communication, December 15, 2021)

Grand goes on to say that,

It could reasonably be argued that the responses are covariant in the aggregate, since the average of the two wavelengths used in the first example is roughly the same as the single pure wavelength in the second. But, that’s not always the case. And we definitely have two very different physical stimuli that are producing exactly the same qualia.

As you know, the so-called ‘primary’ colors (for light, as opposed to pigments) are red, green and blue. They are primary explicitly because (most humans) have three types of cone cells, and for each of these wavelengths one type of cone will show its peak response.

As previously mentioned, in yellow, the R and G cones respond equally strongly, and the B cones do so weakly. If instead we cause the G and B cones to respond equally strongly and R hardly at all, we get another secondary color, called cyan. Again, there are two completely different ways to make us experience the sensation of cyan quale: we can shine monochromatic light whose wavelength is somewhere between green and blue. Or, we can shine polychromatic light that contains both green and blue together.

Again, it is fair to say that the average of the two wavelengths in the second case matches the pure wavelength in the first case. But again, we have two completely different physical phenomena resulting in exactly the same qualia. It’s not correct it to say that color perception is exactly covariant with wavelength. (Grand, personal communication, December 15, 2021)

Grand then explains,

If red, green and blue are the primary colors, and yellow and cyan are secondary, what is the third secondary color? Well, yellow can be produced by mixing red and green and hence stimulating R and G cones equally, while cyan can be produced by mixing green and blue and hence stimulating G and B cones equally. So, there must be a color we perceive when we mix red and blue, and hence stimulate R and B cones equally.

That color is experienced as magenta. Yellow, cyan and magenta are the three secondary colors. We all know what magenta looks like – it is kind of purply. And we know how to make it using a mixture of two pure wavelengths – red and blue. Since red is long and blue is short, the average of the two will be medium. Yet pure medium-wavelength light looks green.

There is no monochromatic wavelength of light that represents magenta. We can only get magenta by combining red/long with blue/short wavelengths. The average of the two is a medium wavelength, but that does not look a bit like magenta – it is perceived as green. So, it is very often not true that our perception of color co-varies with wavelength, and it is not even always true that our perception of color co-varies with the average wavelength of polychromatic light.

The logic of color perception has everything to do with the fact that we have three types of cone cells, and nothing directly to do with energy or even wavelength. It is just an indirect photochemical fact relating to the proteins that make up different kinds of cone cell. It is just not true that color is directly covariant with a physical quantity. (Grand, personal communication, December 15, 2021)

Grand’s closing comments,

Your general idea that qualia are genetically driven by evolution, for ecological fitness reasons, is definitely correct. Some animals find it really important to be able to differentiate ultra-violet from violet, while others need to differentiate infra-red from red. We in our turn used to have a strong need to differentiate between red (fruit), green (leaves) and blue (sky). If that is what a species needs, then that is what evolution gives them. Perception is consciously experienced as being covariant with reality, but in actuality it is not. At least not in a numerical sense, and in the case of light that is the only sense there is – light is not colored; it differs only in frequency and intensity. Color qualia are also influenced by intensity, but again not in a proportional way – yellow and brown look different to us but they are exactly the same in wavelength terms and vary only in intensity. (Grand, personal communication, December 15, 2021)

**8. Conclusions**

(1) Apart from a few exceptions, qualia evolved to be useful and consistent highest-level higher-order characterizations of nature acausally coordinated with in-coming stimuli. (2) Perceptions are meaningfully expressed via these non-representational phenomenal modalities, and they consist of anticipatory mini-assumptions dealing with the structure and function of external reality in immediate relation to the observer. Sensory mini-predictions combine to form larger heuristics. (3) All mini-predictions and heuristics are learned and approximated through ongoing environmental, cultural, and familial interactions, as a consequence of individual trial and error, and are not based on the physical properties of the initiating stimulus. And (4) The covariance and synchronicity exhibited by our conscious simulations of reality are due to evolution and learned behavior and are not the result of direct causality. Viewed in this way, our five perceptual modalities may be considered as distinct sensory languages for the of higher-order expression of heuristic assumptions correlating to the structure and function of external existence in immediate relation to the conscious observer.

Additional support for all four proposals comes from a form of synesthesia in which some adults see black letters and numbers in color. Hubbard, Arman, Ramachandran, and Boynton (2005, pp. 975-985) established that this type of synesthesia does not result from a genetic mutation, and that adults with this condition really do see black letters and numbers in color.

The research confirms that these individuals utilize color to aid in identifying the shapes, position, and spatial orientation of specific symbols. The same group determined that this perceptual cross-wiring between geometric shapes and colors occurs at two to three months of age, when very young children begin making inferences about their immediate environment.

The study suggests that a majority of children eventually bring their varied letter/color and number/color assumptions in-line with external reality, by coming to the approximate understanding that letters and numbers are predominantly represented as black symbols on a white background. However, a few individuals never modify their original assessments. So, for those children, sometime between ten or twelve years of age, their incorrect inferred letter/color and number/color permutations become fixed, but may differ from person to person, depending on their particular trial-and-error perceptual experiences.

My overall thesis supports Hofstadter, French, and Chalmers’ position that “low-level perceptual processes are inseparable from high-level cognition” (Hofstadter, 1995, pp. 170–171). This is because the sensory qualia that enable us to generate a precise internal awareness of the shape, position, geometric orientation, and motion of external objects are useful, abstractions in their own right. And secondly, because the linked holistic cell-assemblies that cumulatively generate meaningful phenomenal experience are continually being created, sharpened, and focused through a process of ever-more complex experiences.

New experiences lead to very small physiological refinements in our genetic mental models of reality, which chaotically lead to more complex and precise abstract assumptions of the spatiotemporal properties and cause-and-effect relations between objects in space and time. Furthermore, this overall study substantiates and expands upon many of the ideas first expressed in the book, Where Mathematics Comes From (2000), by George Lakoff and Rafael Núñez.

Starting from broad indirect hypothetical characterizations of nature, this two-way process of meaningful knowledge acquisition, standardization, approximation and synchronization continued to evolve, increasing in complexity and resulting in the physiological generation of new, more accurate, higher-order anticipatory models of reality.

First, this process produced our embodied sensory abstractions along with emotion, feeling, and meaning; then language and logic, and ultimately culminating in the previously discussed interplay between mathematical physics and the cosmos itself. Humanity’s five classical senses all initially evolved in a somewhat similar manner. A clear awareness of the acausal but beneficial origins of the sensory qualities is paramount, along with a thorough understanding of how they were incrementally and systematically applied to the physical world, so as to achieve such a close perceptual correspondence.

Such an evolutionary awareness allows us to understand that the apparent richness of sensory detail emanating from external existence is abstract and largely illusory, and that our sensual modalities of color-vision, hearing, touch, taste, and smell do not need to be, in themselves, direct and true or near approximations of the essences of objects, so long as they efficiently provide useful meta-information concerning external reality, which then leads to behaviors that are advantageous to the survival of the species.

The ideas and sentiments expressed by Dobzhansky (1973, pp. 125–129) in his essay entitled, “Nothing in biology makes sense except in the light of evolution,” are also applicable to this analysis of sensory evolution. This is so because, at first glance, it seems improbable that acausal genetic predictive algorithms can give rise to conscious sensations and perceptions that do not directly represent any definitive material qualities of objects.

And yet—based solely on the evolved synchronous covariance between stochastic spatiotemporal energy distribution patterns and the higher-order abstract spatio-temporal/causal-objective sensations that they elicit, they still yield useful meta-information relating to the non-sensory world we inhabit. As improbable as it may seem, that is precisely what is being proposed.

Pertaining to our sensations and perceptions, this dissertation modifies, but still endorses, the original acausal nature of feeling and meaning initially sketched out by Jung. Moreover, when coupled with other empirical research indicating that all our sensory systems incrementally evolved indirect but efficient and consistent modes of synchronous prediction, the resulting synthesis may turn out to be the proper starting point for a coherent theory of phenomenal experience, along the lines Pauli may have envisioned.

Although modern science has not advanced to the point where it can empirically describe the physiological generation of qualia, according to Steven Grand, “there is no doubt that color is a percept created by the brain and not a fact about nature” (personal communication, October 26, 2010). Moreover, it is also clear that the consistent and efficient synchronous application of acausal chromatic correlations to external existence enabled primitive organisms to respond more appropriately to the vagaries of the natural world. By that means, acausality and synchronicity had favorable evolutionary consequences for the survival of species; in other words, increased their fitness level.

The idea that distinctly separate events, connected only by their close proximity in time, can be used to meaningfully model external reality in internal conscious experience, is mirrored in the profound words of Wolfgang Pauli:

To us the only acceptable point of view appears to be the one that recognizes both sides of reality—the quantitative and the qualitative, the physical and the psychical—as compatible with each other, and can embrace them simultaneously. It would be most satisfactory of all if physics and psyche (i.e., matter and mind) could be seen as complementary aspects of the same reality.

—Wolfgang Pauli, 1900–1958 6

6 Pauli and Jung (1955, pp. 208, 210).