

Dirac Quantum Bra-Ket Notation in Experimental Mathematics: Observer-Operators in the 4-Stage Cycle of Creative Consciousness & Cognition

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Abstract

We review of Dirac's transformational equation set from early quantum dynamics to the classical calculus of variations. We then apply Dirac's bra-ket notation for an experimental mathematical conceptualization of activity-dependent gene expression, brain plasticity, behavior, consciousness, cognition and dreaming in the modern evolution of psychotherapy. We introduce observer-operators into quantum physics, biology and the 4-stage creative cycle of psychology to illustrate how the quantum qualia of these observer-operators are evident in everyday human consciousness and cognition during a wide range of experiences ranging from negative stress and psychopathology to positive life transformations that can be measured and facilitated with our quantum stress to creativity psychotherapeutic protocol can be applied to groups as well as individuals. Innovative quantum field theory research on how the quantum qualia of the human observer/operator in subjective experience can be a causal agent in facilitating health and problem solving on the objective molecular/genomic level now need to be replicated and extended to replicate these new approaches to psychological health and well-being.

Introduction

We propose an integrated quantum field theory (QFT) of physics, biology and psychology in new applications of experimental mathematics for optimizing health and wellness in the current evolution of psychotherapy. Our unified quantum field theory brings together a variety of interdisciplinary fields ranging from stress reduction, psychosomatics, psychoneuroimmunology, meditation and mind-body medicine to the psychobiology of optimizing human performance, problem solving and creativity. Paul Dirac's transformational equation set from early quantum dynamics to the classical calculus of variations is utilized as an experimental mathematical bridge in Box 1 to illustrate how the quantum qualia of human experience during activity-dependent gene expression, brain plasticity and new consciousness may be conceptualized. This new application of Dirac's [1] original quantum formulations [2, 3] is consistent with Penrose (2004), Wilczek [4, 5] and Carroll's [5] insights into "The essence of the Core Theory – the laws of physics underlying everyday life – expressed in a single mathematical equation." We propose how the highly sensitive quantum qualia of problematic dissociations during Stage 2 of the 4-Stage Creative Cycle are source of quantum level conflicts between Real and Grassmann numbers that can lead to war, discord, inappropriate competition, hate crimes, terrorism and other stress related psychosocial pathologies that can be resolved in Stages 3 and 4 of therapeutic consciousness and cognition. Quantum Bayesian concepts of the novel observer/operator have insightful applications in counseling, psychotherapy, translational medicine and virtually all the mind/body therapies. We conclude with clinical case illustrations of how innovative psychological quantum field theory applications of Dirac's Bra-Ket experimental mathematical notation of how the quantum qualia of the human observer/operator in subjective experience can be a causal agent in facilitating problem solving on the objective molecular/genomic level.

Box 1: Dirac's Transformational Equation Set from Quantum to Classical Calculus: The Quantum Qualia of Brain Plasticity, Behavior, Consciousness and Cognition

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We carefully follow Dirac's own concise mathematical reasoning [20] in this review. Dirac begins with the idea of Schrödinger's wave function in 3-dimensional space. The wave function is designated as ψ , a function of the three coordinates x_1, x_2, x_3 that can vary with time:

$$\psi(x_1, x_2, x_3; t) \quad (1)$$

Dirac notes that the usual interpretation of this wave function when normalized is that the square of its modulus $|\psi|^2$ providing the probability of the particle being localized in a particular place. This wave function ψ is a complex number so it can be multiplied it by its phase factor $e^{i\gamma}$, where γ is a real number and $e^{i\gamma}$ has a modulus of unity. Dirac then multiplies ψ by $e^{i\gamma}$ to get another wave function designated as Ψ :

$$e^{i\gamma}\psi \equiv \Psi \quad (2)$$

Which now has its modulus squared just as ψ :

$$|\Psi|^2 = |\psi|^2 \quad (3)$$

This allows Ψ and ψ to have the same probability distribution. Dirac then notes that γ in equation (2) could be a function of position as well as time so that the new Ψ has the same probability distribution as ψ in equation (4):

$$\Psi(x_1, x_2, x_3; t) = e^{i\gamma(x_1, x_2, x_3; t)} \psi(x_1, x_2, x_3; t) \quad (4)$$

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However, the new Ψ and the original ψ do not satisfy the same wave equation! This becomes evident when Dirac forms $\partial \Psi / \partial x_r$ with r taking on the values of 1, 2 or 3 so that he obtains equation 5:

$$\partial \Psi / \partial x_r = e^{i\gamma} (\partial / \partial x_r + iK_r) \psi \quad (5)$$

Where K_r is a function of position in equation 6:

$$K_r \equiv \partial \gamma / \partial x_r. \quad (6)$$

Dirac then states We would have to consider K_r as something more general, something such that when we take $K_r dx_r$ and integrate around a closed loop, the result need not be zero:

$$\oint K_r dx_r \text{ need not be equal to } 0. \quad (7)$$

Dirac then concludes If we do that, we get a physical theory which is definitely more general than what we had before. We now interpret Dirac's comment that the contour integration of equation 7 need not be equal to 0 has profoundly new implications for integrating current day scientific perspectives of physicists, biologists, neuroscientists and psychologists. This integration illustrates how new awareness could arise from a cycle of activity-dependent gene expression brain plasticity and emergent quantum qualia of consciousness and cognition [2, 3, 6-8].

Integrating Subjective Quantum Qualia of Mind with Objective Molecular/Genomic Dynamics

Why have many cultures developed practices of rest, relaxation and the inner focusing of attention typical of therapeutic meditation and hypnosis to facilitate health and well-being? Recent research on sleep has uncovered a surprising yet sensible answer to this question. Sleep clears the mind by permitting 60% more cerebral spinal fluid to wash through the brain to remove the toxic byproducts of normal molecular metabolism [9]. This unexpected finding integrates what we now believe we know about associations between the quantum qualia of the subjective experiences of mind and the objective molecular/genomic dynamics of consciousness and cognition, as well as their utilization in the holistic healing arts such as meditation, mindfulness and therapeutic hypnosis. Controversial concepts originally formulated in quantum physics [1, 10], biology [11-13] and psychology [14-16] over the last century are reviewed and utilized for developing a new mind/body concept of the observer/operator to optimize self-care and health via psychosocial and epigenomic RNA/DNA molecular mechanisms. We propose and illustrate a new quantum Bayesian mathematical notation for conceptualizing a causal role for consciousness and cognition in the theory, research and practice of psychotherapy on many levels from mind to genes.

In a clear and concise paper the physicist Hans von Baeyer [17] recently outlined a new Bayesian interpretation of quantum information, which we now apply to brain research on consciousness, cognition [18] and behavior [19, 16].

A new version of quantum theory sweeps away the bizarre paradoxes of the microscopic world. The cost? Quantum information exists only in your imagination. In 2001 a team of researchers began to develop a model that either eliminates the quantum paradoxes or puts them in a less troubling form. The model, known as Quantum Bayesianism, or QBism for short, re-imagines the entity that lies at the heart of quantum weirdness—the wave function.

In the conventional view of quantum theory, an object such as an electron is represented by its wave function, a mathematical expression that describes the object's properties. If you want to predict how the electron will behave, you calculate how its' wave function evolves in time. The result of the calculation gives you the probability that the electron will have a certain property (like being in one place and not another). But problems arise when physicists assume that a wave function is real.

QBism, which combines quantum theory with probability theory, maintains that the wave function has no objective reality. Instead QBism portrays the wave function as a user's manual, a mathematical tool that an observer uses to make wiser decisions about the surrounding world—the quantum world. Specifically, the observer employs the wave function to assign his or her personal belief that a quantum system will have a specific property, realizing that the individual's own choices and actions affect the system in an inherently uncertain way.

Another observer, using a wave function that describes the world as the person sees it, may come to a completely different conclusion about the same quantum system. One system—one event—can have as many different wave functions as there are observers. After observers have communicated with one another and modified their private wave functions to account for the newly acquired knowledge, a coherent worldview emerges. By interpreting the wave function as a subjective belief and subject to revision by the rules of Bayesian statistics, the mysterious paradoxes of quantum mechanics vanish...

Bayesian probability, named after 18th century English clergyman, Thomas Bayes, deals with subjective probability—the degree of belief that an event will occur. This is in striking contrast with the statistics most of us are taught today, which is about objective probability—based on counting how frequently something occurs in the outside world. It is now striking to realize how Bayesian or subjective probability—the degree of belief that an event will occur—is very similar to the emerging concepts of psychosocial genomics and expectancy in therapeutic consciousness (meditation, counseling, psychotherapy expectancy theory in therapeutic hypnosis) which is also concerned with subjective belief.

These realizations motivate us to propose and illustrate how quantum field theory could optimize the quantum Bayesian dynamics of expectancy in most schools of therapeutic consciousness and psychotherapy ([20-23], [24]). We begin by outlining a new quantum Bayesian version of the quantum RNA/DNA field theory of life and consciousness ([19, 25, 15, 16], [2, 3, 6, 7]).

The Quantum Field Theory (QFT) of the RNA/DNA Dynamics of Life and Consciousness

Our proposal for a very broad functional definition of the role of genes in the complex adaptive systems of life [26, 27] is now applied to the quantum field theory of therapeutic consciousness, cognition, behavior, psychology and health in general in Figure 1.

We have documented how the fundamental systems of life and consciousness are characterized by the wave nature of circadian (daily) and ultradian (hourly) rhythms on all levels from the mind to genes [28, 29]. We now outline how neuroscience research illustrated in Figure 1 underpins a general quantum field theory of consciousness, cognition and creativity ([30, 19], [2, 3, 6]).

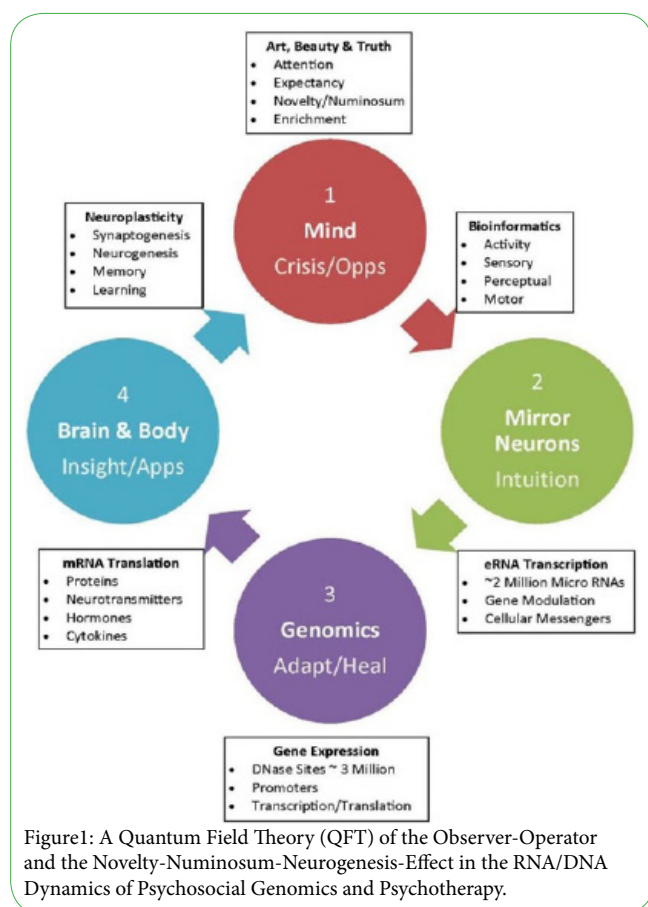


Figure 1: A Quantum Field Theory (QFT) of the Observer-Operator and the Novelty-Numinosum-Neurogenesis-Effect in the RNA/DNA Dynamics of Psychosocial Genomics and Psychotherapy.

The Classical Mind/Gene Communication Cycle of Molecular Biology

The top circle of Figure 1 updates the classical research of psychology with the most recent consciousness studies of art, beauty, truth in the coming age of quantum biology [13]. We now propose how research on the qualia of Novelty-Numinosum-Neurogenesis-Expectancy Effect (NNNE) operates on the quantum level of molecules that makes life possible [19, 31]. The subjective experience of Novelty evokes highly motivating experiences of the Numinosum (fascination, mysteriousness, and tremendousness [32]) that turn on gene expression and the growth of the brain that gives rise to a new level of consciousness and cognition [30, 20-23, 33-36, 19, 37, 38, 25, 39 15, 16]. Research by the ENCODE project integrated activity and experience-dependent gene expression and brain plasticity. Key research is now exploring complex adaptive systems of information transduction in the transcription process arising from ~2 million eRNAs carrying signals from the physical environment and psychosocial milieu (termed epigenomics) to genes bearing ~3 million docking sites recently summarized by the ENCODE Consortium [40].

Current research documents the use of DNA microarray technology to measure the expression levels of many thousands of genes simultaneously [41]. This evidence-based research in molecular biology has become a new standard in for validating personalized medicine. We now propose that this DNA microarray research also can be used to assess the psychosocial genomic validity and reliability of many diverse cultural, historical and holistic traditions of mind-body healing.

The primary research literature of psychosocial genomics today brings together a variety of top-down psychotherapeutic processes. They include the relaxation response [42], therapeutic hypnosis [43-46, 16, 3], meditation [47], the therapeutic placebo [48], social psychology [49-53], and yoga [53]. The motivation all psychosocial genomic research to facilitate the resolution of stress related dysfunctions [54, 55]. We mentored the use of DNA microarrays, for example, to explore the hypothesis that such top-down therapeutic protocols, epitomized by The Psychosocial Genomic Healing Experience (CPGHE) and the Mind-Body Transformations Therapy (MBT-T), as a scientific foundation of a more general theory of mind-body communication and healing with therapeutic hypnosis [43]. A full description of the administration, scoring and clinical application of the top-down creative protocol for facilitating therapeutic cognition is freely available [16].

Some of the most recent research that has reached the popular press is how mindful meditation can modulate gene expression in cancer patients that has been reported as follows (Stekra, 2014).

Lead investigator Dr. Linda E. Carlson [56] and her colleagues found that in breast cancer patients, support group involvement and mindfulness meditation—an adapted form of Buddhist meditation in which practitioners focus on present thoughts and actions in a non-judgmental way, ignoring past grudges and future concerns are associated with preserved telomere length. Telomeres are stretches of DNA that cap our chromosomes and help prevent chromosomal deterioration – biology professors often liken them to the plastic tips on shoelaces. Shortened telomeres aren't known to cause a specific disease per se, but they do whither with age and are shorter in people with cancer, diabetes, heart disease and high stress levels. We want our telomeres to stay intact.

In Carlson's study, distressed breast cancer survivors were divided into three groups. The first group was randomly assigned to an 8-week cancer recovery program consisting of mindfulness meditation and yoga; the second to 12-weeks of group therapy in which they shared difficult emotions and fostered social support; and the third was a control group, receiving just a 6-hour stress management course. A total of 88 women completed the study and had their blood analyzed for telomere length before and after the interventions. Telomeres were maintained in both treatment groups but shortened in controls. Previous work hinted at this association. Studies led by diet and lifestyle guru Dr. Dean Ornish [57, 58] reported that the combination of a vegan diet, stress management, aerobic exercise and participation in a support group for 3 months resulted in increased telomerase activity in men with prostate cancer, telomerase being the enzyme that maintains telomeres by adding DNA to the ends of our chromosomes [59].

We now propose that further research with these protocols could replicate these findings in a more standardized form to update the mind/molecular/genomic efficacy of translational medicine recommended as a standard of clinical excellence by Insel [60-62], Director of National Institute of Mental Health.

The Classical to Quantum Transition of Observer-Operators via Mirror Neurons

The original research on mirror neurons initiated by Rizzolatti et al. [63] Iacoboni [64,65] and others Grodzinsky & Nelken [66] has been greatly expanded in current neuroscience to include epigenomic processes

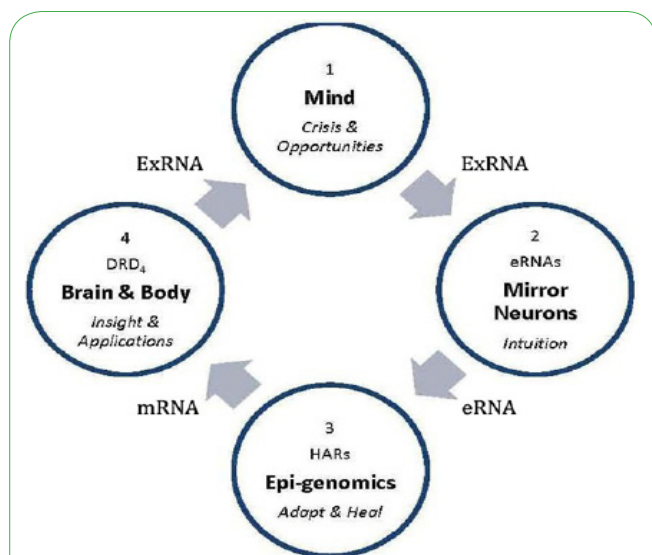


Figure 2: Conscious thoughts dialogue with our genes via the bio-informatic epi-genomic loop of communication between nature and nurture. Cognitions are converted into eRNAs (enhancer RNAs) to enhance DNA (gene expression), which codes for mRNAs (messenger RNAs) that generate the proteins (hormones, neurotransmitters, cytokines, etc.) and brain plasticity that generates mind/body communication and problem solving with therapeutic cognition [19, 25, 15, 16, 67]. In this context we propose that Ebstein's [68] saga of the adventure gene, novelty seeking, and substance abuse associated with the dopamine DRD4 receptor gene could be one example of the psychosocial genomic basis of what we call the Novelty-Numinosum-Neurogenesis-Expectancy effect in via the quantum observer-operator. A multimodal mathematical model of the therapeutic quantum observer-operator in the healing arts has been outlined [69, 19].

(the integration of nature and nurture) that modulate mind/gene communication. Research on bird song courtship dynamics, for example, documented how eRNAs (enhancer RNAs enhance gene expression) respond to thought by modulating the transcription/translation cycle of activity and experience-dependent epigenomic expression. Clayton, a specialist in songbird neurogenomics, made the salient comment, This is the firsttime a microRNA has been shown to respond to a particular thought process (Saey [70], Warren, Clayton et al. [71] Clayton [72], Drnevich et al. [73], Gunaratne et al. [35]). How could this be possible? Presumably the wave nature of the sound spectra of the bird song is encoded by the wave nature of molecular eRNAs resonance in mirror neurons. We now propose that an analogous cycle of informational transformation occurs in human consciousness and cognition as illustrated in Figure 2. This is the fundamental insight that integrates the top-down paths of mind, consciousness, and the expectancies of so-called free will with the bottoms-up molecular-genomic paths of communication. We now propose that this is a manifestation of the quantum Bayesian observer-operator bridging the so-called Cartesian gap between mind and body in psychosocial genomics, meditation and therapeutic hypnosis.

More recent research on the social communication of bats confirms and extends this earlier research on bird songs. Since bats are mammals their songs provide greater detail about their appropriateness as a model of human cognition. A recent issue of Science (Morell [74]) details how the FOXP2 gene, which is associated cognition and vocal learning in humans, birds and bats, may be a closer model for human speech. The trills, chirps and buzzes of bats, for example, can communicate a series of expectancies

such as announcing (1) I am species P. Nathusii, (2) a male, (3) specifically I am the only male with this song (4) so land here next to me. (5) We share a common social identity and communication pool. (6) The soft tones of the male lure ladies while (7) harsh tone compete with other males and warn them away. Although these songs typically last only ~1.6 seconds they may contain ~20 syllables combined in specific ways with individual rhythmic patterns of communication that are appropriate for current life conditions.

Such research on bird and bat song syntax and semantics illustrates how behavior encoded in the RNA/DNA transcription/translation cycle could mediate the vastly more complex cycle of information transduction that occurs in human consciousness, cognition, expectancy and health illustrated in Figures 1, 2 and 3 (Gell-Mann, [26], Szczepanski & Joyce, [75], Shelka & Piccirilli [76]). We propose this is the fundamental insight of bioinformatics that integrates the top-down path of consciousness, cognition and expectancy in quantum field theory with the bottoms-up molecular-genomic paths of communication within and between individuals.

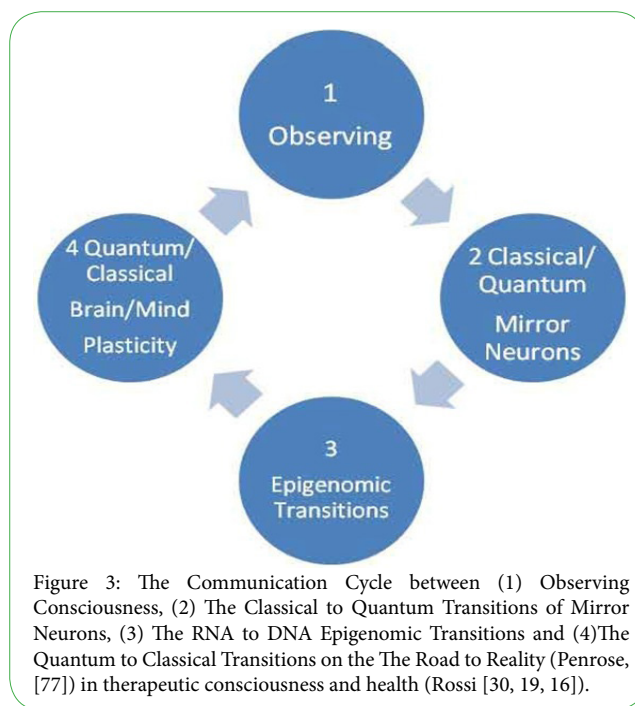


Figure 3: The Communication Cycle between (1) Observing Consciousness, (2) The Classical to Quantum Transitions of Mirror Neurons, (3) The RNA to DNA Epigenomic Transitions and (4) The Quantum to Classical Transitions on the The Road to Reality (Penrose, [77]) in therapeutic consciousness and health (Rossi [30, 19, 16]).

Free public data bases are being updated daily by the National Institute of General Medical Sciences, which offers information on these advances of the new genetics by Francis Collins, Director of the National Institutes of Health (NIH) is now funding research on their new Extracellular RNA (ExRNA) Communications Program. The NIH Common Fund provides research grants to catalogue all types of ExRNA that flow between mind and body in blood, tears, saliva and every other body fluid to provide a baseline that can be compared with ExRNA profiles associated with Alzheimer's, ageing, autism, development, diabetes, obesity, psychiatry, Parkinson's, stress, trauma, etc. (Leslie [68]).

Figure 2 gives precise bio-informatic meaning to the commonly used terms of the 4-Stage creative cycle such as Crisis/Opportunity (Stage 1), Intuition (Stage 2), Adaptation/Healing (Stage 3) and Insight/Applications (Stage 4). The integration of such psychological terms with brain/body research is the psychogenomic foundation in the RNA/DNA transcription/translation cycle of coding for mRNAs,

proteins at the molecular-genomic level of therapeutic hypnosis. Key research explores how these proteins, often called mother molecules, are cleaved into the neurotransmitters, hormones, and cytokines of the complex adaptive system of psycho neuroimmunology (Irwin & Vedhara [77]), which integrate cells of the mind, brain and body that ultimately facilitate the dynamics of memory, learning, behavior, and the qualia of consciousness itself in therapeutic cognition (Rossi & Rossi, [3]). Research illustrated in Figure 2 lead us to propose how the quantum field theory of ExRNAs signaling between nature and nurture are the molecular/genomic underpinning of the complex adaptive dynamics of normal everyday as well as meditation psychotherapy, and other therapeutic approaches to psychosocial and cultural health (Gell-Mann [26], Holland [27]).

Brain/Mind Plasticity and the Classical/Quantum Transitions

Psychosocial genomic transitions between classical-to-quantum dynamics of Stage 2 and quantum-to-classical dynamics of Stage 4 are actually experienced psychologically is illustrated in Figure 3. Genomics Research via the ENCODE project that includes qualia and experience-dependent gene expression is currently manifesting a profound breakout on the epigenomic level in Figure 3. Key research is now exploring complex adaptive systems of information transduction in the transcription process arising from ~2 million eRNAs carrying signals from the physical environment and psychosocial milieus to genes bearing ~3 million docking sites recently summarized by the ENCODE Consortium [79]. Pollard [80, 81] has recently pioneered research into the Human Accelerator Regions (HARs) that are now recognized as groups of genes that are undergoing very rapid adaptation distinctively different from our nearest primate relatives.

Brain/Mind Plasticity and the Quantum to Classical Transition

Figure 3 illustrates how the transitions between classical-to-quantum dynamics in Stage 2 and quantum-to-classical dynamics in Stage 4 are experienced in the nonlinear dynamics of therapeutic consciousness and cognition (Chiarucci et al. [82]). It is interesting to ask, for example, whether the intuitions of Stage 2 are psychologically sensed or felt to be the same or different in comparison with the experience of insights during Stage 4. This is important because Stage 4 of the creative cycle is the quantum-to-classical transition that purportedly takes place in the Penrose/Hameroff Orch OR model of consciousness entangled with microtubules within the cells of brain (Hameroff & Penrose [83]). Jeong, Lim & Kim [84] recently investigated the classical/quantum and quantum/classical transitions in a manner that we believe are consistent with the deep psychosocial genomic dynamics of therapeutic consciousness and cognition. Their research supports some little known but startling research at Carleton University in Canada that implies how the quantum Bayesian dynamics are manifest in the wave nature of sleep, dreams and therapeutic quantum observer/operator (Rossi [14]).

The Quantum Wave Nature of Mindfulness: Consciousness, Cognition, Sleep, Dreams, Psychosocial Genomics and Therapeutic Hypnosis

The wave nature of psychosocial genomics, meditation, mindfulness, and indeed, all holistic forms of psychotherapy is mapped onto the 90-120 minute 4-Stage Basic Rest-Activity Cycle (Lloyd & Rossi [28, 29])

illustrated in yellow in the upper curve of Figure 4. The proteomics (protein) pink profile in middle curve depicts the energy landscape for protein folding within neurons of the brain into the correct structures needed for adaptive brain plasticity (Cheun al. [85]). This proteomic profile arises from the functional concordance of co-expressed genes illustrated by the green genomics profile below it (Levsky et al. [86]). This psychosocial genomic curve represents the actual gene expression profiles of the immediate-early gene *c-fos* and 10 other genes (alleles) over the typical Basic Rest-Activity Cycle of 90-120 minutes. The lower diagram of Figure 4 illustrates how the qualia of consciousness cognition and behavior are typically experienced within the normal circadian cycle of waking as well as REM dreams while sleeping (Rossi [37, 25], Rossi & Nimmons [87]).

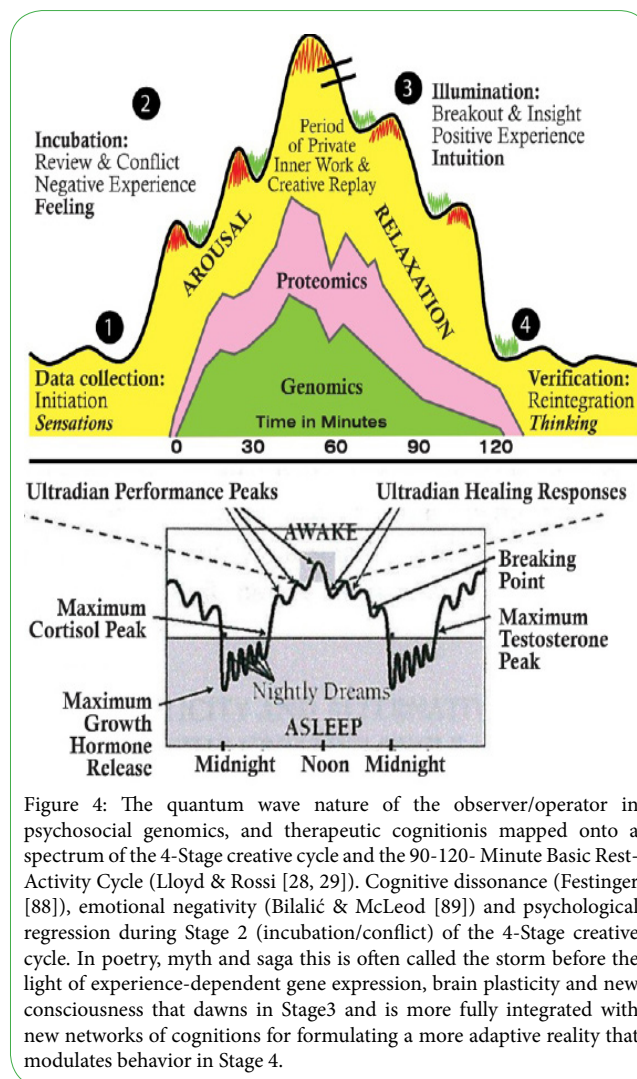
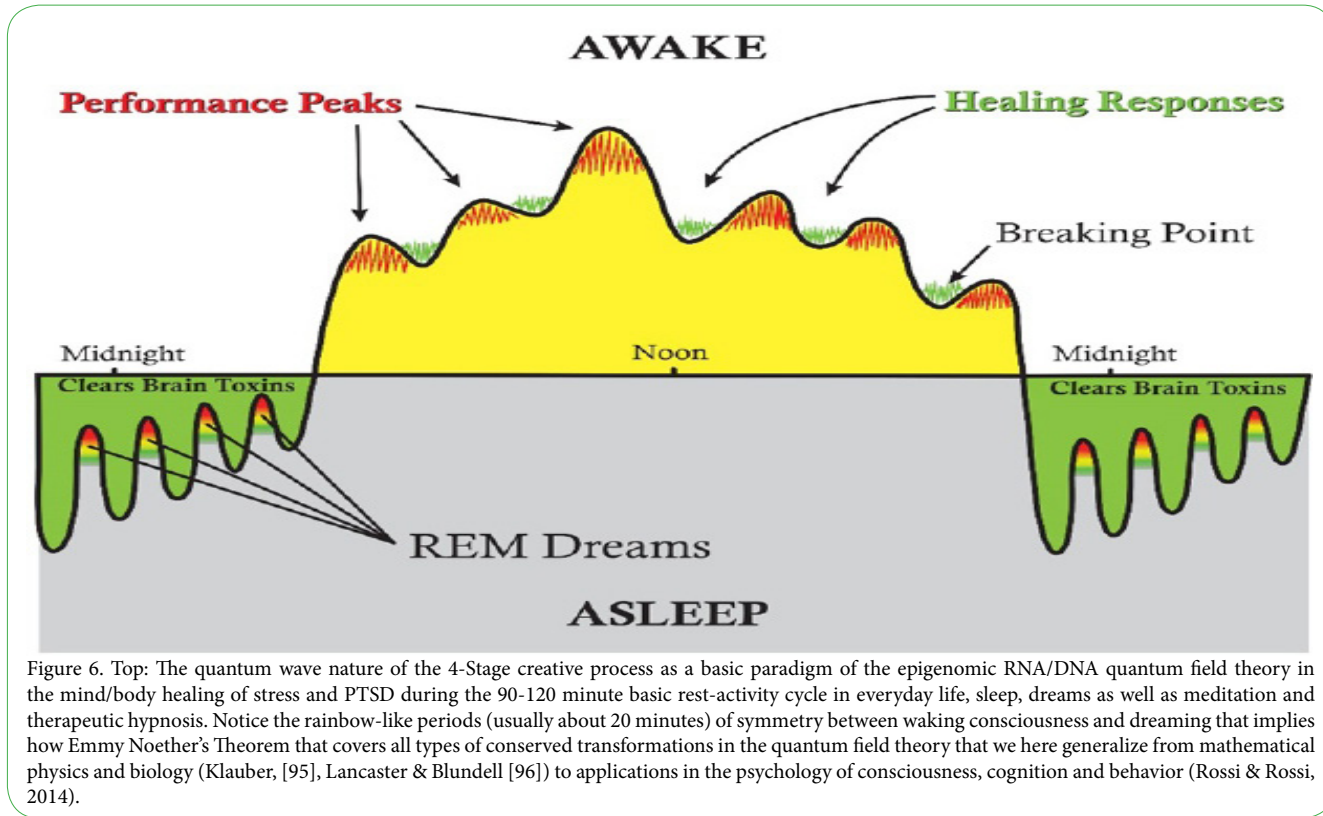
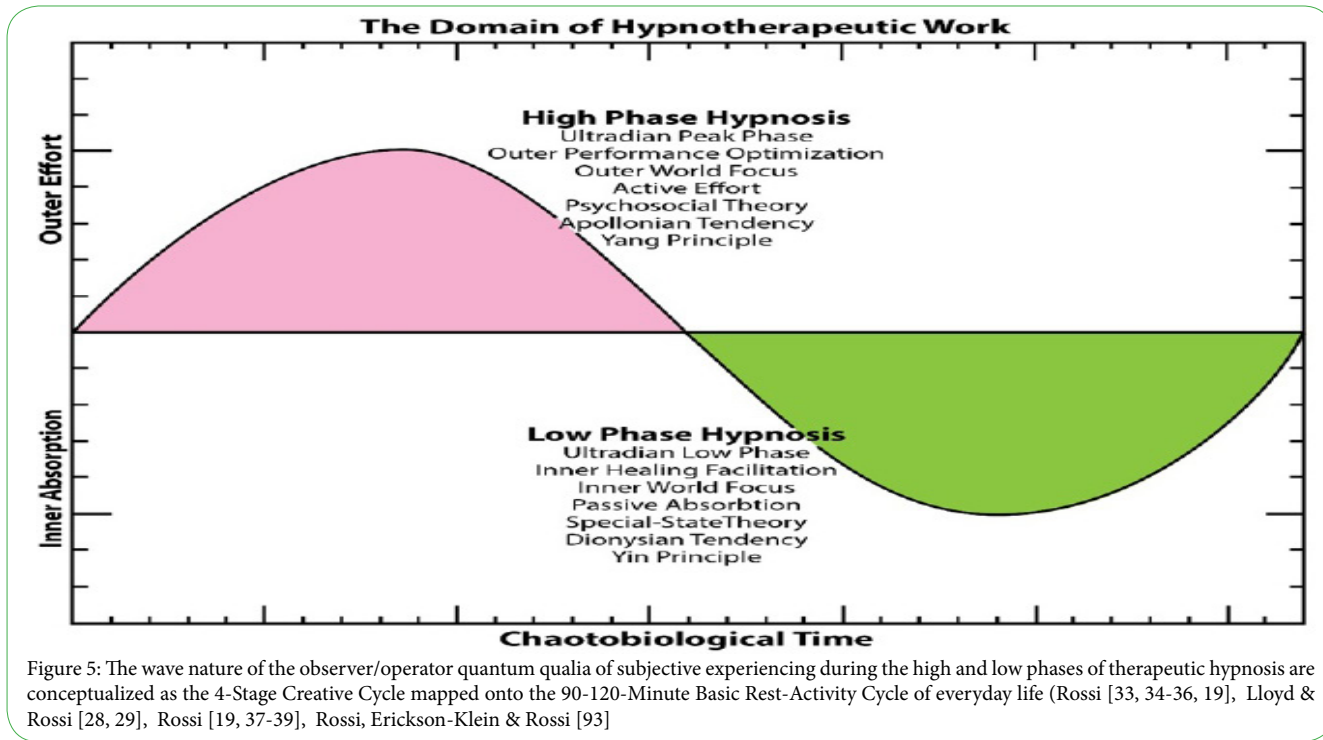


Figure 4: The quantum wave nature of the observer/operator in psychosocial genomics, and therapeutic cognition is mapped onto a spectrum of the 4-Stage creative cycle and the 90-120- Minute Basic Rest-Activity Cycle (Lloyd & Rossi [28, 29]). Cognitive dissonance (Festinger [88]), emotional negativity (Bilalić & McLeod [89]) and psychological regression during Stage 2 (incubation/conflict) of the 4-Stage creative cycle. In poetry, myth and saga this is often called the storm before the light of experience-dependent gene expression, brain plasticity and new consciousness that dawns in Stage 3 and is more fully integrated with new networks of cognitions for formulating a more adaptive reality that modulates behavior in Stage 4.

Pioneering electronic monitoring of catalepsy during hypnosis by Milton H. Erickson and his early student, Leonard Ravitz ([90, 91]), motivated the formulation of a new two-factor theory of therapeutic hypnosis by Rossi ([92], Rossi, Erickson-Klein & Rossi [93]) that is now being investigated with more advanced EEG methods (Chiarucci, et al. [82], Jamieson & Burgess [94]). Such research documents how the overall domain of hypnotherapeutic work is a combination of high and low phase hypnosis in chaotic biological time of mathematical chaos theory illustrated in Figure 5 (Rossi [19]).

The high performance phases of activity are illustrated in red in the top part of Figure 6. These red high performance peaks alternate with low phases of healing and recovery shown in green during the 90-120 minute basic rest-activity cycle. The bottom part of Figure 6 illustrates the recent research of Xie et al. [9] documenting the cleaning up of toxic metabolic waste products of daily conscious work during sleep (green) and dreaming (rainbow).

The small rainbows imply how many such alternating phases of RNA/DNA activity during REM dreaming as well as waking consciousness, which clean up toxic waste products of brain/mind metabolism could be the molecular/genomic foundation of many therapeutic practices that emphasize rest and relaxation (therapeutic hypnosis, prayer, meditation, yoga, etc.) developed independently over the ages by many cultures. The alternating phases of consciousness,



rest and sleep look very similar to the basic quantum Bayesian wave nature of many natural epigenomic processes that could enhance psychotherapy and all schools of therapeutic consciousness. We now need to assess how such wave patterns are consistent with a more general quantum RNA/DNA psychosocial genomic theory of consciousness, cognition, creativity and positive expectancy. To do this we introduce some fundamentals about quantum Bayesianism as a new notation for a mathematical model of quantum field theory of therapeutic consciousness.

Quantum Bayesian Notation¹⁰¹ for a Mathematical Model of Therapeutic Consciousness

The original publication that began the current quantum Bayesian revolution emphasized how the extreme accuracy of the calculations of quantum physics probability replaces the determinism of classical Newtonian physics (Caves, Fuchs & Schack [97]). What could Bayesian dynamics really mean for the quantum field theory of mindfulness, psychotherapy and therapeutic consciousness? The first fundamental insight for physics, biology and psychology is that the quantum qualia of subjective experience are probabilistic in the normal consciousness and behavior of everyday life.

The second fundamental insight is that the highly sensitive quantum qualia of subjective experience are discrete; this means they are quantized into tiny, separate, natural Planck units of sensation and/or perception (Fuchs [98, 99], Schiller [100]). The qualia of the redness of red and the blueness of blue, for example, can be experienced as continuous blends in the rainbow, but also we can distinguish about 7 separate or discrete colors depending on how we humans choose to interpret them. Mathematicians have formulated an axiom of choice in logical systems (Doxiadis & Mazur [101]) and physicists have had a century of struggle formulating the mathematical notation of light itself having a dual nature as either discrete particles or smooth continuous waves depending on how experimental situations are arranged to observe photons (Baggott [11, 102]). We now note that letters, words, emotions and states of consciousness as well as cognition, mathematics, music and the 4-Stage creative cycle also have a dual nature depending on how we choose to arrange our observations of them. The observer/operator qualia of human highly sensitive subjective experience manifests an infinite axiom of choice in creating and organizing its own world. This vast possibilities of human choice can be confusing and stressful in the transitions between Stage 2 (conflict/incubation) and Stage 3 (insight) of the 4-Stage creative cycle, however (Rossi [19, 25, 15], Rossi & Rossi [3]).

The third fundamental insight for physics, biology and psychology is that quantum Bayesian dynamics are manifest (observable) on all levels from mind to genes in living systems (Fuchs [103, 104]). Although quantum physics began with the need to resolve the paradoxes that emerged from atomic and subatomic levels, early theorists like Bohr, Dirac, Heisenberg and Schrödinger realized that the quantum level underpinned the entire universe as well as the molecular chemistry of life and consciousness (Baggott [11, 56], Susskind & Friedman [10] Wilber [105]).

The fourth fundamental insight integrating physics, biology, psychosocial genomics, psychology and therapeutic consciousness and cognition is the central role of quantum Bayesian expectancy in an uncertain world (Fuchs, Mermin & Schank [106], Fuchs & Schank [107]). Heisenberg's fundamental uncertainty relationships are the basis for understanding the broad scope of how modern

Quantum Field Theory (Klauber [108], Lancaster & Blundell [109]) is challenging our conceptions about creating new consciousness, our sense of free will and reality itself (Rossi & Rossi [6-8]).

The Quantum Field Theory of Psychology, Consciousness, Creativity and Health

The process of formulating a quantum field theory of consciousness, health and self-care can be found in the new text for students by Lancaster & Blundell [109] with their very first words on page one.

What is Quantum Field Theory?

Every particle and every wave in the Universe is simply an excitation of a quantum field that is defined over all space and time.

This remarkable assertion is at the heart of quantum field theory. It means that any attempt to understand the fundamental physical laws governing elementary particles has to first grapple with the fundamentals of quantum field theory. It also means that any description of complicated interacting systems, such those that are encountered in the mind-body problem [cosmos, consciousness and all life processes] will involve quantum theory to properly describe the interactions ... In any case, quantum field theory is the best theory currently available to describe the world around us, and in a particular incarnation known as quantum electrodynamics (QED), is the most accurately tested physical theory ... The ideas making up quantum field theory have profound consequences ... Interactions in quantum field theory involve products of operators which are found to create and annihilate particles and so interactions correspond to processes in which particles are created or annihilated; hence there is also the possibility of creating and destroying virtual particles which mediate forces.

If we do an interesting thought experiment with this quote by replacing the word Field with Consciousness and the word Particle with Person and the word Interaction with Relationship it suggests new quantum inspired perspectives for generalizing Lancaster and Blundell's quantum field theory from physics to biology, psychology and consciousness in general. We can begin this thought experiment with an overview comparing and contrasting the physicist's outer worldview of objective quantum reality with the psychologist's inner worldview of subjective quantum reality (QBism). We then will review a popular mathematical presentation of chance, probability and expectancy in objective quantum physics with a classical and easy to understand model of playing a game of dice for the insights it may provide into the concepts of uncertainty and expectancy in therapeutic consciousness studies. We will then illustrate how Dirac's quantum bra-ket math notation could be applied to the problems of the human consciousness and cognition as we experience them in the psychodynamics of everyday life, psychology, dreams and psychotherapy (Rossi & Rossi [6-8]). The late mathematical physicist, Steven Holzner [110], introduced a relatively simple probabilistic dice model to illustrate the basic concepts of quantum physics and the math of the wave function. Table 1 illustrates the Holzner model that we will apply to the dynamics of expectancy psychosocial genomics, psychotherapy and cognition (Kirsch [111], Mazzoni et al. [112], Pekala et al. [113], Wagstaff [114]).

The initial Dice Sum column lists all the possibilities of the roll of a pair of dice in Table 1. The next column lists the Relative Probability of each possibility – the number of ways of rolling a particular sum

on the dice. Quantum physics does not deal directly with such probabilities, however, but rather with the Probability Amplitudes, which are the square roots of the probabilities in the middle column. These probability amplitudes represent the height of the wave state. Dirac's quantum bra-ket notation is introduced in the next column as a compact way of expressing the sum of all the possible ways rolling the dice with a single Greek letter $\langle\Psi|$ (ψ) denoting the wave nature of consciousness, cognition and creativity as probability amplitudes. The final Expectation Value column is expressed in Dirac's quantum bra-ket mathnotation $\langle\Psi| E|\Psi\rangle$ that denotes our emerging mathematical model of the meaning of expectancy in therapeutic cognition from a quantum Bayesian perspective.

Dice Sum	Relative Probability	Probability Amplitude	Quantum Notation $\langle\Psi $	Expectation Value $\langle\Psi E \Psi\rangle$
2	1	$\sqrt{1}$	1/6	7
3	2	$\sqrt{2}$	$\sqrt{2}/6$	7
4	3	$\sqrt{3}$	$\sqrt{3}/6$	7
5	4	$\sqrt{4}$	2/6	7
6	5	$\sqrt{5}$	$\sqrt{5}/6$	7
7	6	$\sqrt{6}$	$\sqrt{6}/6$	7
8	5	$\sqrt{5}$	$\sqrt{5}/6$	7
9	4	$\sqrt{4}$	2/6	7
10	3	$\sqrt{3}$	$\sqrt{3}/6$	7
11	2	$\sqrt{2}$	$\sqrt{2}/6$	7
12	1	$\sqrt{1}$	1/6	7

Table 1. The dice roll model of probability, quantum notation and expectancy applied to the quantum field theory of psychosocial genomics, psychotherapy and therapeutic cognition (Adapted from Holzner [110]).

The Expectation Value of $\langle\Psi|E|\Psi\rangle$ illustrates another convenient and very flexible feature of Dirac bra-ket notation: the single letter E represents a mathematical operator in quantum dynamics. In psychology the operator could be any activity A, behavior B, cognition C or function such as R for Rolling the dice. The operator R acts simultaneously on the bra $\langle\Psi|$ on the left and a ket $|\Psi\rangle$ on the right. Since quantum dynamics always deals with a range of possibilities (probability amplitudes) rather than a single value, $\langle\Psi|R|\Psi\rangle$ is a very compact notation. Doing the matrix math (easy with software) yields the final answer of our dice roll example that is entered into a computer looks like this.

Doing the matrix math provides the answer as is shown in Table 1: $\langle\Psi|R|\Psi\rangle = 7$. So, the expectation value of a roll of the dice is 7. It's always 7 even though you hope your dice roll may be different when gambling at a casino. The casino management, however, has arranged the rules of the game so they will always win in the end as the result of many dice rolls. But you may be temporarily lucky due to probability amplitudes of chance. Now we can appreciate where Dirac's terms bra and ket come from—they bracket the mathematical operator that transforms one function into another. We propose that the quantum qualia of the Bayesian novelty-numinosum-neurogenesis-expectancy observer/operator can transform subjective experience into the objective molecular/genomic dynamics underpinning of consciousness and cognition in the psychosocial genomic activity of psychotherapy and virtually all the mind/body therapies in modern psychology and medicine..

$$\langle\Psi|R|\Psi\rangle = \begin{bmatrix} \frac{1}{6} & \frac{\sqrt{2}}{6} & \frac{\sqrt{3}}{6} & \frac{2}{6} & \frac{\sqrt{5}}{6} & \frac{\sqrt{6}}{6} & \frac{\sqrt{5}}{6} & \frac{2}{6} & \frac{\sqrt{3}}{6} & \frac{\sqrt{2}}{6} & \frac{1}{6} \end{bmatrix} \begin{bmatrix} 2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 4 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 6 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 7 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 8 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 9 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 10 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 11 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 12 \end{bmatrix} \begin{bmatrix} \frac{1}{6} \\ \frac{\sqrt{2}}{6} \\ \frac{\sqrt{3}}{6} \\ \frac{2}{6} \\ \frac{\sqrt{5}}{6} \\ \frac{\sqrt{6}}{6} \\ \frac{\sqrt{5}}{6} \\ \frac{2}{6} \\ \frac{\sqrt{3}}{6} \\ \frac{\sqrt{2}}{6} \\ \frac{1}{6} \end{bmatrix}$$

The expectation value of an operator turns out to be the average value one would expect to find by performing the same measurement many times. In the matrix math notation of Holzner's example above the long diagonal from the top left to the bottom right above can be recognized as a list representing the wave state of probabilities amplitudes engendered by the R dice operator. The possibilities are limited only by the constraints of imagination one chooses to impose. We could use the Dirac bra-ket notation to explore, for example, some interesting ways of understanding the quantum qualia and dynamics of what we choose to call the observer/operator in dreams, meditation and psychotherapy as well as the 4-Stage creative cycle in everyday life.

Illustrations of the Quantum Observer/Operator in Consciousness, Dreaming and Psychotherapy

In classical psychology episodic memory, originally discovered and defined by Turving E [115, 116] can now be assessed by neuroscience imaging of the mind/brain (Kellogg [117]). Memory and its transformations during learning, REM dreaming and cognition (Rossi & Rossi [24]; Rossi & Rossi, [8]) can be easily evaluated with our new quantum Bayesian notation. We illustrate this with the dream and therapeutic intervention in a 78-year-old male patient still recovering from a childhood post traumatic syndrome disorder (PTSD) perpetuated by his abusive father.

My father is a young man as he was when he used to beat me so badly that I would scream so loudly that our neighbors would knock on our windows yelling, Stop beating that child! Anyway, in my dream he is now a nice guy who is building a new home and I am a little boy helping him! The house is now almost finished but there is still fresh dirt piled up roughly around in piles. This dirt is clean but it needs nutrients. So we scatter organic fertilizer on it so that green grass and flowers and trees will grow real pretty in our new yard.

I can hardly believe I'm now having such a nice dream about my long ago terrible father who abused me sexually! All my life I have hated him and struggled to get away from my family vowing never to forgive any of them! I left home as a young man and never went back! But somehow, I now seem to actually like my father and we are doing nice things together in my dream. Can this really be happening to me, doctor? Is this what you call, brain plasticity?

Brain plasticity, indeed! We summarize the therapeutic reframing of this life story with the observer/operator [O] in positively transformative bracket notation like this.

$$\langle \Psi_{+FUTURE} | O_{\text{Psy}+} | \Psi_{-PAST} \rangle$$

Consciousness can function as a Janus-faced positive quantum operator/observer [O] in the intense focus of the dream work; to observe is to operate simultaneously on the past as well as the future! The patient still has an urgent question. He needs the help from the psychotherapist [O_{Psy+}] to convert the quantum probability amplitude of a possible therapeutic reframing of his life story with his father into the qualia of new quantum Bayesian psychological reality in Hilbert space (math notation for infinite possibilities). The patient urgently needs the therapist to witness and validate the patient's own newly created and nascent reality by answering, Yes, this is the result of gene expression and brain plasticity operating successfully within you! Suppose the psychotherapist had responded with the common but cynical, destructive and false public opinion: Too bad it was only a dream.

A young woman dreams:

I am an apprentice to a baker making a sandwich several yards long! An inspector comes by and asks the baker if he is responsible for making the sandwich. But with a cynical attitude the baker ignores the inspector. I am puzzled in the dream about why the baker is ignoring the nice inspector.

Upon awakening the young woman's first sleepy early morning thoughts spontaneously replays her dream: she would have told the nice inspector the truth about how the baker was indeed responsible for making the huge sandwich. She intuitively needed this information so someone could be rewarded for such excellent work.

In this dream the observer/operator (O_{±BAKER}) was her ambivalent identification the baker. In bra-ket notation there was no complete positive transformation in her dream. She is still stuck in an ambivalent and puzzled Stage 2 at the end of her dream.

$$\langle \Psi_{\pm PUZZLED} | O_{\pm BAKER} | \Psi_{-CYNICAL} \rangle$$

Fortunately this young woman has the wit to utilize the axiom of choice in her early morning thoughts to give her identity a wonderful makeover that generated a positive transformative to Stage 4 of the creative cycle. This is expressed in bra-ket notation:

$$\langle \Psi_{+REWARDED} | O_{+CHOICE} | \Psi_{-CYNICAL} \rangle$$

During her nighttime of sleep her brain was cleared of metabolic toxins (she had been stressfully overworked lately) so she could more objectively re-consider the cynical side of her personality that requires therapeutic reframing to empower her to tell the world (the inspector in the dream) the truth about her growing abilities (symbolized by making fantastic sandwiches) so she can be appropriately recognized and rewarded.

A depressed middle age man reports a spontaneous daydream during psychotherapy.

I am down deep in a bomb shelter with a small group of cowering fearful people. A strong muscular fellow is guarding the exit door so we cannot run out in panic when the bombs start to fall. This guard

has a long pole with a soft cushion on the end so he can safely push people back in if they foolishly try to exit when the bomb begins exploding above. In quantum Bayesian bra-ket notation:

$$\langle \Psi_{+INCUBATION} | O_{+GUARD} | \Psi_{-WAR} \rangle$$

Together the depressed man and therapist intuited a helpful and hopeful therapeutic interpretation of this dream. The man's depressing dream is a Stage 2 expression of the 4-Stage creative cycle wherein he needs to recognize the realities of his currently dangerous but temporary life situation. The guard is an emergent manifestation of the positive observer/operator in his dream protecting him and others so they can safely incubate about their condition. The need to incubate in Stage 2 until appropriate quantum Bayesian probability amplitudes of the adaptive RNA/DNA transition/translation dynamics of experience-dependent gene expression and brain plasticity evolve new Stage 3 therapeutic possibilities. This hopeful expectancy will optimize his ability to recognize the fruits of a good night's sleep in clearing his brain to facilitate gene expression and brain plasticity for creating new quantum qualia of consciousness.

All these clear examples of Dirac's brief BraKet notation document how an initially dysfunctional quantum qualia of consciousness and cognition have a state identified with a negative subscript such as Ket |Ψ⁻>, that could be a medical or psychological symptom, which is then therapeutically transformed by the observer/operator into a positive final state identified with a positive subscript such as a Bra <Ψ⁺|. This concise Dirac notation characterizes the typical human condition as problematic – needing a 4-Stage Creative 90-120-minute Basic Rest-Activity Cycle (BRAC) on all levels from mind to activity-dependent gene expression and brain plasticity 12 times a day to maintain life and consciousness itself.

But why all this negativity in the first place? Why after 4.5 billion years of Darwinian evolution has life and mind not achieved a state of permanent positive bliss and nirvana? Our psychologically oriented quantum field theory of cosmos and consciousness suggests an obvious hypothesis about these questions in the following statement about "That little minus sign makes a huge difference?" between real and quantum numbers by Wilczek [115].

We map ordinary dimensions onto ordinary, so-called real numbers. We pick a reference point, usually called the origin, and label any point by a (real) number that describes how far you must go to get there from the origin. Real numbers, in a word, are suitable for measuring distances, and labeling continua. They satisfy the multiplication rule

$$xy = yx$$

Quantum dimensions use a different kind of numbers, called Grassmann numbers. They satisfy a different multiplication law,

$$xy = -yx$$

That little minus sign makes a huge difference? Notably, if we put $x = x$ we get $x^2 = -x^2$, and so we conclude $x^2 = 0$. That strange rule encodes, in the physical interpretation of quantum dimensions, Pauli's exclusion principle: you can't put two things in the same (quantum) place.

After those preparations, we're ready to meet SUSY. Super symmetry is the claim that our world has quantum dimensions, and

that transformations exist which interchange ordinary with quantum dimension (change), without changing the laws of physics (without change).

Super symmetry, if correct, will be a profound new embodiment of beauty in the world. Because the transformations of supersymmetry turn substance particles into force particles, and vice versa, super symmetry can explain, based on symmetry, why neither of those things can exist without the other: Both are the same thing, seen from different perspectives. Supersymmetry reconciles apparent opposites, in the spirit of yin-yang. (Wilczek [5]).

It will require a great deal of the further research on our psychologically oriented quantum field theory to confirm That little minus sign makes a huge difference in the therapeutic transitions from negative stress to positive states of creativity. Of such stuff are the dreams of therapeutic consciousness, cognition, health and well-being created.

Summary

The quantum field theory of the evolutionary psychology, consciousness, creativity and health is reviewed for a new conception of psychotherapy, mindfulness and meditation, as well as most ancient and modern healing transformations of consciousness and cognition. Research in the quantum field theory is updated with an adaptive RNA/DNA theory of the quantum Bayesian transformations of consciousness, creative cognition and expectancy in meditation and therapeutic hypnosis. Alternating classical-to-quantum and quantum-to-classical transitions on all levels from mind to genes of complex adaptive systems are integrated for facilitating the 4-Stage creative cycle as the foundation for a new definition of therapeutic consciousness.

Surprising tendencies toward cognitive dissonance, conflict, negativity and psychological regression during Stage 2 (incubation/conflict) of the 4-Stage creative cycle were uncovered. This becomes particularly evident in dreams when parsed with our new psychological bra-ket quantum Bayesian math notation of the observer/operator characteristic of all complex adaptive systems. Creative psychosocial epigenomic healing experiences provide opportunities for resolving cognitive dissonance, symptoms, and psychopathology due to observer/operator malfunctions in the quantum qualia of human subjective experience. We propose how the highly sensitive quantum qualia of problematic dissociations during Stage 2 of the 4-stage creative cycle are source of quantum level conflicts between real and Grassmann numbers that can lead to conflict, discord, inappropriate competition, hate crimes, terrorism, war and other stress related psychosocial pathologies that can be resolved in stages 3 and 4 of therapeutic consciousness and cognition. Quantum Bayesian concepts of the novel observer/operator have insightful applications in counseling, psychotherapy, translational medicine and virtually all the mind/body therapies. Innovative quantum field theory research on how the quantum qualia of the human observer/operator in subjective experience can be a causal agent in facilitating health and problem solving on the objective molecular/genomic level now needs to be replicated and extended to replicate these new approaches to psychological health and well-being.

Conflict of Interest

No authors have a conflict of interest or any financial tie to disclose.

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