THE NEUROPSYCHOLOGY OF YOGIC MIND MASTERY:

AN INTEGRATIVE REVIEW AND TRANSLATIONAL TEMPLATE

by

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The same organizing forces that have shaped nature in all her forms

are also responsible for the structure of our minds.

~Werner Heisenberg

Every man can, if he so desires, become the sculptor of his own brain.

~Santiago Ramon y Cajal

I think 99 times and I find nothing.

I stop thinking, swim in the silence, and the truth comes to me.

~Albert Einstein

Now that light which shines above this heaven, higher than all, higher than everything, in the

highest world, beyond which there are no other worlds,

that is the same light which is within man.

~Chandogya Upanishad 3.13.7

Abstract

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The emerging field of contemplative neuroscience studies how various contemplative practices influence brain circuitry and mental activity, and how practitioners experience and neurocognitively express mastery of contemplative practices. This study attempts to integrate remarkable neuroscientific discoveries into a translational evidence-based guide for the developmental stages of yogic mind mastery. A meditation-based structural theory for synthesis of multimodal findings, both from within and across disciplines, is proposed based on the empirical systematic mind training found in the *Yoga Sutras*, which in itself entails 8 stages of embodied mind training and 4 levels of practice mastery. This study examines the yogic spiritual tradition to find, and make explicit, the underlying neural correlates otherwise implicit in their progressive practices for mastery of mind. Using an integrative review method, this translational heuristic research takes a closer look at yogic maturation of contemplative self-regulation and self-identification. The findings in this review show that there are major shortcomings in the current scientific literature that typically fail to distinguish cogent systematic integrative strategies for meditation-based spiritual self-realization. This study makes a scientific case that substantiates the extraordinary potential in applied systematic integrative strategies of yogic self-development.

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The course of this project has been a marker in the explortation of the depths of my own ultimate existential concerns that required the advantage of truth that had to be sifted from vast aeons of whole-world ethnopsychological systems of self-understanding. At the heart of it, there are many to thank in the broad scope of this life project. And together, everyone who has shaped my understanding has been an instrumental voice that has led to this passage. I give fullest thanks to each and all who have been of supportive of this endeavor, both knowingly and unknowingly, with bright heart and endearing acknowledgement both in this life and beyond.

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Chapter 1: Introduction

Systematic training of the mind has been practiced in different civilizations for thousands of years to accurately map replicable ways to still, rebalance, and clear the mind in order to cultivate heightened awareness and insight. In particular, many contemplative traditions explicitly aim to relax and de-automatize the mind by eliciting altered states of awareness through applied methods that are embedded within complex contemplative-based systems. Although the earliest recorded systems of mind training come from India, ancient indigenous traditions in yoga and meditation have now spread worldwide, and the study of contemplative practices is now an expanding field of scientific research. To address the remarkable diversity of contemplative traditions, researchers have categorized the main styles of meditation across cultural, geographical, and historical contexts, based on the core goals and principles of the cognitive techniques involved (Davidson & Kaszniak, 2015).

Arguably, however, most of these studies take a limited view of meditation, and have focused on isolated parts of practice, without a systematic view that integrates core features in a relationally useful way. For example, as research on meditation becomes more inclusive of diverse systems of contemplative practice, framing research approaches based mostly on isolated features for Westernized scientific theoretical categorization of different meditation styles tends toward oversimplification and fails to fully comprehend whole intact contemplative systems, with implicit biases toward single agents for outcome values (Desbordes et al., 2014; Ritenbaugh, Verhoef, Fleishman, Boon, & Leis, 2003). So, most meditation research has mainly focused on changes in cognitive mechanism without investigating mechanisms associated with a stable transformation of psychospiritual awareness intrinsic to traditional meditation systems.

For example, neurocognitive researchers commonly reinforce a dissociation of meditation techniques according to whether they focus attention on an object in awareness (focused-attention), or focus attention on awareness itself (open-monitoring). However, disintegrative approaches within the field of contemplative research have produced categorical variances in interpretive findings when attempting a unifying taxonomy and core construct of meditation (Awasthi, 2013; Dahl, Lutz, & Davidson, 2015; Josipovic, 2010, 2013; Nash & Newberg, 2013; Travis & Shear, 2010). When examined contextually, meditation in the focused-attention (coupled to mental content) and open-monitoring (decoupled from mental content) categories are embedded in whole-intact traditions that systematically layer sets of practice in order to stably induct experiential insight into the true nature of self beyond mere mental ideation. If meditation training is divorced from its traditional religious, social, and cultural contexts, there is a risk that the traditional psychospiritual intent to surpass ego-mind and awaken transcendental awareness could be overlooked, marginalized, and misinterpreted. In order to have realistic and accurate expectations of the possible outcomes of meditative practices, researchers in this field should be aware of the full trajectory and ethos of practice detailed in traditional religious literature.

In most meditative traditions, a beginner typically will start with a focused-attention form of meditation (absorption in an object) and will then proceed to an open-monitoring form without content (absorption in awareness), in mutually inclusive manner to attain consummate levels of experiential unity with transcendental awareness (Ott, 2003). With this in mind, some meditation techniques cannot be unequivocally assigned to the commonly used identifying categories in the scientific literature, because they are embedded in contemplative systems that require practitioners to sequentially re-train (focus) attention in order to free-up (open) attention for balanced induction of thoughtless, egoless, effortless undivided awareness to emerge. Part of

the reason for this omission in the scientific understanding of meditation derives from the fact that scientific research on meditation, especially at the clinical level, has become increasingly divorced from the study of the literature and practitioners from contemplative traditions. Consulting traditional sources is an essential and important step in furthering the scientific understanding of meditation.

A greater understanding of distinctions embedded in systems of practice, combined with integration between findings, can provide a more accurate discipline-informed scientific theoretical framework (Thomas & Cohen, 2014). Collaborative and integrative research is needed to develop greater accuracy and more comprehensiveness in mapping meditative mind mastery. Despite the large number of studies that have been conducted to research the effects of contemplative training, there is a lack of neuropsychological theories that make evidence-based predictions to address the ontogenetic psychology of contemplative mind mastery. Due to this, scientific understanding of the effects of meditative mind development can be strengthened if empirical studies are guided by traditionally-informed neuropsychological constructs that can better predict stages underlying the systematic changes that occur in the process of contemplative maturation through embodied mind training (Amihai & Kazhevnikov, 2014; Braboszcz, Cahn, Levy, Fernandez, & Delorme, 2017; Brown, 1986; Fell, Axmacher, & Haup, 2010; Sedlmeier et al., 2012; Schoenberg, Ruf, Churchill, Brown, & Brewer, 2018; Vieten et al., 2018).

Meditation practices are embedded in different cultures, worldviews, traditions, and conceptual frameworks that describe states beyond ordinary waking experiences. This study will examine the process of contemplative development for some common stage-based features and characteristics that may be shared across traditions. That said, neuropsychology can provide the language of brain functioning to discuss contemplative practices across disciplines. In this way,

signature brain correlates could provide an objective language to discuss procedures and experiences resulting from different meditation practices (Josipovic, 2014; Tang, Hölzel, & Posner, 2015; Travis & Shear, 2010; Vago & Silbersweig, 2012). Due to the difficulties of categorizing different forms of meditation in order to study them scientifically, this study will present a convergence of evidence that suggests a similar underlying scheme of developmental stages in which each step has identifying neural processing features, according to level of mastery. To clarify, this study was not designed to attempt to evaluate similar mental states that are exhibited across traditions or to compile and review all the correlates associated with different types of practice.

However, integrative translational research can provide key indicators from current neuroscience research to better assess, comprehend, and interpret specific systems of applied traditional practice methods in order to provide the millions of practitioners in the world today an unbiased, structured body of evidence. This type of interpretive research is part of a continuum in which research bench findings develop into practical evidence-based applications. Thus, this study is an attempt to translate remarkable neuroscientific discoveries into an evidence-based guide for the developmental stages of yogic mind mastery. Neuropsychological theories are ideal platforms from which to integrate findings, both within and across traditional disciplines, that may not otherwise engage in critical exchange and innovation (Strauman, 2017).

Ancient traditions that cultivate contemplative practices are like old-growth forests of the mind, embodying entire ecosystems of psychospiritual evolution. Despite all the differences of existing meditation practices, descriptions of deep states of meditation across traditions and practices all support access to forms of self-regulatory introspective awareness that are called by different names, depending on the tradition. Taken together, theories of self-awareness contained

in ancient traditional texts have the potential to modify and complement existing mainstream neuropsychological theories of introspective brain states (Caplan, Portillo, & Seeley, 2013). For example, they can serve as a basis for arriving at more comprehensive theories for research areas that lack strong theoretical grounding, such as: self-regulation (Baumeister & Heatherton, 1996; Beauregard, Levesque, & Bourgouin, 2001; Heatherton, 2011; Kober et al., 2017), introspective metacognition (Dorjee, 2016; Drescher, Bussche, & Desender, 2018; Jankowski & Holas, 2014; Schooler, 2002; Teasdale, 1999), transpersonal awareness (Berkovich-Ohana, Dor-Ziderman, Glocksohn, & Goldstein, 2013; Brown & Engler, 1986; Josipovic, 2013; Schoenberg et al., 2018; Travis, 2013; Vieten et al., 2018), attentional control (Anticevic, Cole, Murray, Corlett, Wang, & Krystal, 2012; Braboszcz et al., 2017; Chan & Woollacott, 2007; Garcia-Cordero et al., 2017), self-identity (Dahl & Davidson, 2015; Dor-Ziderman, Ataria, Fulder, Goldstein, & Berkovich-Ohana, 2016), emotional regulation (Desbordes et al., 2012; Dorjee, Lally, Darrall-Rew, & Thierry, 2015; Farb et al., 2010; Garland, Farb, Goldin, & Fredrickson, 2015), and neurocognitive psychology (Cahn & Polich, 2006; Creswell, Way, Eisenberger & Lieberman, 2007; Josipovic, Dinstein, Weber, & Heeger, 2012).

This study takes an integrative approach to neuropsychological research with a transpersonal theoretical orientation. A clear understanding of the evolution of the brain with evidence-based transformative tools for the yogic mastery of the mind is of personal, academic, cultural, scientific, and psychospiritual significance (Christoff, Gordon, Smith, & Vancouver, 2006). Individuals who engage psychospiritual development adapt through value-based action, peace, wisdom, non-ordinary states of consciousness, compassion, and meaning in life (Bogart, 1991). As ecological, sustainability, and peace-making challenges increase, it becomes more urgent for society that more people learn, practice, and master the stages of contemplative

development. However, the psychology present in a given spiritual tradition may be meaningfully engaged from within the tradition, but remains relatively obscure due to its embedded nature in the tradition. There is value in examining spiritual traditions to find, and make explicit, the underlying universal core structure otherwise implicit in their beliefs and practices. Simply put, it fosters an understanding of meditation to bridge contemplative traditions and research psychology.

Meditation has roots in the contemplative practices of different religious cultures from around the world, supporting metacognitive self-regulation and spiritual identity development through embodied mind training (Poll & Smith, 2004; Sahdra et al., 2011). Despite a diversity of techniques, meditation traditions converge around systematic processes for developing deeply aware, self-transcending metacognitive pliability that relates to the contents of mind and constantly disciplines them through specialized regulation of attention and awareness. Within the contemplative tradition of India, meditation can be likened to cultivating regulatory control of the embodied mind and honing introspective awareness in the service of understanding the true nature of self, mind, and phenomenological reality (Whicher, 1998). The most translated classical Indian text, the *Bhagavad Gita*, ranks meditation above intellectual knowledge (BG, 12.12), echoing a sentiment that is widespread in the sacred literature of India.

Metacognitive self-regulation refers to processes by which people initiate, maintain, regulate, and control their own thoughts, behaviors, or emotions in order shape outcomes. Metacognitive experience is responsible for creating an identity that matters to an individual. It includes an ongoing awareness of the contents of consciousness. Individuals interpret experience through the metacognitive lens of their currently active stage of identity development (Oyserman & Destin, 2010). Metacognition, or awareness of one's own thinking and active self-regulatory

control over the processes of thinking, is an essential skill for the development of contemplative self-mastery, integration of transcendent experiences, and spiritual identity formation (Fox & Riconscente, 2008; MacDonald, 2009).

Self-regulatory processes can be identified at both psychological and neural levels and can be automatic as well as intentional (Heatherton, 2011). These distinctions can matter, especially as an expanding body of research shows that what happens in the mind, our proximal cognitive processes and our reactivity to experience, have distal physical consequences in our brains and bodies (Davidson, 2000). Research has identified mechanisms in this ongoing loop of self-reinforcing recruitment and regimentation of brain circuitry, which has been variously referred to as experience-dependent neuroplasticity, adult neuroplasticity, self-organized neuroplasticity, and event-related neuroplasticity (Acevedo, Pospos, & Lavretsky, 2016; Brewer et al., 2011; Brunner, Abramovitch, & Etherton, 2017; Fuchs & Flugge, 2014; Saatcioglu, 2013).

Many of the processes of meditation are aimed at stable effortless flow of unified compassionate awareness through a gradual reshaping of biologically predestined habits of attention and awareness (Schoenberg et al., 2018). Metacognitive self-regulatory processing leads to the development of attentional skill mastery (Schneider, Pimm-Smith, & Worden, 1994). Contemplative cognitive functions that are manifested cross-culturally point to their underlying change in neural dynamics involving similar functionally-related cytoarchitectonic networks of awareness unique to the contemplative brain (Saatcioglu, 2013; Sperduti, Martinelli, & Piolino, 2012). For example, sustaining attention with a silence of mind is common across a large number of introspective traditions and valued for its beneficial effects on psychospiritual wellbeing (Chiesa & Serretti, 2010; Ospina et al., 2007). Meditative practices offer a long history of systematic investigations of subjective experience that provide maps to direct the present study.

Defining Yogic Meditation

Yogic meditation (*samadhi yoga* in Sanskrit; *sama* meaning integration, *dhi* meaning mind, and *yoga* meaning union) was originally developed, not as a unidimensional practice, but rather as a cogent system of training for the embodied mind. It was one the world's first developed ways for retraining dysfunctional perception and cognition in order to discover the true nature of self and existential reality; yet it remains relevant today. Historically, by the beginning of the first millennium BCE, yogic meditation had emerged in India, as a discipline to reduce and eliminate forms of existential suffering (Le Page, 2002). This region maintained a tolerant and cooperative approach to religion. As a result, contemplative traditions in this region were poised for refinement through collaborative heuristic introspective investigations of the mind and awareness.

Meditation is a complex mental process that aims to calm the fluctuations of the mind and improve introspective metacognitive functions (Dorjee, 2010). Meditation techniques from diverse traditions (e.g., Carmelites, Zen, Yoga, Taoist, Kabbalist, Sufi, Vipassana, Dzogchen, Mahamudra, Tantra, etc.) use regular long-term practice for progress in stages (Brown, 1986). Pertaining to a closer examination of this claim within the tradition of Yoga, two of the most important traditional Yoga texts, Patanjali's *Yoga Sutras* (YS; 200 CE) and the *Bhagavad Gita* (BG; 600 BCE), very well describe the connection between meditation and mental modifications. Nested within the *Yoga Sutras* eight-stage system, Patanjali identified three core integrated stages of cognitive control for yogic mind mastery (*samyama* in Sanskrit; YS, 3.4-3.6) that have been described as: (a) undistracted attentional focus (*dharana* in Sanskrit; YS, 3.1); (b) sustained flow of effortless undistracted awareness (*dhyana* in Sanskrit; YS, 3.2); and (c) absorptive release of mental representation in the natural state of unified awareness (*samadhi* in Sanskrit;

YS, 3.3). On the other hand, when not in meditation, it is said that the mind may be distracted and identified with random scattered thinking (*chanchalam* in Sanskrit; BG, 6.34); and fluctuating mental states (*vikshepa* in Sanskrit; YS, 1.31). This, in turn, leads to disturbances, apathy, reactivity, frustration, cognitive distortion, disease, and suffering (YS, 1.30). The practice of yogic meditation trains the mind to sustain states of one-pointed attentional control, quiet ego, mental stillness, self-discernment, and lucidity of introspective awareness.

The theoretical framework for a proto-psychological approach to yogic meditation was first comprehensively compiled and archived by Patanjali, and presented in pithy treatise with extended commentary, collectively referred to as the *Yoga Sutras.* Patanjali presented an applied system founded on yogic meditation, that also delved into an analysis of the psychology of the mind, in ways not previously or so thoroughly revealed before. The *Yoga Sutras* is one of the most important classical texts in India and thus a classic of Eastern, and world thought. Nearly all modern yoga teacher training programs worldwide include the *Yoga Sutras* as core to their theory and practice. However, modern students of contemplative traditions need to be provided a base of evidence that shows how and why their study and practice can be most effective and worthwhile, through a detailed and elaborate treatment of the subject. For this purpose, the *Yoga Sutras* was the most suitable source for the present study, not only because it gives all the essential information about meditation in a concise way, but also because it is recognized as the primary source text of the tradition.

Historically, the systematic approach that Patanjali developed was compiled from the confluence of ancient Indian streams of mind training, with various Hindu and Buddhist influences among them. Gerald James Larson (2008), distinguished scholar and professor emeritus of Indian religions stated:

> The influence of Buddhist thought on the *Yoga Sutras* and the influence on some of the notions of Yoga on Buddhist thought are undeniable. Similarly, influences of Yoga on Jaina thought and on early Vendanta are likewise undeniable. In this regard it can be plausibly argued that until these relations between Yoga, Samkhya, Buddhist thought, Jaina thought and Vendanta have been clarified it will not be possible to write a cogent history of early Indian philosophy (p. 24).

Therefore, the *Yoga Sutras* is not an overtly sectarian text. As a template, it can be and has been appropriated and reconfigured by followers of different schools and traditions throughout Indian religious history and certainly continues to lend itself to such appropriations, most recently including modern Westernized contexts of personalized health and wellbeing (Davidson et al., 2003). In fact, the *Yoga Sutras* serves as the Ur-text of modern yogic traditions, propitiating its own technical language that introduces and defines a specialized process for delving into the mind and consciousness, calling for cross-referential translation methods (Bryant, 2009). In other words, the intention of Patanjali was not mere philosophical-religious speculation, but rather, to develop an applied contemplative psychology that offered a concise systematized practical model to guide further refinement through direct application by all humankind.

As a result of this, Patanjali's methods were theoretically grounded by competencies in attentional control, introspective metacognitive self-regulation, and authentic spiritual identity discernment and development. This contemplative system, therefore, came to be known as a school of practice that offered practitioners a testable, phenomenological database from which they could calibrate their own practice in order to produce a greater degree of optimization in consciousness and existential wellbeing. With this, we see one of the central insights of a yogic worldview: It matters how much work one has done to accurately master the practical training of the embodied mind. Hence, yoga is a multivalent term, and in the broadest sense, we may say that there are Buddhist yogis, Hindu yogis, Muslim yogis, Taoist yogis, Jewish yogis, and Christian yogis (YS, 1.39, 2.44). In other words, yoga refers to the genesis, maturation, and

mastery of contemplative experience through proficiency in self-regulating the embodied mind in order to have true self-insight. Yogis analyzed what the mind is, how it works, known limitations and dysfunctional tendencies, what we can do to improve its functioning, and what it might be capable of with understanding and specific practices.

Generally speaking, one of the primary concerns of both yoga and psychology is to understand the nature of the mind and awareness, and to understand the relationship between our mental experience and our existential reality. Both yoga and psychology rely heavily on introspection to affect change. By integrating evidence from neuropsychology with evidence of introspective training in particular traditional yogic descriptions of meditation practices, some important insights into the mind are made available for more effective practice and research. The study of contemplative science is reflective of the academic dialogue between psychology and spirituality, which has given rise to the related fields of transpersonal psychology and spiritual psychology.

Purpose of the Study

Science has demonstrated that contemplative practice is relevant to the contemporary medical and psychological disciplines (Fox et al., 2016; Slagter et al., 2011; Tang et al., 2015). As the visibility and utility of yoga and meditation increase in Western culture, clinicians and researchers will be asked by clients and colleagues to evaluate current empirical findings, provide clinically sound treatment recommendations, and knowledgeably discuss the nature, benefits, limitations, and integration of these contemplative techniques (Davidson, Goleman, & Schwartz, 1976; Ekman, Davidson, Richard, & Wallace, 2005; Engler, 1984, 2004; Epstein, 1986, 1990; Epstein & Lieff, 1981). This may pose an unexpected difficulty, given that not long ago meditative techniques were mostly dismissed as irrational ritualistic beliefs by scientists

(Brown & Ryan, 2003). As the field of contemplative neuroscience has gained more detailed knowledge of meditation effects at the neural level of investigation, there has been a comparative lack of broad consensus and coherent modeling of their diverse mechanisms and effects.

The present study contributes an integrative review of yogic development of the mind. The findings provide an neuro-theoretical overview of the predictive effects and outcomes of yogic mastery of the mind. The growing scientific support and popular demand for translational approaches to optimal self-mastery make an integrated review of the evidence of contemplative science necessary and timely. Such a study would be useful to both individuals in the public sector who wish to make informed choices about integrative approaches to mental optimization, and to professionals who want to develop a meaningful evidence-base for understanding mind optimization. The purpose of this study was to integrate ancient and modern perspectives regarding the effects of yogic meditation, in order to provide a more comprehensive presentation of the subject, contextualized by the tradition from which it arose.

First, this study examined traditional proficiencies of meditation in order to map investigations by researchers through the lens of integrative neuro-theory. Second, the neuropsychological effects of meditation in the scientific literature are structurally reviewed through the lens of a whole intact contemplative system. Lastly, with the integration of both these lenses, the researcher examined the manner in which the applied neuropsychology of meditation meaningfully demonstrates unique potentials. This study focused on four primary objectives. The first objective was to systematically connect neuroscience research (third-person) on meditation with core yogic meditation theory (second-person) and applied contemplative practice (first-person). The second objective was to make accessible the major findings, controversies, and developments in our understanding of meditation, including its neural

correlative mechanisms. The third objective was to provide structured review of evidence for meditation techniques. The fourth objective was to determine the efficacy of meditation as applied to neurocognitive science and contemplative psychology. The intended audience of this study includes professionals interested in expanding their therapeutic repertoire and integrating current empirical findings regarding meditation; and the lay person, who could benefit from having a greater knowledge and comprehension of the nature and effects of integrative approaches that have grown in visibility in mainstream culture.

What is needed for the millions of students of contemplative practices today, is a clearly intelligible presentation of contemplative psychology that gives an accurate and balanced analysis of its aspects in terms of modern science. In this way, meditation can be understood by students who are prepared to bring an open and informed mind to their own introspective self-development. Students can understand this psychology of meditation sufficiently to be able to decide through integral analysis of evidence whether to undertake a deeper study of the subject, and to get an enhanced understanding about how to accurately master contemplative training using the integration between traditional and neuropsychological perspectives. In the initial stages of practice, meditation begins to bring about fundamental changes in psychological tendencies to gain real insight into mentally reinforced self-constructs. This study is meant to give student-practitioners, psychologists, and neuroscientific researchers of meditation a pragmatic stage-based neuropsychological perspective with regard to traditional methodology, in an evidence-based and integrative way.

In its originally intended form, those who studied yogic mind development had access to teachers who elaborated the knowledge and methods embedded in sacred texts and gave practical guidance in a relational context. The modern student who is interested in the study of

yoga, and is not practicing it under an expert teacher, has none of these faculties and needs an elaborate and clear exposition for an adequate understanding of the subject. The millions of meditation students in the world today need modern integrative commentaries that not only aim at explaining the phenomenological meaning, but also the significance of the proscribed practices in terms of valid evidence, structured in a functional way in order to foster translational research for psychospiritual development.

Traditionally, contemplative truth claims are based on the radically empirical experiments of mystics, saints, and sages who have continued in the ongoing research and development of contemplative practices and teachings throughout the ages (James, 1912). There is a vast literature dealing with all aspects of meditation. However, beginners are frequently confused and need a clear and educated balance of evidence for practice. Yoga and meditation practice has developed over the course of thousands of years with its own literature composed of technical terminology, discourse, commentaries, and expositions of systems of practice. Students can easily feel overwhelmed deciphering ancient literatures for the purposes of modern self-psychology, even more so when considered in the context of the vast amount of research on yoga and meditation available today. In order to better understand the science of meditation, it is important to research its theoretical, pre-scientific background as well as develop more precise methods for modern implementation.

Significance of the Study

As contemplative science has developed, significant challenges have emerged. For example, there is an ongoing lack of overarching theoretical structure and a lack of convergence in different constructs, which tends to lead to the compounding of interpretive arbitration. To further highlight this, many researchers have recently criticized the current state of contemplative

science and emphasized consequences if the fundamental religious and scientific ethos of do-no-harm gets misappropriated as a result of sensationalism, misinformation, and poor theoretical and methodological approaches that can lead to public consumers and practitioners being misled, harmed, or disappointed (Thomas & Cohen, 2014; Van Dam et al., 2017; Wolever et al., 2018). Due to the hype, evidence has become oversimplified to the point of distorting the truth. Overly simple models and hyped marketing approaches, rather than science, risks misleading consumers when it comes to brain training and meditation (Wieczner, 2016).

In modern America, the distribution system for meditation is usually the media, medicine, and science, rather than from traditional texts or schools. As a result, many people think of meditation only from the perspective of reducing stress and enhancing executive functions such as attention, cognitive performance, and emotion regulation. The funding sources for research and media outlets are primarily interested in research that promises to deliver based on economic principles such as greater labor productivity, less recovery time from medical procedures, better stress management and emotional regulation. However, these are practices taken from indigenous contemplative systems that were based on serious existential questioning, and the methods developed from within them were designed to bring the overwhelming awareness of worldly illusions, existential impermanence, and critical examination of conventional forms of self-identity. The differences between traditional and modern approaches are dramatic when you consider that the traditional purpose of meditation was not a restorative timeout to improve your performance in the world of business as it is often packaged and sold to the public today (Wieczner, 2016). With this sort of hype, potential pitfalls are missed. The gulf has become extreme, meditation divorced from its traditional ethical, moral, and renunciate codes has been used to generate computer software applications intended to develop proprietary

profit schemes using intellectual property taken and misappropriated from indigenous cultures. Likewise, meditation removed from the intensive relational support and nuanced guidance of expertly trained and verified teachers has more potential for existential crises, dissociation from reality, or mental disaffection (Engler, 1984, 2004; Epstein, 1990; Lindahl, Fisher, Cooper, Rosen, & Britton, 2017; Schlosser, Sparby, Voros, Jones, & Marchant, 2019).

The processes involved with the stages of meditation-based neurocognitive development are not well understood by psychologists today, and this integrative review will synthesize a framework in order to scientifically map meditative outcomes from ancient traditional descriptions preserved in the literature. In terms of psychological research, one of the most compelling scientific challenges is the potential of using neuropsychological tools to scientifically investigate the cultural products of the past (Craver, 2005; Fabbro, Fabbro, & Crescentini, 2018). Using anthropological and neuropsychological perspectives to study ancient literature was first initiated by researchers studying ancient Greek literature (Dodds, 1951; Jaynes, 1977; Wasson, Hoffman, & Ruck, 1978). This approach has broadened to other areas as well, for example in the neuropsychological interpretation of the prehistoric art (Froese, Woodward, & Ikegami, 2013; Lewis-Williams & Clottes, 1998), prehistoric tools (Stout & Chaminade, 2007), the Hebrew Bible and New Testament (Fabbro, 1994; Shantz, 2009), Guatama Buddha's life teachings (Hanson, 2009; Kingsland, 2017), Freudian psychoanalytic theory (Carhart-Harris & Friston, 2010; Panksepp & Solms, 2012), and the literature of Fyodor Dostoevsky (Baumann, Novikov, Regard, & Siegel, 2005; Fabbro, 2003).

One of the aims of contemplative psychology is to understand the neurobiological substrates associated with extraordinary phenomenological states of mind, in order to find core overlapping features among traditions that can be distilled and updated for translational

application and research. Unlike most meditation research, this study investigates the field from an integrative neuroscientific point of view. This study will synthesize perspectives that are neglected in the field: the perspective of indigenous contemplative traditions that have been training expert practitioners and empirically applying practice for centuries, combined with modern neuropsychological approaches. Despite our recent advances, the field still falls far short of a coherent picture of meditation mechanisms and outcomes. This study is grounded in interdisciplinary and cross-cultural points of view, considering the perspective of the ancient contemplative traditions. In effect, we can benefit from consulting the explanatory models of traditional contemplative disciplines, in order to inform psychological scientific inquiry (Walsh & Shapiro, 2006).

One of the main issues specific to contemplative psychology relates to the introspective dimension of contemplative practices and the associated difficulty in capturing first-person and second-person data. The first-person information refers to phenomenological aspects of meditation experience that only the practitioner can discover. The second-person data is usually provided by an experienced meditator, often a teacher or text, that can report in an informed, experienced, or relational way on aspects that influence progress and accuracy in practice. These types of data need to be meaningfully linked with third-person data from behavioral, physiological, and neurocognitive measurements (Varela, 1996; Davidson & Kasniak, 2015; Lutz, Jha, Dunne, & Saron, 2015). Contemplative training experience, sacred texts, and expert teachers can offer first and second-person perspectives that can be integrated with these third-person approaches to further scientific understanding. However, some of the fundamental limitations in the burgeoning field of contemplative science need to be addressed through greater

theoretical, terminological, structural, and methodological convergence (Dorjee, 2016; Van Dam et al., 2017).

This study is structured by underlying similarities and differences, in terms of mechanisms across practices, and thus contributes to advancement of integrative contemplative theory. Interpretive constructs can create theoretical bridges enabling unique potentials for contemplative theory to contribute more broadly to psychological research. In particular, this research project has focused on the contemplative models preserved in yogic meditation, from where they first were systematically recorded millennia ago. Traditions of meditation training depict a progression of psychospiritual development, and yogic meditation is one of the earliest proto-scientific systems of mind development known. The integration of ancient theories of mind preserved in ancient texts will help guide this investigation, making connections between traditional literature and the most recent finding from neuropsychological research.

In the available literature, much of the current research in the contemplative sciences has been separated from the traditional psychospiritual habitat from which meditative practices emerged and has focused instead on clinically laden outcomes. However, when meditation training is divorced from its traditional context, there is a risk in the clinical application of meditative practices that transpersonal experiences could be limited, not supported, misidentified, or marginalized without context and evidence to support them. With this in mind, current research shows that the impact of meditation can be seen nearly immediately with objective measures of the brain, and the changes are meaningful (Cahn & Polich, 2006). But, to have those changes stick and then become the new normal or become the new baseline requires maturity and mastery of practice. And mastery of practice requires a long-term supportive and sustaining context as demonstrated in traditional natural meditation settings (Lymeus, Lindberg,

& Hartig, 2018). In many studies, these practices have been taken out of their religious and cultural contexts in order to scientifically study them. However, there are elements of the traditional meditative practice communities that are important to retain and study for their impacts (Deshmukh, 2006). Without this, studies may be limited to the realm of the merely physical and economical when they have the potential to offer access to pristine states of extraordinary consciousness and existential awareness.

There is an important relation between the level of expertise in practice and the extent to which practice effects are spontaneously available in everyday life (Boccia, Piccardi, & Guariglia, 2015). However, in the existing research, there have been a limited number of attempts to scientifically investigate outcomes of generating states of meditative awareness in expert meditators. The findings from initial investigations of expert meditators have produced remarkable neuroscientific evidence of non-ordinary awareness and cognitive control (Fell, Axmacher, & Haupt, 2010; Schoenberg et al., 2018; Thomas, Jamieson, & Cohen, 2014). A central investigative feature of this study is exploring how the level of meditator expertise has neural correlates that are hypothesized to provide objective measurement of proficiency in the brain regardless of the particular contemplative tradition (Braboszcz et al., 2017). These findings are worthy of further analysis, given that such neurocognitive proficiencies can potentially inform ethical, emotional, cognitive, existential, and transpersonal domains.

Cognitive agility in sustaining an uninterrupted flow of pristinely uncluttered awareness is often hypothesized to be a key factor mediating the relationship between meditation and the numerous benefits ascribed to it within the current scientific literature (Cahn & Polich, 2006; De LosAngeles et al., 2016; Garrison et al., 2013; Tanaka et al., 2015). Long-term meditation practitioners can effortlessly manifest contemplative conscious experiences, quiet the ego, as

well as override deeply entrenched mental tendencies. These capacities open new avenues for retraining evolutionarily outdated cognitive processes in order to develop optimal brain states and traits. Taken together, contemplative practices typically involve subduing involuntary conceptualization and mental inner-narrative overshadowing processes (Kozma & Freeman, 2017), that would otherwise interfere with a more existentially reflective form of embodied awareness (Dorjee, 2016). This study proposes ways meditation may provide key neurocognitive intermediation for helping subjects suspend mental contents, loosen deep-seated patterns of conceptual elaboration, and sustain pristine awareness of the true nature of phenomenological reality. The outcome and principle aim of meditation practice in the traditional contexts from which these practices originate is very relevant for practitioners, psychologists, and researchers today (Desbordes & Negi, 2013).

Chapter 2: Method and Approach

Integrative Literature Review Method

The Integrative Literature Review (ILR) was the research method applied in this study to "summarize the accumulated state of knowledge concerning the practices of interest and to highlight important issues that research has left unresolved" (Creswell, 1994, p. 22). Creswell (1994) clearly indicated that an ILR is employed when information about a subject has broadened and matured, and requires consolidation and synthesis to bring it up-to-date, or when a subject is novel and ambiguous and requires integration from various sources to provide a more comprehensive overview. The integrative review method allows for the inclusion of diverse methods (i.e., experimental and nonexperimental) simultaneously, and integrates the evaluation of a broad set of literature with an established evaluative framework to develop a more complete understanding of the study topic (Phillips & Merrill, 2015).

The integrative review method has significant contributions it can make to the body of contemplative research, including evaluating the strength of the scientific evidence, identifying gaps in current research, bridging between related areas of research, identifying central issues in an area, generating research questions, identifying a theoretical or conceptual framework, and exploring synthesis of research findings (Russell, 2005). As the stream of contemplative research continues to saturate various academic disciplines such as mind-body training, adult learning, psychology, the need for a comprehensive ILR is warranted to summarily connect the assorted mosaic of contemplative research and provide targeted direction moving forward. Tarraco (2005) asserted, "the integrative literature review is a form of research that reviews, critiques, and synthesizes representative literature on a topic in an integrated way such that new frameworks and perspectives on the topic are generated" (p. 356).

The expectation is that integrative reviews provide new frameworks or ways of conceptualizing an issue for theory-development that can challenge and extend existing knowledge, not simply rewrite it. The ILR was designed to provide synthesis of conflicting reports, developments in understanding and research direction, and findings from various fields of inquiry. Tarraco (2005) suggested an ILR is appropriate when, "contradictory evidence appears, when there is change in a trend or direction of a phenomenon and how it is reported, and when research emerges in different fields" (p. 359). In order to enhance the rigor of this method, Whittemore and Knafl's (2005) five-step method was followed: (a) articulate the problem to be studied, (b) data collection, (c) evaluate data and find gaps in the literature, (d) analyze methodological issues, and (e) synthesis for presentation. Based on the above factors, the justifications for the use of the ILR method in this study of yogic meditation gain more certitude.

Meditation practice has been a subject of scientific research for more than 50 years and may be considered a mature subject in need of consolidation and synthesis. There have been significant developments in our understanding of contemplative science as collaboration and dialogue between contemplatives, scholars, scientists and researchers increases. Meditation is no longer a subject confined to the field of religious studies; rather, it has expanded into the domains of clinical psychology and more recently into cognitive neuroscience. To reflect this last point, the present study examined: (a) the utility and effects of meditation from the yogic perspective, (b) the neuropsychological effects of meditation from a scientific perspective, and (c) the applied integrative psychology of contemplative training. There was thus sufficient justification to support the use of the ILR method for the present study of yoga psychology.

According to Tarraco (2005), synthesis integrates existing ideas with new ideas to create a new formulation of the topic or issue. Synthesizing the literature means that the review

weaves the streams of research together to focus on core issues rather than merely reporting previous literature. Synthesis is not merely a large collection of reported data. It is a creative activity that produces a new model, conceptual framework, or other unique conception informed by the author's intimate knowledge of the topic. The result of a comprehensive synthesis of literature is that effectively new knowledge or new meta-perspective is created despite the fact that the review summarizes previous research.

Webster and Watson (2002) indicated that once a synthesis of the literature was created, typically it culminated in one of four forms: (a) new research directions, (b) a taxonomy of constructs, (c) an alternative conceptual framework, or (d) a metatheory. The present study is an attempt to contribute to a new theoretical approach for future translational research by posing questions that will stimulate interest in the origins of yogic psychology, an area that has been largely misinterpreted (Whetten, 1989). Currently the general conceptualization of meditation is largely of a mind-body practice that is of benefit when integrated with other western behavioral and cognitive psychotherapies. This study provides a new integrative theoretical framework for meditation, which can predict robust outcomes (Whittemore & Knafl, 2005).

The ILR is a relatively new method employed in research, and thus a novel approach for a dissertation as well. To date, there is not a well-established format to organize an ILR as there is for other empirical methods (Webster & Watson, 2002). Tarraco's (2005) report provided some initial guidelines for an ILR to counter the misconception that ILRs are less rigorous or easier to write than other types of research articles. On the contrary, the ILR is a comprehensive form of research that "requires a great deal of research skill and insight" (Tarraco, 2005, p. 356). The tendency is for researchers to extrapolate meditation techniques from their contextual basis in the so-called prescientific systems of India and integrate them into

their own Western health disciplines. This extrapolation increases the risk of key components of the practice being lost in transition and translation. The process of reductionism and extraction is a symptom embedded within a worldview of cultural imperialism, which repudiates the mutual exchange of ideas, denies the possibility of genuine cross-cultural comparison, and stifles the potentially enriching collaborative research between two divergent yet equally viable traditions (Thurman, 1998).

To conduct this ILR, a taxonomy of major conceptual factors influencing meditation were identified in order to categorize the diverse variables permeating the literature. This study provides a comprehensive synthesis of the more rigorous contemplative research available and presents guidance for future research aimed at developing theories and knowledge regarding meditation. Using Torraco's (2005) guide for conducting an ILR, we examine and evaluate the literature with the goal of answering the following research questions:

1. What variables in the mature and diverse meditative literature have exhibited strong empirical support for influencing outcomes?
2. Where are the gaps most pressing across each factor affecting transfer?
3. What methodological progress has been made and what variables remain understudied?
4. How should future theoretical and empirical contemplative research proceed given the findings?

Ultimately, a critique of the state of scientific contemplative literature is provided and targeted suggestions are outlined to guide future empirical and theoretical work in a meaningful direction. Meditation is a practical science and every practical science has a theoretical basis which may or may not in reality correspond exactly with the facts which form the real basis of

the science. However, an IRL is the most comprehensive method of approach for developing theories, as it allows experimental and non-experimental studies to fully understand the phenomenon being analyzed, by combining data from theoretical and empirical literature; and has a wide range of uses due to its "comprehensive panorama of complex concepts" (de Souza, da Silva, & de Carvalho, 2010, p. 105).

Nevertheless, the ILR has significant limitations that need to be disclosed and considered. First, the potential bias of the researcher must always be taken into account in any authored study. And with the integrative review method, there may be a lack of balance in assessing rigor and relevance of the sources due to overemphasis on a specific theme (Phillips & Merrill, 2015). There is also the potential for bias in the use of a framework for evaluation and interpretation. Likewise, it is therefore possible that the evaluation favored findings that supported the framework. With the integrative review method, it is inherently difficult to compare results due to the inconsistency of measures used by the broad range of research studies reviewed. Additionally, there tends to be a lack of consistency in the research studies on yoga and meditation, in general. The broad definitions and multiple styles utilized in contemplative research complicated this integrative review.

In sum, the ILR has many benefits including evaluating the strength of scientific evidence, identifying gaps in current research, identifying the need for future research, bridging related areas of work, identifying central issues in an area, generating research questions, identifying a theoretical or conceptual framework, and exploring which research methods have been used successfully (Cooper, 1998). Several threats to validity exist when using the integrative review method. In order to reduce threats to validity, Cooper (1998) advised that the information gathered about the relationship of the variables under study are clarified, conceptual

definitions are balanced, adequate broad differentiated sampling of data are performed, and quality studies are included. The broad nature of the integrative review can lead to the potential for systematic bias or misanalysis. For the purposes of this integrative review, the constant comparative method of analysis was employed as it has been identified as a valid method to establish systematic organization and facilitate recognition of patterns, themes, variations, and relationships within datasets (Patton, 2002). Constant comparison is the data analysis process whereby each interpretation and finding is compared with existing findings as it emerges from the data analysis itself. This process undergoes continuous refinement throughout the data collection and analysis procedures.

In order to support the metatheoretical arch of this study, nearly six hundred supporting references were included from a total of more than four thousand candidate articles mostly from six scientific research article databases: PubMed, PubPsych, PsychINFO, ResearchGate, JSTOR, and ScienceDirect. Keywords used for this review were meditation, yoga, awareness, and consciousness with further isolation of studies conducted in neuroscience and psychology. Candidate articles were assessed by title and abstract for inclusion. The inclusion criteria were: (a) works written in the last twenty years, (b) scholarly works from peer reviewed journals, (c) relevant historical references, and (d) works written in English. In addition, sources from the reference lists of the studies reviewed were included. Out of these, about a third were current research on contemplative neuroscience. Another third, comprised current research on cognitive neuroscience. The last third of the cited research were just about evenly split between developmental evolutionary psychology, transpersonal psychology, and historical references. Data extraction and analysis were then completed on all included studies. The studies were analyzed with consideration of purpose, methods, and findings. These were identified and

summarized based on common patterns and central issues, and then organized and integrated. As a final note, the author's paraphrased transcriptions of the *Yoga Sutras* and the *Bhagavad Gita* used herein were transliterated and translated through the works of Edwin Bryant (2009), who has a Ph.D. in Indology from Columbia University; and Baba Hari Dass (1999, 2008, 2013, 2017), an expert yoga master and Sanskrit scholar. For this, cross-referencing between a highly qualified academic scholar and highly qualified expert practitioner-scholar provided a balanced approach to accurately paraphrase primary traditional source-text material in this study.

Chapter 3: Literature Review

Integrative Yogic Psychology

Science as we know and understand it in its earliest forms was widely practiced in ancient India (Subbarayappa, 2014). Astronomy, mathematics, surgery, psychology, physiology, and logic were some of the areas in which the ancient Indians excelled (Bose, 2009). In fact, the scientific movement in ancient India was not isolated from other parts of the world. It entailed examination of truth claims and acceptance of only those claims that passed tests of validity. However, the Indian theory of knowledge was not limited to investigations of the objective world, and in many ways exemplified investigative study of introspective experience and states of consciousness. In fact, the Indian theory of knowledge included volumes of empirical data on introspective awareness practices to understand thought processes and mind states.

Practically unknown to Western psychologists, ancient Indian scriptures contain very rich, empirically derived psychological theories that are embedded in religious-cultural-philosophical content and that require further extraction and cross-analysis for scientific understanding. Notably, the Indian theory of knowledge dealt with other ways of knowing such as methods of contemplative training to access states of inner peace, lucidity, and wellbeing. It was within this intellectual context that the discipline of meditation first developed. In fact, meditation developed from the premise that the conventional processes of mind are not the only way for us to know, understand, and connect with the world. However, before describing further theoretical claims, it is necessary to clarify the apparent incompatibility of the religious aspects contained in the Indian systems on the one hand and Western psychological science on the other. In other words, there are barriers to be overcome in terminological and theoretical variance. A problematic issue arises from the way ancient Indian psychology is embedded in a religious-

philosophical context, so the language and arguments used are not familiar to present-day psychologists.

That being said, this study aims to investigate some of the psychological content in these systems, and the empirically-based theories contained within them, rather than engage in a more elaborative study of the systems of religious belief, in which they are culturally embedded. The tradition of meditation offers its own form of hypotheses testing for its truth claims. Contemplative training techniques are used to obtain subjective results that are reproduced, compared, and debated for further evidence, in an ongoing heuristic cycle. As a result, the student of meditation is encouraged to test suggested practices through experiential insight. That said, an integrative translational scientific framework for consciousness studies provides room for theoretical revisions that propose that the development of scientific technology can be utilized to demonstrate that centuries ago developments in contemplative training constituted an earlier soft tissue/high technology scientific revolution (Bushell, 2009).

To explicate the value of this ancient scientific revolution for modern psychology it is necessary to first give some background information. The Western words, medicine and mediation, both come from the Latin verb *medeor*, which means to amend, cure, heal, calm. Meditation and yoga in many various forms was practiced in order to cure physical, psychological, and spiritual suffering in ancient India. The Indian word *yoga* is derived from the Sanskrit verb *yug,* which means to join or unite. Historians note that term *yoga* is found in ancient India's earliest known scripts, which date to at least 3000 BCE and served as the first documentation of meditation practice. One of the earliest preserved texts to teach specific yogic meditation practices was the *Chandogya Upanishad* from the early part of the first millennium BCE. This text expounded upon a hierarchy of progressive meditation skills, guided by a teacher,

in order to integrate self with a unified reality (Olivelle, 2008). Historically, the psychologically technical aspects of yogic meditation continued to develop over the centuries as a system of mind mastery with a list of supportive auxiliary practices.

The *Katha Upanishad* (600 BCE) can perhaps be acknowledged as the first text that explicitly described meditation at length, where it was referred to as the yoga of the inner self (*adhyatma-yoga*). The *Katha Upanishad* provided a map of contemplative directives for the yogic processes of relaxing the mind and its faculties in order to free attention for the introspective identification with the true self. It stated that once the mind is undistracted and stabilized then one can discover inner unified spiritual identification with vast consciousness. The *Katha Upanishad* (1.3.15) stated that the true self is without sound, without touch, and without form: You will know the true self when your senses are still, your mind is at peace, your heart is pure and free from death (Olivelle, 2008). The true self was described as transcendent, peaceful, pure unified awareness free from identification with mental content and self-reference.

Later, in the same course of discipline-specific development in the ancient literature of India, the *Maitrayaniya Upanishad* (300 BCE) presented a more systematic mapping of yogic meditation theory and praxis. The *Maitrayaniya Upanishad* expounded upon a proto-scientific system of meditation to augment consciousness by calming the breath, disengaging externalized perception, controlling attention, maintaining uninterrupted flow of introspective meta-awareness, cultivating deeply aware intelligence, and practicing immersion in unified states of awareness. This text represents a formidable degree of applied psychological knowledge for its time, and demonstrates the continued advancement of yogic meditation practices for centuries in India. The *Maitrayaniya Upanishad* listed six auxiliaries for effecting oneness or union (*sayujya)* with our unchanging center of being: (a) breath control, (b) withdrawal of the senses,

(c) concentration, (d) meditation, (e) reflection, (f) unification (Olivelle, 2008). Included here are the very first systems of practice that laid the groundwork for later and more expanded works in the field of contemplative practice systems.

The traditional orthodox schools of thought in India are divided into six broad categories in the historical literature—Samkhya, Yoga, Nyaya, Vaisheshika, Mimamsa, and Vendanta. Samkhya seems to hold a place as the earliest Indian philosophical system, which subsequently permeated all other Indian traditions (Larson, 2008). Thus, Samkhya contributed theoretical systematization and philosophical structuring to the Yoga tradition. However, the two traditions are distinguished in the ancient literature of India as representing distinct ways for attaining salvation: (a) Samkhya recommends scriptural knowledge and intellectual detachment, and (b) Yoga recommends meditation experience and embodied action. In Yoga, the truth can never be understood merely through conceptual means. In addition, Yoga further distinguished itself by stating that the goal of yoga (*samadhi*) can be attained directly through devotion and the grace of God (*Ishvara*). God in the Yoga tradition is undogmatic, nonsectarian, eternally perfect, and the timeless teacher of divine spiritual truth, in whom the seed of omniscience is unsurpassed (YS, 1.25). One of the earliest references to being granted the vision of God occurs in the *Katha Upanishad* (1.2.20): Greater than the great, smaller than the small, the spiritual self (*atman*) is hidden in the heart of all beings. One without desires and free of sorrows sees the majesty of the spiritual self by grace of the Supreme One (Olivelle, 2008).

In Yoga, the dualistic habits of the mind cannot be changed without a systematic embodied application of practices. Yoga is best understood as a hierarchical cluster of practices, some more and some less systematized, that pervaded the history of ancient India from earliest recorded times. Yoga was not meant to replace other systems and has demonstrated a significant

degree compatibility throughout history. Yoga is based on the fact that each person is unique and has access to the universal capacity for radical embodied psychospiritual transformation. Yoga is a practical approach accessible to most for reaching an enduring state of self-liberation and true happiness. Yoga cannot be reduced to any one system of thought and practice, however the various schools all tend to agree that yoga practice allows one to develop capacities for transcending superimposed mental activities that tend to pattern our life with an underlying sense of dissatisfaction, stress, and superficiality.

For centuries the primary reference book in the field, the *Yoga Sutras*, written by the sage Patanjali, has been an essential resource for anyone exploring the yogic path for self-insight, mind mastery, and existential wellbeing. The *Yoga Sutras* offers concise observations on the nature of mind and consciousness, and is considered a systematized manual for understanding and mastering the mind through yogic meditation. The *Yoga Sutras* has endured with a track record of offering directions to guide and inspire yogis, mystics, and scholars because it effects the attenuation of mental suffering through praxis and theory. The *Yoga Sutras* is open to many interpretations, and the more deeply one is engaged in a meaningful yoga practice, the deeper one's understanding of the teachings. At the causal root of human suffering, in Patanjali's view, is lack of contemplative mind training and introspective spiritual identity development.

Yogic meditation is a practical science and every practical science has a theoretical basis which attempts to correspond accurately with the facts which form the real basis of the science. Since the system of yogic meditation outlined by Patanjali is essentially a proto-scientific approach, it provided a relatively comprehensive theoretical treatment of the subject and therefore has remained useful to real practice. Patanjali's yoga psychology offered a mapped theory of life enhancement through mind mastery, in a paradigmatic manner. Patanjali proposed

that real truths of existence were to be discovered directly and experientially by following a practical system such as the one he outlined in the *Yoga Sutras*.

The *Yoga Sutras* is a complete step-by-step manual containing 196 aphorisms that serve as systemic auxiliaries of *samadhi yoga*. The *Yoga Sutras* form the theoretical and philosophical basis of what are considered to be the most organized and defined writings of in the formative stages of this discipline of yoga. Commentary offers an opportunity to expand upon the concepts and lessons of the sutra. The *Yoga Sutras* are broken down into four chapters, each presenting Patanjali's four differentiated levels of integrative practice:

1. *Samadhi Pada* (51 sutras): Chapter on Yogic Contemplation
2. *Sadhana Pada* (55 sutras): Chapter on Yogic Practice
3. *Vibhuti Pada* (56 sutras): Chapter on Yogic Mind Mastery
4. *Kaivalya Pada* (34 sutras): Chapter on Yogic Self-Realization

To this end, the *Yoga Sutras* are based on a foundation which includes the prescribed adherences to stages and their integratively related practices and states. Patanjali instructed yogis in the structured theory and praxis of psychospiritual empowerment (Braud, 2008). India's ancient streams of psychology recognized millennia ago that in normal everyday life our attention constantly shifts. India's best known classical text, the *Bhagavad Gita,* states that mind is ordinarily in a state of obstinately shifting, fluctuating, turbulent activity (BG, 6.34). Through synthesis and distillation of various streams of ancient Indian psychology, Patanjali developed an applied integrative psychology of attentional self-regulation for acquiring true wisdom (YS, 1.48), lucidity of the inner self (YS, 1.47), and introspective metacognitive spiritual discernment (YS, 2.5-2.6, 2.17, 2.25-2.28). Metacognition can be seen as the ability to self-monitor mental processes and regulate the processes of cognition that form individual identity through

associative self-representation of objects. The mind, which is colored by the seer as well as by that which is seen, knows all objects (*drastr-drsyoparaktam cittam sarvartham*; YS, 4.23).

Cognition and self-psychology play a crucial role in Patanjali's system because what are normally held to be independently existing things are seen to be fluidly linked and influenced through the perceptual processes of the mind. Thus, ordinary mundane existence is experienced as an egoically referenced reality based on chronic self-referential information processes that fragment human identity with partialized ways of cognizing reality. Psychologically, due to the fragmented state of selfhood (*cittavrtti*), the network of subconscious influences (*samskaras*) and habituated mental patterns (*kleshas*); life is experienced through the repetitive generation of ego-derived mental constructs (Wenk-Sormaz, 2005). Therefore, a thorough study and retraining of the mind is the key to the success in Patanjali's system.

As briefly touched upon in the introduction, Patanjali utilized and strengthened attentional regulatory mechanisms (YS, 1.13) in order to activate three core proficiencies (YS, 3.7) in his contemplative psychology: (a) one-pointed attention (*dharana*); (b) stable flow of effortless awareness (*dhyana*); (c) absorption in nondualistic states of pure unified awareness to acquire integration, wholeness, and true insight (*samadhi*). When all three become proficiently pliable, the fullness of yogic mind mastery (*samyama*) yields unrestricted intuitive insight into the universal matrix (*mahat-pratiprasavana*) of manifest existence (*prakriti*). However, Patanjali drew a clear distinction, the attainment of the *samadhi* state involves the elimination of mind wandering and the development of cognitive control (*sarvarthataikagratayah ksayodau cittsya samadhi-parinamah*; YS, 3.11). The degree of freedom from unwanted thoughts and the degree of pliable mental concentration are the measures to gauge yogic spiritual progress. This development of mind mastery incorporates many forms of practice depending on the needs of the

practitioner and includes the physical, moral, psychological, and spiritual dimensions of our being. Considering all of this, Patanjali's yoga psychology demonstrates the potential for addressing ways of reconstructing dissociated dimensions within humans and human collectives not adequately accounted for in modern psychology or science.

In total, eight sequential stages and more than twenty types of practice can be undertaken for development through four levels of meditation mastery in Patanjali's system. However, it necessarily involves a serious inquiry into the structures and contents of the mind along with experiential analysis of why and how to understand and retrain the mind. Following five external stages: *yama* (ethos), *niyama* (virtues), *asana* (posture), *pranayama* (breath control), *pratyahara* (sensory isolation); the practitioner progresses through three internal stages: *dharana* (concentration), *dhyana* (meditative flow), and finally *samadhi* (absorption in pure unified awareness). As a whole, humans are more than just conscious they are also self-aware. Consequently, human individuals embody various levels of awareness and intentional set-points when they begin contemplative practice. However, *samadhi* signifies increasing degrees of integrating differentiated levels of awareness and self-agency.

So according to Patanjali, true self-awareness is associated with a meditation-based differentiation and integration of all levels of awareness, which purifies consciousness and transcends ego-based states of mind. Ego is to consider the nature of the seer and the nature of the instrumental power of seeing to be the same thing (*drg-darsana-saktyor ekatmatevasmita*; YS, 2.6). Repeated experience of these states during meditation practice leads to a long-term progressive refinement in the sense of self (*asmita*). The impediments to *samadhi* are spiritual ignorance, ego, desire, aversion, and clinging to what changes (*adiyasmia-raga-dvesabhinivesah klesah*; YS, 2.3). One's self-identity becomes progressively detached from identification with

externally oriented perceptions, then from identification with the body, then from identification with thoughts, to developing sagacity for absorption in optimal states of pure unified awareness called *samadhi* (YS, 1.17).

A majority of the concepts in the *Yoga Sutras* are the synthesis of many centuries of prior experimentation, hypothesis testing, and theoretical evolution (Bryant, 2009). Patanjali reworked these claims into a schematized system of theoretical principles and constructed a proto-psychology of mind (Whicher, 1998). Patanjali described yogic meditation as self-mastery in effortlessly resting the mind in a natural state of awareness freed from mental patterns of distraction, reaction, attachment, and misidentification (YS, 3.2). Patanjali provided steps through which each person can fulfill the primary purpose of yogic proficiency, which is to master the embodied mind, and by training attention, rest in the true nature of undivided whole pure awareness (YS, 1.2-1.3, 1.12-1.14).

Yoga is defined by Patanjali as: *Yogas chitta vritti nirodha* (YS, 1.2). Which translated, states that yoga is the stilling regulation (*nirodha*) of the fluctuating contents (*vrittis*) of the mind (*chitta*). Patanjali suggested controlling misidentification, fusion, and nonconscious entanglement with one's own mental processes through a progressive path of interiorization for pliability in cognitive control that yields authentic insight into the intersection of mind, self, and phenomenological reality. The entomology of the Sanskrit word *nirodha* is derived from *ni* (down, into) and *rudh* (regulation, inhibition). Interestingly, this Sanskrit term also describes the effects of focused-attention meditation practice on neural activity in terms of the cortical top-down recruitment of attention networks to inhibit nonconscious bottom-up primary processes originating in subcortical somatosensory hubs, also referred to as associative based brain processing. The contents during ego-based mind-wandering includes: elaborate self-relevant

spontaneous thoughts, emotions concerning the ruminating about the past, fantasies about the future, unfulfilled goals, interpersonal feelings, intrusive thoughts, and strategizing for challenges with mentalized inner-narrative (Smallwood, Beach, Schooler, & Handy, 2008). Likewise, cognitive fusion occurs when we fuse our thoughts with reality in a nonconscious manner (Dahl et al., 2015). Consequently, the conscious aspects of the mind usually identify with the contents and their associated fluctuations in the mind, which are reflected in their measurable widespread activation and intersubjective synchronization of brain wave patterns (Hasson, Nir, Levy, Fuhrmann, & Malach, 2004; Smallwood & Schooler, 2015; von Stein & Sarnthein, 2000).

In other words, the goal of yoga is attained through critical self-mastery of mind, which can otherwise remain chronically absorbed in and identified with randomly fluctuating contents of mind (YS, 1.13). When that is accomplished, the seer can abide in its own true nature (*Tada drastah swarupe vasthanam*; YS, 1.3). This accomplishment is achieved by intensity and degree of accuracy in practice (YS, 1.21-1.22). According to Patanjali, skill in discernment, mental focus, sustained attention, and introspective awareness are necessary for stable flow of pure unified awareness (*samadhi*). Upon the purification of the mind, one attains clarity, happiness, one-pointedness, somatosensory mastery, and fitness to perceive the true self (YS, 2.41). The truth claim of yoga is that it is possible to reliably train optimized levels of human consciousness, through the conscious process of stilling mental rumination and fine-tuning attentional control, in order to develop free attention for accessing states of *samadhi*, which are considered consummate states of contemplative mastery (YS, 1.40-1.41). The process involved is technical and involves precision in embodied cognitive control (YS, 3.9-3.13). Practice becomes firmly established when it has been cultivated uninterruptedly and with devotion over a prolonged period of time (YS, 1.14). Yoga psychology involves, among other things, cultivating

self-regulatory proficiencies with mental and physical stimuli. If practiced regularly, disciplines for yogic mind mastery can allow you to experience feelings with a kind of non-attachment (*vairagya*; YS, 1.15) or indifference (*vaitrsnyam*; YS, 1.16), which means neither struggling uncomfortably to escape (*dvesha;* YS, 2.3-2.8) the bad feelings; nor trying, desperately and futilely, to hang to (*raga*; YS, 1.37, 2.3-2.7) the good feelings.

From Patanjali's perspective, neither aversive or appetitive drives are deemed worthy of much attention. Rather, yogis train the mind to transcend the orthogonal processes of aversion and desire in favor of a condition in which mental activity is stilled through the regulatory action of contemplative practices (*nirodha*). According to Patanjali, yogis must have the discriminative intelligence to develop identification with pure awareness rather than mental overshadowing (YS, 3.54-3.55). This has to happen at three levels: (a) self-referential information processing, (b) mind-wandering, and (c) subconscious influences. For example, the things in the environment, such as traffic patterns or social media, trigger neurobiologically-based feelings that set-in motion subconscious self-related trains of random thought and reactions that govern behavior. These effects condition individuals unless through contemplative mind training they start to develop dexterous control of their mind processes.

Walsh and Shapiro (2006) suggested a definition of meditation as a set of self-regulatory techniques focused on maintaining attention and awareness with the goal to achieve a greater degree of wellbeing and peace through the enhancement of control over psychospiritual processes. All of this points to the sense in which Patanjali's appraisal of the human condition shares theoretical ground with contemporary psychology (Engler, 2004; Sedlmeier & Srinivas, 2016). The human brain is conditioned by natural selection to respond in reflexive fashion to the sensory input impinging upon it. The brain is phase locked, in a certain sense, to be overly

controlled by that input due to biological imperatives that drive the system, tending to function in an automated pre-patterned manner. In response to maladaptive tendencies of mind, indigenous practitioners of contemplative practices found ways to evolve consciousness with methods for enhancing introspective mind training. Contemplative practitioners commonly went out into the wilderness and used disciplines, such as fasting, prayer, meditation, and sacred medicines to encourage the body not only to stop producing the chemistry of stress, anger, desire, and fear; but to start developing another kind of neurochemistry and neurocircuitry altogether. Through the integration of yogic theory and neurobiology, this study posits the hypothetical claim that implicit evolutionary mechanisms of the nervous system are programmed to awaken higher circuits of function when lower functional centers are downregulated through contemplative training (Vaitl et al., 2005).

The brain must be thoroughly deconstructed as a biological organ in order for us to become cognizant of its constituents and how they interact to affect phenomenal experience as Patanjali described. Everyone knows what it feels like to have consciousness, the self-evident sense of personal awareness that gives the feeling of ownership and control over the thoughts, emotions, and experiences that occur throughout the day (Serino et al., 2013; Serino et al., 2015). It is easy to assume that the contents of consciousness are somehow merely chosen, or caused and controlled by our personal awareness. However, nonconscious modes, conscious control, and experience overlap; and are not merely separate and distinct. Research findings suggest that many neurocomputations are generated behind-the-scenes by fast, efficient, non-conscious systems in our brains (Wan et al., 2012). Even the brains of young babies not only organize sensory information, but supply what is missing, infer cause and effect, and use the information to generate implicit theories about how the world operates (Blackmore, 2016). Most

neurocognitive investigators agree that the mind and the brain processes can be decomposed into two basic categories known by various names: conscious-nonconscious, controlled-automatic, explicit-implicit, or volitional-spontaneous.

The power of the brain to control our perceptions is well established, implicitly molding information to fit facts into pre-established mental frameworks. Dating back as early as 1860, the German physicist, physician, and polymath Herman von Helmholtz referred to unconscious inference as an involuntary, pre-rational and reflex-like mechanism which is part of the formation of sensory perception through the integration of sensory input and generative conceptual impressions, which later became known as top-down cortical (conceptual) and bottom-up thalamic (sensory) processing (Clark, 2013). However, cognition and consciousness do not necessarily inherently coincide. Without consciousness, nonconscious cognitive processing and behaviors are performed habitually in an automated way.

The concept of nonconscious processing was first expounded upon in the essay "The Unconscious" by Sigmund Freud (1915/1963). However, Freud's view was that the main purpose of unconscious and subconscious layers of the psyche is storing information, rather than information acquisition and processing. Consequently, Freud underestimated the nonconscious mind. According to a large body of psychological and neuropsychological research conducted in the last thirty years, what happens in our conscious thinking, perceiving, and learning account for only a small fraction of our mental processing. The actual bulk of the processing occurs in the nonconscious mind, and the conscious mind is less adept, slower, and less efficient at processing information. Therefore, the nonconscious mind has its own type of influence on the development of a significant part of our personality, functional intelligence, behavioral tendencies, and individual talents.

For example, the nonconscious spontaneous mind helps us understand so many unspoken rules when it comes to social interaction and communication. This requires language with numerous idiosyncratic grammatical and semantic rules that make up what we must know in order to communicate effectively. All such rules are not explicitly conscious, because they are processed so fast, they are nonconscious. This is one example, but these nonconscious structures underlie every thought and action. Most importantly, the nonconscious mind is active every moment of our lives, waking or sleeping. Generally, conscious events rely on the processing of thousands of pieces of nonconscious information. We are unable to consciously access all this information for a reason, as it would be impossible to function efficiently and survive otherwise. In the observer's experience, phenomenal holism is faster recognized than discrete parts, indicating that object recognition is not simply representation of elementary features but the result of synchronously unified and coordinated interactions of large numbers of neurons (Antzoulatos & Miller, 2016; Harris & Gordon, 2015; Liu, Bartsch, Lin, Mantegna, & Ivanov, 2015; Pajevic, Basser, & Fields, 2015; Uhlhaas & Singer, 2013).

Consider how effortlessly we regain consciousness each morning after losing it the night before; how thoughts and emotions arrive already formed in our minds; how meaningful objects take hold of us without any effort or input from our conscious mind. To further illustrate the implicit nonconscious constructivist powers of the brain, it has been established that the brain predicts what your eyes will see before you look (Edwards, Vetter, McGruer, Petro, & Muckli, 2017). The eyes send input to the visual system in the brain (feedforward), while at the same time, the brain also sends information to the visual system (feedback). Feedback information influences our perception of the feedforward input using expectations based on our memories of similar perceptual events in a process of hierarchical predictive coding in the brain that

constantly generates and updates input through feedback connections (Clark, 2013). And so, the brain preferentially samples evidence and edits data to confirm one's prior belief through nonconscious cognitive processes (Talluri, Urai, Tsetsos, Usher, & Donner, 2018). The capacity for making meaning is colored by these fast momentary nonconscious cognitive comparisons.

What is more, mental contents take on the form of a constantly updated personal narrative permeated by core themes, such as self-identification and interpersonal motivational processes (McAdams, 2001). The personal narrative helps to bind information that allows us to generate survival strategies; for example, by learning to predict environmental factors and other's behavior in order to create alternative biological hierarchies (Veglia & Di Fini, 2017). This, in turn, consolidates a series of mental representations that regulate, select, and process perceptual information and social actions in order to constantly generate implicit predictive strategies (Liotti & Monticelli, 2011). It is interesting to examine why people accept and act on certain kinds of information while dismissing others. Narrative themes are very powerful agents for affecting human behavior. So much so, that the United States Defense Department has invested millions in studying why some narrative themes are successful at building support for terrorist groups, hate crimes, and acts of violence, while others are not (Boyte, 2017).

The adaptive strategies produced from constant internal streams of narrative content with mental constructivist overlay are cortical mechanisms recruited to carry out evolutionary passage. One of the unique scientific values of meditation rests on its ability to selectively target processes that appear to be critical for introspective self-regulatory discernment of the contents of consciousness. In effect, mental energy and attention are disburdened through proficiency in decoupling the experience of consciousness from the constantly fluctuating contents of consciousness. Due to this, the capability of meditation experts largely depends on the

neurobiological shaping of intuitive, implicit, and conscious attentional strategies through intensive long-term practice. In this way, meditation can recondition the ingrained mechanisms that natural selection uses to direct our behavior and construct our reality. Meditation comprises hundreds of different techniques to accomplish this, but many of these can be grouped into a few broad categories, however these categories typically are not meaningfully related to one another within the context of a coherent map of an applied integrative method.

The Western term *meditation* entails a wide variety of different practices. Notably, there is no comparable term in the East, used in the same way that Westerns have signified the term *meditation*. So, it tends to represent an overly-generalized and imprecise Western terminological conceptualization dissociated from the whole intact contemplative systems from which it emerged. And thus, terminologically, meditation is of Western origin, and its generic conceptualization and partializing terminological standardization in the literature tends to be overly fragmented and imprecise. Considering this, it makes little sense to use the term meditation without contextual descriptors. This study takes a pragmatic approach towards this problem by referencing the specific systematic, methodological, and phenomenological descriptors in the yogic spiritual tradition. In addressing the action of meditation on the brain, the intention is to offer an integrative account of how whole intact meditation systems inherently work to change brain function in order to refine awareness and change biological predestination. There is currently a vast amount of research on meditation, however there is relatively few theoretical reviews that consolidate the existing literature into a practical integrative stage-based theoretical framework. Existing research includes few theoretical accounts describing components that attempt to elucidate the underlying convergence of neuropsychological mechanisms and methods that substantiate differentiated stages of meditation proficiency.

The most popular Western scientific scheme uses two basic categories of meditation: focused attention (FA) and open monitoring (OM). Each of these categories of meditation has been explored with functional neuroimaging in some detail in the last twenty years. This considerable body of work shows that psychologically distinct meditation practices demonstrate correspondingly distinct neural correlates. Unfortunately, systems or types of meditation that do not fit neatly within these separate categories have only rarely been investigated. For instance, contemplative researchers commonly do not discuss why there are different categorical types to begin with, and how different types of meditation are meaningfully and specifically related to one another through various intact systems of meditation development. That said, the majority of psychological studies include the cognitive role of attention in meditation practice (Brown & Ryan, 2003; Carmody, 2009; Lutz, Slagter, Dunne, & Davidson, 2008; MacLean et al., 2010). Yet, attention requires our brains to balance focus with awareness guided by self-directed targets.

A few studies have suggested discrete processes that mediate beneficial targets of meditation practice. In one of these studies, Brown, Ryan, and Creswell (2007) posited discrete intersecting processes underlying the beneficial effects of meditation, including: (a) insight, (b) exposure, (c) nonattachment, (d) enhanced mind–body functioning, and (e) integrated functioning. Likewise, Shapiro, Carlson, Astin, and Freedman (2006) posited that attention, intention, and attitude are the three critical components of meditation. Additionally, Baer (2003) hypothesized convergent factors that may explain how meditative skills can lead to symptom reduction and behavior change, namely (a) exposure, (b) cognitive change, (c) self-management, (d) relaxation, and (e) acceptance. Two related studies proposed neural-based components to describe the mechanisms of meditation. Holzel et al. (2011) claimed (a) attention regulation, (b) body awareness (c) emotion regulation, and (d) change in perspective of the self as core

mechanisms of meditation. Furthermore, Tang, Holzel, and Posner (2015) held that the core components of meditation practice are (a) attention control, (b) emotional regulation, and (c) self-awareness; that proceed through the stages of effort until mastery. Lastly, Vago and Silbersweig (2012) cogently posited a framework for understanding discrete neuropsychological mechanisms of mindfulness meditation based on (a) self-awareness, (b) self-regulation, and (c) self-transcendence.

Whole intact contemplative systems include practices that address core values and help discern the true nature of the self. The ongoing constantly updated personal narrative, spoken of earlier, is identified in this capacity as a maladaptive mental overshadowing process that limits potentials for wellbeing and spiritual identity development. As seen in the latter studies listed above, psychologists and cognitive neuroscientists have started to postulate theories to include the effects of meditation on mental representations of self. For example, Dahl, Lutz, and Davidson (2015) proposed that their former widely popular classification of meditation styles into FA and OM types was useful to the field of contemplative research, but now given what they have learned, they consider them outdated theoretical categories. In order to expand this framework to include a broader range of traditional and contemporary meditation practices, the researchers grouped them into three updated categories to better map practices based on primary cognitive mechanisms: (a) attention regulation and meta-awareness (attentional); (b) perspective taking, reappraisal, and self-schema (self-constructive); (c) self-inquiry and insight (self-deconstructive).

Psychological or behavioral tests help provide empirical support for some of the proposed mechanisms in the scientific literature. However, the neuroimaging literature has begun revealing brain activity during the meditative state to map changes in neural structure and

function associated with meditation practice. Neuroscientists first applied methods of functional neuroimaging to the investigation of brain states at the turn of this century, in order to see brain circuitry dynamics, which have been very useful for meditation research. Mainly, there are three ways in which the functional investigation of meditation has been approached in the available scientific literature: (a) find the neural correlates of specific forms of meditation practice, (b) compare novices and expert meditation practitioners to see how different types of meditation change the neural response to certain tasks and experiences, and (c) examine enhanced introspective abilities of expert meditation practitioners that are difficult to study otherwise.

Given this, no previous study has tried to integrate these approaches in the neuroscientific literature with an intact traditional framework, providing an evidence-based theoretical map of signature stages of contemplative mastery that suggest an underlying mechanism in yogic meditation systems. The aim of this integrative review is to index existing findings and put forth a cohesive neuropsychological metatheory of meditation systems based on a convergence of several empirically supported components. Previous theoretical models have described the process of meditation almost exclusively from a conceptual, cognitive, or psychological perspective. This integrative review will also include evolutionary, neuroscientific, and transpersonal perspectives as well. It offers a contemplative theoretical framework sufficiently broad to connect biology and psychology in a way that is consistent with evolutionary mechanisms. This integrative review structures a convergence of evidence in a way that furthers scientific investigation of the components and mechanisms of contemplative science, and discusses theoretical processes of meditation systems that predict stage development of contemplative maturity. The results obtained from integrating different methods offer new, interesting perspectives and insights that can have a significant impact on neuroscientific

research, as meaningful synthesis of multidisciplinary results is more than the sum of the parts.

Functional Neuroimaging of Contemplative States

Neuroscience has provided us with astonishing breakthroughs through minimally invasive methods of imaging the human brain, revealing mechanisms of the brain's complex and extraordinary repertoire of functional activity. In general, the development of cognitive neuroscience is an effort to understand how the brain processes mental events. A comprehensive analysis of mental events includes complex system dynamics. The general problem of brain mechanisms is now being studied by means of methods for recording the activity of large populations of neurons. However, the prevailing research paradigm in neuroscience considers neurons as stationary binary computational units, not necessarily as members of a shifting dynamical entity. Neural computations do not operate merely as a binary read-out from computational units, but also as a dynamic and diffuse pulses of waves, in tight millisecond time range, synchronizing across the brain in spontaneous self-organized cadence. Scientists have argued that, due to the complexity of these circuits, a structural map alone will be ultimately remain deficient in capturing the variability and richness of circuit output and coherence (Gjorgjieva, Drion, & Marder, 2016; Pulvermuller, Garagnani, & Wennekers, 2014).

The methods for measuring changes in the complex functional networks of neurons impacted by meditation practice include indirect means of measuring changes in cerebral flow in local regions of the human brain, by way of functional magnetic resonance imaging (fMRI). By far, the most influential fMRI technique is based on hemodynamic responses to neuronal activation, also known as the blood oxygenation level dependent or BOLD effect, which renders a 3D recording of brain activity from changes in BOLD signal that can be utilized to identify areas of increased or decreased neuronal activity (Raichle & Mintun, 2006). This technique has

proven to be extremely valuable, allowing researchers to identify brain areas associated with various cognitive states and conditions (Raichle, 2000). fMRI BOLD has discovered important features of functional connectivity between remote brain regions. It has been consistently observed that regions with similar functional properties exhibit coherent BOLD fluctuations even in absence of movement under resting conditions (Fox & Greicius, 2010).

To unpack this further, the brain network most associated with resting-state cognitive processing is the default mode network (DMN), which is known to be engaged in a broad range of functions that fall under the construct of the ego-self (Buckner, Andrews-Hanna, & Schacter, 2008; Ostby et al., 2012; Qin & Northoff, 2011). It encompasses the following brain areas: the dorsal and ventral medial prefrontal cortex (PFC), the posterior cingulate cortex (PCC), the precuneus, posterior inferior parietal regions, lateral temporal cortex, and the hippocampus including the parahippocampus (Raichle & Snyder, 2007). The neurologist and neuroscientist Marcus Raichle coined the term *default mode network* in 2001 due to patterns of brain waves he observed in people as they lay quietly in fMRI machines, letting their minds wander. Stimulus-independent resting-state networks challenged the assumption that the brain quiets itself when not actively engaged in a task (Gusnard & Raichle, 2001), and was linked with mentalized social-associational self-monitoring (Blakemore, 2008).

However, this scientific discovery had already been revealed 70 years prior. Hans Berger, the inventor of the first electroencephalogram (EEG), which is a device to detect electrical activity in the human brain, was the first to propose the idea that the brain is constantly busy. In a series of papers published in 1929, he showed that the electrical oscillations detected by his device do not cease even when the subject is at rest (Haas, 2003). Berger was the first scientist to observe that the brain is never truly completely at rest. Despite this, his findings were

not taken seriously at the time. All said, it has now been well-established that even when doing nothing, the brain is active, burning almost as much energy mind-wandering as it would trying to solve a difficult problem (Gusnard & Raichle, 2001; Mason et al., 2007).

The fMRI-BOLD signal that reveals functional connectivity patterns through analysis of changes in blood flow gives science an in-depth lens that compliments the electroencephalogram (EEG), which tracks the brain's surface-level electrical activity signatures. However, when contrasting the two, the EEG readings are more precise in time; whereas the fMRI readings are most accurate in neural locations. So, an EEG does not reveal structural changes with spatial precision like the fMRI. On the other hand, fMRI tracks the timing of functional activity changes far slower than EEG. As a result, EEG methods are commonly used to measure brain activity associated with brain states such as wakefulness, sleep, hypnosis, mediation and attentiveness.

Although the research available using fMRI is very useful and important, some circumspective qualifications are necessary. The BOLD signal has to be pre-processed before being analyzed using either functional connectivity measurements or statistical methods. Current research shows that data preprocessing steps may influence the results of analysis, yet there is no consensus on preprocessing methods (Eklund, Nichols, & Knutsson, 2016; Ge, Pan, & Dou, 2017). Researchers have also demonstrated that the acquisition parameters used to acquire BOLD fMRI data can at times be inconsistent, ranging from positive to negative, or disappearing entirely, under identical stimulus conditions (Renvall, Nangini, & Hari, 2014). These discrepancies can result in non-BOLD effects potentially masquerading as BOLD signals (Greve & Fishi, 2018; Murphy, Birn, & Bandettini, 2008). A number of precautionary considerations are necessary for EEG as well, due to signal acquisition, artifacts, and processing error potentials; so due diligence and critical review of study characteristics is required here as well. Ideally for data

accuracy, fMRI and EEG should be used together in complimentary fashion to help overcome characteristic processing errors.

From a pragmatic standpoint, fMRI has some disadvantaging features in terms of data collection: difficulty in performing long distance measurements (long-range brain connections), low temporal resolution (not able to capture real-time dynamics of brain activity), high cost ($3000 per scan), and restriction to hospital settings where they are housed with limited accessibility (very large 2 ton machines), discomfort for study subjects (very loud, immobilized in an extremely tight metal tube in supine position), and test demands that limit study design. However, the debate continues, and fMRI stands out for its remarkable capacities to make something visible that was once invisible, in a very presentable and illustrative manner that is captivating and very informative for the media and the wider public (Haller & Bartsch, 2009).

Despite all this, a recent advance that offers more promise for improving the clinical and translational applicability of fMRI involves focusing on spontaneous modulations in brain signals that occur during resting-state conditions (Jensen, Adachi, & Hakimian, 2015). Analysis of these resting-state dynamics of the brain involves the identification of correlations between remote brain areas, commonly referred to as resting-state functional connectivity. Resting-state signal acquisition has the distinct advantage of having less potential for producing movement artifacts that can interfere with data processing. Additionally, neuroscientific research has revealed that increases and decreases in blood supply, as measured by BOLD, reliably follows increases and decreases in EEG gamma power (Conner, Ellmore, Pieters, DiSano, & Tandon, 2011; Logothetis, Paulis, Augath, Trinath, & Oeltermann, 2001; Magri, Schridde, Murayama, Panzeri, & Logothetis, 2012; Shmuel & Leopold, 2008). So, researchers can choose to analyze brain states at any level of detail they choose. For example, some neurophysiologists may be

interested in the effects of the timing of individual neuronal spikes on brain function, others in the effects of broad interregional fluctuations in the activity of populations of neurons.

Nonetheless, when it comes to least invasive and most accessible data collection methods, the best brain artifact correlating with states of consciousness is coherent electrical activity in specific frequency bands recorded by the electroencephalogram (EEG). EEG is particularly useful for deciphering activity associated with contemplative states that produce operative changes in brain states. Such brain states can be difficult to decipher using other imaging modalities such as fMRI. Lastly, it is important to note that new, better, cheaper, faster imaging technologies are just around the corner. Devices that are akin to portable, miniature fMRI's using infrared and ultrasound in combination to form higher resolution holographic images of the brain will be common affordable at-home technology in the near future. Computer algorithms will be able to predict our state and our perceptions based on the scan, which will be utilized in tele-psychological protocols. In fact, researchers at UCLA have already discovered that scans of the brain, specifically the medial prefrontal cortex (mPFC), allow them to predict our future behavior better than we can (Falk, Berkman, Mann, Harrison, & Lieberman, 2010).

Originally, human brain waves were first observed in 1924 using EEG methods to record functional brain states, or psychic energy, as they called it back then. Micro-voltage fluctuations producing complex continually varying signals are recorded from the scalp that directly correspond to real-time electrophysiological properties of functional brain organization. These micro-fluctuations produce accessible, useful real-time measurable features of consciousness. However, it has been argued that measuring directly from the scalp is a diffused representation of the actual brain sources and the results may be spurious due to volume conduction effects (Delorme, Makeig, Faber-Thorpe, & Sejnowski, 2002). Even so, Delorme and his team said this

can be avoided by applying techniques that separate unrelated noise sources caused by volume conduction, while maintaining the same time resolution as the recorded EEG.

At the time of their discovery, these rhythms were enigmatic because their cellular basis was unknown. As briefly mentioned earlier, the first person to invent a device to record brain waves in humans was the German psychiatrist Hans Berger. At the time, he was so unsure of his results that it took him five years to publish his findings, which remained controversial for more than a decade after first publishing his research paper in 1929 (Haas, 2003). However, even now, the EEG remains a key electrophysiological diagnostic and research tool in the fields of medicine and psychology. For example, the United States Defense Department of Advanced Research Projects Agency (DARPA) is using EEG-based technology for neuromodulatory electrical prescriptions (ElectRx) and targeted neuroplasticity training (TNT). ElectRx seeks to advance understanding of the anatomy and physiology of specific neural electrical circuits and their role in health and disease. Whereas, TNT uses noninvasive EEG technologies in combination with training to boost the neurochemical signaling in the brain that mediates neural plasticity for optimizing cognitive skills. That said, EEG is an important tool in optimized performance training and contemplative science due to its accessibility, affordability, and portability. Technologies to record electrical activity in the brain on a massive scale have enormous potential for neuroscientific discovery.

In fact, freely available open-source software with user tutorials, sophisticated data sampling, extensive documentation, and user friendly graphic interfacing can be easily downloaded at no cost by contemplative practitioners and researchers (Delorme & Makeig, 2004). In the scientific literature, noninvasive and portable tools are key for investigative research of contemplative systems that bracket relevant data to include ecological validity for

their natural environments and traditional sacred contexts. As is often the case in the culture of scientific research, preforming practices to be meet expectational demands of research design, for example in a hospital or clinical setting, may encumber study characteristics due to the nature of the investigative tools and the circumstances they require. Nevertheless, considering these functional imaging technologies as especially relevant to contemplative science, we will explicate neurophysiological evidence in the scientific literature.

Neural Phylogeny of Contemplative Self-Reflection

In the course of evolution, adaptive behavior emerges in the course of individual development. And individual development depends on adaptive systems of neural specialization in consciousness. These adaptive neural capacities act as particular indicators of the evolution of consciousness in the phylogenetic tree of life. Any animal that uses complex senses to create a neural mapping of the body and the world and is able to use and adjust those maps for operant learning has the capacity for a type of primary sensory consciousness (Merker, 2005). This type of primary sensory consciousness has been compared with Sigmund Freud's theoretical constructs of primary process and automatized defenses that forms the basis of his model of the human psyche (Carhart-Harris & Friston, 2010). Freud, for example, considered human behavior to be determined mainly by biological impulses and the unconscious interplay of psychic forces that influence thoughts and behaviors. He described the individual as usually unaware of these intrapsychic fluctuations and their downstream effects. Primary process is the most primitive part of the personality and is an implicit vestige of earlier phylogenetic stages comprised more fully of unconscious unwieldy instinctual forces.

According to Freudian theory, the primary process involves forming a mental image of the desired object in order to resolve tension created by the pleasure principle (Panskepp &

Solms, 2012). The pleasure principle creates tension and unconscious processes of the psyche must find a way to discharge the energy. The primary process is referred to as primary because it is present at birth (early ontogeny), and is assumed to have emerged quite early in human evolution (early phylogeny). In fact, the cortex is not essential for the generation of primary process, however, robust evidence suggests that primary process (instinctual) behaviors and feelings are induced by homologous subcortical brain regions in vertebrates that mediate affective experience when instinctually aroused (Panksepp, 2011). As a result, barring few exceptions, the phylogenetic tree shows a clear distinction between invertebrates and vertebrates in the capacity to form multivalent instinctual-emotional based mental representations.

Scientific studies on the phylogeny of consciousness demonstrate that the structure of the vertebrate central nervous system is evolutionarily ancient and highly conserved across species and that the basic neurophysiological mechanisms supporting consciousness are found at the earliest origins of vertebrate brain evolution (Vincent et al., 2007). Vertebrate neurobiology is distinct in its use of senses to create a complex mapping of the body and the world through the capacity to create mental images (Fabbro, Aglioti, Bergamasco, Clarici, & Panksepp, 2015). The general features of the mental images add numerous unique neurobiological features such as: (a) greatly increased specialization in sensory processing, (b) a multitude of new neural processing subsystems, (c) increased ability for combining information from different senses, (d) increased levels of information processing at the top of the brain, (e) more complex decision-making processes based on internal mental representations alternative to current sensory experience, and (f) more intercommunications between brain levels (Cabanac, Cabanac, & Parent, 2008). As a result, the brainstem and thalamus are conserved across species as subconscious primary sensory-based processing hubs for keeping the cortex in an aroused or awake state, whereas

specialized cortical regions are more recent in phylogeny and are thought to serve as specific cognitive functions contributing to the rich contents of conscious experience (Fan et al., 2011). The key defining attribute of the human mind is that it is self-aware and self-reflects, and so constantly generates mental states with contents that reflect self-identity and self-relevant conceptual constructs. This type of consciousness is considered to exclusively reside in the human mind because it is last to develop in ontogeny and phylogeny (Zalazo, 2004).

To further unpack this, it is widely accepted in the science of consciousness that there is an important distinction between the contents of consciousness, on the one hand, and states or experiential structures of consciousness on the other. Even researchers who support different theories of consciousness assume that consciousness involves these two basic dissociable components (Dehaene & Changeux, 2011). From a scientific perspective, more research is needed on how new thought content spontaneously arises in our minds (Christoff, Gordon, & Smith, 2011). There are wide gaps in our understanding of various forms of spontaneous introspective contents and their neural correlate states (Christoff, 2012). Notably however, spontaneous thought is key to understanding creative thinking, meditation, scientific discovery, and mental health (Christoff, Irving, Fox, Spreng, & Andrews-Hanna, 2016). Recent findings by Tacikowski, Berger, and Ehrsson (2017) reported tested verification that the neural representation of self-relevant information processing has two levels: (a) conscious conceptual processing in anterior brain regions, (b) spontaneous nonconscious perceptual processing in posterior brain regions. However, both these specific regions overlap as part of a large-scale brain network called the default mode network (DMN), which has been shown to be anticorrelated with conscious attentional networks at rest (Broyd et al., 2009). The discovery of this circuit of brain regions that is highly active at rest has led to investigations to reveal the

possible overall function of the DMN. Examining resting-state dynamics in the functional connectivity of the human brain offers insights on how spontaneous integration of information relates to human cognition, and how this organization may be altered in different conditions, behaviors, and cognitive processes (Brandmeyer & Delorme, 2016). The DMN network is an internalized evaluative network involved in both spontaneous (nonconscious) and volitional (conscious) information processing via coordination with attentional control networks that can be shaped through meditation practice (Jang et al., 2010; Mittner, Boekel, Tucker, Turner, Heathcote, & Forstmann, 2014; Vago & Zeidan, 2016).

It seems obvious that the activity of functional brain units makes little sense if they cannot communicate with other units of the brain. Sleep-induced reductions in consciousness attenuate correlations between frontal and posterior areas of the DMN, therefore the integrity of the DMN is dynamically modulated by the level of consciousness through thalamocortical circuits (Horovitz et al., 2009). So, the frontal regions of the DMN are functionally decoupled from the rest of the DMN during reductions of consciousness, suggesting integrated DMN activity may reflect level of ongoing self-relevant cognitive processing. Remarkably however, conscious awareness does not necessarily ensue from cognitive processing, especially in the resting state. What is more, without consciousness, nonconscious cognitive processing and behaviors are performed habitually, instinctively, or in an automated way. From a yogic perspective, the unenlightened human individual's mind is effortlessly automated to be absorbed in states of constant ruminating concern and ideation centered on the preservation of a falsely assumed self-identity, even though this concern may not always be conscious. Most meditation practices reduce mind wandering and mental construction, and thus should produce a deactivation of parts of the DMN (Brewer & Garrison, 2014). Given this, contemplative

psychology analyzes how best to become conscious of ways the brain tends to be chronically impaired by spontaneous nonconscious cognitive processes such as mental rumination, mind-wandering, self-related thoughts, narrative overshadowing, autopilot mode, craving, and distraction (Maalouf et al., 2010). Contemplative researchers have suggested that the enhanced attentional and introspective skills of meditation experts can be utilized to help neuroscientists explore subtle cognitive phenomena that can be difficult to investigate otherwise.

For example, Ellamil et al. (2016) examined meditators expertly trained to quickly discern spontaneous thought, in order to see which brain areas were most active just prior to conscious awareness of a thought arising, by comparing first-person reports with third-person neuroscientific data. They found that the DMN and the medial temporal lobe were most active as a thought was arising. Interestingly, practitioners of yogic meditation seem to take advantage of the anticorrelated networking of brain circuitry, using contemplative training for strengthening the dexterity of the attentional network to better inhibit the self-related information processing of the DMN. However, attention is implicitly limited in duration and constant re-engagement or refocusing of the system is required (Lagner & Eickhoff, 2013). What is more, intact contemplative systems target this anticorrelated axis with associated attentional reserve strategies based on mapped integrative approaches that share common features. We will take a closer examination of this claim within the context of Patanjali's yogic psychology further on.

Underlying the approach of this study is the investigation of convergent mechanistic conceptions of how contemplative training works in order to reorganize the brain, altering evolutionarily conditioned programming through contemplative discernment and control of the dissociability of self-related mental representations and true self-nature. Albeit, the evolutionary advantage of this skill has its own distinct vestige in the neural phylogeny that can be inferred

from isomorphic comparisons of the brains of humans and anthropoids lower on the phylogenetic tree. In this way, we can speculate that contemplative development represents a growing tip in the evolutionary continuum of the neural phylogeny of consciousness.

Certainly, when you look at the logic of natural selection, it makes sense that the human brain operates in such a conditioned manner. Biological imperatives, such as safety, nutrition, and sex, have been embedded in our neurobiology to help us get genes into the next generation. In order for biological imperatives to function properly, all living organisms, are pre-wired to be recurrently dissatisfied, and constantly mentally ruminating even at rest. In fact, ongoing low-frequency brainwave fluctuations in the resting state, referred to as resting-state networks, consume 60%-80% of the brain's energy (Raichle & Mintun, 2006; Shulman et al., 2004). So, in the physiological processes of natural selection, neurochemical signals associated with feeling-sense and thinking processes associated with novelty and reward satiation are always cycling and overdriving mechanisms set by evolutionary imperatives (Sethi et al., 2018).

Even if biologically-constrained mental patterns tend to shift the balance of brain activity to restlessly cycle through satiation-based mental appraisals and self-referential thoughts, this does not necessarily have to be deterministic because the brain can be further optimized through contemplative training. Research has shown the mind has the ability to not merely respond to events as they unfold, but also to adapt its own operational patterns to change critical brain-state dynamics, in a process referred to as experience-dependent neuroplasticity (Schwartz & Begley, 2003). That said, experiences and activities literally shape the brain at the physical level, which has compensatory effects on our state of mind and sense of wellbeing.

Activity in the brain is pliable and brain structure is plastic, so circuits of awareness and attention can downregulate subconscious automated reward systems through core integrative

hubs of neurocircuitry (Brass, Lynn, Demanet, & Rigoni, 2013; Garland, 2016; Heatherton & Wagner, 2011; Hoffman & Van Dillen, 2012). In fact, the efficiency of brain tissue plasticity has been measured, revealing that *in vivo* brain tissue protein synthesis rates in humans occur 3-4 fold higher than skeletal muscle tissue protein synthesis rates (Smeets et al., 2018). The brain inherently undergoes continuous reconditioning and restructuring via complex orchestration of changes in tissue protein synthesis and breakdown via mechanisms of morphing neuroplasticity. At a basic level, the mind is conditioned to shape internal models of self and the environment from primitive novelty-seeking, satiation-driven brain circuitry (Moors, 2016). Survival-based brain activities tend to stimulate electrochemical profusions in the body that enable it to function and survive under stress, but that do not allow the circuitry of expanded awareness and self-knowledge to strengthen and develop (Wilson & Dunn, 2004). On the contrary, chronic stress chemistry triggers potentially degenerative processes that are observable in the complex functional networks of neurons, for which meditation has shown promising therapeutic effect meta-analytically (Arias, Steinberg, Banga, & Trestman, 2006; Goyal et al., 2014; Hoffman, Sawyer, Witt, & Oh, 2010).

Contemplative neuroscience has found that resting-state functional connectivity within certain brain networks, like the DMN, is associated with level of meditation practice (Jang et al., 2010; Taylor et al., 2013). The regions implicated in the DMN include three main components: the medial prefrontal cortex (mPFC), the posterior cingulate cortex (PCC), and the precuneus. And the main processing hubs of the DMN are the precuneus/PCC (posterior) and the mPFC/ACC (anterior). The mPFC plays a pivotal role in narrative self-referential processing that maintains the continuity of identity across time (Gallagher, 2004; Gusnard, Akbudak, Shulman, & Raichle, 2001), and meditation has been shown to diminish activity in the mPFC (Farb et al.,

2007). As a result, reduced DMN activity during meditation appears to be consistent across different meditation practices in experienced meditators (Brewer, Worhunsky, Gray, Tang, Weber, & Kober, 2011; Garrison et al., 2015; Jang et al., 2010; Tomasino, Fregona, Skrap, & Fabbro, 2012). In particular, studies have found a decrease of activity in key nodes of the DMN in the mPFC (Brewer et al., 2011; Farb, Segal, & Anderson, 2013; Scheibner, Bogler, Gleich, Haynes, & Bermpohl, 2017), and the PCC (Brewer et al., 2011; Pagnoni, 2012; Brewer & Garrison, 2014; Lutz, Dunne, & Davidson, 2007; Scheiber et al., 2017). A recent study using dynamic causal modeling suggested that self-referential processes are driven by PCC associative activity and modulated by the regulatory actions of the mPFC (Davey, Pujol, & Harrison, 2016).

Notably, DMN attenuation is more significant during meditation compared to other cognitive tasks (Garrison, Zeffiro, Scheinost, Constable, & Brewer, 2015). Consequently, researchers have demonstrated that attenuated DMN activity is a potential biomarker that indicates the level of expertise in meditation training (Brandmeyer & Delorme, 2016). So, through the ongoing practice-related activation of attentional brain networks, lasting inter-network functional connectivity changes between certain circuits indicated level of meditative proficiency (Doll, Holzel, Boucard, Wohlschlager, & Sorg, 2015). Increased mind-wandering has shown greater activation of the anterior and posterior DMN (Mason et al., 2007). Moreover, mind-wandering and self-referential thought are related to activity within the DMN itself, as well as connectivity between the DMN and other key cognitive networks; and both accordingly are altered during different types of meditation (Tang, Holzel, & Posner, 2015). Doll et al. (2015) found decreasing connectivity between the anterior hub of the DMN (ACC/mPFC) and posterior hub (PCC/precuneus) of the DMN with increasing skill in meditation practice. As a result, Doll et al. postulated that instead of mere engagement in mind-wandering, regions in the dorsal

medial PFC may help regulate attentional focus on the present experience, due to observed stronger anti-correlated coupling between the central executive network (CEN) and DMN. And related to this, the deactivation of the precuneus/PCC in the DMN and the activation of dorsal lateral prefrontal cortex (dlPFC) in the central executive network (CEN) have been correlated with attentional states of meditative awareness (Garrison et al., 2013; Shackman, McMenamin, Maxwell, Greischar, & Davidson, 2009). In sum, the regulatory capacity of an individual is closely linked with the personal development of individual attentional reserves, and contemplative systems work to effect functional neural networks for increasing the depth and span of this attentional reserve, which through the orthogonal processes the conscious-nonconscious axis of DMN connectivity works to control mental overshadowing of awareness.

Hasenkamp and Barsalou (2012) categorized four different mental states during meditation related to activity in different intrinsic brain networks: (a) focus on the present experience correlated with dorsolateral prefrontal cortex (dlPFC) activation of the central executive network (CEN); (b) mind wandering was associated with the DMN; (c) awareness of mind wandering was linked with activation in the salience network (SN); and (d) a shift of attention back towards focus on the present experience was linked with the right dorsolateral prefrontal cortex (dlPFC) and right posterior parietal cortex, with both regions being part of the CEN. Researchers have associated modifications in parietal cortex with: novel and useful thinking (Jung et al., 2009); self-transcendence as a stable personality trait (Urgesi, Aglioti, Skrap, & Fabbro, 2010); implicit spirituality/religiousness (Crescentini, Aglioti, Fabbro, & Urgesi, C., 2014; Crescentini, Di Bucchianico, Fabbro, & Urgesi, 2015); stepping out of a corporeal self (Blanke & Arzy, 2005; Farb et al., 2007); and utilization of multimodal perceptual processing out of a total field of awareness meditation (Schoenberg et al., 2018).

So, the SN directs the DMN, which is active when the brain is in resting-state; as well as the CEN, which controls the DMN when the brain engages in exacting attentional states, suggesting its operant role in mind mastery. These three networks in particular have been the focus of an accumulation of neuroscientific studies that have found that the major intrinsically-organized networks responsible for higher-level most-human cognitive functions are the CEN, SN, and DMN (Sridharan, Levitin, & Menon, 2008). In terms of cognitive control, the CEN and SN exert causal control over the DMN, specifically via the dlPFC portion of the CEN that inhibits the mPFC portion of the DMN (Chen et al., 2013). This is a relatively new phylogenetic advancement in hierarchical neural organization, and higher cognition relies on dexterous SN switching from the DMN (Sikora et al., 2016). So higher species show increasing ability in exerting causal cognitive control over the DMN, and reductions in the ability to exert this control over the DMN are evident in a wide range of clinical pathologies and cognitive deficits (Maalouf et al., 2010; Putcha, Ross, Cronin-Golomb, Janes, & Stern, 2016). In this way, functional reciprocity and compensatory connectivity in neural networks are essential for developing a better understanding of the functional interaction and exchange of information for the operations of the brain as whole.

On the following page, Figure 1 illustrates the spatial orientation and clinical distinction of these three primary networks of phylogenetically-advanced neural networks that are instrumental for higher-order cognitive processing. You will notice that the SN sits at the top of the illustration due to the transposition it renders in switching between the lower anti-correlated networks, the DMN and CEN.

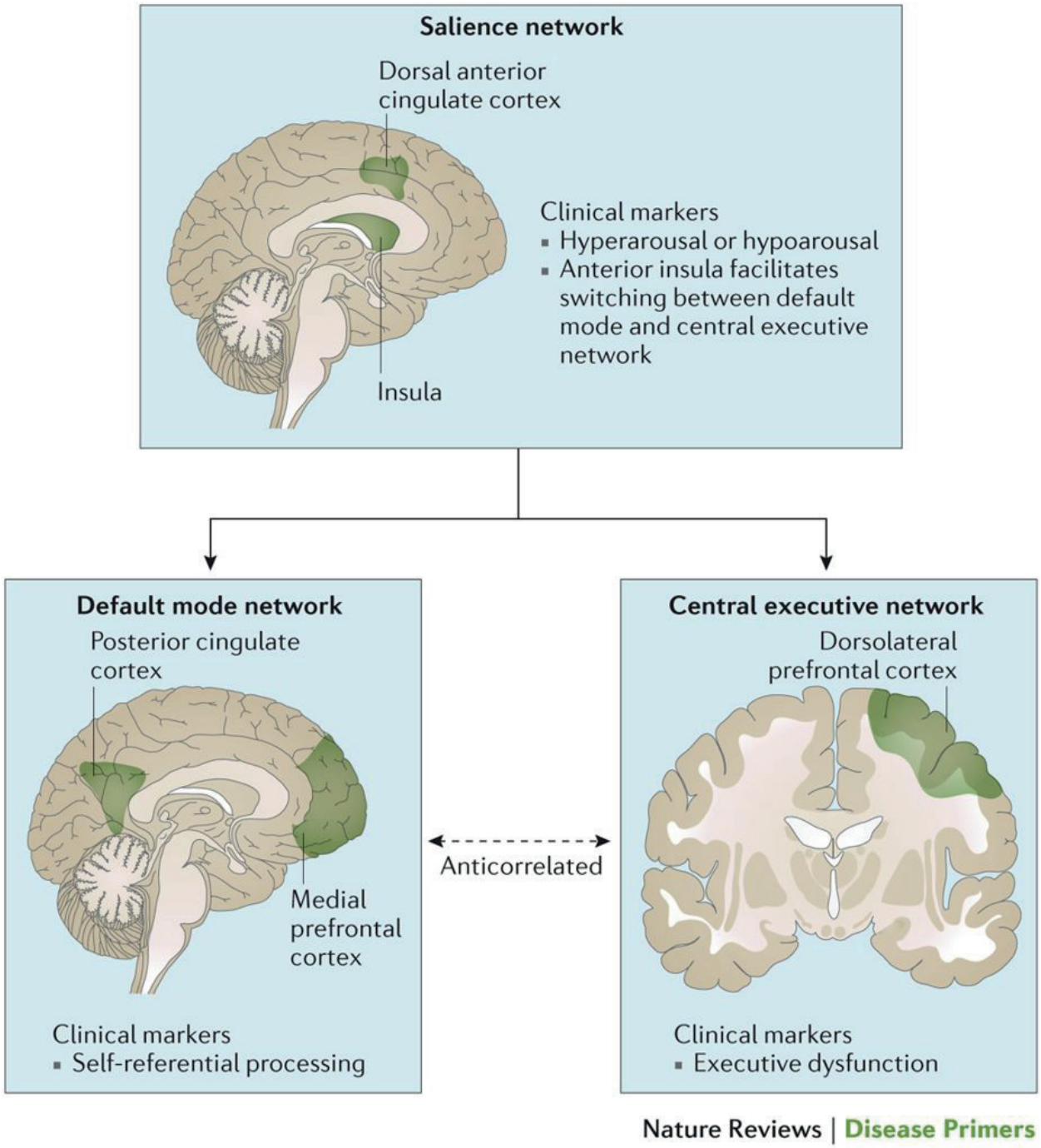

Figure 1. Higher-order cognitive neural networks
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The salience network (SN) is very rich in von Economo neurons (VENs), which are hypothesized to contribute to the neural mechanisms of self-awareness and metacognition (Allman et al., 2011). It is very important to highlight that compared with brains lower on the phylogenetic ladder, the human brain is uniquely adapted in the amount of cognitive control available for selecting, switching, and attending to salient events in the environment (Sridharan, Levitin, & Menon, 2008). The appearances of the perceived world and our ability to act coherently in the presence of a diverse stream of mental and sensory stimuli require extremely fast processes of neural integration that must occur at many different levels of self-organization. The integration of salient features in cognitive processing across functionally segregated neural networks must occur with millisecond precision for the synchrony of temporal coding between large-scale networks necessary for adaptation and experience-dependent plasticity to occur (Cauda et al., 2013).

Ontogenetically and phylogenetically, late development has been demonstrated for induced high-frequency oscillations and their long-range synchronization at the basis of the neuropsychological processes of plasticity for learning, adaptation, and maturation (Khazipov & Luhman, 2006). From early in ontogeny, gradual changes begin to occur in the amplitude of neural oscillations, with accompanying changes to synchronized resting-state oscillations that continue typically until early adulthood (Thatcher, North, & Biver, 2008). One of the most replicated developmentally-based electrophysiological findings is a gradual age-related increase in synchronized oscillatory activity that is essential for the shaping and generation of neuronal cortical circuits in the maturing brain, from fetus through adulthood, beginning in the posterior regions and finishing last in frontal regions (Uhlhaas & Singer, 2011). If we examine these findings through the lens of contemplative development, the experience-dependent adult

neuroplasticity that occurs in contemplative brain reorganization involves comparable, high-frequency synchronization of oscillatory activity for the development of new neural networks. Amongst other things, contemplative maturation seems to require unusually high-level gamma-band oscillatory signals for the experience-dependent shaping and self-directed generation of new neuronal cortical circuits that support high-level states and traits such as mental stillness, openness, flow, awe, bliss, altruism, gratitude, cooperation, compassion and oneness (Farb, Desormeau, & Dinh-Williams, 2016).

High-level human states have self-reflective awareness capacities that have inferable evolutionary roots. To partially trace this neural phylogeny at the micro level, von Economo neurons (VENs) are one of the most recently evolved cell types which have been shown to be involved in awareness, higher-order insights, and the integration of fast intuitive assessments of complex situations due to the high speed and distance with which they can project brainwave signals (Fan et al., 2011; Fischer, 2016). An extraordinary morphological characteristic of the anterior insula (AI) and the anterior cingulate cortex (ACC) in humanoid primates is the uniquely high concentration of clusters of large spindle-shaped VENs amongst the pyramidal neurons (Cohen et al., 2010). Pyramidal cells comprise the majority of the brains excitatory neurotransmitter system (Nimchinsky et al., 1999). These regions are critical for monitoring and processing internal and external saliency of present experience, and are highly implicated in human social and emotional intelligence due to connections with the amygdala, hypothalamus, basal ganglia, and orbitofrontal cortex that regulate approach motivation and avoidance motivation (Decety, 2015; Nielsen & Kaszniak, 2006).

They were first examined in passing by the pioneering neurologist Santiago Ramon y Cajal (1900) through his early neurological investigations. These neurons were later described in

detail and localized to the ACC and AI by the Austrian psychiatrist and neurologist Constantin von Economo, who predicted that these cells support phylogenetically new functions in humans, perhaps by creating internal representations of the autonomic nervous system (Butti, Santos, Uppal, & Hof, 2013; von Economo & Koskinas, 1925). In the phylogenetic tree, they are found in greatest concentration in humans and great apes; however, they are far more abundant in humans than in apes (Allman et al., 2010). They are thus a phylogenetic specialization that has arisen within the last 15 million years in hominoids and have proliferated greatly within the human line of descent (Nimchinsky et al., 1995).

VENs develop late in ontogeny as well as phylogeny. Their distribution in great apes correlates with human-like cognitive abilities and self-awareness (Cauda, Geminiani, & Vercelli, 2014). It has been proposed that VENs are the substrate for fast interconnections between the physically separated sensory-perceptual (AI) and conceptual-affective (ACC) cortices that combined to form the conscious somatic agency of the embodied self (Allman, Hakeem, & Watson, 2002). VENs seem to enable fast, highly integrated representations of insightful moments of awareness. They may underlie the conjoint activity in the AI and the ACC reported in most studies (Ibegbu, Umana, Hamman, & Adamu, 2015). The ACC has been functionally subdivided into ventral (affective) and dorsal (cognitive) regions (Vogt, 2005). The loss of emotional awareness and self-conscious behaviors in patients that correlates with the degeneration of VENs directly supports this notion (Seeley et al., 2007). Functional neuroimaging studies indicate that the ventral ACC is part of the DMN that is active in resting conditions, whereas the dorsal ACC is a component of the of the frontoparietal attentional networks (Margulies et al., 2007). The ACC is crucial for creating internal value representations and then translating those into actual behavioral change sustained over time, based on internal

representation, to evaluate potential alternatives to our current experience (Allman, Hakeem, Erwin, Nimchinsky, & Hof, 2001; Fouragnan et al., 2019). Consequently, it has also been well-established across multiple studies that meditation induces significant structural changes in the insula and ACC (Fox et al., 2014).

During ontogenesis, VENs first appear in very small numbers in the 36th week of gestation, while at birth only about 15% of the postnatal number are present, whereas the adult number is attained by four years of age (Watson, Jones, & Allman, 2006). Notable associated milestones include, social emotional awareness, greater ability to differentiate between fantasy and reality, greater independence, and greater attention span (Allman, Watson, Tetreault, & Hakeem, 2005). For instance, areas containing VENs have been related to sense-of-knowing (Kikyo, Ohki, & Miyashita, 2002). The circuits involving areas in which VENs are located comprise ventral areas in the frontal and parietal lobes and the insula, which are particularly developed in humans, even compared to great apes (Preuss, 2011). Research has implicated VENs in the rapid intuition and insight that relies on an immediate awareness, without the engagement of cognitively deliberative or elaborative processes (Allman et al., 2010; Nelson et al., 2010; Menon & Uddin, 2010).

Analysis of the functional connectivity of regions of interest with the highest density of VENs (AI and ACC) shows that they are part of a frontoparietal network (Vincent et al., 2006; Spreng et al., 2010), including most of the areas of the saliency monitoring network (Menon & Uddin, 2010), part of the control network (Fox et al., 2006), and part of the network encompassing the posterior insula (Cauda et al., 2011). These networks with the highest density of VENs have a share in the action of switching off the default mode network (DMN). This finding is in line with previous studies that related the activity of VENs to predictive monitoring

(Seeley et al., 2007), evaluation of stimuli, and homeostatic functions (Allman et al., 2010). Remarkably, one of the most replicated findings in contemplative neuroscience is the reported structural and functional differences in the insula between meditators and non-meditators, perhaps due to heightened conscious engagement of introspective metacognitive present-state awareness with equanimity towards all internal and external events (Farb et al., 2007, 2013; Fox et al., 2014; Manna et al., 2010; Schoenberg et al., 2018; Wang et al., 2011).

In neuroscientific theory, consciousness is generally based on two critical components: arousal and awareness. Researchers have already shown that arousal is likely regulated by the brainstem, as it regulates when we sleep and wake, and our heart rate and breathing. Even during deep sleep, salient events such as the fire alarm will elicit an arousal response, while other things will not. This illustrates that sensory stimuli continue to be processed across brain states in different ways, even in deep sleep. The key network hub of higher level conscious awareness has been more difficult for scientists to characterize. Researchers have long thought that it resides in a region in the cortex. Recently researchers identified left ventral AI and pregenual ACC as the source of awareness due to the connections they have with the brainstem area responsible for arousal (Fischer, 2016). Cognitive processing depends on neural coalitions for extremely fast and precise synchrony, and meditation development has been shown to specifically affect network hubs with high concentrations of VENs responsible for extremely fast long range neural synchrony. In the neurobiological development from child to adult cortical networks gradually express higher-frequency oscillations and enhanced long-range synchrony (Ulhaas & Singer, 2011).

Self-awareness likely emerges from the coordinating activity of multiple neural regions that have complementary roles in processing. A primary candidate anatomical hub for this

mechanism is the insula. Insula activity has been correlated with both embodied awareness (Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004; Zaki, Weber, Ochsner, 2012) and meta-awareness (Fox et al., 2014; Kikyo & Miyashita, 2004), and was found to play a broad role in the representation of affective information (Craig, 2009). Another possible hub is the ACC, which like the insula, has been implicated in embodied awareness (Critchley et al., 2002, 2004; Khalsa et al., 2008) and metacognition (Shiota et al., 2017). Evolutionary pressures forced the development of ever more integrative neural structures able to process and evaluate the increasing valence in complex information. As a result, those later in the phylogenetic order show more complex operant learning ability when it comes to rewards and consequences, as well as, complex affective orientations to their social bonding and learning strategies.

It is a marker in the evolution of consciousness to be able to regulate and integrate different sources of input based on adaptive mental maps. The insula and ACC are important in this way, and show measurable degrees of conscious awareness advancement in human brains (Butti & Hof, 2010). In fact, researchers have found that in more intelligent persons the AI and the ACC are connected more efficiently to the rest of the brain, lending support to the idea that the integration of processing between functionally specialized brain regions is key for intelligence (Hilger, Ekman, Fiebach, & Basten, 2017). Consequently, this has led to increased behavioral flexibility and adaptability at the core of the evolutionary project. Conceptually, this opens contemplative science to theoretical approaches for neuropsychological research on the connection between the self and the regulation of the self (Schalkwijk, 2018).

Furthermore, studies have also shown that decreased activity in the two primary hubs of the DMN, the medial prefrontal cortex (mPFC) and the posterior cingulate cortex (PCC), correlated with decreased self-referential thinking (Brewer, Garrison, & Whitfield-Gabrieli,

2013; Cheng et al., 2018; Ulrich, Keller, Hoenig, Waller, & Gron, 2014) and its attenuation corresponded to distinctions of degree in mediation practice (Brewer et al., 2011); religious faith (Han et al., 2008); and entheogenic ego dissolution (Barrett & Griffiths, 2018; Carhart-Harris et al., 2012; Griffiths et al., 2018; Letheby & Gerrans, 2017; Milliere, Carhart-Harris, Roseman, Trautwein, & Berkovich-Ohana, 2018). Interestingly, these are all methods that are included in Patanjali's system of practices: meditation (YS, 1.13, 1.39, 2.29, 3.2-3.4, 3.7-3.8); divine faith (YS, 1.23, 2.11, 2.44-2.45); and entheogenic herbs (YS, 4.1). However, Patanjali noted that practice born of meditation (*anasayam*) is able to free one from subconscious impressions and nonconscious processes in ego functioning (YS, 4.6). Meditation in ancient India involved the gradual control of subconscious ego representations that reinforce the ongoing influences of nonconscious processes (Waldron, 2018).

Now that we have key anatomical hubs in mind, we will take a closer look at the integrative neural mechanisms of diminished ego function. It is important to point out, the disintegration of the SN and its component regions, the AI and the ACC, has corresponded with ego dissolution (Seeley et al., 2007). That being said, the SN and the DMN show increased anti-correlation in meditators, and anti-correlated interactions between the SN and the DMN, in particular, are necessary for efficient cognitive control, or switching attention between externally and internally salient stimuli (Craig, 2009; Kilpatrick et al., 2011; Menon & Uddin, 2011; Seth, 2013; Sridharan, Levitin, & Menon, 2008). In sum, meditation across traditions appears to reduce DMN activity, and narrative-self ego dissolution appears to rest on the attenuation of the DMN (Jang et al., 2010; Tang, Holzel, & Posner, 2015). Ego dissolution in mystical and nondualistic experience has been found to be relevant for meaningful transformational outcomes (Letheby & Gerrans, 2017; Josipovic, 2014; Vieten et al., 2018).

These research findings suggest possible modifications of the three major higher-order brain networks in types of hypo-egoic processing (diminished ego), with particular attention as to how networks are modulated to directly inhibit egoic processes by generating competing, experientially salient, hypo-egoic states. The term *hypo-egoic* refers to a variety of states in which: (a) conceptual self-awareness is low, (b) the phenomenal self is not highly individuated from its context, and (c) the person is not selfishly invested in the outcome of a particular situation (Leary & Guandagno, 2001). In the scientific literature, hypo-egoic psychological states include: meditation, hypnosis, mystical experience, flow, love, altruism, and morality (Leary, Adams, & Tate, 2006; Farb, Desormeau, & Dinn-Williams, 2016). The self-referential ego construct in neuroscience literature is based on consistent findings that the medial prefrontal cortex (mPFC) is integral to egoic self-evaluation because it selectively and hierarchically targets self-relevant information on a continuum that varies depending on how relevant the information is for reifying and substantiating our self-concept (Heatherton, 2011; Kelley et al., 2002; Macrae, Moran, Heatherton, Banfield, & Kelley, 2004; Northoff, Heinzel, de Greck, Bermpohl, Dobrowolny, & Panksepp, 2006; Schmitz & Johnson, 2007). It is important to understand, Patanjali posited a distinction in self as the object of attention versus self as attentional agency, what he referred to as the seen versus the seer. This same distinction has been repeated across various psychological fields of psychology with various names and descriptions. This distinction is very important in Patanjali's psychology because he indicates that it does not merely entail an absence of conceptually elaborative self-reference, but also a shift in agency and self-referencing that impacts the scope of experience altogether (Urgesi, Aglioti, Skrap, & Fabbro, 2010).

By developmentally structuring a spectrum of practices for attenuating and surpassing ego-states, Patanjali's system of meditation is poised to more flexibly address stage-specific

variance in the functional organization of neural networks. With an understanding of the entropy-based criteria for robust variability and functional homeostatic redistribution within adaptive brain function, it becomes more evident why practices should be tailored to down-regulate ego-based brain networks and shift agentic saliency networks. Egoic self-representation serves necessary human functions and fosters a sense of identity that extends across time, however it is highly conditioned by repetitive and uniform mental configurations (Buckner & Carroll, 2007). Entropy measures the variety of configurations possible within a system, and the concept of brain entropy has been defined as the number of neural states a given brain can access (Friston & Buzsaki, 2016). Egoic self-representation reflects a lifetime of behaviors, values, and skills that are reflected in neural configurations. Brain entropy refers to the overwhelming complexity and variability in brain activity from one moment to the next, that is marked by greater long-distance correlation in neural activity (Carhart-Harris, Friston, 2011). Within certain homeostatic limits, greater entropy indicates greater intelligence, awareness, and processing capacity; whereas low entropy is characterized by uniformity and repetition, which is seen in deep sleep and coma (Saxe, Calderone, & Morales, 2018).

So, in yogic theory, hypo-egoic processing is not strictly inhibitory, and generative meditative processes that enhance awareness, increase the repertoire of states, create new brain conformations, and positively expand mental content are also included for an integrative approach to contemplative mastery that can address entropy-appropriate access points for specific stage-based competencies. For Patanjali, these consist of the generative mental stages of absorption with physical awareness, absorption with subtle awareness, absorption with bliss, and absorption with the sense of I-am-ness (*vitarka-vicaranandasmita-rupanaugamat samrajnatah*; YS, 1.17). These generative processes, that Patanjali structured into his system, can create

revitalized expanded self-schemas (modes of self-reference, appraisal, identity) and also recondition tendencies toward ego-dominant thinking and elaborate subconscious mental content (Webb & Graziano, 2015). Consequently, this allows more adaptive flexibility in differentiating and decoupling superficial self-related mental appraisals from pure irreducible self-apperceptive awareness. A systematic approach to meditation mastery is a more robust and flexible way to address the range of developmental challenges that will tend to arise. And thus, the adaptability, durability, and holistic practices of indigenous intact yogic systems originating in India need further heuristic elucidation through practice and research.

As mentioned earlier, Dahl, Lutz, and Davidson (2015) designed a revised theory of categorizing types of meditation to replace their former widely popular grouping of forms of meditation. In their new categorical grouping they use three categories for all types of meditation practice: (a) attentional family, (b) self-constructive family, and (c) self-deconstructive family. However, their theoretical framework was designed primarily to classify further research, rather than focusing emphasis on systematic approaches for adaptively applying transformative self-optimization (Machamer & Sytsma, 2007). Interestingly, Patanjali structured all three of the aforementioned family types in his systematic approach, which may serve to develop a brain capable of increased variability in neural configurations, or agility with the range of states that a brain can access. So, traditional indigenous systems of yogic meditation tend to structurally embrace and integrate various types of contemplative access points to more comprehensively address the challenging terrain that they are trying to map. However, scientists tend to try to draw a map without knowing much about the terrain, with a bias for isolating features rather than developing a heuristic integration of features that are designed with the intentional trajectory of awakening stable spiritual self-awareness.

When we are unconscious, we continue to exist without perceiving our own presence. We cease to participate in reality but continue to live. When roused back into consciousness, we lack a narrative to explain the time away. So, the narrative story that seems to be our life is just a function of our brain's mechanisms, not who we are in whole. Due to the essential role of entropic patterns in brain functioning and human intelligence, access to states based on egoic self-representation are necessary. However, egoic self-representation is a partializing and overly repetitive component of human brain functioning that is deeply conditioned in the course of human development. Mental self-representation acts as a source of continuity across conscious experiences that constructs a sense of identity that extends across time. The narrative self (mPFC) is a necessary place-holder in our cognitive work space that allows us to navigate social environments, relating to others in terms of an identity with transactional agency, such as socially desirable characteristics to facilitate appetitive drives and avoidance of harm. Self-representation comprises competing mental narratives conditioned by past experience, self-appraisals, and values. Implicit self-survival strategies that are encoded in our brains drive us to seek, avoid, or ignore objects based on conditioned mental appraisals. However, these patterns of implicit connectivity are shaped by repeated patterns of task-driven co-activated brain regions. That said, it is crucial to know that these co-activations can be driven by adaptive or maladaptive tendencies.

Arguably, the market-driven systemic conditioning of ego-based self-representation has reached its cultural and technological zenith in the modern world. Modern capitalistic philosophy conditions individuals and societies for ego-based concerns that implicitly compete with spiritual concerns on some level, due to the over-prioritization of monetized prerogatives. In fact, billionaire founders of internet and media corporations have exploited this implicitly biased

self-relevant information processing system to fund their companies, and have been accused of conspiring to design their platforms to profiteer from increasing their influence over attentional and behavioral brain networks. However, if we learn to stably increase the contemplative configurations possible within brain states, it could further elicit greater accessibility to consciously cultivated regenerative states. Consequently, this could weaken the hold of our conditioned thoughts, emotions, and behaviors. Patanjali argued, we could then be free to live prosocial, rational, and altogether more enlightened lives.

Electrophysiology of Contemplative Mastery

The brain has more than 100 billion neurons and they all have to be globally coordinated and unified with tight millisecond precision for cognitive functions to occur, so the mechanisms underlying long-range synchronized activity is of substantial interest (Keren & Marom, 2016). Neurons do not function in isolation, but rather are embedded in assemblies and networks, in which they influence each other through excitatory and inhibitory synaptic connections. Activity-dependent mechanisms dynamically adjust the number of cells in cortical circuits, to ultimately establish the appropriate proportions of excitatory and inhibitory neurons in the cortex (Wong et al., 2018). As a result, the neurons in a network are rhythmically activated and inhibited. This rhythmicity is reflected in spontaneous oscillations of the extracellular field potentials of dendritic and postsynaptic currents of many cortical neurons firing in nonrandom partial synchrony (quasi-determinant) as measured by EEG (Lopes da Silva, 1991).

The fact that these oscillatory fluctuations of field potentials can be recorded on the surface of the scalp indicates that large numbers of neurons must be engaged in synchronized rhythmic discharges at the respective oscillation frequency in order to produce a recordable signal (Singer, 1993). There are many different microscopic features at the cellular and synaptic

levels that impact the compensatory balance of neural excitation and inhibition in the brain. Research has demonstrated that EEG patterns measurable at the macro level are correlated with underlying neural computations relative to specific cognitions and behaviors (Andras & Wennekers, 2007). Due to this, we have seen the emergence of new principles for understanding the macrodynamics in the brain. Interestingly, statistical analysis has been used to document clusters of EEG phenotypes, based on genetics, that are reliable indices of brain function in psychiatric populations (Johnstone, Gunkelman, & Lunt, 2005). Even more, EEG oscillations are phylogenetically preserved for brain functions across species, and are causally implicated in cognitive functions and their related environmental influences (Milne et al., 2016). In fact, measurements of macro-activity in the brain EEG records seem to be the most adequate method to measure the extremely fast dynamic properties of integrative brain function. This study proposes key macrodynamic clusters of significant activity-related relationships that can lead to phenotypic characterization of the stages of contemplative development.

Today, cognitive science emphasizes more and more the analyses of multidimensional macrodynamics, instead of linear microdynamics approaches. Interpretive study of brain function should address global activators that mediate the translation of the many microscopic mechanisms to macroscopic circuits of long-range synchrony that globally integrate specialized brain regions (Fries, 2015). As a result, neurocognitive experimenters have begun to consider the brain as an integrative system, and not merely analyses of component structures. So, the analysis of relationships between different regions of the brain is becoming increasingly important in the field of research. In this new paradigm neural assemblies, functional networks, and circuit hubs replace the older single neuron descriptions of integrative brain function.

Phase synchronization and coherence are fundamental electrophysiological neural

mechanisms of integrative brain function (Fries, 2005). Two signals are said to be synchronous if, based on their temporal structures disregarding amplitude, their rhythms coincide (Varela, Lachaux, Rodriguez, & Martinerie, 2001). The majority of cognitive and perceptual functions are based on the coordinated interactions of large numbers of neurons that are distributed within and between different specialized brain areas (Uhlhaas & Singer, 2013). Integrative functions in the brain are manifested by varied degrees of coherences, like resonant tuning forks. Two major elements determining the activity of large assemblies of neurons are coherence and frequency. Coherence is the term for how groups of neurons, firing in coordination, can create a signal that is mirrored instantaneously and precisely by other groups of neurons across the brain (Fries, 2009). The other aspect of large-scale brain activity is frequency of firing, especially of neural circuits essential for neural encoding processes. To illustrate these concepts metaphorically: The difference between a cacophony (noncoherent) and a symphony (coherent) does not necessarily relate to the number of musicians (neurons), or their decibel level (amplitude); but rather, it relates primarily to their harmonic coordination (phase synchrony) and rhythmic flow (frequency-band).

Electrical and chemical synapses provide modes of direct communication between neurons. Even though electrical synapses, otherwise known as gap junctions, were first identified 60 years ago, most synaptic research has focused on chemical synapses (Friston & Buzsaki, 2016). Traditionally, neuroscience has relied on the chemical synapse as the primary signaling mechanism in the brain, due to the fact that synaptic theories emerged out of scientific studies on the effects of agonist (excitatory) versus antagonist (inhibitory) chemical activity on the neurotransmitter signaling systems of the brain. However, the electrical synapse has gained more importance in recent brain research, and has demonstrated that the electrophysiology of gamma

rhythm synchrony regulates the homeostatic balance of neurochemical excitatory and inhibitory potentials (Cardin et al., 2009; Ossandon et al., 2011). Notably, in both invertebrates and vertebrates, electrical synapses arise before chemical synaptogenesis (Cohen-Cory, 2002). As a result, electrical synapses must be present in a neuron or it fails to make any chemical synapses (Bani-Yaghoub, Bechberger, Underhill, & Naus, 1999). Thus, Hormuzdi, Filippov, Mitropoulou, Monyer, and Bruzzone (2004) concluded that: "The appearance of gap junctional coupling in the nervous system is developmentally regulated, restricted to distinct cell types, and persists after the establishment of chemical synapse; thus, suggesting that this form of cell-cell signaling may be functionally interrelated with, rather than alternative to chemical transmission" (p. 113).

Research on the developmental sequence from electrical to chemical synapse has led to the conclusion that the formation of electrical synapses between neurons is necessary at various steps in the formation of chemical synapse junctions (Marin-Burgin, Eisenhart, Baca, Kristan, & French, 2005; Todd, Kristan, & French, 2010). And relative to this, research has highlighted that when two neurons wish to communicate, via chemical signals, they must also synchronize electromagnetic fields, so that electrical and chemical synapses have precise compensatory adaptor effects on brain function (Buzsaki, Anastassiou, & Koch, 2012). For example, a stimulant drug called modafinil used to treat sleepiness works through chemical depolarization that increases electrical coupling and drives coherence at higher frequencies to induce arousal (Garcia-Rill et al., 2008). Drugs that alter the excitatory-inhibitory balance of neurons are associated with the modulation of frequency band oscillations that correlate with the subjective effects that are induced. Hence, the contrast of these mental states is also reflected in the EEG signal, which can be used as predictors of drug effects on cognition (Blokland, Prickaerts, van Duinen, & Sambeth, 2015).

Remarkably, it has been long established that the amplitude and the frequency of the neural oscillations are altered in different mental states. Researchers have noted brain activity over a wide range of different frequencies, from infra-slow (<0.1 Hz) through gamma (30-500 Hz) waves. Slow brain waves are most pronounced during deep sleep or anesthesia, with increasing frequency associated with increasing levels of consciousness and attention. The brain consists of five major types of brain waves: delta, theta, alpha, beta and gamma brain waves. Each of these of these brain waves has a normal frequency range in which they operate. While all brain waves work in concert simultaneously and carry cross coupling potential, one brainwave can be more active and predominant than others, even though different processing modules work in parallel during information processing (Varela, Lachaux, Rodriguez, & Martinerie, 2001). Due to dominant oscillatory functions of interacting frequency bands, low frequency rhythms (theta and alpha) reflect top-down information processing involving attention and retention, whereas high frequency rhythms (high beta and gamma) reflect bottom-up processing of the contents of experience (Razumnikova, 2007). Research has repeatedly shown that individual frequencies can be associated with specific cognitive processes (von Stein & Sarnthein, 2000).

On the following page, Table 1 gives a brief overview of the core functional domains of these five primary types of brain waves. In Table 1, certain ranges in frequency-bands correspond with generalized cross-sections in some associated functional states.

Table 1

EEG Frequency Bands and Functional Brain States

Frequency range	Wave Name	Associated functional states of consciousness
> 30 Hz	Gamma	Higher mental activity, conscious percept, integration
13-30 Hz	Beta	Arousal, active processing: sensory and cognitive
7-13 Hz	Alpha	Calm relaxed yet alert state
4-7 Hz	Theta	Deep relaxation, hypnogogic states, REM Sleep
< 4 Hz	Delta	Deep dreamless sleep, loss of body awareness

Gamma has been associated with the synchronized orchestration of neural signals for the integrated binding of content in various states of consciousness (Jia & Kohn, 2011; Salinas & Sejnowski, 2001). For example, research has shown that conscious smell is produced when odor molecules induces gamma synchrony among olfactory bulb dendrites; and if it is a pleasurable smell, gamma synchrony occurs in the ventral tegmentum area, which is a reward center (Lassen et al., 2007). Beta has been associated with normal waking state arousal, discrete perceptual cycles in the somatosensory processing of information, and effortful concentration (Baumgarten, Schnitzler, & Lange, 2015).

Alpha is the most dominant of all brain rhythms in adults, and there is an extensive amount of literature demonstrating that alpha power can be modulated in a goal-oriented manner to either enhance or suppress sensory information processing (Babu Henry Samuel, Wang, Hu, & Ding, 2018). Most people have increased alpha activity in their EEG when they close their eyes, turn the attention inwards, and relax. Alpha can indicate idleness, or on auto-pilot and not paying more attention. When attention increases alpha reduces, and with the onset of drowsiness alpha

also reduces. Therefore, alpha has been implicated in interregional neural gating and subcortical information processing (Fries, 2009). Thus, alpha exhibited selective intra-cortical inhibition for frontal lateral expression of affective tone (De Pascalis, Cozzuto, Caprara, & Alessandri, 2013).

Theta is the dominant brain rhythm in small children. In adults, theta waves normally appear during dreaming or drowsiness, as well as, during strong emotions and hypnosis. Theta waves seem to be formed deep in the brain and may reflect unconscious activity associated with emotions and dreams. When one comes close to unconscious memories during deep meditation or close to repressed feelings in therapy, the theta activity tends to increase. During hypnosis, theta wave dominance has been a highly replicated finding (Jensen, Adachi, & Hakimian, 2015). Delta is seen in new born babies and in adults during deep sleep. As a result, slow rhythms are commonly associated with basic survival functions and satisfaction deeply seated in the brain.

As a caveat, there tends to be overly generalized interpretative allocation of these proposed electrophysiological signatures to mediation practices in the literature without deference to characteristics of yogic mastery, such as proficient agility in switching between various states and their associated frequency power-bands in the brain. Subsequently, studies get interpreted by researchers based on the context of the research design itself, rather than accounting for individual subjective competency in the development of self-regulatory characteristics, relative to the nature of systems they are trying to study. This, in turn, has led to: (a) a general trend to examine one-dimension of the EEG signal to evaluate global change, and (b) a lack of understanding systems involved in signal generation and what power-bands represent functionally and phenomenologically (Schoenberg & Vago, 2018). In contemplative systems of practice, it is important to match the individual to the right procedure, and in research it is important that we have the right study design for the right question. For example, not all

questions can be or need to be answered with a systematic review or meta-analysis. And often researchers within the field of contemplative neuroscience use a study design that lacks sufficient specificity for their research questions, which can create misleading and divergent findings. In this way, the multimodal paradigm in systems theory can elicit improvements in the targeting process for specificity in neuroscientific research.

For instance, scientists have developed mathematical models to better describe the functional dynamics of multidimensional geometric spaces and multimodal connectivity in the brain (Simas, Chavez, Rodriguez, & Diaz-Guilera, 2015). Reimann et al. (2017) identified ~11 dimensions of brain that provide empirical quantifiable links between neural network structure and emergent function. They additionally noted how structures are formed at the same time that they are interlaced in a unity that creates a precise geometric structure, and suggested that the sequence of activity throughout the brain resembles "multi-dimensional sandcastles that have the ability to materialize out of the sand and then disintegrate in rapid an ongoing succession" (Reimann et al., 2017, p. 104). With this, they concluded that core circuits of the whole brain have reorganized themselves over time in the course of evolution, with certain circuit elements and regions expanding and becoming more complex and intricate, with deeper interconnections and cross-connections that form a complex multidimensional dynamic system that does not easily separate into independent modules.

Electrical synapses, also known as gap junctions, are direct electrical connections between neurons that are ubiquitous across brain regions and species (Baumgarten, Schnitzier, & Lange, 2015). Neurons on distant sides of the brain, linked directly via gap junctions, synchronize electromagnetic fields for long-range communication, allowing for selective synchronization of brain regions through long-range coherence of delocalized brain network

activity (Fries, 2015). The theory that patterns of traveling brain wave coherence correspond to the mind moving around the brain has been widely supported (Nunez & Srinivasan, 2006). Interestingly, this evidence-based theory (third person) confirms Patanjali's ancient yogic theory of mind (second person), however updated and verified through the lens of modern neuroscience.

A telling feature of the brain's organizational coordination is the degree of phase synchrony among voltage fluctuations recorded from different electrodes at any specific frequency (Rodriguez et al., 1999). Current empirical data has suggested that various levels of consciousness require long-range cortical integration (Vincent et al., 2007). What is more, the evidence from anesthesia and sleep states converge to suggest that loss of consciousness can be associated with a breakdown of cortical connectivity and thus of cortical integration, including a collapse of the repertoire of cortical activity patterns (Alkire, Hudetz, & Tononi, 2008). The mechanism by which anesthetics induce a loss of consciousness is marked by a well-defined cortical reconfiguration that is shaped by an increase in similarity between resting-state functional correlations and the nonconscious anatomical connectivity of the brain (Uhrig et al., 2018). In other words, less consciousness leads to high functional and structural similarity in the resting-state signature. Overall, anesthesia research has showed that they generally induce loss of consciousness by disrupting the integrative properties of the cerebral cortex, and suppressing DMN functional connectivity between the PCC and precuneus (Hudetz, 2012).

Due to its ability to produce endogenous activity to supplement and represent reality, the brain does not simply process information subconsciously (feedforward) but also generates information (feedback) in its repertoire of cortical patterns. Researchers found that feedforward, or bottom-up processing was subliminal (Balconi, 2011), whereas feedback (frontal to posterior, or top-down) information transfer was associated with conscious perception (Lee, Kim, Noh,

Choi, Hwang, & Mashour, 2009). Additional findings have shown that feedback processing is selectively suppressed during general anesthesia and in the vegetative state, whereas feedforward processing is preserved (Imas, Ropella, Ward, Wood, & Hudetz, 2005). Specifically, they found anesthetics interfere with the exchange of information encoded in gamma oscillations between the frontal and posterior cortices. As a result, the world outside is not simply coded by meaningless bits of neuronal spikes but is a whole integrated cognizable synchronous stream, of which coordinated rhythmogenic neuromodulatory circuits are a crucial part (Yarger & Fox, 2018; Ziskind-Conhaim, Mentis, Wiesner, & Titus, 2010). Amazingly, what makes the brain functional is its organized periodic action in time, with coherent near-instantaneous rhythmic timing in the hundredths-of-a-millisecond range (Axmacher, Mormann, Fernandez, Elger, & Fell, 2006). A team of neuroscientist from MIT found that the human brain can process entire images that the eye sees for as little as a dozen milliseconds, which is such high speed that it indicated that the eye finds pre-established concepts (feedforward) in the ongoing attempt to rapidly understand what is being seen (Potter, Wyble, Hagmann, & McCourt, 2013).

One of the most fundamental laws of the universe is the law of periodicity, referred to as Mendeleev's law for his work in creating the periodic table of elements (Mendeleev, 1889). Periodicity refers to nonlinear regulatory systems of repeating pattern or structure in time and space. It has since been found that this law describes manifestations of scaling properties in the living and nonliving alike (Goldberg et al., 2002). In this way, periodicity, oscillation, rhythm, waves, fractal dynamics, and cyclic process all signify the same property originally identified by the Russian chemist Dmitri Mendeleev. Interestingly, through an altered state of transpersonal knowledge acquisition (Tart, 2008), Mendeleev claimed he envisioned the complete arrangement of the periodicity of elements in a dream: "I saw in a dream a table where all elements fell into

place as required. Awakening, I immediately wrote it down on a piece of paper, only in one place did a correction later seem necessary" (Baylor, 2001, p. 90).

In harmony with Mendeleev's dream-derived theory of periodicity, it has long been appreciated that the brain is oscillatory, with constant waves of bioelectric communication, even at rest and in sleep (Steriade, McCormick, & Sejnowski, 1993). Even in the absence of external stimuli the brain continues to display a rich continuity of spontaneous activity. Such activity is often structured, rhythmic, and can occur with periodicities ranging from fractions of a millisecond to minutes. The study of neural oscillation is key to understanding the coherent integration of unified neural systems that support consciousness. In fact, multifractal temporal signal integration has been a measurable feature of the prerequisite physiology that supports the basis of consciousness, through the synchronous bioelectric action of the heart and brain (Dutta, Ghosh, Samanta, & Dey, 2014; Ivanov et al., 1999; Peng, Havlin, Stanley, & Goldberger, 1998; Wink, Bullmore, Barnes, Bernard, & Suckling, 2008). The oscillatory synchronization hypothesis of brain function proposed observable electrophysiological signal synchronizations among neural activities as correlates of perceptual and cognitive coherence between elaborately integrated brain processing components, which in turn correlate with coherent mind states that include representations of self, sensory objects, decisions, and motor activities (Fries, 2009, 2015; Melloni et al., 2007; Ulhaas et al., 2009). In the brain, the cortex and the thalamus form a complex system of extensive and reciprocal connections, capable of generation and distribution of oscillatory rhythms (Saalmann, 2014). Connectivity with the cortex enables the thalamus to participate in global oscillations, which are reflections of coordinated neural activity.

Human cortical neurons are larger than other species and due to elongation exhibit distinct integrative properties (Beaulieu-Laroche et al., 2018). Actual loss of consciousness is

typically accompanied by breakdown of the brain capacity to integrate neuronal activity across distant areas (Aggleton, Saunders, Wright, & Vann, 2014; White & Mathur, 2018). Therefore, state-dependent changes in the electrical firing properties of the neurons across the cortex has been a strongly supported biomarker of conscious experience (Boly et al., 2013; Fries, Nikolic, & Singer, 2007). Conscious cognition is marked by brain wave synchrony, which can integrate across distributed neuronal networks to achieve a unified conscious experience (Meador, Ray, Echauz, Loring, & Vachtsevanos, 2002). In sum, neural activity in the brain is bioelectrical synecology poised for maintaining a critical dynamic balance in a tight millisecond-range transition zone between the order and disorder of spontaneous brain integration for conscious experience (van Lutterveld et al., 2017).

In terms of the debate over physiological features supportive of consciousness, it has not been a widely accepted scientific topic even in mainstream neuroscience. To highlight this, in the past 50 years of annual meetings of the Society for Neuroscience there have been few symposia explicitly focused on consciousness. Despite this, a reasonable place to approach the topic scientifically are the universally accepted stages of the loss and recovery of consciousness from sleep and anesthesia, both of which have well-established convergent scientific data. For example, findings have demonstrated that rapidly fluctuating gamma band oscillations are a brain-wide property of the awake brain, and there must be a sufficient number of brain regions manifesting gamma band activity to maintain full awareness (Fries, 2009; Fries, Jia & Kohn, 2011; Nikolic, & Singer, 2007; Garcia-Rill, 2017; Imas et al., 2005; Salari, Buchel, & Rose, 2012; Uhlhaas et al., 2009).

Hudson, Calderon, Pfaff, and Proekt (2014) have demonstrated that upon waking from sleep or anesthesia, as different levels of awareness are achieved in stepwise manner, brain

regions are recruited, and activity rises from low frequencies (delta, theta) to higher and higher frequencies (alpha, beta, gamma). Here, they showed that these different stage transitions are structured in such a way that they connect brain regions that are otherwise disconnected in antipodal manner, increasing the natural repertoire of states. In this way, you cannot be awake and asleep at the same time. The natural frequency of the brain during initial waking from sleep is 10 Hz. As the brain awakens, it steps from ~10 Hz to ~20 Hz to ~30 Hz to ~40 Hz, achieved through the ability to generate significant stepwise levels of gamma range activity, which are directly related to stages of different levels of awareness (Garcia-Rill, 2017).

Gamma waves were initially ignored before the development of digital EEG because analog EEG is restricted to recording and measuring rhythms that are usually less than 25 Hz (Hughes, 2008). Digital EEG became feasible in the 1990s, as inexpensive and powerful microprocessors and high-capacity storage digital medium storage became more widely available. In a landmark study from 1990, Francis Crick, who is better known for his co-discovery of the structure of DNA, and Christof Koch argued that there is a significant relation between gamma waves and conscious perceptions, and that consciousness arises when certain brain regions synchronize in the 40 Hz frequency range. This finding has been further replicated and expanded upon. Following Crick and Koch's discovery, Llinas and Ribary (1993) proposed the thalamocortical dialogue hypothesis for consciousness, which posits that the basis of conscious states is 40 Hz oscillations throughout the cortical mantle in looping and fluctuating process of thalamocortical iterative recurrent activity, providing the temporal binding required for cognitive experience.

The gamma wave hypothesis that developed out of this initial research further expanded through anesthesia, coma, and psychiatric research. It can be summarized as positing that gamma

range of brain wave oscillations originate in the thalamus and sweep from the back of the brain to the front and back again 40 times per second, synchronizing activity for the integration of computational outputs from neuronal populations (Jia & Kohn, 2011). With respect to this hypothesis, Singer (2007) emphasized temporal codes in the brain, and argued that gamma synchrony is ubiquitous in cognition and that conscious perception depends on prior gamma wave synchrony. Most conscious activity produces beta and alpha waves. And gamma waves generally mark complex operations such as mental concentration, predictive appraisals, and insightful experiences (Fries, 2009). Altered oscillations have been observed in disorders such as autism, Parkinson's disease, depression, anxiety, attention deficit disorder, diabetes, normal aging, Alzheimer's disease, seizure disorder, schizophrenia, bipolar disorder, and more (Ford, Goethe, & Dekkar, 1986; Hasler et al., 2007; Urbano et al., 2012).

Research conducted by researchers at MIT and Boston University (Buschman, Denovellis, Diogo, Bullock, & Miller, 2012), suggested that when focused in attention in our minds, corresponding groups of neurons are oscillating in synchrony in a high frequency range (> 30 Hz, gamma), whereas when no longer focused in mind, the brain oscillates at lower frequencies. The human brain exhibits profuse interregional connectivity via gamma waves. These gamma oscillations, which are coupled to slower waves, allow ensembles of neurons to be dynamically coordinated through flexible signal routing in neural circuits from a greater heterogenous population of neuronal outputs (Fries et al., 2001).

Akam and Kullman (2010) gave an example: When you read a book in a noisy place, information from your visual stream is processed by language regions while auditory input is ignored. Then, if something catches your attention, you can effortlessly switch focus, processing the auditory content that you were ignoring through sensory gating mechanisms a moment

before. It is the brain's ability to keep bundles of neurons simultaneously oscillating at 40 Hz that determines attentional and informational capacities (Buschman et al., 2012). It is this synchronized gamma that enable postsynaptic potentials to integrate and provide dynamic synchrony of mental processing (Salinas & Sejnowski, 2001) in the recovery of full awareness from sleep or anesthesia—and habituated nonconscious mind states in general, which are targeted by contemplative practice.

Currently in the field of contemplative neuroscience, there is no widely accepted objective measure of meditator proficiency. However, crossover data demonstrates that gamma range brain activity is key for both the neurophysiology of processes of awaking from the dullness of sleep (Garcia-Rill, 2017), and the processes of awaking from the dullness of awareness through mastery of contemplative practice (Schoenberg et al., 2018). For example, Lutz, Greischar, Rawlings, Ricard, and Davidson (2004) published a landmark study, in which they found gamma-band activity in advanced meditators that was higher than any other gamma-band activity previously observed in healthy humans. Remarkably, all of these findings relate to recent meditation research that has found significant and highly unusual patterns of gamma-related change common across expert meditation subjects from diverse traditions, observed in meditating and non-meditating conditions, as well as states of waking and sleep (Beauregard & Paquette, 2008; Berkovich-Ohana, Glickson, & Goldstein, 2012; Braboszcz et al., 2017; Cahn, Delorme, & Polich, 2010; Hauswald, Ubelacker, Leske, & Weisz, 2014; Ferrarelli et al., 2013; Jang et al., 2018; Lutz et al., 2004; Shoenberg et al., 2018; Thomas, Jamieson, & Cohen, 2014).

The importance of the convergence of these findings is truly groundbreaking for the scientific study of the contemplative mastery of mind. Specifically, EEG research that addresses power and synchrony measures shows that the higher frequency range in gamma-band has been

associated with experiences of non-judgmental awareness (Cahn, Delorme, & Polich, 2010), loving-kindness compassion (Lutz et al., 2004; Schoenberg et al., 2018), self-disintegrative equanimous states (Schoenberg & Barendregt, 2016), and selflessness (Dor-Ziderman, Berkovich, Ohana, Glicksohn, & Goldstein, 2013; Lehmann et al., 2001). A number of studies have also found gamma-band activity across different electrode sites that correlate with particular meditative states across different types of contemplative practices (Berkovich-Ohana et al., 2012; Cahn et al., 2010; Lehmann et al., 2001; Ferrarelli et al., 2013; Kozhevnikov et al., 2013; Rubik, 2011; Thomas, Jamieson, & Cohen, 2014; Vialatte et al., 2009).

In particular, Ferrarelli et al. (2013) suggested that increased gamma power correlates with level of experience and may be a marker of plasticity that remains during restful or even states of deep sleep. Findings have suggested that gamma phase synchrony between neural assemblies fire cooperatively with precise millisecond timing to control the flow of neural information (Engel, Fries, & Singer, 2001; Jacobs, Kahana, Ekstrom, & Fries, 2007; Salinas & Sejnowski, 2001). In the process of neuroplasticity, modification of synaptic connections requires gamma synchrony for the cooperative firing and restructuring of neural networks. Researchers have established that gamma synchrony is a necessary modulatory agent for the process of neural plasticity (Axmacher et al., 2006; Pajevic et al., 2014). Relatedly, Fell et al. (2010) concluded that the strongly increased synchronized gamma activity in meditation experts may be associated with processes of cortical restructuring necessary to stabilize meditative mastery.

As a result, the convergence of these findings suggests that stable high gamma-band activity in specific brain regions may be a useful state and trait biomarker of advanced meditators across traditions. As well, traditional systems of practice seem designed to gradually

and stably induce high gamma activity in the brain of the practitioner (Braboszcz et al., 2017). Therefore, high-gamma band activity was elevated in advanced meditators compared with novices in the resting-state (Lutz et al., 2004; Schoenberg et al., 2018; Thomas, Jamieson, & Cohen, 2014). A principal aim of integrative contemplative neuroscience study is to address the neurobiological substrates associated with extraordinary states that may be reflected in brain mechanisms, and therefore show up across traditions. With this, a hypothesis emerged out of the convergence of this evidence, which claims that long-term practice of different systems of meditation have similar underlying patterns of neurocognitive developments, and those underlying patterns can be used to stage-identify biomarkers of contemplative practices (Luders, Toga, Lepore, & Gaser, 2009). For example, Yoga and Buddhist meditation traditions both describe the progressive regulation of distraction and mind wandering during the early phases of meditation training, irrespective of content (Brown, 1986; Thomas, Jamieson, & Cohen, 2014).

Low frequency changes seem to have a significant role in the early stages, which was consistently evident when comparing long-term meditators with novices, especially in frontal brain areas (Kubota et al., 2001). Specifically, studies have consistently found that the EEG signals of meditation practitioners show increased theta and alpha power, and alpha functional network topology is better integrated in experienced meditators than in novice meditators (Lomas, Ivtzan, & Fu, 2015). In terms of stage effects, the first stages of meditation are generally marked by increased low frequency bands due to increased relaxation (Cahn & Polich, 2006). In particular, a large portion of the EEG research in the field has reported increased alpha band coherence and synchrony involvement in introspective attention (Takahashi et al., 2005; Travis & Shear, 2010), and practice-induced changes in somatosensory attention (Sacchet et al., 2015).

Notably, these findings on increased low frequency bands were not dependent on either

the experience level of the practitioner or the particular meditation tradition of the practitioner (Fell et al., 2010). So, changes to this band of electrical activity in the brain were the easiest for beginners to shift and modify upon initiating novice level meditation practice (Stinson & Arthur, 2013). Electrophysiological changes in the theta bands, which are slower than alpha bands, may indicate even deeper levels of relaxation and increased internalized order. Alpha and theta band changes may correlate with the relaxation, reduced mentalization, and psychosomatic reshaping in *asana, pranayama,* and *pratyahara* stages in Patanjali's system.

With increased relaxation and stabilization of stillness in introspective attention due to further brain-trained reorganization of endogenous activity, intermediate stages of meditation are marked by incorporation of self-regulatory control of attention and introspective metacognitive awareness. Here, we see attention skill training with focused types of mediation. Due to the inherent difficulty in retraining habitual mental patterns, graduated improvements are initiated by effortful top-down cognitive and emotional control mechanisms (Harenski & Hamann, 2006). However, with greater mastery, meditation practitioners are able to modulate bottom-up cognitive and emotional content without as strong of a need for top-down control (Gard, Noggle, Park, Vago, & Wilson, 2014; van den Hurk, Janssen, Giommi, Barendregt, & Gielen, 2010). Patanjali offered a description of this in terms of his contemplative psychology: The transformation toward total stillness of mind occurs as new latent impressions fostering cessation arise to prevent the activation of distractive stored ones, and moments of stillness begin to permeate consciousness. These latent impressions help consciousness flow from one tranquil moment to the next. Consciousness is transformed toward integration as distractions dwindle and focus arises. In other words, consciousness is transformed toward focus as continuity develops between arising and subsiding impressions (YS, 3.9-3.12).

In Patanjali's early stages, frontal top-down control is developed structurally from primarily exogenous sources that are gradually internalized in the process of maturation. However, beginning in the intermediate phase we begin to see a shift from top-down dominance to integrated regulation of top-down and bottom-up signals due to practice effects on resting-state networks (Gard et al., 2014). At each stage in Patanjali's system this early effortful top-down self-regulation is strengthened and stabilized, before later effortless flow of integrated phases of bottom-up/top-down self-regulation can become accessible and pliable (van Lutterveld et al., 2017). In this way, the process can be likened to the invariant plateau in temperature change when water starts to boil, which remains constant until the phase transition is complete and all the liquid has vaporized. Chemists explain this invariance during phase transitions in terms of the field potential activities of molecules in discrete phases.

Researchers have established a phasic feature in practice-effect by finding that novice meditators have higher beta in frontal cortex during meditation than experts, and thereby interpreted more beta-band in frontal regions as mental efforts exerted to maintain attention (Chiesa, Serretti, & Jakobsen, 2013; Tanaka et al., 2015). So, through selective changes in brain frequency, rhythms interplay to precisely render neural communication correlative to changes in attention and awareness. Attention samples stimuli at a 7-8 Hz theta rhythm (Voloh, Valiante, Everling, & Womelsdorf, 2015). However, selective top-down attentional control is mediated by alpha-beta-band synchronization (Ainsworth et al., 2012). Top-down alpha influences might convey influences that render inhibition of bottom-up stimuli (Carver, 2008), whereas top-down beta influences wake-up local circuits and modulate gamma-band for effective synchronous connectivity (Akam & Kullmann, 2012).

This is why there may be higher beta initially and increasing alpha with practice

(Andersen, Moore, Venables, & Corr, 2009). Gamma-band (30-90 Hz) synchronization modulates excitation rapidly enough that it can escape localized inhibitory alpha cycling to flexibly alter the pattern of communication, therefore selective attention has higher-frequency gamma band synchronization (Fries, 2015). During attentional shifting, there are increases in theta-gamma phase cross-correlations between the anterior cingulate cortex and the prefrontal cortex (Holzel et al., 2007; Voloh et al., 2015). In contemplative training, the initial stages are effortful (beta), but with more experience skill deepens through the reallocation of mental energy (alpha/beta) that triggers cognitive reset mechanisms (theta/gamma) through selective frequency interactions for equable reconfiguration. Voloh et al. (2015) found that flexible goal-directed behavior is coordinated by entraining distributed neural networks with slow oscillations to phase-align their local fast oscillatory activity, suggesting a functional mechanism to the evolutionary phylogeny of increased brain coordination.

Valderrama et al. (2012) reported that gamma oscillations in low (30–50 Hz) and high (60–120 Hz) frequency bands recurrently emerged in slow wave sleep and their amplitudes coincided with specific phases of the cortical slow wave. In this way, theta phases synchronize long-range high-frequency gamma coherence (Fries, 2015). Slow-wave stages synchronize electrophysiological features at a slow oscillatory frequency to shift attentional reserves in order to reset encoded field potentials. For example, boosting slow oscillations during sleep potentiated learning (Marshall, Helgadottir, Molle, & Born, 2006). Synchronized fast wave activity in the gamma-band has been found to be crucial for neural plasticity and the development of new brain processing circuits (Axmacher, Mormann, Fernandez, Elger, & Fell, 2006; Pajevic et al., 2014). This process may correlate with slow and fast frequency bands that are induced in the brain during contemplative training. In the early phases of meditation development, slow oscillatory

frequencies shift attentional reserves to recalibrate field potentials. And in the more advanced phases of meditation development, the primary biomarker of increasing levels of practice is the gradual stage-based induction, intensification, and cross-state stabilization of high-frequency gamma activity across key brain regions. In this way, we can speculate that Patanjali's system of contemplative skill mastery has design features based on the endogenous architecture of the sleep cycle that reorganizes and consolidates information in oscillatory phases of state change necessary for the synaptic plasticity of learning and skill mastery (Massimini, Tononi, & Huber, 2009).

Perhaps, in a similar manner as the architecture of sleep phases needed for learning and skill mastery (Fogel, Ray, Binnie, & Owen, 2015), the electrophysiological architecture of Patanjali's stages goes through a morphogenic cycle of state phases to better consolidate, internalize, and integrate contemplative skill mastery. In this way, phases that increase gamma-band induced neuronal synchronization can flexibly alter brain communication for higher integration phases of state consolidation (Sandkuhler & Bhattacharya, 2008). Perhaps due to fast-wave oscillations in both meditation and sleep, transcendence can surpass informational limits; and slow-wave oscillations can encode and integrate the reorganization of informational boundaries (Travis, Tecce, Areander, & Wallace, 2002). In this respect, increased low alpha power may reflect reduced cortical activity and detached witnessing of multimodal information processing; theta may indicate an implicit affect-based representational orientation toward information sampling; delta may reflect neural silence and satisfaction; and gamma may indicate transcendence, temporal-spatial binding, and salience (Horan, 2009).

Even in the earliest contemplative neuroscience research, Das and Gastaut (1955) observed seven expert yogis elicit an increase in alpha frequency and a decrease in alpha

amplitude coupled with the appearance of fast 40–45 Hz gamma waves during *samadhi*, that eventually returned to alpha-theta activity. West (1980) reported a number of studies that found high-frequency high beta and gamma (>20 Hz) in cases of meditators achieving *samadhi*. Raja yoga practitioners exhibited focused arousal at 40 Hz during the concentration (dharana) phase of meditation (Ray, 1988). Fenwick et al. (1977) summarized generally agreed EEG changes during meditation: (a) on beginning meditation alpha amplitude increases and alpha frequency slows, (b) later in meditation trains of theta rhythms occur intermixed with alpha, dependent on meditator experience level, (c) during deep *samadhi* meditation, sustained high frequency occurs, and (d) at the end of meditation alpha persists beyond the meditation state.

Systematized Yogic Optimization

The broad, long-term objective of this study was to advance the knowledge in the field of transpersonal psychology through improvement of the understanding of optimal states of consciousness in the context of integrative exchange with intact contemplative systems and our growing neuroscientific database. To thrive now and into the future, humans have to be willing address existential challenges with wisdom-based competencies rooted in a clear understanding of the evolution of individual consciousness, its transformation, and specifically, its nature and unfoldment beyond formal constructs of the mind and ego. The study of the descriptions and commentary given by Patanjali provide a blueprint that can help define stage-based trajectories in optimized brain state potentials designed to target implicit maladaptive tendencies. Here, we will apply the knowledge base of neurocognitive studies to the concept of yogic meditation, building a new framework that is intended to increase the heuristic value of the psychological construct of optimized consciousness.

Yogic methods leverage adaptive limitations with practices designed to create sufficient cognitive flexibility to interfere with implicit default mental tendencies, for furthering the evolution of human consciousness (Moore & Malinowski, 2009). Patanjali's contemplative psychology includes multimodal clusters of practices that are designed to integratively regulate different sources of hierarchical input that feed content into the brain, providing a greater range of flexibility, pliability, and adaptability in the yogic mastery of mind. Each source requires specific methods to tame or still that source. Effectively, these methods are to be systemically activated, so that each stage transcends and includes the stages preceding it. The sources and accompanying methods to tame and regulate the mind's contents are the following:

1. The cognitive affective system is tamed by practicing *yama* and *niyama* (ethics & virtues)
2. The somatosensory motor system is tamed by practicing *asana* (yoga posture)
3. The autonomic nervous system is tamed by practicing *pranayama* (breath control)
4. The sensory perception system is tamed by practicing *pratyahara* (sensory isolation)
5. The central executive system is tamed by practicing *dharana* (focused attention)
6. The saliency system is tamed by practicing *dhyana* (focused attentional flow)
7. The ego identification system is tamed by practicing *samadhi* (nondual attentional flow)
8. The metacognitive monitoring system is trained by practicing *samyama* (yogic mind mastery), the crux of which is *samadhi*

Some characteristics of *samadhi*:

1. Effortless concentration of the mind
2. Absence of observer/observed dichotomy; knowing by being
3. Flexible aperture of awareness
4. Sustained levels of awareness free of mental content

Fell, Axmacher, and Haupt (2010) proposed a neuropsychological stage-based model underlying all forms of meditation based on four stages in the process of meditation maturation, which heuristically align with the core of Patanjali's stage system. However, unlike Patanjali's system, they neglect stages of cognitive moral development in their scheme. So, the first step in their model involves physical demands with fluctuating consistency of attention due to the processes involved in the behavioral and kinesthetic adjustments to new practices, which correlates roughly with the Patanjali's stages of *asana* and *pranayama*, combined. At this stage, awareness of body and breath is used to relax and increase internal attention. In their second step, we see more experience and ability for stable internalized forms of attention, which loosely corresponds with Patanjali's stage of *pratyahara.* In this stage, the normally outward directed flow of attention becomes more stabilized through a more controlled introspection and filtering of attention. In their third step, there is less susceptibility for mental distraction and an ability to sustain focus attention on the object of meditation, with discrimination for automatically generated mental representations. This corresponds to the attentional concentration retraining in *dharana* and *dhyana*, and the development of stable proficient flow in meditation states. In their fourth and final stage, we see experts with various associated transpersonal experiences, which corresponds with Patanjali's final stage of *samadhi.* Patanjali elaborated on the combined integration of later stages through his descriptions of various practical applications for a method of transpersonal knowing, called *samyama* (YS, 3.4-3.8), which corresponds with the functional integration of concentrative flow and transpersonal phenomenology in Fell et al.'s model (2010).

In comparing and contrasting different stage-based models of contemplative maturation, it is important to address the stages of moral development that are built into Patanjali's first two stages of contemplative development. For the most part, stages of ethical value development are

missing from modern theories of meditation in the contemplative neurosciences. To this end, the American psychologist Lawrence Kohlberg coined the term *postconventional* to describe the highest stages of moral development, which he predicated on the movement beyond identification with the formal structures of the mind toward a less self-interested identification committed to larger ethical concerns often associated with maturity, moral integrity, constructive generativity, social responsibility, and individual agency (Rest, Turiel, & Kohlberg, 1969). In the same way, traditional systems of meditation have encoded personal and interpersonal ethics, morals, and values in their systemic approach to contemplative mastery in order to specifically address postconventional ego development (Moll, Zahn, de Oliveira-Souza, Krueger, & Grafman, 2005). In Patanjali's system, his first stage of *yama* refers to ethics associated with our relations to the external social world; centered on compassion, cooperation, and alleviating harm toward all beings. His stage of *niyama* involves virtues related to internal self-regulation, such as: purification, cleanliness, contentment, self-discipline, self-reflection, and devotion.

In practice, this is a problematic omission within the field of contemplative science, especially concerning some of the ramifications in terms of the ethical issues and concerns that have arisen in the field mentioned earlier in the introduction of this study. Therefore, it generates distorted maps for practitioners, public consumers, and the scientific community, which leads to irresponsible and significant translational problems between the science community and the public sector. For example, meditation is commonly construed merely as a form of relaxation. However, meditation development is an arduous psychospiritual endeavor and failure to integrate various aspects of the psyche courts the risk of mental health breakdowns, spiritual crises, and experiences described as: challenging, difficult, distressing, functionally impairing, and requiring of medical support (Lindahl, Fisher, Cooper, Rosen, & Britton, 2017; Voros, 2016). From a

clinical and scientific perspective, fewer than 25% of meditation trials have included methods for assessing adverse events (Schlosser et al., 2019). Therefore, meditation-related difficulties are underreported. So, when they are reported, they are likely more extreme cases.

The American Psychiatric Association's (2013) *Diagnostic and Statistical Manual of Mental Disorders* included diagnostic descriptions of "Depersonalization/Derealization Disorder" potentially associated with meditation experiences (pp. 302-306). Lindahl et al. (2017) used thematic analysis to uncover the phenomenological content of distress and functional impairment from meditation-related experiences to determine factors that can impact such effects. They found four major domains of influencing factors: (a) practitioner-level factors, (b) practice-level factors, (c) relationships, and (d) health behaviors. Surprisingly, they discovered that the majority (73%) in their small sampling (n = 59) indicated moderate to severe impairment in at least one of these domains, with a median duration of symptoms at 1-3 years. In a recent cross-sectional online survey of 1,232 regular meditators with at least 2 months of experience, Schlosser et al. (2019) found that 25% reported unpleasant meditation-related experiences. Due to this, they proposed that an unencumbered open interdisciplinary discussion could enable research approaches to investigate the distinction between negative experiences and experiences that are necessarily difficult for latter stages of meditation training to develop. Millenia ago, Patanjali was aware of these influencing factors and they were taken into account and integrated into his systematic guidelines for practice, designed to diminish the potential for negative impacts from meditation-related experiences. And to build upon this, operating within a given practice context, without interdisplinary and integrative perspectives, might affect the ability to accurately appraise meditation experience. Without an adequate contemplative psychology map, meditation practitioners may fail to recognize the regressive nature of their experience even after

prolonged effects. Due to this, understanding the range of pitfalls is as important as the range of potentials in meditation practice. For example, perhaps those prone to unpleasant meditation experiences may engage in ego dissolving practices in an imbalanced or disordered manner, inordinately seeking to weaken cognitive patterns that need stages of attentional and self-constructive competency to stably initiate.

It takes a fairly mature level of ego organization to practice mediation appropriately, and this is what the preliminaries of practice were designed to strengthen in traditional systems of practice. Otherwise, meditation experiences may become an even stronger source of resistance to integrating contradictory experiences. The great spiritual teachers, saints, and realizers in history have described the difficulties and dangers of psychospiritual development, sometimes referred to as the dark night of the soul in the Christian contemplative tradition. For instance, the Buddha described how he was attacked by illusions and negative energies on his path toward enlightened self-realization (David, Lynn, & Das, 2013). Western students may tend to become fixated by the potential increase in regressed introspective phenomena such as fantasy, reverie, daydreaming, imagery, motivation, or emotions. Likewise, there can be a sense of loss and falling apart as conventional presumptions about existence and our ego-based narrative mentalizations start decoupling from our self-identity, releasing their phase-lock on awareness. Inevitably, those with weakened ego structure are drawn to meditation, and things can worsen as a result. Accordingly, using Dahl, Lutz, and Davidson's (2015) typology of practices, this evidence predicts that difficult and unpleasant experiences could be expected to occur more frequently in the context of self-deconstructive practices. This is why traditional systems included value structuring and attentional strengthening practices initially.

When examined comparatively, we can see that omissions of the value of traditional preliminary capacities stem from a lack of scientific investigation into traditional meditation systems. Traditional systems of meditation practice typically involved contextual components, such as intentions for practice, ethical consideration, background conceptual beliefs, and the support of teachers and community, among others. Therefore, the interpretation of evidence in some ways remains limited to practice in a decontextualized research setting. In traditional systems of practice, buffering from pitfalls may have been due to a stronger sense of community, more contact with fellow practitioners, and easier access to expert meditation teachers. In regard to this point, Ferrer (2002) clearly articulated valid concerns:

> I would like to add that in most traditions—such as Advaita Vedanta, many Buddhist schools, and some forms of Christian monasticism—a period (usually lasting several years) of rigorous study of religious scriptures and "right views" is often regarded as a prerequisite for meditative practice and the experiential enactment of the teachings. The immersion in experiential practices without an appropriate understanding of the teachings is generally considered not only premature by also potentially problematic. Likewise, in the Yoga system of Patanjali, a very demanding ethical preparation (*yama, niyama*)—that includes the practice of non-violence, truthfulness, self-discipline, right speech, devotion and so forth—is considered a necessary foundation for the practice of meditation (*dharana*) and contemplation (*dhyana*), as well as for the attainment of unitive states (*samadhi*) and liberation (*moksha*). All this strongly suggests that the modern Western search for spiritual experiences, usually divorced from serious religious study and deep ethical commitments, may be profoundly misleading. Once inner spiritual experiences are segregated from ethical and traditional contexts, they tend to lose their sacred and transformative quality and become merely peak experiences—temporary gratifications for an ego hungry for subjective spiritual heights, but often leading to further self-absorption and narcissism—the antithesis of what any authentic spiritual path strives for. (p. 27)

External Stages of Yogic Maturation

Due to this widespread omission of right views in the field of contemplative science, aspects of the requisite discriminative discernment (*viveka-khyatih*) and transformations in cognitive control (*nirodha-parinamah*) of the mind's nonconscious latent shadow elements (*samskara-kleshas*) that carry the potential to form distractions in the mind (*citta-vikeshpa*) have

been largely overlooked. For example, Patanjali asserted that for one who has discrimination, everything is suffering on account of the inherent consequences of action, as well as from suffering ensuing from the turmoil of an imbalanced mind (YS, 2.15). Negative thoughts are harmful, and they may be personally performed, or authorized by oneself. They can be triggered by greed, anger, or delusion with various degrees of intensity; and they can be controlled by cultivating counteracting thoughts with the understanding that the consequence of negative thoughts is ongoing suffering (YS, 2.34). These latent impressions (*samskaras*) can be counteracted and positively imbued through generative contemplative practices, which can then tilt the tide of toward balanced (*sattvic*) development of cognitive control (*nirodha-parinama*; YS, 3.9).

As we have seen earlier, there are two main types of mental processes known by various names: conscious-nonconscious, controlled-automatic, explicit-implicit, volitional-spontaneous. Based on this principle of brain function, moral discernment can happen in two ways: (a) automatically and effortlessly as the result of affect-driven moral intuitions, before any conscious processing has occurred; or (b) deliberatively and consciously as a result of choices that require mental simulation to guide the reasoning. So, moral development is influenced simultaneously by conscious control and nonconscious automatic processes. Similar to other cognitive processes, psychology accepts both the fact of conscious or willed causation of mental and behavioral processes, and the fact of automatic or spontaneous cognitive processes in the process of self-regulation (Wegner & Wheatley, 1999). Experiments have determined that self-regulatory control is a limited resource, and must be employed strategically to recondition the functional architecture of intrinsic brain activity for skill mastery (James, Oechslin, Michel, & De Pretto, 2017; Zhang & Raichle, 2010). Patanjali's path employed this limited resource of self-

regulatory control in very strategical and intelligent ways, cross-training stage-based adaptive strategies for balanced top-down and bottom-up control of idiopathic concerns and challenges (Gard et al., 2014). At each stage, skill development is predicated on an effortful ramp-up period at the outset, followed by a period of stabilization, which then provides windows of access to more effortless skillsets that then lays the foundation for later more stabilized stages of profound awareness and insight. This can also be seen in the trajectory of moral development from an early age, beginning with effortful strengthening of top-down circuitry, which is stabilized in a new level of brain integration through neurobehavioral restructuring. This reorganized neurobiology for effortless integration of top-down and bottom-up control processes ensue with greater access to states of what Patanjali called undisturbed peaceful flow (*prasanta-vahita*; (YS, 3.10).

In terms of strategical approaches for contemplative skill development, Patanjali insisted on ethical and moral development as corequisite to meditation practice. He asserted that cultivating an attitude of friendship toward those who are happy, compassion toward those in distress, joy toward those who are virtuous, and equanimity toward those who are non-virtuous: lucidity arises (*maitri-karuna-muditopeksanam sukha-dukha-punyapunya-visayanam bhavanatas citta-prasadanam*; YS, 1.33). Perhaps, in this regard, it could be claimed that without stages of moral development the brain's functional circuitry in the prefrontal cortex (PFC) will not be proficiently modulated to facilitate and provide the appropriate neural platform for contemplative mastery, due to preparatory omissions in the morally-enhanced high frequency reorganization of neural circuits in the prefrontal cortex. Neuroscience has showed how the circuitry for paying attention is shared by moral decision making in the PFC (Pace et al., 2009).

Specifically, researchers have identified three distinct psychological mechanisms linked to dissociable neural processes underlying altruistic decision making: (a) empathy via anterior insula, (b) perspective taking via temporal parietal junction), and (c) attentional reorientation via anterior cingulate cortex (Arzy, Thut, Mohr, Michel, & Blanke, 2006; Tusche, Bockler, Kanske, Trautwein, & Singer, 2016). Interestingly, as mentioned earlier, the PFC is also the part of the brain that is last to develop in ontogeny and phylogeny; it allows people to control themselves, to keep emotions in check, and to feel empathy (Decety, 2015; Oosterwijk et al., 2012). The attentional circuitry in the prefrontal cortex, including the executive and saliency networks, needs to have the experience of sustained episodes of concentration in order to build the mental models that can accurately predict and enhance skill mastery, whether it is playing the violin, skiing, or meditating.

As we have seen earlier, the saliency network (SN) has been implicated in detection, switching, and coordination of the executive control network (CEN) and self-related associative mentalization that is mediated by the default mode network (DMN). Specifically, researchers have found that the SN is essential in the detection of moral information, which modulates downstream DMN and CEN interactions (Chiong et al., 2013; Sevinc, Gurvit, & Spreng, 2017). Due to the coordination of these networks in top-down and bottom-up processing, and their well-established discoordination in psychiatric pathologies (Tillem, van Dongen, Brazil, & Baskin-Sommers, 2018; Woodward & Cascio, 2015), some inferences can be made. Without appropriate network coordination developed through ethical and attentional training, there may be a lack of functional-network fitness for the complex attentional reconfigurations induced by later stages of contemplative practice; and this may cause potential aberrations due to the bypassing of necessary components in contemplative stage development (Uddin, 2015).

Perhaps the most well-known study on attentional self-control is a longitudinal study on a large sample, with ~1000 children in New Zealand, that were tested and measured on their ability to pay attention and ignore distractions, regularly for eight years (Moffit et al., 2011). This research initiative, called the Dunedin Multidisciplinary Health and Development Study was launched in 1972 and led by psychologists Terrie Moffitt and Avshalom Caspi from Duke University. Recently, they tracked down those same children at the age of 32 to see how well they fared in life, and the ability to concentrate and self-control was the strongest predictor of success, health, and public safety (Muffit et al, 2011). From detailed observations of the life courses of ~1000 New Zealander, the Dunedin study has produced more than 1500 papers on various epidemiological, psychological, and genetic aspects to human health and development. This finding is unique because of the rarity of longitudinal studies (expensive and difficult), its high retention rate (95%), and robust sample size (n~1000). It does point out the Patanjali was on to something, and raises the question of when is the optimal time in childhood development to introduce contemplative or attentional training for impacting success throughout life. This research has opened the door for many of these types of further research questions to explore.

Sequentially after Patanjali's first two stages of structured moral-ethical enhancement, comes the third stage of yoga posture, called *asana* in Sanskrit. Ancient yogis of India have claimed also that body posture has a profound effect on the individual's state of mind. This is because yogis see the body and mind, not as separate entities, but as a single continuum, profoundly influencing each other. In Patanjali's third stage, *asana* yoga postures are used to support the development of contemplative mastery. *Asana* practice has become widespread and elaborate in modern society due to its social status as a healthy form of physical exercise. This modern form of yoga associates itself primarily with only one component in Patanjali's scheme,

and has combined it with gymnastics and aerobics to create what has been referred to as modern postural practice, in order to provide a distinction from traditional *asana* practice (Singleton, 2010). However, contrast this with Patanjali statements on *asana* practice: Posture should be steady and comfortable (*sthira-sukham asanam*; YS, 2.46). And such posture should be attained by the relaxation of effort and by absorption in the infinite (*prayatna-saithilyananta-samapattibhyam*; YS, 2.47). From this, one is not afflicted by the dualities of the opposites (*tato dvandvanabhighatah*; YS, 2.48).

Very few studies have examined the neurobiological correlates of *asana* practice. A recent systematic review and meta-analysis lamented that out of the 18 studies found, most studies were of such low quality and heterogeneity, it was difficult to reach any meaningful conclusions (Vollbehr et al., 2018). However, Froelinger, Garland, and McClernon (2012) found significantly higher grey matter volume in prefrontal cortical regions and hippocampal regions in a sample of seven *asana* practitioners, as compared to naive controls. Notably, these are also the primary regions also affected by breath control practice (Hariprasad et al., 2013). Gothe, Hayes, Temali, and Damoiseaux (2018) suggested an association between regular long-term *asana* practice and differential structure and function of regions involved in executive function. Likewise, systematic review found that *asana* yoga practice shows promise for affecting improvements in executive and kinesthetic function (Luu & Hall, 2016). Amornpan, Rachiwong, and Siripornpanich (2018) found significant increase in alpha EEG activity over the frontal, central, and parietal areas on resting-state brain activity from eight weeks of *asana* yoga training for physical disability-related stress.

Next in this progression is Patanjali's fourth stage: When *asana* is accomplished; *pranayama,* breath control follows. This consists of the regulation of the incoming and outgoing

breaths (*tasmin sati svasa-prasvasayor gati-vicchedah pranayamah*; YS, 2.49). This stage involves rhythmogenic manipulation of respiratory breathing cycles to attenuate mental fluctuations and induce states of unified mind-body awareness. Breathing is the most vital rhythm of life for mammals, providing oxygen to the whole organism through a constantly replenished circulation of blood to the body and brain. Patanjali stated: *Pranayama* manifests as external, internal, and restrained movements of breath. These are subtly modified in accordance to place, time, and number (*bahyabhyantara-stambha-vrttih desa-kala-sankhyabhih paridrsto dirgah-suksmah*; YS, 2.50). Then, the covering of the illumination of knowledge is weakened (*tatah ksiyate prakasavaranam*; YS, 2.52). And, the mind becomes fit for concentration (*dharanasu ca yogyata* manasah; YS, 2.53). Research is now corroborating Patanjali's assertion that breathing can shape cognitive function (Herrero, Khuvis, Yeagle, Cerf, & Mehta, 2018; Zelano, Jiang et al., 2016). Likewise, researchers have found neural activations in the dmPFC, ACC, and the insula during a controlled focused breathing practice (Dickensen, Berkman, Arch, & Lieberman, 2013). Researchers have found that the rate of breathing synchronizes electrophysiological activity in a widespread network of cortical and limbic brain structures, that enhances abilities in both cognitive discrimination and cognitive performance (Evans et al., 2009; Herrero et al., 2018; Nakamura, Fukunaga, & Oku, 2018).

As a result, breathing exercises prior to performing a task can hone both cognitive performance and state of mind (Edwards, 2008). Remarkably, Nakamura, Fukunaga, and Oku (2018) showed that certain phase transitions in the breathing cycle can modulate performance on a time scale of several seconds in cognitive tasks, and they conclude that their findings "could explain the benefit of the breathing exercises utilized in meditation and yoga practices" (p. 13). Telles et al. (2011) found that after *pranayama* there were significant decreases in the degree of

optical illusion in practitioners. So, by utilizing and harnessing the breathing cycle, *pranayama* primes physiological prerequisites for optimized consciousness that shape rhythmic electrical activity, entailing subsequent downstream effects on perceptual, emotional, and cognitive functions (Frederick et al., 2016; Melnychuk et al., 2018). Systematic review found that slow-breathing techniques have significant increases in EEG alpha power and decreased EEG theta power (Zaccaro et al., 2018).

The breathing rhythm is generated and modulated by pacemaker neurons in a bilateral and symmetrical neural network located in a cluster of interneurons in the medulla of the brainstem called the preBotzinger complex, which are essential in the generation of respiratory rhythm in mammals (Smith, Ellenberger, Ballanyi, Richter, & Feldman, 1991). The thalamus plays an important role in integrating oscillatory respiratory signals to and from these brain respiratory centers, which then relay to cortical connections (Pattinson et al., 2008). Respiration modulates and entrains gamma oscillations, most prominently in the frontal regions; therefore Tort, Brankack, and Draguhn (2018) hypothesized that respiration-entrained gamma oscillations aid long-range communication in the brain for better overall brain integration. Related to this, Vialatte, Bakardjian, Prasad, and Cichocki (2008) preformed an EEG study on *pranayama* practitioners and found unusual hypersynchronous activity in the high gamma range. In this regard, it is important to emphasize that in traditional systems of meditation, such as Patanjali's, entrainment via forms of breath control prepare the mind for a deepening psychospiritual connection with undivided wholeness that pervades everything.

The fifth stage in Patanjali's system is *pratyahara*, or control of sensory input, which is the last of the five outer stages in the process or contemplative maturation. *Pratyahara* occurs when the senses do not come into contact with their respective sense objects. It corresponds to

the nature of mind when it is free of sensory objectification (*svavisayasamprayoge cittasya svaruanukara ivendriyanam pratyaharah*; YS, 2.54). From this comes the highest control of the senses (*tatah parama vasyatendriyanam*; YS, 2.55). There is some initial research that has been done on techniques loosely comparable to Patanjali's sensory isolation and control. For example, Yoga-Nidra is a meditation for deep physical and mental relaxation in which practitioners lie motionless and flat on the ground, with eye-pillows and ear-plugs to reduce sensory input, and get into a liminal state of consciousness. Researchers found that this form of *pratyahara*-inspired meditation produced significant increase in theta-band activity, and a 65% increase in endogenous dopamine release with a reduced readiness for action (Kjaer et al., 2002), indicating a dynamic balanced neural state (Asada, Fukuda, Tsunoda, Yamaguchi, & Tonoike, 1999; Daw, Kakade, & Dayan, 2002).

As another example of a form of sensory isolation that can be loosely associated with the traditional practice of *pratyahara*, there is a method referred to as restricted environmental stimulation technique (REST), in which a person floats inside a quiet and completely dark tank with heated salt-saturated water for bouncy and weightlessness. Results from limited randomized controlled trials have suggested this form of sensory isolation reduces stress, depression, anxiety, muscle tension, negative affect and pain, accompanied by significant improvements in mood with experiences of serenity, happiness, euphoria, optimism, and an overall sense of wellbeing (Feinstein et al., 2018; Jonsson & Kjellgren, 2016; Kjellgern & Westman, 2014). The study of the use of sensory isolation in the context of meditation is lacking in the scientific literature. However, further scientific examination is warranted based on initial results being reported from preliminary neurophysiological studies that have analyzed cognitive conditions related to yogic types of sensory isolation practice that have demonstrated associated testing characteristics.

Internal Stages of Yogic Maturation

Nevertheless, Patanjali's system of yogic mind mastery supports and adds to these integrative mind-body relaxation techniques by theorizing that most humans get caught in mental states of chronic subconscious concern for the preservation of a falsely assumed self-identity, distorting the true ontological nature of existence with a lack of knowledge concerning mental faculties that tend to obscure true self-awareness. After proficiency in the first five stages of practice, Patanjali asserted, that the mind then becomes fit for concentration (YS, 2.53). In order to address the introspective cognitive reorganization necessary for this deficit, Patanjali referred to the last three stages in his system as the inner stages. These three: *dharana, dhyana, and samadhi* are internal stages compared to the previous outer stages (*trayam antar-angam purvebhyah*; YS, 3.6). In fact, Patanjali provided a gradual progression from the external to the internal through the theoretical structuring of the stages. The *yamas* are the most external, proscribing compassion and cooperation in relations with all other sentient beings. The *niyamas* address more internal aspects of practice such as contentment, self-reflection, and devotion. This progression continues, with *asana* practice to focus attention on embodied aspects of balancing the physical structure to support the contemplative development. And next we see that *pranayama* is more internal still, focusing on the breath that pervades the body. *Pratyahara* continues this progression of internalization by going still deeper within the phenomenological space of individual experience. This process of consecutive stages of internalization culminates in the last three most inner integrative stages yogic mind mastery, which can reconfigure functional neurocognitive networks in phase-specific ways to awaken consciousness.

Neuroimaging of the resting-state activity in individuals carries information about the cognitive capacity for access to variable neural states (Saxe, Calderone, & Morales, 2018).

Patanjali's last three stages of yogic development specifically address contemplative aspects of cognitive training, and he proposed practices that perhaps may speculatively reconfigure the cognitive capacity of the canonical higher brain networks (Chen et al., 2013; Sridharan, Levitin, & Menon, 2008): (a) *dharana* may reorganize the functional connectivity of the frontoparietal central executive network, (b) *dhyana* may reorganize the functional connectivity of the saliency network, and (c) *samadhi* may reorganize the functional connectivity of the default mode network. If a meditation technique involves increasing proficiency in cognitive control, then expertise might be expected to meld these processes together leading to greater automaticity in practice, and so deeper experiences over time (Travis & Shear, 2010). Cognitive control involves bridging the initial state of the individual with an intended goal-state via the continuity and discontinuity of engagement in a solution path designed to elicit insight, mental restructuring, and transformative states (Ash & Wiley, 2006). Due to this, the individual may suddenly and unpredictably become aware of an unimagined solution (Bubic, Yves von Cramon, & Schubotz, 2010; Siegler, 2000).

Meditation is widely viewed by the people today as a procedure primarily intended for relaxation and stress reduction, however research has revealed significant effects on self-regulatory functioning in the cognitive, sensory, and emotional domains (Sperduti et al., 2012). Self-control is in some ways similar to muscle training. As a result, performance in cognitive control under load may be improved by the regular practice of small acts of self-control (Lavie, 2010). The more we train the self-regulation of our minds, the more efficient the mind can become due to less disorder in energy distribution that impairs operations. Prolonged experience of this broadens the self to the point that it is no longer overidentified with mental constructs. Psychic entropy can increase and become chaotic (*rajas*), reduce and become listless (*tamas*), or

stay dynamically poised near critical state (*sattva*). The psychologist Mihaly Csikszentmihalyi (1990) elaborated on this: "The best moments in our lives are not the passive, receptive, relaxing times. The best moments usually occur if a person's body or mind is stretched to its limits in a voluntary effort to accomplish something difficult and worthwhile" (p. 3). Csikszentmihalyi concluded from his research on attentional control and sustained flow of engaged attention that the control of consciousness determines the quality of life.

Research has concluded that self-regulation, whether mental, emotional, or behavioral, is a limited resource which functions or remains latent based upon capacities that are built and strengthened through practice; amending prior misconceptions of the aspects of self-control as relatively fixed (Muraven, 2010). In this regard, *dharana,* or one-pointed concentration, the first stage of cognitive training necessary for the advanced inner stages of Patanjalian mind mastery, requires evenly controlled episodes of concentrative exertion of cognitive control, which contrasts with the forms of psychosomatic relaxation in earlier stages. Concentration is the fixing of the mind in one place (*des-bandhas cittasya dharana*; YS, 3.1). Normally, we are lost in our own thoughts in everyday life. With the development of concentration through meditation thoughts begin to stop, and periods of long stillness begin to emerge. With a stillness of mind induced by concentrative mediation, it becomes possible, through direct experience, to see the distinct difference between thought (*citta-vritti*) and awareness (*citi-darsin*), in order to understand one's own true ultimate nature (*atma*). The seer is merely awareness itself, witnessing the images of the mind (YS, 2.20). In yoga psychology, everything that we experience is a fluid association of the elemental forces (*gunas*) of mind and energy called *rajas* (excitatory)*, tamas* (inhibitory)*, and sattva* (balanced) that dynamically condition our mental faculties. As such, they are constantly changing state along a continuum with relatively strong

deterministic currents, depending on the conditioning of attentional tendencies and patterns of self-control. Ostensibly, through integrative yogic mind practices they eventually dissolve back into their original matrix (*pratiprasavana*), and their true nature can shine forth (*artha-matra-nirbhasa*). It is due to their interactions in functional brain networking and mental representation that we experience things in a more or less obscured or lucid manner.

Practice is an important part of becoming skilled at anything; and to get the most out of practicing, it must be consistent, intensely focused, and target the edge of one's ability. Learning-induced anatomical changes are rapidly-induced from practice and the plastic changes set the platform needed for further mastery (Brodt et al., 2018). Psychology research has sought to define the dynamics of types of focused concentration that target the edge of one's ability and that are doorways to optimized states of consciousness cross-culturally, in examples of extreme human performance (Wrigley & Emmerson, 2013). Concentration is an attentional process that involves the ability to focus on the task-at-hand ignoring distractions, and cognitive research demonstrates that it is vital for success in any field of skilled performance (Brefczynski-Lewis, Lutz, Schaefer, Levinson, & Davidson, 2007). For instance, in the process of studying the creative process in the 1960s, Csikszentmihalyi observed that when the creative process is optimal, the artist persisted single-mindedly, disregarding hunger, fatigue, and discomfort. Following this spark of insight, he continued researching it and later called it the "flow" experience (Nakamura & Csikszentmihalyi, 2014). Csikszentmihalyi (1996) has described it as a state of flow because it is characterized by "an almost automatic, effortless, yet highly focused state of consciousness" (p. 110).

The flow experience of consciousness is a universal human experience that has been tested across cultures, races, sexes, and socio-economic status (Dietrich, 2004). It has been

repeatedly shown to have positive ontological, psychological, and transpersonal implications. Csikszentmihalyi (2008) stated that, "it is not unreasonable to regard yoga as one of the oldest and most systematic methods of producing the flow experience" (p. 106). Flow is considered to be an optimal psychological state in which there is complete absorption in the task at hand which leads to a number of positive experiential states and character traits (Nakamura, & Csikszentmihalyi, 2014). When there is a merging of action and awareness, with a loss of temporal awareness and associated self-related thoughts, one experiences flow. According to Csikszentmihalyi's theory, the elements of flow provide the keys to understanding the optimized experience of a meaningful existence. Csikszentmihalyi has speculated that yoga is highly associated with flow experiences, and the details of how the experience was first systematically trained and reproduced are comprehensively developed in yoga. Csikszentmihalyi (2008) clarifies his point: "This simple truth, that the control of consciousness determines the quality of life has been known for a long time…in the East, techniques for achieving control over consciousness proliferated and achieved levels of enormous sophistication" (p.20). Nakamura and Csikszentmihalyi (2014) identify the following six factors as encompassing an experience of flow:

1. Intense and focused concentration on the present moment
2. Merging of action and awareness
3. A loss of self-representational awareness
4. A sense of personal control or agency over the situation or activity
5. A distortion of temporal experience, subjective experience of time is altered
6. Experience of the activity is intrinsically rewarding, also referred to as autotelic experience

Remarkably, inducing this state of flow has been shown to be effective at exponentially increasing the speed of mastery of new skills. In fact, the United States Navy's elite SEAL Team has been experimenting using sensory isolation tanks to cut new language learning to a fraction of the time used in traditional methods. The premise is to induce a flow-state of optimized distraction-free physiological and neurological relaxation, and then introduce new content; which has reduced learning time exponentially and increased the accuracy in the mastery of skills like foreign languages, musicianship, business leadership, archery marksmanship (Csikszentmihalyi, 2008; Norlander, Bergman, & Archer, 2008; van Dierendonck, & Te Nijenhuis, 2007). This evidence supports Patanjali's techniques of sensory isolation and concentrative flow for the reconditioning necessary to catalyze yogic mind mastery. Patanjali intended to make conscious the activators that were responsible for focused flow (YS, 3.10).

At first, attention wanders from the chosen object (DMN), and upon noticing distractions (SN), the returns to the intended object with the CEN (Hasenkamp & Barsalou, 2012). This practice develops three primary attentional skills: (a) saliency monitoring, (b) the ability to disengage attention from distraction, (c) agility in redirecting focus (Hasenkamp et al., 2012). Patanjali's descriptions of the development of this stage of attention-based practice proposed processes of effortful sustaining and orienting that initially dominate cognitive capacities and reserves in order to strengthen self-regulatory control in focusing attention (YS, 1.21). Patanjali even delineated degrees on this effortful axis: Among these, there is further differentiation of the intensity of this effort into degrees of mild, mediocre, and ardent (YS, 1.22). In that regard, consciousness is transformed toward sustained focus when the flow of images in the mind from one moment to the next have sameness (*tatah punah santoditau tulya-pratyayau cittasyaikagrata-parinamah*; YS, 3.12). The ability at directing attention (*dharana*) is necessary

for stable engagement of attentional absorptive flow that is signatory of the *dhyana* stage of meditation proficiency. Through concentration meditation, overactive thought processes attenuate, which also includes the attenuation of self-referential thought processes.

As expertise in the transformation (*parinama*) of these concentrative (*eka-agrataya*) processes strengthen and develop with more practice (YS, 3.11), representational thinking (*savitarka*) processes gradually fade into the background with greater mastery of concentrative flexibility in awareness, resulting in a form of effortless flow of concentration (*citta prasanta-vahita*; YS, 3.10) that Patanjali referred to in his seventh stage of *dhyana* (YS, 3.2). Therefore, in expert meditators we can expect reduced effortful activation in neural systems implicated in regulating attention, which may be associated with optimized performance in sustained effortless attention (Holzel et al., 2007; Lutz et al., 2008). Research has noted that although traditions differ in conceptualization of the stages, they resemble each other in the structure of experience (Brown, 1986). In Patanjali's integrative approach to optimizing consciousness, there appears to be an underlying structure that correlates with features of brain organization associated with the ability for conscious access to specific sequence of states that qualify practice (Piron, 2001, 2003).

This highlights the importance of understanding systems theory in contemplative practice and research. The findings in this review show that there are major shortcomings in the current scientific literature that typically fail to systematically distinguish integrative strategies. For instance, most traditional meditation systems have an ordered sequence for acquiring meditation skills in which focused types of meditation precede effortless types of meditation. Manna et al. (2010) performed a study comparing advanced meditators and novice meditators, with an integrated FA and OM practice paradigm to measure the features of their contrasts in different

levels of practitioner mastery. It is worth noting, that the advanced meditators in this study were trained in both FA and OM, as is typical in traditional contemplative systems that initially teach meditation in progressive sequence (FA→OM), and later determine competency based on dexterous and rapid switching between both. Researchers have found that OM practices are primarily driven by noradrenergic transmission, wherein a vigilance neural system facilitates reflexive switching ability and a more global attention-awareness vigilance system (Langer & Eickhoff, 2013; Schoenberg et al., 2014).

Interestingly, Manna et al. (2010) found striking differences between the patterns of brain activity in advanced meditators compared to novices, in both meditation types (FA and OM), that showed a permanent shift in the functional reorganization of resting-state networks in the expert meditation practitioners. Namely, they observed that the advanced meditators had resting-state brain activity patterns that resembled the effortless meditation state. This suggests that the advanced practitioners have an ongoing stable flow of unified awareness even when not meditating, as a result of a traditional approach to contemplative training that included both FA and OM types of meditation. The scientists who performed the study referred to this as a potential trait marker of contemplative mastery. And thus, led the researchers to further claim, "it might reflect a neuroplasticity-based reorganization of the monks' brains, with neuronal populations in brain regions ordinarily linked to self-referential processing reallocated to a metacognitive observation of phenomenal experience and of the experiencing subject," and suggested "the cultivation of wholesome mental states going beyond cognition of separated self" (Manna et al., 2010, p. 54).

As Patanjali explained in *Yoga Sutras* 1:17 and 1:18, the process develops in two fundamental ways, with the first marked by the appearance of four different types of cognition:

analysis, insight, bliss-awe, and self-reflection. Later, these are absorbed in yet deeper states of inner awareness where modes of subconscious saliency detection and metacognitive monitoring arise based on impressions formed from the four types of contemplatively-imbued cognition listed above, which function to shape latent impressions and reorganize the brain for integrative yogic maturation. So, a systems-based interpretive analysis shows that intact traditional systems train for rapid and precise pliancy in cognitive control for conscious access to contemplative states that function to reshape the unconscious bottom-up saliency-driven mental filtering mechanisms. Hence the structured nature of ancient yogic theory. Most importantly, this structure was formulated for inducing stable access (*sthita-prajna*) with appropriate forms of cognitive support (*savitarka/savicara*) for non-conceptual (*nirvitarka*) nondualistic (*nirvicara-nirbija-asamprajnata*) states of *samadhi* (YS, 1.42-1.51). Patanjali's hierarchical organization of training combined multimodal auxiliaries for stably accessing nondualistic awareness and flexibly strengthening correlative brain circuitry for yogic mind mastery. When nondual awareness occurs, the mind becomes like a transparent jewel, taking the form of whatever object is placed before it; whether the object be the knower, the instrument of knowledge, or the object of knowledge (*ksina-vrtter abhijatasyeva maner grahitr-grahana-grahyesu tat-stha-tad-anjanta samapattih*; YS, 1.41).

Yogic Neurofunctional Dexterity

In an important study on nondual awareness meditation, Josipovic et al. (2012) investigated the brains of expert meditators for proficiency at voluntarily controlling the interactive anti-correlations between the intrinsic and extrinsic systems, which they found become increasingly synergistic with nondual experience. The division of these two broad anti-correlated awareness systems is a fundamental paradigm in neurophysiology, also referred to as

self-related resting-state processes (intrinsic) and environmental-demand arousal-state processes (extrinsic). Remarkably, extrinsic and intrinsic are anti-correlated during rest, sleep, and anesthesia. In fact, the activation patterns during slow wave sleep can resemble the waking-state default mode network (DMN) activity (Murphy et al., 2009).

Raichle and Snyder (2007) suggested that a large part of the brain's default activity could be devoted to ongoing synaptic processes associated with the maintenance of the balance between excitatory and inhibitory activity necessary to allow neurons to respond appropriately to correlational shifts, and to sustain equable functional connectivity. In this view, global functional brain metabolism would have a potentially decisive role in rate-limiting cognitive reserves for conscious modalities. Josipovic et al. (2012) suggested that the anti-correlated nature of neural activity in these two systems represents a fundamental structural organizational principle of the cortex, that nonetheless can be modulated both ways (increased anti-correlation or decreased anti-correlation), depending on the innate cognitive strategies of different types of meditation. The results of this study replicated previous findings that reported stronger anti-correlations during FA and OM content-based meditations, but found new evidence of reduced anti-correlation in nondualistic contentless states of meditation, suggesting these anti-correlated systems might correspond with the subjective experience of duality between self and objective reality (Josipovic et al., 2012).

With this in mind, Patanjali indicated that stages of identification with the generative aspects of the mind are not without purpose in his system of meditation. Identification with the contents of mind has a power that can be properly trained and harnessed through yogic meditation. For Patanjali, part of the problem is that the average person is born with a limited power of identification that is maladaptively unbalanced toward ego identification. The central

existential concern is of mistaken self-identity apparatus that is built into the human brain. Patanjali described three fundamental dynamics (*gunas*) to the biological makeup of the brain's self-identity apparatus: the extrinsic arousal-state activation (*rajas*), intrinsic resting-state inertia (*tamas*), and dynamic fully integrated physical and mental apparatus of awareness (*sattva*). Patanjali's project hinged on increasing *sattva*, or functional dynamic balance between extrinsic and intrinsic systems of the embodied mind. These compensatory forces are constantly changing brain state along a continuum with relatively strong deterministic currents, depending on prior conditioning of attentional tendencies and patterns of self-regulation.

As indicated by Josipovic et al. (2012), different meditation practices can shift network dynamics for either increased anti-correlation or decreased anti-correlation. Patanjali's system begins with contemplative practices that strengthen the competitive anti-correlation of networks, perhaps to strengthen pliable competency in shifting these network correlations. The later stages of Patanjali's system of meditation arguably involve the dexterous rebalancing and decreased anti-correlation of networks for a flexibly balanced (*sattva*) neuro-ecology that sets the stage for stable access (*sthita-prajna*) to nondual states of *samadhi*. This aligns with Josipovic et al.'s (2012) findings of subjectivity related to the embedded structural components in the anti-correlation of intrinsic and extrinsic brain networks, and how different types of meditation effect these network correlations. Tart (1975) reflected this functional neural systems approach when he stated:

> In terms of the systems approach, we can characterize ego as a continuity and consistency of functioning to which we attach special importance, but which does not have the reality of a solid thing somewhere, which is only a pattern of operation that disappears under close scrutiny. (p. 133)

Focusing on one's self, with an egoistic sense of self, and making this a basis for conscious effort to control one's behavior is problematic from a yogic perspective. The mind

becomes steady when one is free from its own desire as an object (*vita-raga-visayam va cittam*; YS, 1.37). Leary, Adams, and Tate (2006) proposed a strategy known as hypo-egoic self-regulation, which is a self-regulatory strategy that decreases the amount of time spent in a state of conventional self-awareness, meaning behaving automatically and unconsciously, cognitively fused with one's own thoughts. In this formulation, hypo-egoic self-regulation usually requires both the reduction of egoic processing and also the introduction of alternative generative modes of self-reference. Patanjali assumed the existence of very refined generative core of the mind, called *buddhi,* which is luminous and necessary for accurate discernment, identification, and prognosis of egoic mental afflictions. The *buddhi* is primarily composed of *sattva*, which Patanjali proposed is the basis of mind's self-adaptive agency, intelligence, insight, and ability to illuminate truth and understanding. However, it is at the same time the receptacle or deposit (*ashaya*) of all subconscious predispositions and unconscious activators that obscure the luminosity of the *buddhi,* through the covering from the antithetic activity of *rajas* (extrinsic environmental-demand) and *tamas* (intrinsic self-related processes), to the detriment of the awareness and metacognitive clarity of *sattva*. These obscurations have their root in habitual patterns of cognitive operation that make us look at ourselves through the distorted lens of the mentally constructed ego. The *buddhi* has a natural predisposition toward virtue (*dharma*), knowledge (*jnana*), equanimous poise (*vairaga*), and mastery (*aishvarya*). The higher mind is thus a yogi's most important tool for accessing nondual states of awareness free of conceptualization.

As we have seen, Dahl, Lutz, and Davidson (2015) argued that contemplative processes for deconstructing and reconstructing the self in meditation practice have distinct utility. Most domains of human functioning are influenced to some degree by self-related processes on an

ongoing basis. That said, humans have a rather conflicted relationship with self-related processes. Generally, people do not recognize that they conflate their mental representations and their sense of self. Believing that mental representations are self, people naturally identify strongly with those representations and foster, protect, and defend those self-images as if they were more than a product of their impressions and thoughts. So normally, a person becomes ego-involved and overly identified with mental constructions and mental self-narrative. However, rather than just an absence of conceptual self-reference, Patanjali maintained the need for a balanced shift in agency that expansively transforms self-referential processes as well.

Patanjali developed an integrative theory of awareness with hypo-egoic self-regulatory strategies based upon altered states of awareness, of the intentional content-filled (*savitarka-bija-savicara*) types and the non-intentional content-free (*nirvitarka-nirbija-nirvicara*) types. He strategically compiled three main streams for accessing hypo-egoic awareness: (a) spiritual discernment, (b) contemplative pursuit of altered states of awareness, and (c) spiritual self-realization. In Patanjali's theory of mind, there are five states of awareness, some of which are ordinary and egoic, and some of which are extraordinary and hypo-egoic: (a) distracted (*ksipta*), an ordinary level of awareness that is largely dominated by *rajas*; (b) self-absorbed sluggishness or depression (*mudha*), an ordinary level of awareness that is largely dominated by *tamas*; (c) partially distracted (*viksipta*), an ordinary level of awareness that is largely dominated by *rajas* with some *sattva*; (d) one-pointed (*ekagra*), a concentrated state of awareness that largely consists of *sattva* with some *rajas*; and (e) free of mental representation (*niruddha*), a clear state of pure *sattva* in which *rajas* and *tamas* are inhibited through reduced competitive functional opposition between *rajas* and *tamas* influences. In this yogic process of increasing *sattva*, the awareness of the nature of the relationship between spirit (*purusha*) and matter (*prakriti*) is

transformed, and instead of an absolute incommensurability and alienation between the two, a realization free from all mental categories, including spirit and matter, can arise (*nivitarka-nirvicara-nirbija-asamprajnata samadhi*).

Patanjali addressed the shift to extraordinary hypo-egoic states of awareness according to level-specific preparation: (a) the first chapter (*Samadhi Pada*) is a theoretical overview and map that lays the foundation for the yogic samadhi project, (b) the second chapter (*Sadhana Pada*) offers a preliminary sequence of experiential practices that train a distracted egoic mind to become steady through praxis inception and development, (c) the third chapter (*Vibhuti Pada*) explicates practices of yogic mind mastery for advanced yogis, and (d) the fourth chapter (*Kaivalya Pada*) describes the culmination of advanced practice in a permanent nondual spiritual identity shift in consciousness. Yoga allows for a dynamic interplay and creative tension between identification and association with the empirical world through a variety of stage-appropriate contemplative practices for mind mastery. However, they are purposed for shaping cognitive proficiency in decoupling and isolating pure awareness (*sattva*) from powerful subconscious forces of identification and cognitive fusion with extrinsic (*rajas*) and intrinsic (*tamas*) mental content, ultimately in order to stably experience nondualistic consciousness (*samadhi*) and metacognitive spiritual intelligence (*buddhi*).

Traditional maps of meditation stages emerged from the natural states of consciousness all humans share. Clinical psychologist and meditation expert Daniel P. Brown (1986) attempted to resolve the question of similarities and differences across traditions by formulating an in-depth cartography of meditative stages across different traditions. Brown's pioneering study (1986) is unique in the literature, due to its cross database referential integrity of design features between scholarship and practice; and he described it as follows:

> It represents twelve years of study of three Eastern meditation traditions: Hindu Yoga, Theravada Buddhism, and Mahayana Buddhism. Every effort was made to study these traditions from the perspectives of how the cultures understand themselves. This necessitated learning the canonical languages, translating classical meditation texts, interviewing contemporary practitioners and their teachers, and above all, practicing the meditations according to the traditions. In Buddhism, balance between scholarship and practice is considered necessary to avoid the extremes of intellectualism and directionless practice of meditation. (p. 221)

Perhaps, since contemplative systems of practice share the same biological basis, they are the same for humans everywhere in their deep structural form, while their surface-level perspectival features vary from tradition to tradition. This seems to be why different meditation systems share essential similarities, with identifiable underlying structure that demonstrates a highly consistent systematic progression across traditions (Brown, 1986). There are important variations, but there are also many important commonalities, so much so that evidence suggests some universal human structures can be perceived in the cross-examination of traditional systems of meditation. According to Brown's (1986) thorough analysis, a total of six major stages of contemplative practice across traditions were discovered: (a) preliminary ethical training, (b) preliminary mind/body training, (c) concentration with support, (d) concentration without support, (e) ordinary insight meditation, and (f) extraordinary mind and enlightenment. His investigation succinctly examined and charted how Patanjali's system follows this structurally invariant underlying strategy for contemplative skill mastery. And therefore, this integrative contemplative study theorized that non-conceptual effortless-boundless awareness is reached only after deliberate forms of practice, through a convergence of evidence across traditional systems of contemplative mastery.

Due to the nonconceptual content-free trajectory for the mind in advanced contemplative training, all ideas and theories are inherently only stepping stones to transcend conventional conceptual mental constructions. In this way, they can be viewed as vanishing mediators that

exist long enough to facilitate a transition or transformation, and at the point they are no longer required due to the intended resolution, their saliency wanes. Every culture has its own characteristic ego-mythology and ego-definitions encoded in language, with culturally prescribed self-ideas that inherently define self and not-self. Demonstrating the impact of this cultural influence, neuroscience researchers have found that in collectivist cultures compared with individualist cultures, the medial prefrontal cortex (mPFC), which selects self-relevant information, is more highly activated by information of esteemed others, such as one's parents, than by information about self; indicating a hierarchical subjugation of the individual ego to group identification (Zhu, Zhang, Fan, & Han, 2007).

Therefore, the ego is a humanly universal socially-constructed self-idea projected by the human conceptual apparatus. Due to this, traditional contemplative systems such as Patanjali's are complex heuristic devices to guide stable access to altered states of awareness free of ego-based conceptual apparatus. Patanjali's heuristic approach was not built to codify a metaphysical cosmology, however he did indicate supernormal human capabilities that can occur from this shift. In general, to understand contemplative traditions correctly, they should be seen as heuristic devices designed to perturb the binding nature of the conceptual ego-mind in order to manifest identification and realization of a different source of intuitive self-understanding that is not based on self-ideas, memories, or conceptual elaboration of thought. In this sense, contemplative-based heuristic devices employ a practical method, not guaranteed to be perfect, logical, or rational, but instead sufficient for reaching a salient goal.

Many scholars have mistakenly tried to create a permanent invariant dualistic cosmology out of Patanjali's heuristic theories for spiritual self-realization, creating a vast number of concepts irrelevant to the process itself. For Patanjali, spiritual self-realization is a systems-

guided process that fundamentally and radically transforms awareness, and ultimately its result transcends concepts like duality and nonduality. Most scholars make the mistake of drawing an objective scheme of cosmological ideas and categories without ever deeply considering the implications of a soteriology that transforms human conceptual apparatus altogether, which ultimately leads to dubious conclusions. Typically, the soteriology common to contemplative traditions implies that all conventional knowledge categories are perceptual and conceptual objectifications or ego-based mental constructions that imply illusory space-time locatedness. Identifying and realizing that they are merely mental modifications is instrumental in the process of yogic liberation.

Humans have invented complex language-based systems of ego-reference that obscure the truth of the *buddhi*, which is a spiritually intelligent function of the mind that supports yogis in identifying and realizing their true nature. As previously shown, metacognitive ability determines identity development and identity development governs existential awareness. Human beings are in a vulnerable position. Human beings are born into an experiential circumstance in which all kinds of separations can occur: loss, death, harm, and estrangement. The sense of inhering in an indivisible reality, free of opposites, without separation from divine awareness, is lost upon most. Merely entertaining new scientific ideas, religious beliefs, or relaxation rituals is not sufficient to truly cure the sense of human vulnerability. According to Patanjali there must be an actual spiritual self-realization process in order to truly understand and transcend the sense of potential separation and human vulnerability.

Since ancient times, yogic traditions of spiritual liberation have been associated with an understanding of the structures underlying human experience and self-identity. Yogic practices were based on a direct and detailed familiarity with the cerebrospinal system. Yoga as a system

of practices was not based on cosmological mythologies and conventional spiritual ideas. Patanjali devised an ordered system that is associated with an analysis of the human structure, the workings of that structure, and the methods by which yogis can make use of that structure in the process of spiritual self-realization without reducing spiritual significance to the working of the structure. The human psycho-physical structure is the soft-tissue technology for identifying the transcendental self-inherence in indivisible nondual spiritual reality.

In Indian psychology, each individual has four vital functions of mind: sensory processing (*manas*), mental representation (*citta*), egoic conception (*ahamkara*), and intelligent awareness (*buddhi*). The ego mechanism (*ahamkar*) is a vital functional mechanism like the urges to eat and breathe. The ego mechanism first arose in nature as an instinct of self-preservation, to protect the bodily life. It is our personal instinct to life success and achievement. Controlling the ego mechanism is very difficult because it occurs automatically and implicitly before conscious thought or reflection. In relative sense of everyday functioning, the psychological sense of self is very useful and necessary. Patanjali did not recommend destroying the ego, but rather deconstructing a merely gross materialistic reification of self, to allow for a more fluid experientially subtle understanding of self. In phylogeny and ontogeny, awareness and attention emerge before self-representational thinking apparatus. In childhood development, the capacity for representational thinking that is necessary to conceptualize self, objects, and time develops slowly over a relatively long period of time (Rochat, 2003). The development of representational thinking is centered around self-representations. Patanjali affirmed this: Mental constructions (*nirmana*) are made from the ego (*asmita*; YS, 4.4).

So, Patanjali suggested surpassing (*aksepin*) rather than suppressing or bypassing these urges (YS, 2.51). The diversity and flexibility of methods for the actual process of reorganization

and stable illumination of consciousness is of much greater importance to Patanjali than a metaphysical systemization of reality. Patanjali emphasized the processes (*parinama*) leading up to spiritual liberation (*apavarga*) and he clearly preferred a schema that attempts to establish the true essence of existence (*atman*) and distinctness of the seer (*drastrasya-atma*) against all that is of the nature of the seen (*drsya*); including the objectifiable process of the mind (*citta*) with its random fluctuations (*vritti*), and the objective content or constructs (*pratyaya*) of awareness. However, the pedagogical distinction of a non-fractured self-identity (*atma-jnana*) serves as a vanishing mediator for non-conceptual content-free awareness, rather than serving to add more elaborate and grandiose self-constructs to the ego mechanism. The initial provisional dualistic framework that Patanjali adopted reflects the condition of aspiring yogis. It instills a pragmatic and heuristic orientation that engages the practitioner in the cultivation of spiritual practice capable of leading yogis to true self-identification. The reality of the body, mind, nature, and materiality are very immutable to those on the path, until the culminating quantum-leap in experiential transcendence of all conceptual understanding, which transforms all mental constructs and language-based notions regarding identity and conventional reality. Language-based philosophical systems are themselves inherently dualistic, due to the dualistic nature of how language is structured, to serve a way for meaningful exchange. Patanjali spoke not from the standpoint of mere theoretical enumeration or wordy elaboration of thought but from the perspective of actualized experience.

To understand the implications of this shift as not being merely idealistic, Patanjali pointed to a broad array of psychophysical effects that are the signs and merits of yogic mind mastery. The third chapter of the *Yoga Sutras* provides a large taxonomy of approximately twenty-five supernormal yogic mental powers and means for mastering them. These effects are

often referred to as mystical yogic powers, or *siddhis*. However, Patanjali described these yogic abilities in a very pragmatic straightforward manner as natural by-products of proficiency in the practice of yogic mind mastery (*samyama*). He postulated that they first initially arise in four ways: The yogic powers arise due to birth, entheogenic herbs, repetition of sacred sounds, austerity, and *samadhi* (YS, 4.1). Yet, once initiated by any of these means, they can only be tamed and mastered through practice born of meditation (*anasayam*; YS, 4.6). Much of the disbelief and controversy around Patanjali's arcane ideas stem from his assertion of the nature of supernormal powers (*siddhis*) of the mind from yogic mastery (*samyama*). There is anecdotal evidence of a unique set of individuals who seem to display such powers, and some have been put under scientific scrutiny. Yogis have a history of demonstrating a higher level of control over key components of the autonomous system. Marion Wenger, a pioneering former professor emeritus of psychology at UCLA, described early beginnings of this type of research as follows:

> In 1933, a student from India first stimulated my interest in Yoga. In an experiment on muscular relaxation his performance far exceeded that of any other subject. He explained that he employed a Yogic method which was commonly used in India, and I made a mental note to go to India someday. The note got unburied twenty years later when I discovered an article by Therese Brosse, a French cardiologist who had taken a portable electrocardiograph to India in 1935 and measured a few yogis as they attempted to control their heart action. One of her published EKG records was amazing. It showed a gradual reduction in heart potentials to near zero. She concluded that the heart could be controlled voluntarily. (Wenger & Bagchi, 1961, p. 312)

Extreme yogic abilities to control nonconscious autonomic body functions are an important area of psychophysiological research even today. Porges (2011) has developed a polyvagal theory in an attempt to systematically explain self-regulatory autonomic adaptations that evolved phylogenetically in response to selective evolutionary pressures. The polyvagal theory has provided a psychophysiological mechanism that explains the negative psychosomatic effects of trauma, and conversely, the positive psychosomatic effects of embodied contemplative

practices. The vagal nerve plexus is the tenth cranial nerve and the longest nerve tree in the human body, and thus referred to as the wandering nerve. It interfaces with parasympathetic control of all the organs, except the adrenal glands, from the neck to the colon. As a result, Porges (2011) described how the vagus nerve is responsible for regulating many varied tasks such as heart rate, digestion, insulin signaling, sweating, satiation, relaxation, and social stress response. Stressful events disrupt the rhythmic activation of autonomic states (Holzel et al., 2010). According to Porges' (2011) model, the vagus allows mammals to maintain regulation of primitive sympathetic and parasympathetic stress-reactivity in order to support the newly evolved social brain. The polyvagal theory has been used to explain the mechanism behind the broad stress-repairing, relaxation-based, restorative effects of embodied contemplative practices that impact positive health change through yoga practitioners' enhanced ability for vagal control of autonomic functions (Sullivan et al., 2018).

Accordingly, Patanjali offered a number of practices that have been shown to target the vagus nerve to effectively induce relaxation: breath control (*pranayama*), chanting (*mantras*), posture (*asana*), and visualization induction (*kurma nadi*). Amazingly, Patanjali seems to directly refer to the vagus nerve when he described a subtle energy channel (*nadi*) in the trachea area, that is shaped like a tortoise (*kurma*; YS, 3.31). Patanjali suggested yogis become extremely calm and steady (*sthairya*) by practicing *samyama* on this *nadi* in the trachea area, which is where the upper vagus is located, and where the vagus nerve comes closest to the surface to the skin. In fact, it lies beneath the hyoid bone, which arguably resembles a tortoise shell in its independent U-shaped structure, that is necessary for speech (D'Anastasio et al., 2013).

Nevertheless, studies have supported Patanjali's claim, and findings have shown that imagining or expressing soothing calm or vocal tones in chanting (*mantras*) stimulate glossopharyngeal feedbacks that cross-activate the vagal nerve (Porges, 2011). Additional findings included top-down voluntary rhythmic breathing activating the medullary nucleus to control features of the vagus, and rhythmic deep abdominal breathing activating the solitary nucleus from visceral vagal afferents, promoting the bottom-up regulation of primal stress reactivity (Brown & Gerbarg, 2005; Gard et al., 2014). In sum, Porges' (2011) polyvagal theory helps clarify why a broad array of top-down and bottom-up embodied contemplative methods have historically been combined into one integrated practice for optimal learning, skill acquisition, and mastery of extended human yogic capacities.

Outdoor extreme sport has been one of the fastest growing areas in sporting activity in the past century (Puchan, 2004). Psychologists have begun indexing extended human capacities within the field of extreme sport, which is defined as a self-competitive activity that puts physical demands on the subject that can likely result in injury or fatality (Cohen, Baluch, & Duffy, 2018). Muzik, Reilly, and Diwadkar (2018) studied a 57-year old Dutch extreme athlete and holder of 26 world records, Wim Hof, with the supernormal ability for extreme endurance and cold tolerance, which is based on the practice of a combination of controlled breathing, cold exposure, and meditation. For example, he has climbed Mount Everest wearing nothing but shorts and shoes, completed a marathon in the arctic circle wearing only shorts, climbed Mount Kilimanjaro in two days wearing only shorts, holds multiple world records in ice submersion endurance tests, and has run a full marathon in the Namib Desert without water (Carney, 2017). Reportedly through fMRI analyses, it showed he activated higher cortical areas in the left anterior insula and right middle insula for descending pain stimuli modulation, providing

evidence for the primacy of the brain rather than the body in mediating his world-record breaking cold tolerance, which he claims he developed through yogic practices. Neuroscientific researchers have posited that due to the physiological and functional overlaps of attentional and respiratory functions, there is evidence of a relationship between respiratory phase modulation and attentional performance linked with supernormal top-down cortical control of autonomous functions (Melnychuck et al., 2018).

Stig Severinsen is a Danish extreme athlete, with a Ph.D. in medical physiology and a four-time freediving world champion and holder of multiple world-records, who combines yoga and his knowledge of physiology for supernormal abilities for breath retention and endurance. In 2010, he held his breath for 20 minutes and 10 seconds in tank full of sharks. And in 2012, he was awarded the world record for holding his breath for 22 minutes in a tank at the London School of Diving with the water cooled to 30 degrees Fahrenheit. Severinsen (2010) proposed that through working with the breath, a link can be created between body and mind that enables a person to control focus, decrease stress, increase energy, perform better physically and mentally, alleviate pain, and develop endurance.

In another study, Kozhevnikov, Elliot, Shephard, and Gramann (2013) studied the temperature increases in core temperature induced during a special meditation reported to be thousands of years old, called *tummo*, in indigenous Tibetan yogis. They found that core body temperature modulation for extreme cold was primarily regulated by breathing exercises during meditation that significantly increased power alpha and gamma brain waves, further implicating enhanced ability for flexible cognitive influence in modulating brain oscillations through top-down cortical control. Interestingly, ancient respiratory practices may be associated with special blood-oxygen adaptations found in Tibetan people for extreme high-altitude, now recognized as

the fastest case of human evolution in the scientific record, as it is estimated to have occurred in less than three thousand years (Horscroft et al., 2017; Murray, Montgomery, Feelisch, Grocott, & Martin, 2018; Yi et al., 2010). Patanjali referred to accessing a *siddhi* of extreme radiance: By mastery over the vital air, blazing radiance is attained (*samana-jayat jvalanam*, YS 3:40).

Remarkably, one study found a predominance of delta recorded from a yogi while he pierced his neck and tongue with skewers (with no bleeding) to demonstrate voluntary pain control through yogic mind mastery, which suggested the yogi induced a state that may be similar to those found when individuals are under anesthesia, providing clues about underlying control mechanisms and degrees of freedom in yogic mind mastery for self-regulatory pain resiliency and management (Peper et al., 2006). Related to this, Patanjali stated that steadiness of mind is gained when the mind is pain free and luminous (*visoka va jyotismati*; YS, 1.36). Researchers have found autonomic responses to pain are evenly modulated in yoga practitioners, who demonstrated a greater stable state of arousal compared to controls throughout stimulus and non-stimulus conditions (Cotton, Low, Villemure, & Bushnell, 2018).

Fifteen of Patanjali's reported *siddhis* fall into the category of clairvoyance, four fit in the category of psychokinesis, and six in mind-body control (Radin, 2013). Another case study of potential supernormal human capacities involves a scientifically studied case of psychokinesis, or the ability for the mind to directly influence physical objects. Thomas M. Brod M.D., clinical professor of psychiatry at the Geffen UCLA School of Medicine collected EEG data while the subject, Guy Bavli (who reports using meditation and extreme powers of mental focus), demonstrated moving a small object using mental force alone under controlled conditions (Brod & Scott, 2011). The researchers were stunned to see the object move, and even more stunned to see there was a massive shift in the gamma region of the EEG, only on the left side, exactly at

the precise moment when the object moved using psychokinesis. They also noted that at the same time there was even more elevation in the theta region of the EEG. However, the gamma elevation they reported is more impressive because it technically very rarely spikes as high as they observed in the subject, at the exact moment of the psychokinetic movement of the object. What this suggests, is that some of the basic tenets that divide psychology and physics may actually overlap and share ground in some significant ways.

Quantum Biology and Yogic Mind Mastery

In 1934, Wolfgang Pauli's dreams were consistently manifesting symbolism related to the archetypal nature of the cosmos through various dream symbols of oscillations and oscillatory phenomenon (Meier, 2001). Pauli was later nominated for the Nobel Prize in Physics by Albert Einstein, however at this point he was seeing Carl Jung, the famous Swiss psychiatrist, for psychoanalysis due to personal issues. At the time, Pauli was not completely satisfied with Jung's interpretation of his dreams, and felt his archetypal material had a direct relation to his work in physics, whereas Jung maintained a more psychic interpretation of his dreams (Meier, 2001). Relatedly, Patanjali also analyzed dreams to balance and understand the mind: The mind can become steady when it has the knowledge attained from states of sleep and dreams as its support (*swapna-nidra-jnanalambanam*; YS, 1.38). Nonetheless, they later formed a decades long scientific collaboration in attempting to develop a unified connecting theory of the psyche and physical reality (Donti, 2004).

Evidently, the archetypal symbolism of oscillations, frequencies, rhythms, and spectrums in Pauli's dreams proved to be a formative part of his development of a transpersonal view that invoked a powerful influence on his well-recognized quantum mechanical theories and findings, which explain a wide variety of physical, chemical, and astrophysical phenomena. This is similar

to Mendeleev and his discovery of the law of periodicity of elements through the retrieval of transpersonal knowledge from the dream state, reported earlier in this review. Jung's fascination with physics actually began early in his career as a result of a series of dinners with Albert Einstein between 1909 and 1912 (Zabriskie, 2014), and later wrote: "It was Einstein who first started me thinking about a relativity of time as well as space, and their psychic conditionality. Years later this stimulus led to my relation with the physicist Professor W. Pauli and to my thesis of psychophysical reality and the synchronistic principle" (p. 160). Albeit, Pauli's dreams influenced Jung's own theories, and with Pauli's permission, Jung used their content in his writing and lectures. In a letter to Jung in 1937, Pauli wrote, "even the most modern physics also lends itself to the symbolic representation of psychic processes, even down to the last detail" (Donati, 2004, p. 719).

By studying the compendium of letters between Pauli and Jung (see Meier, 2001), one gets an understanding of the gradual influence of Pauli on Jung's thoughts about the existence of ordering principles that both the natural and psychological realms appear to share. Jung theorized an acausal psychophysical connecting principle underlying all phenomenon. This resembles Patanjali's theory of the universal matrix (*pratiprasava*; YS, 2.10, 4.34) that always abides (*avasthana*) in the substratum (*darmi*) from which everything arises and dissolves (YS, 3.14). Similar to Jung, Patanjali suggested that the yogi becomes aware of subtle acausal interactions (*vasanas*), which Jung referred to as synchronicities. In Jung's theory, the psychological and physical worlds mirror one another and weave meaning into the fabric of nature as they both manifest and are composed from a universal acausal connecting substratum. Indian philosophy played an important role in the development and formulation of Jung's theories. Jung was familiar with Patanjali and was very much influenced by his yogic psychology, and he felt there

was significant overlap in their theories. Jung (1921/1971) himself said of this: "Our Western superciliousness in the face of these Indian insights is a mark of our barbarian nature, which has not the remotest inkling of the extraordinary depth and astonishing psychological accuracy…the tradition called Yoga is the most eloquent expression of the Indian mind" (p.213). Nevertheless, what is important to point out is that transdisciplinary approaches to open scientific inquiry can elicit broader potentials for understanding the true nature of consciousness and existence.

So, science has demonstrated quite definitively that the mind can change the brain and body in ways previously thought impossible. The question still remains about the mind's possible influence on an underlying coinciding field that connects with objects outside of the bodily sphere. The potential for integrating physics and consciousness was clearly born-out during the quantum revolution a century ago when the observer effect and the measurement problem (particles vs. waves) forced physicists to reconsider consciousness as more than merely an artifact. Quantum theory is extremely adept at describing what happens at the microlevel, such as when individual photons of light induce photosynthesis. And yet, electrical activity in the brain is synchronized at speeds and over distances that cannot easily be explained. However, a recent transdisciplinary approach to building scientific understanding bridging the gap between neuroscience and physics has been theorized by the physicist Roger Penrose and physician Stuart Hameroff (2014), who argue that there is a connection between the brain's quantum mechanical biomolecular processes and the basic structure of the universe. In addition to the observer effect, they noted neuroscientific findings that show that brain electrical activity correlating with conscious perception of a stimulus can occur *after* we respond to a stimulus.

In 2008, Soon, Brass, Heinze, and Haynes found that the conscious decision to elicit an act was made about a second before the actual act, but surprisingly the outcome of a decision

was encoded in patterns of brain activity in the prefrontal and parietal cortex by as many as ten seconds ahead of time. The neural operation of the decision occurred between the intention (prefrontal cortex), and the delay and response (precuneus). They suggested that prefrontal cortex might be involved in generating the decision whereas the precuneus might be involved in storing the intention across a delay until the decision reaches awareness. This is consistent with previous work suggesting that the precuneus is involved in memory, self-referential processing, and awareness (Cavanna & Trimble, 2006). They argued that consciousness of a decision may be a mere neurobiological afterthought, with no influence on the actual action. This kind of evidence has led scientists to conclude that consciousness is merely epiphenomenal to encoded genetic algorithms and spontaneous neural oscillations.

However, the Penrose-Hameroff theory (2014) avoided reducing consciousness to epiphenomenalism by correlating discrete conscious moments with quantum computations in microtubules inside brain neurons, which are coordinated with gamma (30-90 Hz) synchrony EEG, allowing for quantum entanglement among many neurons. Quantum entanglement is when multiple entangled particles simultaneously and spontaneously react as if one unified particle, no matter the distance and without delay. This is now a highly replicated finding, however, at the time of its discovery, the phenomenon so riled Albert Einstein that he called it spooky action at a distance. In quantum mechanics, events produced by the interaction of subatomic particles happen in jumps (quantum leaps), with probabilistic clouds rather than definite outcomes. Quantum mechanics is the language physicists use to describe all of the forces in nature, except gravity. Classical physics is used to describe gravity, but it is magnitudes weaker than the other forces in the universe. Quantum rules allow connections forbidden by classical physics. This was demonstrated in a recent experiment in which Dutch researchers proved the nonlocal effect, and

showed two particles could influence each other instantly even though they were a mile apart, often referred to as quantum nonlocality (Hensen et al., 2015). The assumption is that the nonlocal part of quantum nonlocality refers to the entanglement of properties across space. At the same time, research has revealed that entanglement also occurs across time (Megidish et al., 2013).

The field of quantum biology studies the quantum mechanical behavior in living systems. Recent evidence is starting to show that quantum coherence operates at the microbiological level to achieve the rapid transfer of excitation over distances via quantum entanglement in photosynthetic living systems to help plants turn sunlight into fuel (Strumpfer, Sener, Schulten, 2012). Photosynthetic cells have nanostructures with tuned energy levels to transport energy using entangled photonic structures (Coles et al., 2017). Indeed, quantum biology researchers have found confirmation of quantum resonance in brain microtubules as well (Sahu, Ghosh, Fujita, & Bandyopadhyay, 2013). Researchers have argued that the unique cylindrical lattice symmetries in the cytoskeletal structural filaments of cells may effectively serve to transfer energy signals through quantum channels aided by electron cloud configurations of aromatic molecules built into the cytoarchitecture of the cell (Craddock, Friesen, Mane, Hameroff, & Tuszynski, 2014). Meanwhile, Fisher (2015) posited quantum cognition through neurotransmitter release triggered by nonlocal entangled quantum coherence of calcium phosphate ions that can last for extended periods of time. In a follow-up study, Craddock et al. (2017) found that quantum channel oscillations collectively correlated with anesthetic potency.

The Penrose-Hameroff (2014) model attempted to provide a relatively detailed account for the temporal non-locality of conscious control that can send quantum information backward according to deterministic time measures in classical physics, providing a quantum mechanism

for the brain speed necessary for conscious control prior to conscious perception of control. Quantum theory suggests that time itself is an emergent phenomenon derived from quantum entanglement correlations (Page & Wootters, 1983). Therefore, research has shown that entanglement can be used to measure time, but it depends on the entangled state of the point of observation (Moreva et al., 2014). Hameroff and Penrose (2014) essentially showed in great detail how the quantum wireless communication of axons via gamma resonance can occur globally between all neurons across the entire brain, without requiring an incredibly powerful wireless signal throughout the brain that must cross fatty myelin sheath in order to communicate. They suggested that beat-frequencies of nested faster microtubule vibrations as a source of the gamma EEG correlates of consciousness. According to their research, all coherent axonal firings are caused by synchronized dendritic-somatic integration potentials reflected in gamma synchrony EEG, which they contend is the best measurable correlate of consciousness. Therefore, axonal firings may serve to convey both conscious and nonconscious processes, whereas dendritic-somatic synchrony may directly mediate conscious processes through wireless communication from entanglement of neurons.

Scientists have found that the neurons in mammalian brain are capable of producing photons of light, or biophotons, that can transmit signals across space in-between individuals, creating inter-animal signaling influences (Mothersill et al., 2013). Additional studies have shown that rat brains can pass one biophoton per neuron a minute, whereas the human brain can convey more than a billion biophotons per second (Kumar, Boone, Tuszynski, Barclay, & Simon, 2016). Popp, Li, Scholz, Wiengartner, and Wolf (1984) concluded that biophotons originate from DNA, which can store light and release it over time in coherent states. Consequently, they proposed that biophotons are able to communicate with all the cells of the

body instantaneously in a synchronous wave of information energy. Rahnama et al. (2010) hypothesized that microtubules can act as wave guides, channeling photons from one part of a cell to another, thus implicating neurons as coherent photonic light weavers in the synchronous integrative functions of the brain.

If this is true, heightened gamma synchrony in advanced meditators may represent high levels of quantum entanglement for high levels of conscious control and the capacity for high-speed complex unified conscious percepts that can more readily evoke and transform information embedded in spacetime geometry at the quantum level. The substratum is that which underpins past, present, and future (*santoditavyapadesya-damanupati dharmi*; YS, 3.14). As a result of this comes speed like the speed of awareness that always arrives prior to the sensory and mental faculties, leading to mastery over primordial matter (*tato mano-javitvam vikarana-bhava pradhana-jayas ca*; YS, 3.48). A great deal of speculation can arise without more research studies to investigate psychophysical findings that can further reveal the connection between physics and consciousness. All said, the connection between physics and neuroscience at least suggests that the universe is actually staggeringly more immense and entangled than it appears on the surface of things (Hawking & Hertog, 2017).

Nonetheless, Patanjali specified the potential for psychophysical effects: These powers are accomplishments for the mind, but obstacles to *samadhi* (*te samadhav upasargah vyutthane siddhayah*; YS, 3.37). That is to say, yogic mastery posits heuristic levels: relative and ultimate. Granted, relative truth claims form the necessary vehicle for ultimate truth claims in Patanjali's system. However, the tendency to overemphasize relative practices can obscure ultimate claims. The truth of relative claims requires five conditions to regulate mental fitness for spiritual intelligence (*buddhi*) to shine forth (*nirbhasa*) and remain bright and luminous (*sattvic*), which is

crucial to properly reflect and orient oneself to the all-pervading wholeness of ultimate reality (*purusha*): (a) optimistic certitude (*shraddha*), (b) high motivation and energy (*virya*), (c) mindfulness of mental traces and impressions (*smrti*), (d) nondualistic meditative absorption (*samadhi*), and (e) integrative wisdom (*prajna*; YS, 1.20). Ordinarily, as findings have shown, we expend more than half of our limited cognitive energy reserves on random thoughts (*citta-vrittis*) associated with self-referential rumination (*ahamkara*), which is strongly associated with depression and unhappiness (Killingsworth & Gilbert, 2010). The redistribution of this massive amount of self-related entropic psychic energy may help explain yogic powers of mind.

To perform mastery of an art or advanced skill, people need to absorb the basic elements and competencies of their craft and recombine them in new generative ways. According to recent EEG brain research, the basic elements in craft mastery need to be combined in hierarchical representations with associative links established through frequency-specific rhythmic activity, which coordinates neural functions that can resonate across time (Kikumoto & Mayr, 2018). Specifically, they found that activity in the alpha-band may code for basic practice elements and the theta-band may code for how the elements are ordered. So, mastery of skill requires a kind of generative, frequency-specific, higher-level representational mental addressing system. In yoga psychology there is a hierarchical threefold mental addressing system (*anatahkarana*) comprised of the functions of the high-level mind (*buddhi*), the ego-maker (*ahamkara*), and the elementary conditioned-mind (*manas*).

Patanjali pointed to generative practices that help the *buddhi* loosen conditionally fixated elementary-mind-based reifications of self by shifting attention to subtle nature of the body-mind complex. By practicing *samyama* on subtle energy centers, latent levels in the coherent wholeness of self-nature can emerge in awareness: (a) the navel center brings knowledge of the

interconnected organization of the whole body (YS, 3.9), (b) the heart center brings knowledge of the true essence of mind (YS, 3.34), (c) the throat center brings knowledge of self-object relations (YS, 3.31), and (d) the head center brings knowledge of the brilliant light in the brain core (YS, 3.32). These practices strengthen spiritual intelligence faculties that support a greatly expanded and positively generative awareness of self-nature as an interconnected ecology of conscious light. In the *Yoga Sutras*, the various nuances of *samadhi* are constantly interfered with by the gross (*sthula*) content of memory (*smrti*) which may be recognized (*pratyaya*) shining forth only as a "flow of light" (*arthamatranirbhasa*) "devoid of its own form" (*svarupashunya-iva*; YS, 1.43), which leads to the collapse of ordinary self-constructs into an awareness where the ordinary points of self-reference recede into the background (Brown, 1986, pp. 241-242).

Due to this hypo-egoic reorganization of mind and brain, the ordinary waking-state mind can be perceived to have a certain likeness to the dream mind because, like any form of mind, the ordinary waking-state mind is a perceptual-conceptual structure, patterned by the brain, and experienced exclusively within the limits and confines of its own patterns and states. Every moment of perception is memory-only *(smrti*), due to that fact that perception is slower than conscious intention, as revealed by modern neuroscience (Soon et al., 2008). The psychophysical apparatus of perception naturally introduces time-lapse, or a necessary interlude for registering and processing, to enable the brain and nervous system to capture any moment of physical perception. What this means is that every moment of conceptual activity is subsequent to inherently late perceptions, and is an exercise of memory-based brain formulations of pre-recorded experience. What the experiencing self presumes to be merely the objectively real world is filtered through a representational mind. The subjective experiencing event of the

psychophysical ego is a perceiving and knowing process that actively causes or constructs an objectively existing world out there that elicits illusory spacetime domains via entangled states that steer relative perceptual and conceptual frame-specific properties, as a matter of conventional mentalized record-keeping. This may help explain why time seems to fluctuate and flow depending on attentional focus and state of mind, regardless of external time (Brefczynski-Lewis, Lutz, Schaefer, Levinson, & Davidson, 2007). So, when people are in traumatic accidents it is frequently reported that time slows down prior to impact (Pariyadath & Eagleman, 2007).

In quantum mechanics, all particles of matter and energy can also be described as waves. And waves have an unusual property, an infinite number of them can exist in the same location. Even in a vacuum, with no particles around, the electromagnetic and other fields are internally entangled (Musser, 2018). Which means that the ordinary pixelated illusions of space and time seems to converge and disappear at a transition point (*bija/bindu*) into wave fields with nonlocal omnipresence, which Einstein stated this way: “People like us, who believe in physics, know that the distinction between past, present, and future is only a stubbornly persistent illusion” (Meier, 2001, p. 139). The sociocultural milieu has not caught-up with Einstein, who showed that matter represents a mass-energy equivalency. In common parlance, one will come across concepts that refer to matter and energy as though they are opposites. This is actually archaic and misleading language. In other words, all perceived matter does not behave like particles all of the time, but also behaves like waves of light fields. Generally, we tend to think of mass or matter as solid, something we can see, touch, and hold that is very different than energy, which is apparently less tangible. However, mass is basically just one way of carrying energy. Whatever we think of as matter is all made up of particles that at their substantive level have no independence.

In the culminating fourth level of yogic maturation, an important distinction is made

about the causal chain of spontaneous activity of the mind, reactivity to the contents, and mental representational elaboration. Subconscious impressions are held together by immediate cause, motive of the mind, and the object of awareness; subconscious binding forces cease when the latter cease (*hetu-phalarayalambanaih sangrhi tatvad esam abhave tad-abhavah*; YS, 4.11). That is to say, this chain of mental events effectively acts as self-reinforcing conditioned illusions of independent separate existence, elaborated from spontaneous evolutionary patterning of the brain. Due to the strong deterministic currents of the cultural influences on self-constructs, individuals in the modern era are psychophysically combined with the conventions of perceptual thinking and verbal conceiving in their understanding of existence (Legrand & Ruby, 2009). Therefore, humans today are preoccupied with waking-state perceptual memory and mental abstractions within the binding constructs of their own mental apparatus. The modern human being thinks that, because the waking-state mind is associated with the conceptualizing and perceiving and remembering characteristic of the waking state, this somehow makes the conceptual mind equal to the real world, rather than merely an interpretive mental world. In many ways, our culture, by means of rules and taboos, confines the mind to the waking state and to the overly materialistic perspective on life.

Characteristically, modern human beings think of the dreaming mind as being primitive and unreal, and merely brain-made fabrications, or memory-based perceptual and conceptual constructs invented by the mental apparatus. However, in fact, modern human beings are merely involved in a different culture of illusion than that of ancient and traditional humans. It is well-established that active biasing processes affect perception and memory, but most take percepts not only as strong evidence, but usually as fact. The assumed link between perception and physical reality is particularly strong for the visual sense. The strong reliance of perception on

top-down processing is the essential key for assuring reliable perceptual abilities in a world full of ambiguity and incompleteness. What we will perceive at first glance is mainly guided through the specific activation of our semantic network. So, we can literally say that we perceive what we know. If we have no prior knowledge of certain things we can even overlook important details in a pattern because we have no strong association with something meaningful. The intimate processing between sensory inputs and our semantic networks enables us to recognize familiar objects within a few milliseconds (Carbon, 2011). Top-down processes are powerful in schematizing and easing-up perceptual processes by compressing large amounts of data from the sensory input with precategorized labels and schematized icons (Carbon, 2008).

Top-down processes, however, are also susceptible to characteristic fallacies or illusions due to their semantically and culturally guided, model-based nature (Carbon, 2014). This reconstructive capability helps us to get rid of ambiguous or indeterminate percepts. Therefore, the waking state can be similarly as binding and illusory, and of the status of mental fabrication or self-construction, as the dream-state mind. The dream-state is the basis for mental constructs of a nonmaterial self-image, whereas the waking-sate is the basis for mental constructs of a material self-image. However, through the process of yogic maturation, the mind's forms and modes are transcended in the self-position of awareness itself. The ego is a mentalized schema and processing activity directed by the brain. Although it is unchanging, consciousness becomes aware of its own intelligence by means of reflective immersion in forms assumed by intelligence (*citer apratisankramayas tad-akarapattau svabuddhi-samvedanam*; YS, 4.22). So, in the last level of yogic development, the return of self-related mental rumination ceases when one clearly distinguishes and differentiates between the mind and pure awareness (*visesa-darsina atma-bhava-bhavana-vinivrttih*; YS, 4.25). At that point, the mind, inclined toward discrimination,

gravitates toward the truth of self-liberation (*tada viveka-nimnam kaivalya-pragbharam cittam*; YS, 4.26).

People tend to presume that they are thinking their own thoughts. But, in both the ancient and modern accounts, our brains are untamed and obsessively perform mentalized self-narrative routines. However, all that is desired, sought, achieved, and loved will inevitably pass away from the experience of the perceiving and knowing ego. So, direct tacit acausal self-apperception of the immutable indivisible spiritual substance of conscious awareness is the yogic quantum-leap beyond the obscurations of the ordinary untamed mind. Yogic mind faculties are somewhat like a laser with its distinctly consistent coherence of photons that is able to pierce the veil of perception for the liberating brilliancy of unfettered awareness to emerge and stabilize the brain to reflect its true nature. But prior to reaching this final level of yogic maturation, awareness remains inextricably fused to mental activity and observable events.

Biological development and dualism are always superimposed on a prior unity. The existence of an organism capable of survival implies prior intelligence prebuilt into the system that can be consciously accessed as a self-organizing structure. Conflict may arise as the result of an inappropriate adaptation. However, recovery of health and wholeness does not involve the synthesis of fundamentally opposed principles, since they are merely concepts for a process that requires contrasting ideation for heuristic mapping designed to guide the ordinary mind to extraordinary awareness. The danger with heuristic models removed from their natural habitat and exemplar-guided context is that most analyses mistake the conceptual map for the soteriological terrain. Mainly, it only seems to do so because the actual condition of the organism has been interpreted using dualistic language. The yogic process does not involve synthesis of pre-existing logical opposites, though it may appear to in the obscure language of dialectical

theories of contemplative mastery, with conventions of syntax, in which a verb must have a subject that can force itself upon perception and seem to be the logic of reality. In order to uncover awareness from conceptual opaqueness, a profound shift in the level of awareness must occur, and thus the "simultaneity of events emerges as an eternal substance (*ashreya*), primordial *prakriti,* capable of reflecting the eternal unchanging transcendent awareness (*purusha*)", as the yogi learns to "remove the interval (*anantara*)" between them (Brown, 1986, pp. 256-257).

Without heightened conscious processing through contemplative training of psychospiritual intelligence, mental representations may become dissociatively nonconscious of the reality of the interval between life and death (Schlitz, Schooler, Pierce, Murphy, & Delorme, 2014). The progression of any object through time corresponds to a series of moments, and this is most perceivable at the final moment of change (*ksana-pratiyogi parinamaparanta-nirgrahyah kramah*; YS, 4.33). Evidence has begun to accumulate due to advances in medicine that allow us to resuscitate people from clinical death and coma, better than in any other time in history. In the past few decades, there have been thousands of self-reported cases. Remarkably, research is beginning to show a potential link between meditation mastery and the conscious process of dying. In a study by Parnia et al. (2014), they included more than two thousand subjects who suffered cardiac arrest and successfully responded to resuscitation treatment, they found that about half of those who survived a cardiac arrest had some degree of awareness during the time that they were clinically dead, before their hearts were restarted. Furthermore, they found that only two percent of these exhibited full awareness during the death process. Remarkably, this finding showed that there are significant degrees of variance in ability for recall and full conscious awareness between different individuals during the interval between life and death. This study corroborated research that suggests consciousness is not annihilated after death, with

the most frequently reported sequence of features being: (a) out-of-body experience, (b) experiencing a tunnel, (c) seeing a bright light, and (d) an exceptional feeling of peace (Charland-Verville et al., 2014; Martial et al., 2017).

Perhaps, meditation training mastery can offer invaluable proficiency of awareness in the process of living as well as dying. Contemplative traditions certainly claim so. Because of the unlimited nature of awareness when all impurities have been dissolved from it, that which remains to be known is little (*taka sarvanarana-malapetasya janasyanantyaj jneyam alpam*; YS, 4.31). A recent 3-year longitudinal study investigated the phenomenon of meditation-induced near-death experience and suggested this is likely, but it required the development of advanced meditation-based conscious awareness skills (Van Gordon et al., 2018). In concomitant support of this claim, Borjigin et al. (2013) have found a paradoxical surge of neurophysiological coherence and connectivity in the dying brain. This study largely confirmed earlier studies that found organized electrical activity can emanate from the brain during the dying process, and asserted that these electrical surges could be responsible for near-death experiences (Auyong, Klein, Roche, Olson, & Habib, 2010; Chawla, Akst, Junker, Jacobs, & Seneff, 2009). Chalwa's research group at George Washington University Medical Center has found that about half of patients who had succumbed in the intensive care unit displayed electrical surges in the brain at the time of death, and the waveform was at a higher frequency than that observed in animals. The significance of this surge of coherent electrical activity in the dying brain remains unknown and remains the source of significant controversy. However, the variance in the presence and degree of this phenomenon within studied populations may be due to electrophysiological brain changes shaped through adaptive cognitive and behavioral tendencies during individual lifetimes.

Interestingly, near-death experiences are reported worldwide across cultures, and are described as extremely vivid, realer-than-real, sacredly meaningful, and life-transforming (van Lommel, 2011). These vivid near-death experiences have also been associated with endogenous and exogenous sources of entheogenic excitatory neuromodulation, due to striking cross-similarities in phenomenological features (Timmermann et al., 2018). So paradoxically, dying induces a high level of synchronized cortical gamma oscillation connectivity in the brain that far exceeds that observed during the waking state (Borjigin et al., 2013). What is even more interesting, is that the highly synchronized gamma oscillations and high levels of interregional coherence in the dying brain are also characteristic brain activity patterns resulting from advanced meditation practice. Consequently, this provides converging evidence for the potential of contemplative cross-over training for heightened cognitive processing in the near-death and advanced meditation states.

Near-death experiences and advanced meditation states are often associated with increased positive affect, sense of meaning in life, increased capacity for unconditional love, and loss of fear of death (Beauregard, Courtemanche, & Paquette, 2009; Schlitz et al., 2014). Perhaps, the exceptionally heightened levels of gamma-band synchrony and coherence are necessary conformations in the brain for the quantum-leap in yogic conversion that supports metacognitive awareness responsible for creating a spiritual identity free from biases of illusory mental representativeness and limited conceptual assumptions. The ultimate goal of yogic mind mastery is to fully realize our transcendent, timeless awareness that underlies all phenomenal experience and that offers a profound sense of source-purpose and self-insight. True liberation is when the *gunas* (*sattva, rajas, tamas*), devoid of any further purpose for ultimate spiritual truth, return to their original latent state and the power of awareness is situated in its own essential

nature (*purusartha-sunyanam gunanam pratiprasavah kaivalyam svarupa-pratistha va citi-sakir iti*; YS, 4.34). Weaving strands of ancient traditions of contemplation with modern science can help us trace a path to true self-apperception, clear of the opacity of mental overshadowing.

We must acknowledge that obviously much more is known about certain aspects of the world now, compared to Patanjali's time, and that this knowledge was attained largely through scientific methods of inference, experimental design, and experimental replication. Patanjali's system certainly lends itself to scientific methods of introspective inference, experimentation, and replication that can be potentially useful in the full development of transpersonal, psychospiritual, and contemplative psychologies (Haimerl & Valentine, 2001). Despite the depth of Patanjali's phenomenological inquiry, it is unwise for modern yogis to embrace the entirety of his claims uncritically without verification through self-experimentation. Contemporary neuropsychology assigns all forms of awareness to neuronal activity in the brain, and acknowledges that awareness is supported by the synchronous coherent patterns of electricity mediated through biological matrix of brain resonance structures. On this point yogis and scientists can find ground to agree, as the inspection and testing of consciousness leads to an understanding of these subtle patterns of electrical synchrony as hierarchically senior and prior to the physical structures that mediate consciousness. Undeniably, every mental representation requires inconceivably complex sequences and dimensions of electrical neuronal synchrony.

Science tends to operate within a web of culturally-bound assumptions that can limit our view of what is possible in modern life. Cross-cultural contemplative science can offer ways of bridging our understanding between culturally-limited assumptions that fundamentally shape forms of inquiry and translation of research. Furthermore, greater comprehension of natural phenomena can update yogic heuristics for affecting mental processes in order to optimize and

enrich patterns of awareness through progressively updated evidence-based means. This does not imply merely identifying a precise material inventory of the meditating brain. Essentially, the same neural structures that interpret inputs from our perceptual apparatus are also responsible for our dreams and illusions. In this sense, the real and the imaginary share the same neural structures that are pliably dependent on hierarchically prior electrophysiological oscillatory rhythms, or syncopated surges of energy pattern shifts that are synchronized and subject to quantum effects from the superposition of observer operations.

Meditation represents just one part of a diverse range of integrated means designed to increase self-awareness, gain insights into the subtleties of consciousness, and develop lasting transformations of being. Perhaps, we could make progress in understanding the problem of the evolution of consciousness if we suppose that levels of collective consciousness alter quantum possibilities that can further induce changes in new baseline neural processing. Entanglement confounded Einstein because of the way it seemed to instantly send information faster than the speed of light. Nevertheless, a multitude of experiments have since proven it is a very real phenomena. But at the time of its discovery, Einstein believed that hidden variables would eventually be found that validated his theory of local realism.

The concept of local realism is the idea that actions or observations do not have effects in other locations, and that what we can observe about the universe stays fixed, even when we are not observing it or measuring it. However, for the first time in a carefully controlled study utilizing the exceptional degree of randomness in human choices, a quantum study called the Big Bell Test recruited over 100,000 volunteers to investigate whether the world exists independently of our observations or whether our observations shape the world (Abellan et al., 2018). The results of this massive study included over 90 million data points and demonstrated that our

observation of the world strongly influences it, effectively disproving Einstein's theory of local realism. With this kind of evidence, it could be posited that Patanjali compiled a system that progressively and permanently modified electrical brain circuitry through consistent application of awareness-based quantum superposition of observer actions and effects that seem to reorganize spontaneous quantum photonic signaling at the basis of consciousness and its entanglement with spacetime geometry altogether.

Conclusions and Future Directions

Science is currently the dominant paradigm for investigating truth in modern societies (Charlton, 2009). Contemplative neuroscience offers a challenge to our current scientific paradigm by directly pointing out the extreme gap in our scientific understanding of subjective first-person observer experience, and consciousness in general. This is extremely significant because introspection necessarily serves in the casual loop of all information flow and knowledge. Nevertheless, neglecting or hopelessly trying to eliminate the observer in scientific investigations is standard scientific practice. Western scientists have mistakenly abandoned introspective approaches due to belief that they are merely fallible and error prone. This points to an often overlooked central bias in scientific research, because contemplative science is both an object and a method of research, which is not typical in the field of scientific practice. Arguably, contemplative scientists should have their own first-person experiences of meditation. It would seem then, the psychologist of the future should also be one who has a competent orientation to evidence-based meditation systems and applications of meditation-based development, as well as potential risks. This would include an agentic sense of one's own capacity for contemplative-based introspective dexterity. Contemplative experience has personally revealed a convergence of evidence worthy of further exploration through my own explorative analysis, experiential

observation, and comprehensive long-term investigation of exemplars. In fact, this study emerged from this introspective position due to my own meditation-related spiritual experiences and research interests as an integrative ethnopsychologist.

The past few decades of work have set the stage for future research to develop a rigorous and thorough understanding of how the brain is changed by various meditation practices and how our phenomenological reality changes as a result. It is quite possible that the development of potential brain technologies, such as breakthroughs in brain imaging devices, will bring us precise, affordable, and widely available brain cameras that will exponentially propel the use of technology-assisted meditation-related research and application. Such technologies could provide more accessible and precise visual check-up, feedback, and tracking capabilities for the development of contemplative proficiency over time with reduced unintended results. However, defining the object of research in contemplative science shows how meditative practices and the scientific approach diverge. Science requires definitions to construct stable research objects that can then be investigated as objects. Any introspective science needs flexible heuristic internal value representations that serve as guides or vanishing mediators for stable self-regulation training in order to maintain a balanced perspective for precise observations of subjective mental states (Amodio, Master, Yee, & Taylor, 2008).

However, meditation is hard to define, and this study attempted to show that the investigation of meditation should not be completely divorced from embedded systems of intact traditions or relegated to one scientific field alone. Contemplative science is inherently a multimodal interdisciplinary field of study. My research in contemplative psychology is due, in part, to the need for a fuller understanding of the collective impairment of the human psyche and our shared human ecology. This study took a pragmatic psychological approach to this very real

and significant issue by exploring potentials for evidence-based integrative contemplative training to help address our collective bio-psycho-spiritual impairments. This present study makes a scientific case that shows the enormous potential for enduring wellbeing from training our minds and brains, making a convincing argument that accuracy, competency, and continuity in contemplative mental exercise can truly enrich and optimize human life in very compelling ways.

Systems of contemplative development, such as the tradition of yoga, empirically address the embodied mind space. Unfortunately, just by holding a posture, regulation of thought modifications will not occur, dynamic self-discernment is necessary for deep introspection. We inherently keep giving momentum to suboptimal patterns of nonconscious mental contents because we do not have proficient mastery of mind. The human mind requires training in stage-specific invariant order to find peace. Yoga is difficult to gain for the one whose mind is not mastered. Thus, according to the *Bhagavad Gita*, yoga can only be gained by the one whose mind is mastered, who makes effort with proper means (BG, 6.36). The universalizing potential of integrative contemplative science is an invaluable tool to help us determine best means to master mind. The main purpose of this present study has been to evaluate neuroscientific data that helps disclose the integrity of intact traditional systems. The findings of this study suggest that the yogic psychology of the cultivation of contemplative wellbeing, peace, kindness, and compassion can enhance not only our individual ability to thrive, but potentially as an interdependent whole planetary body as well.

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