Received: 25 November 2019 | Revised: 7 January 2020 | Accepted: 8 January 2020
DOI: 10.1002/cne.24876

REVIEW

JCN RESEARCH IN SYSTEMS NEUROSCIENCE THE JOURNAL OF COMPARATIVE NEUROLOGY WILEY

Collaborative dialogue between Buddhism and science: A contribution to expanding a science of consciousness

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Peer Review
The peer review history for this article is available at https://publons.com/publon/10.1002/cne.24876.

Abstract

Investigation of consciousness (experience, mind, awareness, subjectivity) has become an accepted endeavor in contemporary neuroscience. However, current work is largely limited to study of neural correlates of consciousness. While this is interesting and important, it may not be sufficient to carry us to a place of truly new insight regarding consciousness. I argue that one element of expanding a science of consciousness is appreciation of the interdependent co-creation or enfolding of mind and world. Addressing this interdependence is an aspect of the collaborative engagement of the traditions of Buddhism and science—a project that is exploring how complementary worldviews and analytic procedures might further the development of an expanded science of mind. In this essay, written for a collection honoring the life and work of Jack Pettigrew, I describe his connection to this project.

KEYWORDS
consciousness, experience, Jack Pettigrew, mind, mind–body problem, Tibetan Buddhism

1 | INTRODUCTION: CONSCIOUSNESS IN CONTEMPORARY NEUROSCIENCE

This essay is written for a special issue of the *Journal of Comparative Neurology* honoring the life and work of John Douglas (Jack) Pettigrew. Herein, I will touch upon several aspects of Jack's varied scientific adventures, and describe a project influenced by some of my work with Jack—a project related to expanding the scientific investigation of mind.

Contemporary interest in neuroscience is in part related to the notion that investigation of the structure, function, and evolution of nervous systems and brains will contribute to deepening our understanding of who we humans are as conscious living beings and how we are related to the rest of the physical universe. After centuries of skirting the study of consciousness—including believing it too vague to be addressed by the methods of science—investigation of consciousness is now considered an acceptable domain within neuroscience. By consciousness I mean *experience*: awareness; thoughts, feelings, and perceptions; mind; psyche; the irreducibly subjective feeling of what it is like to be. (In this essay, we will not deal with distinctions between conscious and unconscious aspects of mind. Nor will we be concerned with the spectrum of possible definitions for "consciousness").

Accepting the investigation of consciousness as a serious area of study within biophysical science was greatly facilitated by the involvement of the eminent biologist Francis Crick (1916–2004), co-discoverer of the structure of DNA and of the genetic code. Crick viewed consciousness as one of the great mysteries of biological science and his interest in the subject began to coalesce in the 1970s. In an article, co-authored in 1990 with his colleague Christof Koch, they outlined a program to explore consciousness by addressing its presumed neural basis:

> It is remarkable that most of the work in both cognitive science and the neurosciences makes no reference to consciousness (or "awareness"), especially as many would regard consciousness as the major puzzle confronting the neural view of the mind and indeed at the present time it appears deeply mysterious to many people. This attitude is partly a legacy of behaviorism and partly because most workers in these areas cannot see any useful way of approaching the problem.… We

> suggest that the time is now ripe for an attack on the neural basis of consciousness. Moreover, we believe that the problem of consciousness can, in the long run, be solved only by explanations at the neural level (Crick & Koch, 1990, p. 263).

Since that time, many investigations into neural correlates of various aspects of awareness have been carried out (Koch, Massimini, Boly, & Tononi, 2016)—marvelous neuroscience and very contributory to deepened understanding of the structure and function of brains. Nonetheless, such a program may not be enough to take us to a place of radically expanded insight into the nature of consciousness. Let us step back and look at the larger picture.

Modern science began its development four centuries ago—during what has been called the first or original scientific revolution (Kuhn, 1957, 1996)—in the time of Copernicus, Kepler, and Galileo. It soon became apparent that observed phenomena could be interpreted in terms of something akin to mechanical actions in a universe existing external to us, the observers. René Descartes (1596–1650) articulated the separation clearly, describing the domain of science to be that of the material world (*res extensa*), including the physical body. Mental phenomena (*res cogitans*)—thoughts, feelings, conscious awareness, subjective experience, the locus of the human soul (whatever that may mean)—were the domain of the spirit, falling outside the purview of physical science and perhaps within the purview of religion. This split of mind from the world (and from the body) was done in part to protect the project of science from influence by religious institutions. At the time Descartes (a Frenchman living in the Netherlands, and a devout Catholic) was writing on the subject, he was well aware that Galileo (another devout Catholic) was suffering censure at the hands of the Catholic Inquisition in Italy.

Science enjoyed remarkable development in the centuries that followed—astronomy, physics, chemistry, geology, and biology all flourished in their capacity to organize observations into beautifully coherent explanatory frameworks. Along the way there have been a handful of major revolutionary turning points—occasions at which our frameworks of explanation dramatically shifted: chemical elements and the conservation of matter, biological evolution, relativity physics, and quantum physics. And there have been any number of smaller revolutions: recognition that the Earth is very old, the introduction of electromagnetic fields in physics, the molecular description of the exquisite information-coding capacities of living cells, and appreciation of the increasingly vast and dynamic nature of the cosmos.

The presence and role of mind could safely be ignored if the focus of scientific endeavor was stars, planets, rocks, oceans, matter and its transformations, atomic nuclei, plants, animals, and—at least for a while—even our own bodies. As soon as we wish to use scientific methodology to investigate the nature of consciousness, however, the issue becomes apparent. How is it that we can account for our subjective (mental, conscious) experience in terms of the objective physical matter and energetic interactions taking place within our brain and body? This is the so-called mind–body problem. Many who have reflected upon the mind–body relationship have concluded that it appears to be a very difficult problem (Nagel, 1974). Indeed, how subjective experience is related to brain and body physiology has been termed the "hard problem" of consciousness research (Chalmers, 1995). It is said there is an "explanatory gap" between mind or consciousness, and brain, body, and more generally, matter (physical stuff; Levin, 1983).

In contemporary science we operate within a metaphysical frame—a worldview—where all of what we call "reality" is conceived as constructed in some way from matter and its interactions as described by mathematical laws of physics. This worldview has enjoyed enormous success in accounting for what we observe. Its success famously impressed Albert Einstein, who wrote: "the eternally incomprehensible thing about the world is its comprehensibility" ("*Das ewig Unbegreifliche an der Welt ist ihre Begreiflichkeit*"; Einstein, 1936, p. 315).

Within this worldview—which in philosophy is called *physicalism* or *physical materialism*—there is a necessity that consciousness be explained in terms of the properties of matter. For what else is there? In such a metaphysical framework, the mind–body relationship may always be a problem. There is a difference in category between the mental and the physical—consciousness being irreducibly subjective and experiential, very different from matter conceived as existing independently of our experience of it. This is precisely what makes the mind–body problem hard, and some would say impossible, at least within a strictly physicalist framework.

Science has flourished over the last several centuries by focusing on organizing observations of the world—the world as it appears to us. We notice patterns and regularities, and we develop frameworks through which we understand or explain the patterns and regularities as aspects of an external, objective, "real" world—a world that is assumed to exist independently of our awareness of it. While the existence of an objective world external to us is assumed and reified, we only come to know this world via our consciousness, our experience. *All we truly know is our experience*. And from this experience we draw conclusions about the existence of an objective world. *World exists within mind*.

Moreover, we understand the nature of our body and brain, and who we are and our place in the world, as part of a long process of physical and biological evolution governed by physical laws: from the Big Bang, to the origins of chemical elements in stars, to the development of solar systems, some of which contain planets conducive to the formation of the elaborate molecular configurations we know as life. After billions of years, in some manner, an experiential aspect of our being also arises. Consciousness. *Mind exists within world*.

World exists within mind. Mind exists within world. There is an enfolding of mind and world. This interdependence, this dependent origination, seems inextricable. Appreciating this, how might we move forward in expanding a science of consciousness?

But first….

2 | INTERLUDE: MEETING JACK PETTIGREW

I met Jack in 1978, when he was a professor of neurobiology at the California Institute of Technology (Caltech) in Pasadena California

USA. I was completing my doctorate in sensory biophysics and was exploring postdoctoral options in neurobiology. The meeting had been arranged by my graduate mentor, Max Delbrück, and took place in the Delbrück backyard, a frequent gathering place for social-cum-scientific discussions, conveniently located a short walk from the Caltech campus. Needless to say—at least to anyone who has personally known Jack—I had never met anyone like him. His persona conjured a wizard from the Australian bush, and it quickly became clear that it was Jack with whom I wished to work and learn.

I had graduated college in the American Midwest with a strong interest in pursuing the study of physics—and in particular general relativity and cosmology—as *the* branch of science that seemed to me to reveal the most about the deep structure of reality. My undergraduate years were focused on physics, mathematics, and chemistry; I did zero coursework in biology or biochemistry, and took a single psychology class, which I found dreadfully dull. Studying relativity physics, I also became interested in the life of its creator, Albert Einstein, and read many biographical and philosophical essays by and about him. I began to wonder how it was that a human being could sit in one's room and create a theory that describes the entire cosmos. How could anyone do that? What is going on with the human mind? And how is mind related to the rest of what we consider to be reality?

This was the early 1970s, and ideas from Asian philosophy—including Taoism, Hinduism, and Buddhism—were penetrating American popular culture, and I was reading from this literature as well. With all this percolating in my mind, I moved to the west coast of the United States to begin graduate studies in physics at Caltech. Because of my interest in general relativity and cosmology I joined the research group of Kip Thorne, who four decades later would receive a Nobel Prize in Physics (2017) for the measurement of gravitational radiation (predicted by Einstein in 1916).

Meanwhile, my reading about and fascination with mind continued to grow. During my first year in graduate school, I heard there was a scientist in the biology department who was interested in the evolution of human cognition and, moreover, was planning to discuss this topic in a biophysics course he was teaching the coming semester. I signed up for the class, taught by Max Delbrück, who had received a Nobel Prize (1969) for his contributions to founding what would become the discipline of molecular biology. In the 1940s Delbrück had developed and promulgated methods using bacteria and bacterial viruses to investigate how genetic information moved from one generation to the next. This would lead to unraveling the structure of DNA, the working out of the genetic code, the advent of gene cloning, and much of what we know today as biotechnology (Stent, 1968, 1969).

Max and I had many conversations. He admonished me that if I were seriously interested in pursuing a scientific study of the human mind, then I had better learn some biology, because biology was an important part of the territory. He offered me the opportunity to work in his lab over the summer, which I accepted, and the following year I switched from theoretical physics to experimental biology and completed a PhD investigating the photochemistry of the exquisite light sensitivity in the fungus *Phycomyces*. After several years of this, I had certainly learned a bunch about biology, but having focused mostly on molecular biology and microorganisms, I was a long way from neurons, brain, and mind. Hence the intention to pursue postdoctoral work in neurobiology and my meeting with Jack (Figure 1).

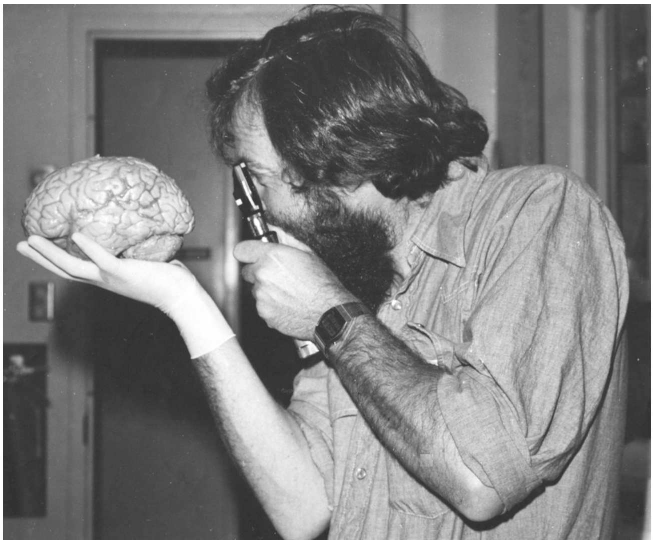

FIGURE 1 Jack in his laboratory at Caltech, 1979. *Photo credits*: All photos by David Presti

3 | THE (STILL) MYSTERIOUS SENSE OF GEOMAGNETIC FIELD DETECTION

Jack's lab at the time was focused on the comparative anatomy and physiology of vision, as well as neural mechanisms of plasticity in early visual development. Fascinating topics to be sure, but I had a particular interest in novel and poorly understood sensory systems; so, we developed a project investigating the unknown mechanism by which birds and other animals detect the Earth's magnetic field and use it as an information source in navigation.

Microscopic particles of the ferromagnetic mineral magnetite (Fe_3O_4), of presumed biogenic origin, had recently been detected in bacteria (Blakemore, 1975), honeybees (Gould, Kirschvink, & Deffeyes, 1978), and inside the skull of the common pigeon (*Columba livia*; Walcott, Gould, & Kirschvink, 1979). Since tiny magnetic particles might form the basis of a sensory receptor for magnetic fields, and given that the head area is innervated by the trigeminal nerve, we began our project by recording from the pigeon trigeminal system while varying the ambient magnetic field, hoping to find some neural correlate. We confirmed the presence of magnetic particles in the pigeon, locating them inside the skull and in the neck musculature as well, and we also detected the presence of magnetic particles in many species of migratory birds. We proposed a detection mechanism involving coupling magnetic particles together with highly sensitive mechanoreceptors, such as those found in muscle spindles—but we were unable to locate any sensory detector structures, nor measure any neural activity correlated with magnetic field variations (Presti &

Pettigrew, 1980). Decades later, though there is an abundance of behavioral data speaking to animals' use of the geomagnetic field as a navigational aid, the mechanism (or mechanisms) of how this is accomplished remains unclear (Mouritsen, 2018; Presti, 1985; Wiltschko & Wiltschko, 2019).

Something that happened during the early course of this work is vintage Jack. For the research we were planning to do, it was important to have a colony of pigeons available with which to work. We were also interested in making sure the pigeons were good navigators, that is, they would be "homing pigeons" selectively bred over many generations by folks interested in the sport of pigeon racing. We wished to get a feeling for their navigational prowess by taking the birds miles away, releasing them, and measuring how rapidly they returned home, even on overcast days when the sun was not visible as a navigational aid. In addition, pigeons love to spend time flying around in the vicinity of their home. Thus the colony needed to be open, so the birds would have free access to the outside.

An obvious choice was the roof of the behavioral biology building at Caltech, but Jack knew it would be very difficult (probably impossible) to obtain permission to build a pigeon loft on the roof of this building. Thus, over the week or so of winter holidays, we went to the lumber yard, secured the necessary building materials, built a lovely little home for a colony of pigeons, connected with local breeders of homing pigeons to secure some birds, and by the time the campus resumed full activity after the new year, there were a dozen or so beautiful homers flying in circles over the campus.

Jack's lab on the ground floor also had its avian residents, including an owl who lived for a time in Jack's office, and my own starling that was imprinted on humans and would sometimes leave its cage in my office and fly up and down the hall, not infrequently landing on someone's head or shoulder. That bird remained a pet for a long time, reaching the ripe old age of 15 years. Jack's lab was a wonderfully animated and creative place, and I learned a bunch of neurobiology.

I also shared outdoor adventures with Jack, introducing him to aspects of the southern California deserts, with their fascinating geomorphology, including some very large and dynamic sand dunes. And he introduced me to backcountry skiing and snow camping, including a trip one mid-winter where we skied and camped in Yellowstone Park in temperatures of -25° Celsius.

By 1982, Jack had decided to leave Caltech and return to his native Australia. And I moved to the University of Oregon to study cognitive neuroscience and clinical psychology, continuing a trajectory of steeping myself in the science of mind. I visited Jack once, in 1997, at the University of Queensland in Brisbane (Figure 2a,b), and we also occasionally met in Tucson, Arizona at the annual winter Fossil and Gem show, the world's largest commercial exhibition of fossils. These Arizona gatherings were convened by V. S. Ramachandran, ardent fossil aficionado (Miles & Miles, 2009) and a postdoc in Jack's Caltech lab contemporaneous with me. I frequently went to the Tucson event and Jack would occasionally come from Australia. It was a marvelous periodic reunion.

Throughout the 1990s I worked as a clinical psychologist treating alcohol and drug addiction and post-traumatic stress disorder at the Veterans Administration Medical Center in San Francisco. I also began teaching neurobiology at the University of California, Berkeley, where Jack had been a postdoc years before. I continued my interest in expanding scientific discourse on the nature of mind, and became involved in efforts directed toward reopening the clinical and neuroscientific investigation of psychedelic medicines, formally off limits for several decades as a result of legal restrictions that began in the 1960s.

Years earlier I had engaged Jack in discussing the investigative potential of psychedelics in probing the brain, mind, and sensory systems. At the time, however, neither the legal landscape nor the research infrastructure was ready to conduct such work. However, two decades later in Australia, when one of the subjects in a binocular-rivalry experiment demonstrated an anomalous pattern of switching and then revealed he had ingested LSD (lysergic acid diethylamide) several hours previously, Jack and his graduate student Olivia Carter followed up with further investigation, collaborating with

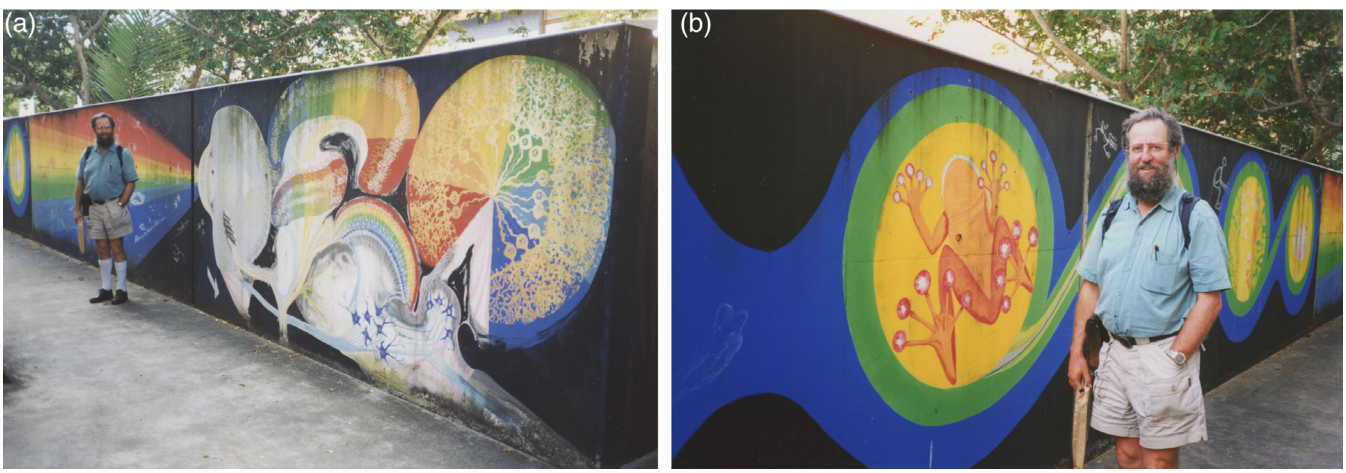

FIGURE 2 (a and b) Jack and the colorful mural he created and painted—a testament to the grandeur of sensory neurobiology and evolution—outside his lab at the University of Queensland, Australia, in 1997 [Color figure can be viewed at wileyonlinelibrary.com]

a group in Switzerland, where a program was in place to safely and legally utilize psychedelics (such as psilocybin and LSD) in research projects involving human subjects (Carter & Pettigrew, 2003; Carter et al., 2005a, 2005b, 2007).

4 | ENCOUNTERING TIBETAN BUDDHISM

During the 1990s, I had also become aware of a dialogue taking place between the Dalai Lama—spiritual leader of Tibetan Buddhism and Nobel Peace Prize Laureate (1989)—and various scientists, in particular neuroscientists, cognitive psychologists, and physicists. The Dalai Lama has lived in exile in India for 60 of his 84 years, and has been interested in science since his childhood in Tibet. Thirty-five years ago he began to implement a vision to nurture a dialogue between his own tradition of Tibetan Buddhism and the tradition represented by contemporary science. Appreciating that the nature of reality and the nature of mind are among the deepest mysteries in science, and are also central topics of Buddhist philosophical investigation, he conjectured that a conversation between the complementary perspectives on mind and world that characterize these two traditions might lead to new insights—insights that would hopefully benefit all parties in the dialogue, and perhaps, by extension, the larger community of humanity (Dalai Lama, 2005). By the turn of the millennium a number of meetings, discussions, and small conferences had taken place, and several books had been produced summarizing some of these encounters (Dalai Lama, Benson, Thurman, Gardner, & Goleman, 1991; Hayward & Varela, 1992; Houshmand, Livingston, & Wallace, 1999; Varela, 1997).

In 2002 Jack visited Berkeley and told me that the Dalai Lama had recently visited Australia and that he (Jack) had participated in a conversation on neuroscience with the Dalai Lama. A plan was hatched to follow up on that encounter by proposing an investigation of sensory perception in Tibetan Buddhist monastics at monasteries in India.

The following summer, in July 2003, I rendezvoused in India with Jack, his graduate student Olivia Carter, his 18-year-old daughter Chloë Callistemon, and her friend Yvonne Ungerer. We traveled to Dharamsala, where a meeting with the Dalai Lama had been arranged (Figure 3). The Dalai Lama is an extraordinary human being—radiating warmth and compassion, and exhibiting a keen intellect and gentle sense of humor. His interest in fostering dialogue and collaboration between Tibetan Buddhism and the scientific community was manifest throughout our hour-long conversation. He offered his support for the project we proposed—an investigation of visual perception, with a focus on binocular rivalry, in Tibetan monastics—and we left with a letter of endorsement from his office.

We began our work at the Institute for Buddhist Dialectics and at Namgyal Monastery, both in Dharamsala, talking with Buddhist monks about brain science and engaging a number of them in a measurement of binocular rivalry switching rate, and testing whether switching was impacted when the measurement was preceded by a short session of meditation. Turns out that it *was* (Carter et al., 2005c). In addition, several of our monastic subjects demonstrated remarkably stable perception in another measure of perceptual rivalry—the switching between two different forms of perceived apparent motion. Upon noting that at least one of these fellows had been living and meditating for long periods of time in an isolated hut in the hills near Dharamsala, we set out to hike into the hills carrying our equipment and locate other monks to test in measurements of perceptual rivalry (Figure 4).

Following this we drove from Dharamsala to Ladakh in far northern India, a 700-km trip requiring 3 days of driving over high mountain roads transiting steep drop-offs. At one point we came upon a narrow section of the road where two vehicles traveling in opposite directions had arrived at the same time. Neither driver wished to back up in the steep terrain to allow the other vehicle to pass. The impasse had continued for some time and a line of vehicles had formed in both directions. Jack would have none of this. He walked up to where the two

FIGURE 3 Meeting with the Dalai Lama in Dharamsala, India, July 2003. Left to right: Chloë Callistemon, Yvonne Ungerer, Olivia Carter, His Holiness the Dalai Lama, Jack, David Presti [Color figure can be viewed at wileyonlinelibrary.com]

drivers were arguing with one another and suggested this really had to be solved, that no one was in the wrong or right, and that a fair way to resolve the impasse was with a coin toss. Through our translator, Jack obtained the agreement of both drivers, tossed the coin, and the road was soon open (Figure 5a,b).

FIGURE 4 Tibetan Buddhist monk in a retreat hut in the hills above Dharamsala, wearing goggles used to display images for the measurement of binocular rivalry [Color figure can be viewed at wileyonlinelibrary.com]

Ladakh is a region of 7,000-m Himalayan peaks as well as the fertile valley of the Indus River. Close to half the population of Ladakh is Tibetan Buddhist and there are a number of monasteries, some quite isolated. We visited several, including Thikse Monastery near Leh, and drove over one of the world's highest motorable passes at Khardung La into the Nubra Valley, to visit there the Diskit Monastery, where Jack engaged in animated conversation with the abbot (Figure 6).

This work was one of the early quantitative investigations of potential links between meditation practice and perceptual processes (Carter et al., 2005c). In the years since, a great many studies have been conducted investigating how meditation practices impact physical and mental health, as well as exploration of neural and physiological correlates of various aspects of meditation and mindfulness practices (see, e.g., Tang, Hölzel, & Posner, 2015; van Dam et al., 2018). A PubMed search on "meditation or mindfulness" currently brings up approximately 11,000 publications, more than 80% of which have been published within the last decade. Nonetheless, our work, conducted in 2003, remains one of the few investigations with a group of monastics whose experience draws from their immersion in a culture of contemplative practice.

That these practices have beneficial effects on mental and physical health, and that this is being confirmed by modern research studies is, of course, wonderful. However, a hugely important aspect of this conversation and collaboration between science and Buddhism is the engagement of complementary worldviews. One of them—modern biophysical science—views the physical world as external to the human psyche and introduces mind or consciousness as a relative latecomer, appearing only after conditions for its emergence have been created following billions of years of physical and biological evolution. The other worldview—Buddhist philosophy—begins with appreciating that all we know is via our mental experience, and thus mind and world are likely to have a far more bidirectional and interdependent relationship. How this encounter will inform an expanded contemporary science of consciousness is very much a work in progress, the benefits of which remain to be seen.

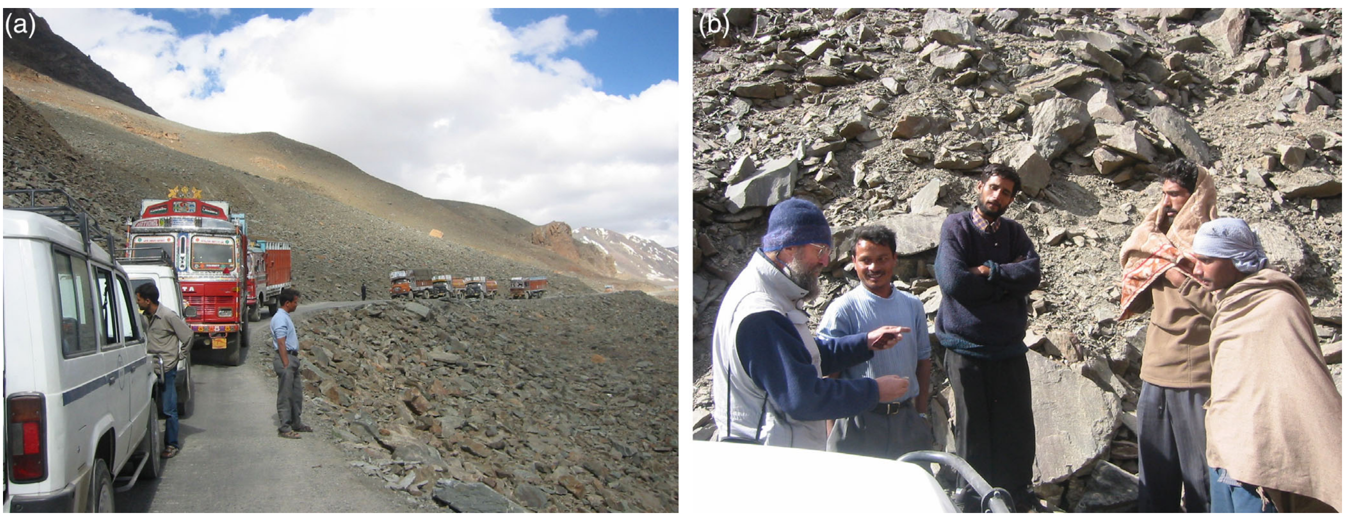

FIGURE 5 (a and b) On the road to Ladakh: (L) Impasse and (R) Jack's resolution by coin-toss [Color figure can be viewed at wileyonlinelibrary.com]

FIGURE 6 Jack sharing a demonstration of visual rivalry with the abbot at Diskit Monastery, Nubra Valley, Ladakh, India, 2003 [Color figure can be viewed at wileyonlinelibrary.com]

5 | ONGOING WORK WITH TIBETAN BUDDHIST MONASTICS

As with many of the Dalai Lama's projects, his intention has been to seed potentially beneficial ideas, hoping others will take up the ideas and nurture their expansion. Early on he appreciated that in order for the science-Buddhism dialogue to flourish, it would be important to have a larger community of contributors representing the Buddhist tradition. Experts in Buddhist philosophy and practice would need to become informed enough about contemporary science to engage in the conversation and carry it forward, so that the dialogue would truly thrive—perhaps opening new territory in the investigation of mind and physical reality.

In the 1990s the Dalai Lama began suggesting that science education be introduced into the monastic institutions of his tradition. This would be an essential step, he maintained, to insure the deepening of a conversation between the worldviews of the Buddhist and scientific traditions. It was slow going at first. The monastic curriculum in Buddhist philosophy and practice is substantial, and the relevance of adding science to all that was already required in a monastic education was not at all apparent to many.

Despite some initial reluctance, in the year 2000, the first science workshop was delivered at a south Indian monastery to a group of 50 Tibetan monks. The workshop was organized by the Library of Tibetan Works and Archives, located in Dharamsala, India. And then in 2001, the “Science for Monks” project was initiated through a partnership between the Library of Tibetan Works and Archives and the Sager Family Foundation (Sager, 2012). Although this program was unknown to us during the time of our perceptual-rivalry work in India in 2003, shortly after returning to America I had the very good fortune of receiving an introduction to the “Science for Monks” program.

Through a mutual friend and colleague, scholar and teacher of Buddhism Alan Wallace, I was introduced to Bryce Johnson, a graduate student completing his doctorate in environmental engineering at UC Berkeley, who for several years had also been directing the development of—along with the director of the Library of Tibetan Works and Archives in Dharamsala—the “Science for Monks” educational program. Bryce invited me to introduce neuroscience into the program, and in 2004 a group of Buddhist monastics in northern India received their first educational classes in neurobiology, a topic they had been very much anticipating (Figure 7). Since that time, the program has continued to evolve and flourish under the outstanding guidance of Bryce Johnson, with a focus on nurturing leaders in the monastic community to engage in education and dialogue related to science. I have continued to teach and converse with Tibetan Buddhist monks and nuns (the program is now “Science for Monks & Nuns”) about brain, mind, perception, consciousness, and the physical-science view of “reality” on multiple occasions at monastic institutions in India, and more recently in Bhutan and in Nepal (Figure 8).

In addition to the “Science for Monks & Nuns” program, a project originating in Switzerland and called “Science Meets Dharma” began teaching small science classes in monasteries in 2002. And beginning in 2007, a program out of Emory University in Atlanta, Georgia has provided science education to large numbers of monastics in the Tibetan Buddhist monasteries of India (“Emory-Tibet Science Initiative”). In support of all this, over the last decade, science educational

FIGURE 7 Tibetan Buddhist monks discover their visual blind spots. "Science for Monks" workshop, Dehradun, India, 2006 [Color figure can be viewed at wileyonlinelibrary.com]

FIGURE 8 Tibetan Buddhist nuns investigate visual disparity. "Science for Monks and Nuns" workshop, Kopan Nunnery, Kathmandu, Nepal, 2018 [Color figure can be viewed at wileyonlinelibrary.com]

texts in the Tibetan language have been and are continuing to be produced.

In the Tibetan Buddhist Gelug tradition, the major monasteries in India have recently established science education centers—places that serve as libraries, classrooms, laboratories, and workspaces for research, writing, and translation projects. And beginning in 2017, the exam for the advanced monastic Gelug Geshe degree in Buddhist philosophy now includes questions about science, in particular biology, neuroscience, and physics. Science education is reaching thousands of Tibetan Buddhist monks and nuns, and the monastics themselves are increasingly assuming control of the educational process. This is all really quite amazing.

The dialogue between Buddhism and science is indeed expanding and deepening—and at the same time, it is only getting started. One aspect of this expansion is the initiation of truly collaborative projects between Buddhist monastics and scientists. For example, a project is ongoing in south India investigating the psychology and neurobiology of Tibetan Buddhist monastic debate—a form of analytic meditation that contributes to the cultivation of reasoning and critical thinking, focused attention, working memory, emotion regulation, confidence in one's reasoning skills, and social connectedness (van Vugt et al., 2018, 2019). This is a first step in what is hoped to be a continuing creative and collaborative journey together—within a dialogue envisioned as a very long-term project, one that will hopefully expand the scientific investigation of mind and reality in ways we are not yet even able to imagine.

6 | TOWARD EXPANDING THE STUDY OF CONSCIOUSNESS IN CONTEMPORARY NEUROSCIENCE

William James (1842–1910)—a pioneer in the study of mind within modern science—suggested in his writings that a science of mind be based upon a multifaceted approach: empirically investigating behavior, the biological underpinnings of behavior, and mental experience as well. The first two approaches have been extensively developed in the century since James. However, the direct investigation of experience has not yet achieved a similar level of development within the scientific enterprise (Wallace, 2000).

James argued in his classic book on *The Principles of Psychology* that empirical study of experience was essential to a science of mind: "*Introspective Observation is what we have to rely on first and foremost and always*. The word introspection need hardly be defined—it means, of course, the looking into our own minds and reporting what we there discover" (James, 1890, p. 185). But careful introspective observation requires a sustained focus of attention internally—on the experiential contents of one's own mind—and sustained focusing of attention does not come easily. James again spoke to this: "the faculty of voluntarily bringing back a wandering attention, over and over again, is the very root of judgment, character, and will.... An education which should improve this faculty would be *the* education *par excellence*. But it is easier to define this ideal than to give practical directions for bringing it about" (James, 1890, p. 424).

Not only James, but also other founders of modern scientific psychology, championed a view that it was possible to investigate consciousness with the same empirical rigor that accompanies the study of the physical world. Scholar and researcher of consciousness Ralph Metzner points out that:

> Wilhelm Wundt, Gustav Fechner, and Edward Titchener all initiated projects of systematic introspection and the experimental analysis of subjective sensation and feeling states. But these projects came to an end very soon when the observers encountered material of the sort now called resistances or complexes, that is, thoughts, feelings, or sensations surrounded by something similar to a negative force field that prevents further direct awareness without outside intervention (Metzner, 1971, p. 3).

The Delphic maxim "know thyself" is no simple task and, over the millennia and throughout the world, a variety of psychological practices have been explored in an effort to overcome barriers to knowing one's psyche (Metzner, 1971). In particular, methods to train attention, coupled with introspective observation and analysis of mind, have been extensively explored within the tradition of Buddhism. Alan Wallace has written about the ways contemplative practices might contribute to an expanded science of mind:

> The mind-body problem, which remains in the domain of philosophical speculation, calls for an unprecedented expansion of the scientific method. Integrating scientific and contemplative modes of inquiry in the exploration of the mind and its origins may enable us to finally solve it. This will not occur as long as our starting assumptions about the mind are materialistic and our research methods observe only physical behavior and neural correlates of mental states and processes. In all branches of natural science, the most revolutionary insights are gained by directly and meticulously observing the phenomena under investigation. Observation of the mind itself is the strength of the contemplative traditions of the world, and the union of contemplative and scientific methods may yield a true contemplative science that revolutionizes our understanding (Wallace, 2012, pp. 70–71).

In addition to providing a forum of discourse regarding refined methods of observation and analysis of mental experience, the Buddhism-science encounter touches upon other topics of importance to a science of mind. Among these are how the weirdness of quantum physics (as manifested in the measurement problem and in entanglement) may reflect the interdependent nature of mind and world (Presti, 2019; Rosenblum & Kuttner, 2011; Sharf, 2018; Stapp, 2009; Zajonc, 2004); and how a variety of phenomena that have been investigated across cultures suggest interactions between mind and world that transcend the current explanatory framework in biophysical science (Cardeña, 2018; Kelly et al., 2007; Kelly, 2013; Kripal, 2019; Presti, 2018). Each of these topics may provide directions for expansion of a science of consciousness, and all will be served by continued cultivation of the collaborative conversation with Buddhism already well underway (Hasenkamp & White, 2017; Presti, 2018; Wallace, 2003). From all this will come as well a deeper appreciation of what a very different worldview—one grounded in acknowledging the interdependence of mind and world—can offer this project.

UC Berkeley psychologist Eleanor Rosch put it this way:

> The least recognized time bomb of the 20th century may be contact between the Asian meditation traditions and Western Culture. At their best, these traditions offer a portal into a radically new (lived) understanding of what it is to know, to be, to act, and to be an embodied self in time. Western approaches have so far tended to only nibble around the edges of these traditions…. What the meditation traditions have to offer science is not just more data to plug into the old ways of looking at brains, but a whole new way of looking (Rosch, 1999).

And so, the journey continues….

I am forever grateful to Jack Pettigrew for my introduction to the world of working directly with Tibetan Buddhist monastics (Figure 9).

7 | FULL CIRCLE: CONSCIOUSNESS, REALITY, AND ANCIENT ROCK ART

Jack spent the last decade of his life immersed in the investigation of the Bradshaw rock art in the Kimberly region of far northwest Australia (Pettigrew, 2011; Pettigrew, Scott-Virtue, & Goodgame, 2019). He noted similarities between the Bradshaw rock art and the Sandawe rock art of eastern Tanzania, thousands of kilometers across the Indian Ocean in Africa. Jack speculated that there might have been trans-oceanic migration of humans from Africa to Australia more than 60,000 years ago. He argued that both the Bradshaw culture and the Sandawe were shamanic cultures that employed psilocybin-containing *Psilocybe* mushrooms to induce nonordinary states of consciousness, states that included out-of-body experiences representing a kind of "astral travel." These things he inferred from rock-art depictions having mushroom-shaped heads, as well as horizontal figures in full dress, akin to flying—fascinating, speculative hypotheses, to be sure. Of relevance, numerous species of psilocybin-containing mushrooms are found throughout the world, including in Australia and Africa (Guzmán, Allen, & Gartz, 1998; Stamets, 1996). It is likely that multiple cultures throughout the long history of human evolution and migration would have discovered and utilized their powerful psychotropic effects.

As we explore ways to expand a science of consciousness, the remarkable properties of nonordinary states of consciousness—as may be found in association with psychedelic substances, other shamanic practices, and long periods of dedicated contemplative work—may provide important avenues of investigation (Presti, 2017). Shamanic cultures living in intimate communion with the natural world

FIGURE 9 Jack demonstrating a motion illusion to Tibetan Buddhist monastics. Dharamsala, India, 2003 [Color figure can be viewed at wileyonlinelibrary.com]

FIGURE 10 Jack and dinosaur fossil. Tucson, Arizona, 2008 [Color figure can be viewed at wileyonlinelibrary.com]

are well versed in these things. Few such cultures remain, and those few may be rapidly disappearing. The history and practice of Tibetan Vajrayana Buddhism, and the tantric Hindu traditions from which it in part derives, also speak to this.

The nature of mind and the nature of reality—who we are as conscious living beings and how we are connected with the rest of what we call physical reality—is arguably the most important question in all of science. How we choose to address the relation of mind and world impacts every aspect of our behavior. It influences our biomedical science, and how we relate to our bodies in health and disease. It influences our relationship with the living world—other humans, animals, plants, fungi, the microbial world, and the entire biosphere. It influences how we relate to technology and to our planetary environment—geological resources, oceans, and climate. And it impacts our concepts of past and future, and our connections with ancestors and descendants. Literally everything is shaped by how we understand mind and world.

All our science to date points toward deeper and more nuanced connectivity and interdependence. Not only is all of life on Earth deeply interconnected, but life interacts with other planetary processes as well—ocean dynamics, climate, geology. Research reveals that trees and other plants in forests and fields are engaged in continuous and elaborate communication via root systems, vast underground fungal and microbial networks, and airborne molecular signals. There is increasing appreciation of the symbiotic relationship we have with trillions of microorganisms living on and within our own bodies, far surpassing anything previously known or imagined. There is deep interconnectivity and interdependence everywhere we look. The ideas outlined in this essay suggest that mind as well may be interwoven into this fabric of interconnectivity in profoundly significant ways, beyond what we are presently able to incorporate within our biophysical explanatory framework. The task now is to see where such expanded perspectives take us, empirically. There is no single right way forward into this new terrain. Science is best served by pursuing diverse paths and methodologies—the kind of innovative, intrepid, and passionate inquiry so well embodied by Jack Pettigrew (Figure 10).

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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How to cite this article: Presti DE. Collaborative dialogue between Buddhism and science: A contribution to expanding a science of consciousness. *J Comp Neurol*. 2020;1–12. https://doi.org/10.1002/cne.24876