

MEDITATION AND BRAIN ACTIVITY FROM THE BIOSCIENCE-BIOETHICAL PERSPECTIVE

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Abstract

Spirituality draws people to places of worship, prayer, meditation, sacred dance, mountain tops or other inspirational activity. Some of us find spirituality through religion; others find it through science, music, art or a connection with Nature, while still others find it in their personal values and principles. No matter how it's defined, this elusive entity describes the way we find meaning, hope, comfort and inner peace in our lives. Having some sort of mystical or religious experience is not an uncommon human experience and for some the experience may be so intense that it changes their life forever. But what does this experience mean? Is it a trick of the brain's structure, the subconscious self, or a manifestation of the presence of a higher being? The scientific exploration of spiritual consciousness and the brain-generated sensations unique to this experience, has provoked both skepticism and critical acclaim. Experiments on the human brain have, however, led neuroscientists to accept that 'spirituality' is somehow hardwired within. Hence our preoccupation, through the millennia, with relationships between Nature, science, medicine, ethics and spirituality. But how is spirituality related to health? No one really knows but since body, mind and spirit are connected, the health of any one of these affects the health of the others. This review adopts a bioscience-ethical perspective. It discusses recent observations that have forced scientists to rethink the workings of the human brain and its ability to be rewired in the regulation of common emotions such as happiness, anxiety, fear, sadness and depression. An analysis of the meditating Buddhist mind will form a point of comparison. In conclusion, a fresh concordance between secular-based science and spiritual practice provides new possibilities for the advancement of mental and social wellbeing.

1. Introduction

The essential evolutionary characteristics of *Homo sapiens* are intelligence - particularly creativity - and communal lifestyle. Scientists believe that creativity more than any other element was responsible for giving us our dominant status in the union of life. Creativity is also believed to have given rise to exceptional artistic expression, ethical consciousness and technological supremacy. In biological terms human uniqueness resides primarily in our brains with its products being co-operation in family and tribal units, long education, self-consciousness, sophisticated language and culture.

The human brain's evolution can be divided into three distinct ancestral stages. These are; the primitive or 'reptilian' brain which embodies an essential core of survival functions, the primitive mammalian brain which embodies the first layer of the cortex responsible for the social and family behaviors of mammals, and the new mammalian brain with its extensive cortical development making possible the reasoning and abstract intelligence found in the primates, particularly human. The fossil record shows that human brain size has more than doubled in the past 2 million years to a volume of some 1,500 cubic centimeters. This steady growth in brain size made possible a steady growth in intelligence, and an increasing mastery of the world. But size isn't everything. What also matters is how the brain is structured, with the human brain's uniqueness lying in its flexibility. Flexible intelligence is demonstrated by the ability to solve problems in surprisingly diverse and unexpected ways, which can then be shared with the rest of the clan. It is believed that the analytical, conscious mind was born out of intellectual flexibility helped along by an innate life-long love for learning, exploring and playing. An early hallmark of human evolution was the capacity to reason, to reflect on actions and to engage in sophisticated discourse. The evolution of self-consciousness presaged consciousness of other and the development of ethics seen as the rules of adaptive conduct (Pollard, 2002a).

Cognition is a collective term for the psychological processes involved in the acquisition, organization and use of knowledge. It includes perception, memory, attention, problem-solving, language, thinking and imagery. Interaction between the child and its environment changes not only the child's behavior and/or physiology, but also its experience of the environment. Memory allows experience to become knowledge. Emotion, on the other hand, deals with highly individual feelings that defy any attempt at objective definition and, consequently, has long been ignored in human biology. Yet, emotions have an experiential component that is an essential part of human nature and which play a fundamental role in growth and development, social relations, and in overall wellbeing. Because of their adaptive value, emotions evolved relatively early in evolution with their expression being located in old parts of the brain; notably, the thalamus, amygdala and hypothalamus. These structures lie between the brain stem (the oldest part mainly controlling movement) and the neocortex, the most recent part, mainly related to higher cognitive functions such as perception and thought (Figure 1). As a result an emotional activation can travel much faster through subcortical routes to produce an immediate response to a stimulus. In addition, emotional activation does not automatically require cognitive mediation and may escape intellectual processing and recognition. This implies that the origin of emotions and their attendant feelings may be difficult to recognize and acknowledge.

In each of the brain's two hemispheres the overlying cortex is divided into four anatomically distinct lobes: frontal, parietal, temporal and occipital. These lobes have specialized functions:

- a) The frontal lobe is largely concerned with planning future action and with the control of movement.

- b) The parietal lobe is largely concerned with somatic sensation, forming a body image, and with relating one's body image with extra-personal space.
- c) The occipital lobe is largely concerned with vision.
- d) The temporal lobe is largely concerned with hearing; and through its deep structures – the hippocampus and the amygdala – with aspects of learning, memory and emotion.

Intellectual development in humans advanced not just by overall enlargement of the cerebral cortex, but particularly by expansion of the most recent part to emerge in the evolution of the brain - the prefrontal cortex housing the frontal lobes. The frontal lobe is the largest of the four lobes constituting each of the two cerebral hemispheres and, as summarized above, is devoted exclusively to higher functions. It is responsible for voluntary control over most skeletal muscles and significantly influences personality. It is also associated with higher mental activities such as planning, judgment and conceptualization. Intelligence is the product of co-operative functions where the frontal lobe's contribution is creative and voluntary initiative, resulting in our unique ability to respond to challenging situations with novel solutions. As a consequence, evolution of rational will also provided us with the basis of freedom, which could then be used in symbolic activity (art, for instance), or to initiate planning, make purposeful use of the imagination, and solve problems by reasoning. The net result was not only unparalleled biological advancement as a species, but also ruthless technological power. The problems that this awesome power created may have provoked a survival strategy based on reasoning, ethical reflection and the development of moral rules (Pollard, 2002a).

Together the frontal lobes and the limbic emotional brain allow us to mingle thought and feeling, cognition and emotion, providing an adaptive mix of intellectual and emotional brain power. The functional compartments of the emotional brain include the thalamus, hippocampus, amygdala, hypothalamus and pituitary gland (Figure 1). The thalamus processes incoming information from the senses (eyes, ears, nose, touch etc.), and relays sensory information to the cerebral cortex after the information is appraised. The hippocampus, central to the operations of memory consolidation and learning, is where the thalamus's information is sorted and significant emotional memories are adapted for long-term storage. Anterior to the hippocampus is situated the amygdala which processes emotional experiences and reactions. The amygdala originally played a central role in the acquisition and processing of fear, anger, flight and defense (all stress-mediated) but now is also crucial in processing emotions indispensable for social communication. It is here that judgment on the emotional significance of all incoming information is made and emotional memories are stored, conveniently close to the elaborate connections to and from the prefrontal cortex. The amygdala is intimately connected to the hypothalamus. The hypothalamus, together with other brain circuits, is concerned with motivation and reward mechanisms. Through the endocrine system it controls most of the body's housekeeping needs such as brain clocks, temperature regulation, appetites for food, sex, aggression and pleasure. Attached to the hypothalamus

is the pituitary gland, which orchestrates the messenger hormones influencing the homeostatic stability of every organ in the body including the brain itself (Pollard 2003a).

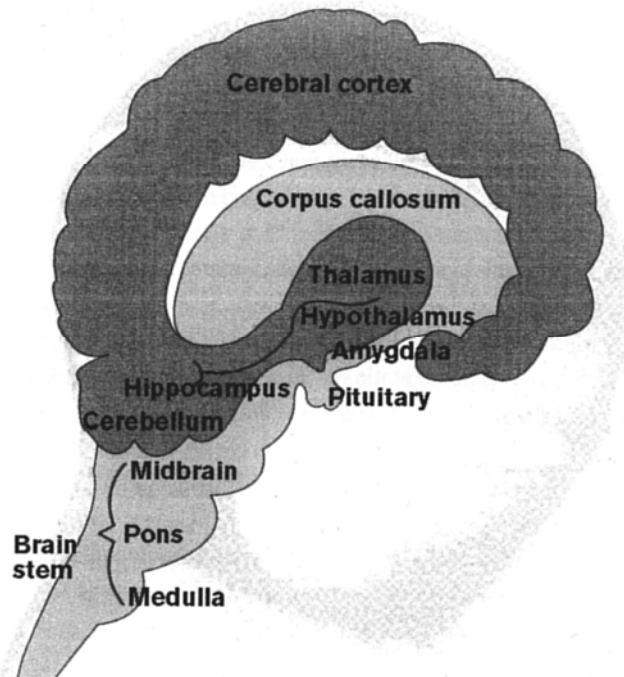


Figure 1. The functional compartments of the limbic or emotional brain (thalamus, hypothalamus, amygdala, hippocampus and pituitary gland) embedded within the brain's other major anatomical divisions. The emotional brain is central to working memory, depression and also serves as the prime target for consciousness-changing/mood altering substances (reproduced from Pollard. I. From Happiness to Depression. *Today's Life Sciences* 15:2003;22-26 page 23, with permission).

The frontal lobes, the amygdala, and the hippocampus are all extensively interconnected with the body; particularly with the immune system, the endocrine (hormonal) system and the autonomic (involuntary) nervous system. Understanding this interconnectedness also provides an understanding of how the mind influences the body and how emotions impact not just on mental health but also on our physical health and wellbeing.

2. Western Dogma: Historical Perspective

Until fairly recently the prevailing dogma in neuroscience was that the brain contained all of its neurons at birth and their number remained unchanged by life's experiences. It was believed that the only changes that did occur over the course of one's life were alterations in synaptic (interneuronal) connections and accelerating cell death

with aging. However, in the early 1990s, prominent neuroscientists began to discover that new neurons are being generated throughout one's entire lifespan (Eriksson *et al*, 1998; Van Praag *et al*, 1999) and, contrary to popular dogma, these newly differentiated neurons are associated with new learning and memory. Magnetic Resonance Imaging (MRI) studies have confirmed that, for example, the brain region which controls finger movement in the hand increases in size in string players engaged in specific 'fingering' exercises. Furthermore, those who start their training earlier in life and practice longer show more pronounced changes in the brain (Elbert *et al*, 1995). The term which describes this important discovery is 'neuroplasticity' and expresses the reality that the brain continually changes as a result of our experiences, whether through fresh interneuronal connections or through the generation of new neurons.

Thus modern neuroscience is establishing what already seems intuitive; that the environment constantly impacts on brain development and that the brain remains functionally plastic throughout life, adjusting its neurophysiologic/psychologic development to the prevailing conditions. As a rule, western medicine has considered the child's social development and cognitive development to be separate, but we now know that there is an inseparable interconnectedness to these processes. To optimize adaptive neurophysiological growth and maturation prenatally and during infancy, the brain develops chronologically much earlier and faster than any other part of the body (Bogin, 1999). Despite the brain's rapid overall development, it is also the last organ to mature anatomically, allowing the prefrontal area to continuously reflect the progressive mental and social landmarks of a child's life. For example, children raised in nurturing environments develop physiological responses important in the regulation of emotions, and *vice versa*. Since the prefrontal area remains very plastic shaping its circuitry to match the experiences and learning children undergo, the early years of life are windows of opportunity for mastering helpful planning skills and emotional awareness for adaptive living. Children equipped with good planning skills by the time they enter school at the age of five or six, are much less likely to suffer from developing aggression and anxiety disorders (Spring, 2000). Various lines of thought and research agree that insufficient emotional stimulation and/or an excess of negative stimulation in the early stages of life are likely to result in a higher risk of mental health troubles. Exposing children to an atmosphere of genuine love and compassion within family and school environments significantly increases overall health and wellbeing – essential if we are to look forward to a more humane and peaceful future. However, there is also hope for those not raised under ideal conditions because, as this review reveals, the human brain has the ability to be rewired in the regulation of common emotions such as happiness, anxiety, fear, sadness, depression and, therefore, spiritual wellbeing.

3. The Neuroscience of Emotion

Modern science is beginning to unravel the mysteries surrounding human spirituality by elucidating the neurological mechanisms which reinforce traditional customs and rituals. Such a new-found concordance between science and spiritual practice is opportune because, in order to survive adaptively, present-day culture is increasingly dependent on our ability to cope with new possibilities requiring emotional flexibility. In an age of rapid technological advances, intelligent flexibility makes

evolutionary sense. However, in order to access a level of newfound freedom and wellbeing, we may also have to break with outmoded belief systems and constraints, even if this means losing or reworking some aspects of our valued heritage.

Research has established that individuals who have high levels of brain activity in the left prefrontal cortex, experience feelings such as happiness, enthusiasm, joy, high energy and alertness. When these same people are provoked or threatened, they experience only transient amygdala activation and raised circulating cortisol, which quickly returns to baseline levels. On the other hand, individuals with a high level of activity in the right prefrontal cortex, relative to the left, are more prone to feelings of sadness, anxiety and worry. An extreme rightward tilt in the ratio of activity in these prefrontal areas predicts a high likelihood of clinical depression or an anxiety disorder at some point in life; people in the grip of depression have the highest levels of activation in those right prefrontal areas (Goleman, 2003). Most individuals, however, fall into a middle ground where moment-to-moment adaptive regulation plays an important part in the generation of physical harmony and mental balance. When emotional stability is threatened, compensating mechanisms are activated in order to regain fitness by adapting to the changing conditions. This adaptation is known as 'reactive homeostasis', the 'General Adaptation Syndrome' (GAS) or the 'fight or flight' response (Pollard, 1994). It has long been known that when cortisol is present at high levels over prolonged periods, it leads to degenerative diseases such as atherosclerosis, hypertension, diabetes, cancer, disorders such as posttraumatic stress syndrome and depression (Pollard, 2002b; Pollard 2003a). Stress hormones such as cortisol have particular adverse morphological effects on the hippocampus because this structure is a primary glucocorticoid target site. As a consequence, chronic stress and resulting withdrawal from social engagement, can damage neurons in key brain regions such as the hippocampus and its memory storage mechanisms (Sapolsky, 2000).

Each of us has a characteristic ratio of right-to-left activation in the prefrontal areas. This ratio represents a mean emotional set point around which our daily moods swing. Mood is the consistent extension of emotion in time, while emotion is typically transient and responsive to the thoughts, activities, and social situations of the day. Mood, or the state of emotional balance, influences the way an individual interacts with and perceives the world. It is important to appreciate, however, that when we experience emotions we build a circuitry of neural connections by exercising that part of our brain corresponding to those emotions. As the same emotion repeats itself, the brain circuitry associated with that emotion strengthens (just as exercise strengthens muscles) and becomes, over time, our default pattern of emotion or temperament. Importantly, if we experience strong negative emotions without equally positive ones, the negative ones will dominate, and will show up in an increased activity in the right side of the prefrontal lobes. Alternatively, by experiencing strong positive emotions these will show up in an increased activity in the left side of the prefrontal lobes and strengthen the parts of the brain that calm anger and fear and elicit happiness. However, right/left brain science is not that simple and we still have much to learn about brain configuration.

4. Adaptive strategies: Mindfulness Meditation, Yoga, Guided Imagery and other forms of Contemplative Practice

Loosely defined, meditation is a method of mental training which involves focused attention for the purpose of spiritual development and self-actualization. It has long been accepted that ‘tuning out’ on a regular basis reduces stress and can make one calmer, healthier and happier. Meditation is a well recognized complementary health-enhancing strategy whose key objectives include empowerment to cope with loss and depression, and to sustain a sense of fulfillment in life. Decades of tests with monks and yogis in western labs have revealed remarkable abilities to control respiration, brain waves, or core body temperature (Delmonte, 1984). Psychologists are now beginning to focus more on the normal rather than abnormal, by studying everyday adaptive qualities and their effects on health and wellbeing.

Many empirical studies have shown that forms of contemplative practice, such as meditation, are effective in overcoming and treating stress-related states. The contemplative customs practiced in many cultures evoke decreases in heart rate, breathing and blood pressure. Compared to controls, individuals who meditate enjoy significantly increased alpha brain wave activity (low frequency brainwaves that occur during relaxation), increased orderliness of brain activity (Khare & Nigam, 2000), and a unique form of consciousness different from relaxation states (Dunn *et al*, 1999). Meditation also has a positive health effect in cancer treatment (Tacon, 2003), with a notable study showing tumor cell growth rates to be significantly decreased in prostate cancer patients who practiced Zen Buddhist meditation (Yu *et al*, 2003). Other studies have added new details of possible mechanisms by which meditation may relieve the physiological symptoms of stress. Meditation stimulates the release of nitric oxide, which is an antagonist of the stress hormone noradrenaline released in preparation for the fight or flight response. Nitric oxide dilates noradrenaline-constricted vessels and restores efficient blood flow (Moncada *et al*, 1991). Nitric oxide is also linked to the release of endorphin – our natural body opiates that counter pain and produce feelings of wellbeing. For details of the neural basis of meditation and its effects on body and brain chemistry, see the review by Newberg and Iversen (Newberg & Iversen 2003). Further details can be found in Daniel Goleman’s book written for the general interested reader (Goleman, 2003).

So far modern science has focused on formulating ingenious chemical compounds to help us overcome stress and its toxic consequences but, through Buddhist meditation and related practices, it is possible to access alternative methods. To this end a major significant scientific investigation was planned during meetings in Dharamsala, India, between the Dalai Lama and a group of western scientists and philosophers (Goleman, 2003). The Tibetan leader held a series of discussions with chosen authorities from disciplines such as psychology, philosophy and neuroscience. The aim was to examine what science could learn about the mind and body, particularly emotions, from Buddhism’s 2,500-year tradition of meditation. As analyzed above, the mind-body complex is intricately connected and the state of the mind has direct effects on overall health and wellbeing – an observation acknowledged for centuries by Eastern philosophers, particularly Buddhist. For example, in Tibetan medicine two of the most important factors affecting a patient’s ability to heal are the mindset of the doctor and the mindset of the patient. The Dalai Lama proposed that the medical and emotional benefits of meditation should be investigated in controlled laboratory experiments; and, if so established, meditation should be divorced from its religious roots and made universally

available. Moreover, the Dalai Lama promised that should science disprove the benefits of meditation, he would be willing to rethink thousands of years of Buddhist tradition; in his own words “*If science proves facts that conflict with Buddhist understanding, Buddhism must change accordingly*”, and “*We should always adopt a view that accords with the facts.*”

5. Brain Activity of Tibetan Buddhist Monks During Meditation

A. Functional Magnetic Resonance Imaging (fMRI) tests

The data collected in this series of experiments suggests that meditative practice is effective in generating neuroplasticity, inhibiting destructive emotions and fostering positive ones. Standard magnetic resonance imaging (MRI) machines are widely used in hospitals and offer a graphically detailed snapshot of the structure of the brain. The more sophisticated functional magnetic resonance imaging (fMRI) machines provide an ongoing video record of how specific zones of the brain dynamically change their level of activity from moment to moment. Conventional MRI lays bare the brain’s structures, while fMRI reveals how those structures interact as they function.

During the meditative state the brain shows very high levels of activity in the left prefrontal cortex region. This was first demonstrated by fMRI in the meditating mind of Lama Öser in his role as test subject whilst in the ‘compassion’ meditative state (Goleman, 2003). In compassion meditation, the meditator focuses on compassionate thoughts for specific individuals, other species or for all of humankind. This Tibetan Buddhist monk’s left prefrontal brain lit up to a level indicating a very high level of ‘happiness’. Even when he was not meditating, the left prefrontal cortex showed unusually high activity. Such investigations provide support for practical neuroplasticity – the ability of the brain to be molded by experience – and force scientists to rethink their understanding of the human brain and its ability to be rewired for health. Importantly, these preliminary tests show that as well as helping people manage destructive emotions like anger, hatred and jealousy, meditation may also have profound effects on promoting happiness. Not long ago the prevailing scientific dogma was that people have a preset capacity for happiness being determined by biology and changing little whether a person wins the lottery or experiences a debilitating accident. The thinking was that if someone was prone to unhappiness and has more activity in their right prefrontal cortex, winning the lottery might temporarily spike activity in the left cortex, but it will not tip them into the company of happier, left-brain people in the long run. It now seems that happiness is not as static as previously believed. The human community at large can benefit from classical mental techniques which produce greater self-control and help cultivate an internal calmness and happiness. This may even be our natural state if only we can shut out layers of emotional turmoil and redundant mind chatter.

It is possible, however, that a naturally happy temperament, a monk’s stress-free ordered lifestyle, or the result of a disciplined rigorous meditation protocol was responsible for the shift in Öser’s emotional temperament. That years of meditation in a closed community are not needed to experience positive effects, was shown with a series of studies (Davidson *et al*, 2003) with employees at Promega - a biotech firm in Wisconsin. Prior to the study, it was established that the workers exhibited high levels of

right-brain activity and reported feeling ‘stressed-out’ and unhappy with their jobs. After eight weeks of meditation training and practice, the activity in the left side of their brains increased significantly, and the workers reported feeling happier, with a renewed sense of enthusiasm for their life and work. The control group showed no change. While more long-term research is required to eliminate confounding factors, the findings are very optimistic in that meditation practice can alter an individual’s emotional setting towards the positive, which may then become the mind’s default state.

B. The Electroencephalogram (EEG) tests

The next set of tests utilized the electroencephalogram or EEG machine which measures brain activity waves. Most EEG studies use 32 sensors on the scalp to pick up electrical activity in the brain – and some may use as few as six. But in this unique set of experiments, Öser’s brain was monitored using two different EEG caps - 128 sensors and 256 sensors. The first cap captured data while Lama Öser went into the meditative state; the second was used synergistically with the earlier fMRI data (Goleman, 2003). While the fMRI can detect brain changes within a millimeter, the computerized EEG can detect changes in the brain in a thousandth of a second. The various brain readings acquired with the powerful EEG sensors were analyzed using software called source localization which pinpoints the neural location of a signal. Specifically, source localization can penetrate sites deep within the brain, unlike ordinary EEG measures which can monitor only the topmost layer of the brain. The strength of the EEG is speed – just as the MRI’s is spatial precision.

The EEG findings reinforced the previous data in that Öser’s brain shift during compassion reflected extreme wellbeing, reinforcing scientifically a general acknowledgement that volunteer work or assisting friends in need, benefits not only the receiver but also the person giving it. The very act of concern for others’ wellbeing, it seems, creates a greater state of wellbeing within oneself. Likewise, it seems, that the person doing a meditation on compassion for others is also the immediate beneficiary (see section ‘Meditation and the Immune System’). It is surprising therefore, that compassion is an emotional state which is, for the most part, ignored by modern psychologists - we may be well served to focus less on what can go wrong and highlight physiological states when things go right. Psychology’s negative spin may reflect the lead of medicine, which has traditionally focused on disease rather than on health.

If the main motivation for the practice of compassion is self-interest – then this is an important evolutionary insight. Another insight comes from the realization that individuals who use humor to cope with stress have a more resilient immune system and age more gracefully. Moreover, psycho-immunologists have confirmed what we all know instinctively, that the immune system is boosted by helping others and, ingeniously, just hearing about other people’s good work appears to boost our immunity. The scientific evidence again confirms the point that not only are we physiologically constructed to need others, we are also constructed to want to be needed (Pollard, 2003b). That is, during critical periods in our evolution, *Homo sapiens*’ social drive for personal survival became interdependent with our collective survival. Put in anthropomorphic terms ‘our immune system knows that helping others ultimately helps our own wellbeing’ – the result ‘I feel less fear, more happiness’ (Pollard, 2002b). This biological insight also

seems to be the common substance of all religious faiths, whether Hindu, Muslim, Christian, Jewish, Buddhist or any other. In all cases, religious faith is preoccupied with rendering service to the Deity and fellow human beings. And in the final analysis, we do know that people who score high on measures of positive emotions also report engaging in more altruistic actions.

C. Single Photon Emission Computed Tomography or SPECT tests

Positron emission tomography or PET scanning is a computerized radiographic technique that employs short-lived radioactive substances to examine the metabolic activity of various body structures such as the biochemical activity of the brain. In PET studies the patient either inhales or is injected with a suitable substance, such as glucose, carrying a radioactive tag that emits positively charged particles or positrons. When these positrons combine with negatively charged electrons normally found in the cells of the body, gamma rays are emitted. The gamma rays are then converted into color-coded images that indicate the intensity of the metabolic activity of the region of the brain involved; that is, the tracer binds to brain structures in proportion to the blood flow and so is indicative of brain activity. By measuring the distribution of the tracer, a snapshot of brain activity at the time of tracer injection can be obtained, allowing meditating brain scans to be compared with those taken whilst the subject was simply at rest. When studying Öser's meditating brain Andrew Newberg and his colleagues (Newberg *et al*, 2001) used single photon emission computed tomography or SPECT tests - a variation of computed tomography scanning in which the gamma-ray detector rotates around the body allowing the subject to meditate in relative peace rather than being exposed to the claustrophobic whirr of a scanner chamber. SPECT and PET technologies rely on the same technological/biological principles described above.

During meditation, SPECT tests showed intense activity in parts of the brain that regulate attention and deep concentration while parietal lobe activity decreased. This change was not observed when the subject was merely relaxing. As spelt out in the introductory, the parietal region of the brain is where the distinction between self and others originates. Broadly speaking, the left-hemisphere side of the parietal region deals with the individual's sense of body image, while its right-hemisphere equivalent handles its context – the space and time inhabited by the self. The results suggest some form of synchronization between the subjective feeling of oneness and the disconnection of parietal activity from the usual touch and position signals that help create body image. Meditation, apparently, turns off key sensations from the outside environment, generating a condition where sights and sounds don't disturb. As the spatial and temporal context disappears, the meditator may also feel a sense of infinite space and perhaps even eternity. The above experiment was repeated using Franciscan nuns in prayer as subjects (Newberg *et al*, 2001). The nuns – whose prayer centers on words rather than images as in Buddhism – showed activation in the language areas of the brain but they too shut down the same parts of the brain that regulate oneness when the prayers reached their peak. It is well documented that there are two sensations unique to all religious experience and which are shared by people of all faiths - the sense of oneness with the Universe and feelings of awe and wonder that accompanies such an experience.

5. Meditation and the Immune System

The discipline of psychoneuroimmunology investigates how loss of personal control - disempowerment - causes unhappiness which, in turn, adversely modifies hormonal secretory profiles, causing a cascade of secondary effects leading to the gradual degeneration of the body. The ability to control decisions depends on changed behavior, which requires relevant information within the context of empowerment (Pollard, 2002b).

Negative emotions not only affect our happiness and mood levels, they also affect our health and wellbeing. As we have seen, the prefrontal lobes, along with two other areas of the brain that play crucial roles in the initiation of emotions – the amygdala and the hippocampus – are closely tied to blood pressure, hormones and the immune system (Pollard, 2003a). In the experiment described in section 5A, Davidson and colleagues (Davidson *et al*, 2003) conducted additional tests with the Promega workers by giving them influenza vaccinations after their initial eight-week meditation course. When subsequently their blood was tested for infection-fighting flu antibodies, the meditation group had significantly larger amounts of the antibodies compared with the control group. Interestingly, the larger the leftward tilt in a person's brain activity, the greater the beneficial response to the flu vaccine indicated by the level of antibodies in the circulatory system. A follow-up check four months after meditation classes ended revealed that the meditation group retained a significantly increased left-sided activation compared with before their meditation course. Subsequently a correlation was observed between high antibody titers and decreased likelihood of flu infection.

6. Spirituality, Health and Wellbeing

Spirituality is the way humans find meaning, hope, comfort and inner peace in their lives. Some find spirituality through religion; others find it through science, music, art or a connection with Nature, while still others find it in their personal values and principles. Exactly how spirituality relates to health is unclear but since the body, brain, mind and spirit are connected, the health of any one affects the health of the others. The experiments described in this review demonstrated in scientific terms that a spiritual life, whether gained from religion, meditation, prayer or other positive ideology, can provide comfort and strength which contributes to healing and a sense of overall wellbeing. Spiritual health may not cure advanced illness, but it may slow its progression, help you to feel better, prevent certain illnesses and provide the means to cope with illness or death. Thinkers have repeatedly emphasized that spirituality is a construct that, although related to religion, is a distinct phenomenon (Benjamin & Looby, 1988). On the other hand, opinion polls indicate that religion is part of the lives of many, so understanding the role of religious beliefs in life's coping processes is very important (Pargament *et al*, 1994). What is certain is that spirituality, however expressed, provides a significant moderating effect for both depression and anxiety (Young *et al*, 2000) and is an integral component of recovery from a variety of psychological difficulties such as substance abuse, gambling or other self-destructive behavior (Le *et al*, 1995). Thus in practical terms, spirituality provides a buffer from stressful life events that are perceived as negative, particularly in providing protection against organic disease and depression.

Spirituality also provides the relationship between ethical development and purpose in life.

Technological advances have offered humans, especially those living in industrialized communities, innumerable opportunities to enjoy a more comfortable, healthier and efficient lifestyle. The rapid expansion of scientific knowledge and medical skills has provided options that could not have been anticipated by those living one or two generations ago. It's appropriate, while enjoying the modern biomedical revolution, to reassess both ancient and modern insights with a view to integrating the essentials of healing and wellbeing. In biological terms, health and ill-health are not alternative states; rather they are part of the same continuum. Traditional wisdom is supported by a rapidly growing research-based literature, particularly that of stress physiology. Researchers, since the early 1950s, have identified key factors in the generation and maintenance of physical, psychological and social wellbeing. The early ground-breaking studies paved the way for more recent wisdom, the most notable being that a sense of control over our lives promotes wellbeing more powerfully than an appropriate command over lifestyle behaviors such as smoking, diet and exercise (Pollard, 2002b).

However, when it comes to the commitment to transform society, it will not come through some fixed ideology but through general education with a scientific basis – and this is where bioscience ethics can assist. By linking scientific endeavor and its application into adaptive forms of bioethical consensus, bioscience ethics has become the practical interface between science and bioethics. Its major elements are increased understanding of biological systems, responsible use of technology, and reassessment of ethnocentric debate in tune with new scientific insights (Pollard, 2002c). Bioscience ethics does not displace bioethics; rather it wishes to democratize major scientific advances to promote the development of informed secular ethics free from out-of-date constraints. Analysis of the scientific evidence free from any specific morals or religion is important when trying to effectively engage the public. In science, new data can at any time overturn established theory, law or dogma. This is how scientific research provides a self-corrective mechanism. New understanding gained from research generates ethical maturity which, in turn, increases justice and freedom, demonstrating that the truth requires more than mindless conformity to extant moral consensus or following the 'right' dictates of the time. Bioscience and bioethics involve not only respect for rights and responsibilities, but also includes abstract qualities such as truth, gratitude, guilt, love, communication, consensus and compromise – effective mechanisms for dealing with ethical pluralism. Fundamental to this process, if the bioethical discussion is to be relevant to our knowledge-based lives, is the expectation of high biological standards.

I would like to end this review with a quote from the foreword of Daniel Goleman's book 'Destructive Emotions and How We Can Overcome Them: A Dialogue With the Dalai Lama' Page xiv:

“With the ever-growing impact of science on our lives, religion and spirituality have a greater role to play in reminding us of our humanity. What we must do is balance scientific and material progress with the sense of responsibility that comes of inner development”

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