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REVIEW ARTICLE

MEDITATION AND MENTAL WELL BEING

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The concept of mental well-being refers to optimal psychological functioning and experience. Mental health has largely been defined as absence of psychiatric illness. *Mind influences health and disease* was once considered very essential part of medicine but in last few hundred years mind and medicine have slowly drifted apart. For much of the last century, psychology's focus on the amelioration of psychopathology has overshadowed the promotion of well-being and personal growth. But beginning in the late 1960s with a shift in focus towards prevention, and continuing to the present, a few researchers have been studying growth, well being and the promotion of well beingness.

How can we prevent problems like depression, substance abuse, and schizophrenia in young people who are constitutively vulnerable or who live in worlds that nurture these problems? Prevention researchers have discovered that human strengths such as courage, optimism, interpersonal skills, faith, and hope act as buffers against mental illness. In other words, by minimizing the destructive state of mind and enhancing the constructive states of mind mental well-being may be promoted. Low self esteem, harboring negative emotions, jealousy, jack of compassion and inability to have close interpersonal relations are *destructive states* of mind. *Constructive states* of mind include self-respect, self-esteem, feeling of integrity, compassion, benevolence, generosity, truth, the good, the right, love and friendship.

Meditation in Science

What is the practical answer to the perennial human conundrum of how we can better balance negative and positive emotions and hence improve mental well-being? While modern science has focused on formulating ingenious chemical compounds to help us overcome toxic emotions, traditional practices such as meditation, albeit more labor-intensive, is an important method for training the mind. Meditation may be considered as an antidote to the mind's vulnerability to toxic emotions. If destructive emotions mark one extreme in human proclivities, research seeks to map their antipode, the extent to which the brain can be trained to dwell in a constructive range: contentment instead of craving, calm rather than agitation, compassion in place of hatred.

Can modern neuroscience make use of Yoga's experience of investigation of the mind through meditation practice? How can meditation improve the well-being? What is the role of meditation in effecting change in the neuroscience of the emotions? What is the role of meditation in working with destructive emotions and negative emotions?

With the widespread and growing use of meditative practices in hospitals and academic medical centers for outpatient for mind/body or integrative medicine, the question of possible biological mechanisms by which meditation may affect somatic, cognitive, and affective processes becomes increasingly important. Research on the biological concomitants of meditation practice is sparse and has mostly focused on changes that occur during a period of meditation compared with a resting control condition in a single experimental session (1–3). Whereas these studies have been informative, they tell us little about changes that are potentially more enduring. Moreover, virtually all forms of meditation profess to alter everyday behavior, effects that are by definition not restricted to the times during which formal meditation itself is practiced. Thus, it is important to focus not on the period of meditation itself, but rather on the more enduring changes that can be detected in baseline brain function as well as brain activity in response to specific emotional challenges.

A search for the place of yoga in science elicits a mixed response. Numerous studies claiming a beneficial effect of either various asanas or mediation can be found. These reports are mostly of the kind in which various effects measured during or after meditation are enumerated. Reports of investigative nature i.e., studies trying to elucidate the mechanism by which the observed effects may be produced are however very few. Nevertheless such scientific evidences is being examined by the policy makers on health issues before treatment strategies can be formulated.

Before going into the scientific evidence for the use of meditation it would be worth discussing the *types of scientific studies* that can be undertaken. A dilemma exists between those who believe that the most valuable lessons about the brain can be learned from statistical analysis involving large number of subjects and those who believe that doing right kind of experiments on the right subjects -even a single person can yield more useful information. Its resolution is obvious: it's a good idea to begin with experiments on single cases and then to confirm the findings through studies on additional subjects.

Studies on meditation too follow the same pattern. Two kinds of research on meditation are done, one is work with individuals who in fact are naive to meditation, train them with a short-term program of meditation based on certain meditation practices and then look at changes that occur over a relatively short period of time, just over the course of several weeks or months. What's actually remarkable is that significant changes are found over such a short period of time which are important since they have profound implications for the potential human development.

The second kind of work is with experts, people, who have spent many years in contemplative practice and have really very finely honed their skills in these practices. Individuals who have spent quite a bit of time training their mind is actually a more vigorous and scientific way to proceed in looking at relations between brain events and mental events because one is working with individuals whose minds, if one will, are as well calibrated as physiological instruments. In these individuals we should expect to see more robust associations between specific neural events and reports of their mental experiences than we would see in individuals who are untrained. Studies on meditators who have practiced one particular school of meditation for ten to fifty thousand or more hours constitute this type of studies. These studies have contributed tremendously about the physiological and especially the psychological changes brought about by the practice of meditation. Number of subjects is compromised but the reproducibility of results is remarkable. The shift between the normal and meditative state makes the experimenter try a large number of sophisticated experimental paradigms possible. The results of these studies are landmark findings for neural mechanisms underlying meditation effects.

What sort of person is attracted to and can be benefited by meditation? Evidence suggests that subjects who are highly anxious and who have some capacity to voluntarily self regulate their attention are likely to experience subjectively positive effects from meditation (4). It is suggested that meditation will be undertaken by individuals who, on an average, show low cognitive and somatic anxiety because evidence suggests that people with elevated levels of anxiety will not, at least initially, be benefited by meditation and will be less likely to persist in their practice (5). Long-term meditation is known to reduce cognitive anxiety compared to physical exercises which is known to reduce somatic anxiety. Longitudinal study performed on meditators reported that those who practiced regularly for more than 12 months characterized themselves as less anxious, more calm and peaceful than those who dropped out before 12 months (6, 7). Further it was shown that individuals who are interested enough in meditation to have begin to practice, report more instances of spontaneous, total attentional involvements than a comparable control group. This substantiates the use of non random study designs in Yoga and meditation as is generally reported in literature.

Meditation in practices for mental well-being

Meditation is a relaxing experience, and has therefore been used primarily for the disorders to which mental stress makes a significant contribution. These disorders include hypertension, coronary artery disease, insomnia, incontinence, headache, chronic pain, especially low back pain, stress-related symptoms in cancer, anxiety disorders and premenstrual syndrome (8, 9). The efficacy of meditative techniques in such a wide variety of disorders is not surprising in view of mounting evidence in favor of the mind-body relationship. Physical and mental relaxation, as achieved during meditation, has reproducible physiological effects such as an increase in EEG alpha activity and skin resistance, and reduction in respiratory

rate, oxygen consumption, arterial lactate levels, and sympathetic activity (10–12). It has been reported that those who have been meditating for more than 5 years are, on an average, biologically 12 years younger than people their age in the general population (13). The indicators of aging used in this study were acuity of hearing, near-point of vision and systolic blood pressure. At cellular level, slower aging may be due to reduced oxidative stress as suggested by lower lipid peroxide levels in meditators (14). However, by far the most impressive evidence in favour of the mind-body relationship, which meditation exploits for securing health-related benefits, has come from psychoneuroimmunology (15).

Assessment of the subjective well being and anxiety levels after a brief lifestyle modification educational program based on the principles of yoga showed improvement of both the parameters in two separate studies (16, 17). A separate study conducted on 38 patients revealed that the intervention was effective in reducing the state anxiety in males but anxiety as a trait was more effectively reduced in females (18). With the same lifestyle intervention, serum lipids and fasting plasma glucose levels were found to be improved in ninety-eight subjects (19). These studies suggest that a yoga-based short educational programme positively modifies the people's subjective well being and anxiety levels. Psychological stress is an important risk factor for many diseases (20–22) and thus above mentioned improvements appear to be valuable in terms of primary prevention.

Murphy and Donovan (23) have reviewed extensively the behavioral effects of various types of meditation. Perceptual and cognitive abilities, concentration, attention, memory, creativity, comprehension and empathy have been shown to improve with meditation practice. A review on studies on yoga as a therapeutic intervention has been published evaluating the psychophysiological effects (24). These studies are mostly based on a variety of meditation techniques other than mindfulness meditation which is more common in Buddhist meditation.

According to Buddhist view meditation influences emotion and cognition, processes that cannot be separated. Every region in the brain that has been identified with some aspect of emotion has also been identified with certain aspects of cognition (25). The circuitry that supports affect and the circuitry that supports cognition are completely intertwined—an anatomical arrangement consistent with Buddhist view. For achieving enduring happiness Buddhists and psychologists alike believe that emotions strongly influence people's thoughts, words, and actions and that, at times, they help people in their pursuit of transient pleasures and satisfaction. From a Buddhist perspective, however, some emotions are conducive to genuine and enduring happiness and others are not. Buddhist practices themselves offer a therapy, not just for the disturbed, but for all who seek to improve the quality of their lives (26)

Lutz et al (27) conducted a study on eight long-term Buddhist practitioners (with 10,000 to 50,000 hours of meditation experience over time periods ranging from 15 to 40 years) and 10 healthy student volunteers who underwent meditative training for 1 week. High-amplitude gamma-

band oscillations and phase-synchrony during meditation was obtained in long-term Buddhist practitioners. These electroencephalogram patterns differed from those of controls, in particular over lateral fronto parietal electrodes. In addition, the ratio of gamma-band activity (25–42 Hz) to slow oscillatory activity (4–13 Hz) was initially higher in the resting baseline before meditation for the practitioners than the controls over medial fronto parietal electrodes. This difference increased sharply during meditation over most of the scalp electrodes and remained higher than the initial baseline in the post meditation baseline. These data suggest that mental training involves temporal integrative mechanisms and may induce short-term and long-term neural changes.

Several studies have found an increase in slow alpha or theta rhythms during meditation. The comparison is limited by the fact that these studies typically did not analyze fast rhythms. More importantly, these studies mainly investigated different forms of voluntary concentrative meditation. These concentration techniques can be seen as a particular form of top-down control that may exhibit an important slow oscillatory component. Various meditative states (those that involve focus on an object and those that are objectless) may be associated with different EEC oscillatory signatures. The high-amplitude gamma activity found in some of these practitioners is, the highest reported in the literature in a nonpathological context. Assuming that the amplitude of the gamma oscillation is related to the size of the oscillating neural population and the degree of precision with which cells oscillate, these data suggest that massive distributed neural assemblies are synchronized with a high temporal precision in the fast frequencies during this state. This gradual increase also corroborates the Buddhist subjects' verbal report of the chronometry of their practice. Typically, the transition from the neutral state to this meditative state is not immediate and requires 5–15 s, depending on the subject. The endogenous gamma-band synchrony reflects a change in the quality of moment-to-moment awareness, as claimed by the Buddhist practitioners and as postulated by many models of consciousness. In addition to the meditation-induced effects, a difference in the normative EEG spectral profile between the two populations was found during the resting state before meditation. It is not unexpected that such differences would be detected during a resting baseline, because the goal of meditation practice is to transform the baseline state and to diminish the distinction between formal meditation practice and everyday life. The differences in baseline activity suggest that the resting state of the brain may be altered by long-term meditative practice.

This study is consistent with the idea that attention and affective processes, which gamma-band EEG synchronization may reflect, are flexible skills that can be trained. It remains for future studies to show that these EEG signatures are caused by long-term training itself and not by individual differences before the training, although the positive correlation that was found with hours of training and other randomized controlled trials suggest that these are training-related effects. The functional consequences of sustained gamma-activity

during mental practice are not currently known but need to be studied in the future. The study of experts in mental training may offer a promising research strategy to investigate high-order cognitive and affective processes.

In a randomized control study alterations in brain and immune function produced by mindfulness meditation were examined (28). Effects on brain and immune function of 8-week clinical training program in mindfulness meditation applied in a work environment with healthy employees was done in an experimental and a wait listed control group. EEG was measured before and immediately after, and then 4 months after an 8-week training program in mindfulness meditation. At the end of the 8-week period, subjects in both groups were vaccinated with influenza vaccine. For the first time a significant increases in left-sided anterior activation, a pattern previously associated with positive affect, in the meditators compared with the nonmeditators was demonstrated. The asymmetries reflect both state and trait components (28, 29) with both phasic positive mood as well as dispositional positive affect associated with greater relative left-sided anterior activation. On the basis of an extensive corpus of both animal and human data, Davidson and colleagues suggested that prefrontal activation asymmetries are plastic and could be shaped by training (29). On the basis of a growing literature on the neural bases of emotion regulation it has been suggested that left-sided anterior activation is associated with more adaptive responding to negative and/or stressful events. Specifically, individuals with greater left-sided activation have been found to show faster recovery after a negative provocation. A significant increase in antibody liters to influenza vaccine among subjects in the meditation compared with those in the wait-list control group was found. Also, the magnitude of increase in left-sided activation predicted the magnitude of antibody titer rise to the vaccine. These findings demonstrate that a short program in mindfulness meditation produces demonstrable effects on brain and immune function. These findings suggest that meditation may reduce anxiety and negative affect and increase positive affect.

How meditation works

Some of the facts and speculations on the influence of yoga on brain and behavior have been discussed in a guest editorial earlier (30). A decade ago the dogma in neuroscience was that the brain contained all its neurons at birth and it was unchanged by life's experiences. The only change that occurred over the course of life was alterations in synaptic contacts and cell death with aging. But the new watchword in neuroscience is *neuroplasticity*, the notion that the brain continually changes as a result of our experiences-whether through fresh connections between neurons or through the generation of new neurons. Musical training, where a musician practices an instrument for every day for years, offers an apt model for neuroplasticity. MRI studies find that in a violinist, for example, the areas of the brain that control finger movement in the hands that does the fingering grow in size. Those who start their training earlier in life and practice longer show bigger changes in the brain. Presumably a similar effect by practice occurs in meditation, which can be seen,

from the perspective of cognitive science as the systematic effort to retrain the related mental and emotional skills (30).

Despite the popularity of meditation, little is known about the physiological pathways and biological structures involved. Trust, belief and other subjective or more general factors may play a role (31–33). Thus, the role of belief, emotions, and limbic activation is of interest. Belief has an emotional component in that the brain motivation and reward circuitry- linked to the limbic system – is reinforced with a positive emotional valence attached to the believed in person, idea, or thing. This emotionalized memory, potentially accompanied by 'somatic markers' (bodily sensations that may escort an emotion), sets the 'feeling tone', i.e., it strongly influences what 'feels right' to a person (34). Furthermore, emotion may reinforce a belief and trigger positive physiological reactions even 'against' rationality (35). Thus, belief in regard to a doctor or a therapy (e.g., meditation) may stimulate naturally occurring 'healthy' processes (34). These subjective processes may particularly involve limbic structures, i.e., 'remembered wellnes (34). Belief and expectation are crucial components of acupuncture, massage, meditation and music therapy treatment. When patients actively participate in their treatment, i.e., positively anticipate clinical effects, the chosen therapy presumably is more effective (33). It is well know that subjects who show interest in learning meditation are better benefited by it (33).

Relaxation response: An elemental physiological phenomenon called the 'relaxation response' (RR) has been shown to produce changes similar to meditation. It is an innate physiological response that is the opposite of the stress response (34). The RR has the potential to be elicited actively, i.e., consciously (in humans), not only automatically, but by the use of various techniques such as repetitive imagination or verbalization of a word, prayer, phrase, or even repetitive muscular activity, progressive muscle relaxation, meditation, yoga and other methods (36). With regard to the CNS, the RR activates areas in the brain responsible for emotion, attention, motivation, and memory (e.g., anterior cingulate, hippocampal formation, amygdala) and may also serve the control of the autonomic nervous system (37–39). Improvement of concentration and cognitive function, e.g., memory (33, 40) may be due to hippocampal/limbic activation, including reward or motivation circuitry involvement (34). The anxiolytic effects of the RR may occur by promotion of an inhibitory (GABAergic) tone in specific areas of the brain (41). As already mentioned meditation has been shown to increase left-sided anterior activation of the brain, a pattern that is associated with positive affect (28). Again, positive emotion-related brain activity is a substantial part of the CNS reward circuitry, and the frontal regions of the brain not only are involved in RR pathways, but also exhibit a specialization for certain forms of positive and negative emotion (25). Interestingly, reliable increases in left-sided activation are observable with meditation training in response to both the positive and negative affect induction (28, 29). Specifically, individuals with greater left sided anterior activation have been found to show faster recovery after a negative provocation (29).

Increases in regional cerebral blood flow (i.e., brain activity) following or coming along with meditation have been detected, for example, in the dorsolateral prefrontal cortex, inferior or orbital frontal cortices/ anterior regions, inferior parietal lobes, pre- and postcentral gyri, temporal lobes, cingulate gyrus, hippocampus and para hippocampus, amygdala, globus pallidus/ striatum, thalamus, and the cerebellar vermis (38, 39, 42, 43). Several studies demonstrated an inverse correlation between the dorsolateral prefrontal and the ipsilateral superior parietal lobe blood flow change. This correlation may reflect an altered sense of space experienced during meditation (39, 42). Clearly, meditation is a complex phenomenon that involves several coordinated cognitive processes and autonomic nervous system alterations. Further, belief affects mesocortical-mesolimbic appraisal of an experience, leaving one, for example, well and relaxed. Yet, trust or belief in a therapy/therapist may facilitate positive affect, sense of well-being, and motivation, thereby involving limbic/reward circuitry activation, possibly leading to relaxation (i.e., elicitation of the RR) or initiating beneficial placebo response (34). Focus on emotion-related brain activity is important because meditation has been found in numerous studies to reduce anxiety and increase positive affect (16, 17, 44–48).

Thus we believe that reasonable evidence indeed exists for the use of meditation to promote well-being. Scientific studies are available demonstrating the beneficial effects of meditation; a few of them tell us about changes that are potentially more enduring. The long lasting effects of meditation are probably what we are looking for improving the well-being. An understanding of the neural circuitry underlying emotions, cognitive behavior, negative and positive psychological processes will definitely help scientists to explore the evidence we are seeking for the effectiveness of traditional practices like meditation. However, Bernie Siegel (49) has stated *“science teaches us that we must see in order to believe, but we must also believe in order to see. We must be receptive to possibilities that science has not yet grasped, or we will miss them. It is absurd not to use treatments that work, just because we don’t yet understand them”*. Therefore while the scientific studies on how meditation brings about the positive effects continues, it should be used as an effective therapy to reduce or prevent the incidence of stress related disorders and psychopathology while improving the quality of life and mental well-being.

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