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## **The Importance of Brainwave Coherence in Education Achieved through a Mind-Body Intervention: Evidence-based Findings on Transcendental Meditation Focusing on the EEG Brain Integration Scale, Health, and Epigenetics**

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### **ABSTRACT**

Mind-body interventions have been used extensively to improve health, especially methods that reduce stress and promote brain development. Some of these techniques alter gene expression and promote epigenetic change. In education particularly, the Transcendental Meditation (TM) technique has been applied all over the world to achieve these purposes. The TM program is used for developing the total potential of consciousness, leading to improved brainwave coherence. The TM program has been found to improve scores on the Brain Integration Scale, reduce stress, improve health, and to produce epigenetic changes that promote a long, healthy life.

### **INTRODUCTION**

In a holistic educational system, one should consider all factors involved in the teaching-learning ecosystem. The factors are not only the “object of knowing” and the “process of knowing” but also the “knower.” In most educational systems, the “object of knowing” (instruction paradigm—curricula and measurement standards such as tests) and the “process of knowing” (learning paradigm—using certain methods, such as reading, listening, and experimenting) are emphasized. The most important part, the “knower” (developing consciousness paradigm—developing the student’s and the teacher’s total brain potential) has been forgotten. In the recent past, the educational system has lacked a way of preparing the knower for maximum learning. The “soft skills” of handling the impact of psychosocial stress, fatigue, academic competitiveness, and teacher absenteeism are not emphasized in the learning experience.

The “knower” refers to the quality of the individual’s awareness—how alert or awake they are. By systematically developing the subjective basis of knowledge, which is consciousness, the knower will more fully realize their inner potential. In short, a technique is needed to develop inner potential, as indicated, for example, by EEG coherence measures of brain functioning.

### **What is EEG coherence?**

The human brain is a complex network of fiber tracts that are entangled through synchronized electric brain activity. The synchronized network in the brain can be detected by electroencephalographic (EEG) monitoring devices and imaged using a network connectivity analysis. The EEG measurement identifies wavelengths of brainwaves. The phase coherence or synchrony is a way of quantifying the correlation of frequency and amplitude of neuronal patterns of activity in different brain areas [1]. Highly coherent brainwaves indicate that every part of the brain is working in synchrony. It is like the synchrony of a symphony orchestra. Or



it is like a business meeting that engages all the members (the president, the vice presidents, the managers, and the technicians) on a common basis of agreement and calmness, while the cleaning services are doing their role proportionally, next door, maintaining their steadiness knowing that their bosses are in an important meeting for the sake of a better life for everyone. If this harmony is applied in the field of exercise, it is yoga as opposed to “body pump.” So again, coherence is the correlation among areas of the brain compared at a given frequency across time. Coherence scores range from 0 (no coherence) to 1.0 (perfect coherence). Brainwave coherence is therefore an accurate measure of the degree of orderliness of interaction between brain regions. It indicates how different brain functions are unified moment by moment to support the quality of our thinking.

### **Why is brainwave coherence important?**

Higher coherence, as measured in a number of scientific studies, is associated with more integrated and effective thinking and behavior, including greater intelligence, creativity, learning ability, emotional stability, ethical and moral reasoning, and self-confidence, as well as reduced anxiety [2]. In recent years, Travis et al (2002)[3] have developed a scale to measure brain integration which he has called the “Brain Integration Scale” (BIS). The BIS is a scale related to the interdependence of integrative experiences, brain executive functioning, and sense of self in various subject populations. The BIS includes EEG frontal coherence, and thus also reflects structural and functional connectivity between brain areas [3], which can be correlated with emotional stability, moral reasoning, and inner directedness. It is reported that top olympic athletes, world-class musicians, and top managers and leaders have higher BIS scores [4-6]. Wenuganen et al. found a lower BIS in average older people (in preparation).

### **Is there a technique to achieve higher brain coherence?**

Researchers have found that higher brain coherence can be achieved by mind-body interventions. The most documented research in this area involves the Transcendental Meditation (TM) technique or program of practice. The Transcendental Meditation technique is a simple, natural process. It is not a religion or a religious practice, and it requires no change in spiritual practices, lifestyles, habits, or beliefs. The technique was brought to light by Maharishi Mahesh Yogi. Millions of people around the world, of all cultures and backgrounds, have learned and continue to practice this meditation technique as part of their daily routine.

During practice of the technique, mental activity settles down in a natural way and transcends the thinking process and emotional contents of the mind. People who practice the technique report experiencing a state of “unboundedness,” which is indicated by the loss of time, space, and body sense, while alertness is maintained and may be enhanced [7]. This subjective experience appears to give rise to a different physiological state, compared to the waking, sleeping and dreaming states [7-9]. Through the routine, twice-daily practice of this technique, a new style of mental and physiological functioning is cultured in which the transcendental state comes to coexist with the waking and sleeping states [10]. The experience of the transcendental state gives an EEG signature corresponding to a state of “restful



alertness” and is commonly experienced during TM practice. Research shows that regular practice of the TM technique leads to long-term changes in brain function, as seen in meditators who experience this restful alertness throughout their daily activity. These people display the EEG signature of restful alertness even outside of their TM practice. The growing presence of brainwave coherence throughout the day is directly correlated with healthier, more integrated brain functioning. The restful alertness state has the ability to release deep rooted stress and to a healthier functioning of the hypothalamic-pituitary-adrenal axis of hormone regulation. In turn, this experience regulates gene expression, including genes in the NF- $\kappa$ B pathway, which affect, organ functioning, including the brain (Wenuganen et al., in preparation).

### **Research relating TM practice to cognition, stress, health, and gene expression/epigenetic regulation**

The Transcendental Meditation program is the most extensively validated program of personal development in the world. It has been the subject of more than 600 scientific research studies, conducted at more than 250 universities and research institutions in more than 30 countries worldwide. These studies have been published in more than 150 scientific and scholarly journals covering a broad range of topics, including neurocognitive functions, stress, general health, and gene expression.

Research has shown that the TM technique cultures the brain to behave more coherently and efficiently over time, as seen in a person’s improved response to stimuli—with better performance on spatial tasks, memory tasks, creativity scores and reaction time tests. Such global improvements are not reported for other meditation practices. The development of brain functioning includes: increases in the BIS; greater integration of diverse styles of brain functioning [5]; longitudinal increase in the BIS [4]; correlations of greater coherence of brain functioning with enhanced cognitive abilities, such as higher moral reasoning, improved mind-body integration, increased concept learning, increased emotional stability, higher grade point average, and increased creativity [2 5 11]. Many of the qualities found to improve were thought to stop developing in adolescence, such as intelligence, ego development, and field independence [12-14].

### **Reduced stress and improved health**

Currently, the Transcendental Meditation program is one of the most extensively investigated programs for stress reduction, including evidence for reversal-of-aging effects [15-18]. The TM program reduces effects of chronic psychosocial stress, such as elevated basal cortisol level and high blood pressure, in as little as 3-4 months after beginning the practice [19-21]. Such effects apparently derive from a reduction of stress-related alterations in adaptive mechanisms and are likely responsible for the large range of physical, mental, and behavioral improvements reported (e.g. [22-26]). In general, evidence for the long term effects of the TM technique on stress mechanisms indicates these effects are opposite to those caused by chronic stress [17 19 27]. Studies have reported lower levels of oxidative stress, for example, as indicated by lower serum lipid peroxide in a cohort of older, long-term



practitioners of the TM technique compared with matched controls [28] and reduced ultraweak photon emission in a TM practitioners, an indication of reduced free radicals and pro-inflammatory states of patients [29 30].

The Transcendental Meditation technique has been reported to balance many physiological functions and psychological states in the body. Greater physiological balance may be reflected in the reduction of a variety of important risk factors for disease, including reduction of high blood pressure, improved cardiovascular efficiency, improved flow of cerebral blood, improved homeostatic recovery, reduced cardiovascular disease, increased relief from asthma, and reduced insomnia [31-33]. In the psychological field, many beneficial changes have been reported, such as reduced depression, improved sleep efficiency, improved quality of sleep, reduced psychological stress levels [34-36], and reduced anxiety, depression, and hostility [25 37 38].

### **Improved global gene expression and epigenetics**

Recently, Buric et al.2017 [39] concluded, from their review of studies analyzing gene expression of people using mind-body interventions, that the common outcome was down-regulation of *NF-κB*-targeted genes and may reflect a reversal of the molecular signature of chronic stress. There is evidence for a “conserved transcriptional response to adversity (CTRA),” that accompanies chronic or extreme stress [40]. This response involves up-regulation of pro-inflammatory genes and down-regulation of antiviral and antibody components of the defense response [41]. Current studies by Wenuganen et al (2017, in preparation) report results consistent with this conclusion and may further indicate a reduction of both components of the CTRA. Also the TM program group showed an anti-aging effect, as evidenced by a gene expression pattern in an older TM group that more closely resembled that of a young non-TM group than it did an older non-TM group. Another study [42] indicated increased expression of the telomerase genes, *hTERT* and *hTR* in hypertensive patients, suggesting a greater ability to improve the epigenetic regulation.

## **CONCLUSION**

In education, it is essential to emphasize the knower or consciousness aspect. Therefore, a mind-body intervention is needed to develop full brain potential by bringing stress-free individuals and a stress-free environment. Such an intervention can improve gene expression to foster healthier people. A scientifically-verified, mind-body intervention, the Transcendental Meditation technique, is offered to everyone to achieve this goal.

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