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Effect of meditation on psychological distress and brain functioning: A randomized controlled study

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ABSTRACT

Background: Psychological stability and brain integration are important factors related to physical and mental health and organization effectiveness. This study tested whether a mind-body technique, the Transcendental Meditation (TM) program could increase EEG brain integration and positive affect, and decrease psychological distress in government employees.

Method: Ninety-six central office administrators and staff at the San Francisco Unified School District were randomly assigned to either immediate start of the TM program or to a wait-list control group. At baseline and four-month posttest, participants completed an online version of the Profile of Mood States questionnaire (POMS). In addition, a subset of this population (N = 79) had their EEG recorded at baseline and at four-month posttest to calculate Brain Integration Scale (BIS) scores.

Results: At posttest, TM participants significantly decreased on the POMS Total Mood Disturbance and anxiety, anger, depression, fatigue, and confusion subscales, and significantly increased in the POMS vigor subscale. TM participants in the EEG-subgroup also significantly increased in BIS scores. Compliance with meditation practice was high (93%).

Conclusion: Findings indicate the feasibility and effectiveness of implementing the TM program to improve brain integration and positive affect and reduce psychological distress in government administrators and staff.

1. Introduction

According to the World Health Organization (WHO) psychological stress is one of the most common occupational health problems affecting workers worldwide (World Health Organization, 2013). Psychological stress adversely affects organizational commitment and work engagement and productivity, as well as contributing to poor mental and physical health (Muse, Harris, & Field, 2003).

The impact of self-development and mind-body programs such as the practice of meditation recently has been studied in the fields of health and management. One such program that has received wide attention is the Transcendental Meditation® (TM®) program,[1] a neuropsychological technique for mind-body integration. TM is a traditional form of meditation described as an "automatic self-transcending technique, which produces a unique state of brain integration" (Travis & Shear, 2010).

Transcendental Meditation practice is reported to decrease effects of stressful experiences. TM practice is characterized by (1) lower sympathetic tone (Dillbeck & Orme-Johnson, 1987); (2) higher parasympathetic tone (Travis, 2001); and (3) higher levels of frontal EEG coherence (Dillbeck & Bronson, 1981; Travis et al., 2010) and higher frontal-parietal phase synchrony (Hebert, Lehman, Tan, Travis, & Arenander, 2005). Simultaneous recording of EEG and MEG during TM practice reported that higher frontal and central alpha EEG activity is associated with MEG source location in medial frontal and anterior cingulate cortices (Yamamoto, Kitamura, Yamada, Nakashima, & Kuroda, 2006).

A meta-analysis of 141 studies reported larger effect sizes for reduction of anxiety through Transcendental Meditation practice compared to other traditional meditation and clinical relaxation responses

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(Eppley, Abrams, & Shear, 1989). A recent meta-analysis reported similar large decreases in anxiety in 16 random assignment studies (Orme-Johnson & Barnes, 2013).

Transcendental Meditation practice also changes brain patterns during challenging cognitive tasks. In a previous study, (Travis, Tecce, Arenander, & Wallace, 2002) nine brain measures derived from EEG recorded during simple and choice paired reaction time tasks were entered in a multiple discriminate analysis to distinguish non-TM, short-term (7.1 yrs TM) and long-term TM subjects (24.2 yrs TM). The EEG-derived measures included inter- and intra-hemispheric coherence, absolute and relative power, power ratios, and contingent negative variation (CNV) calculated during simple and choice reaction time tasks. CNV reflects brain processes as a subject prepares to respond to an expected stimulus (Tecce, 1972). Of these nine brain measures, three significantly differentiated the three groups: (1) higher frontal (F3-F4) coherence averaged across 8–50 Hz, (2) higher 6–12 Hz frontal, central and parietal power, and (3) frontal, central and parietal CNV measured during the simple reaction time test minus CNV measured during the choice reaction time test. These empirically identified measures were converted to z-scores and combined to form the Brain Integration Scale (BIS) (Travis, et al., 2002). This name was selected because coherence, which reflects the level of connectivity between brain areas (Thatcher, Krause, & Hrybyk, 1986) was the first variable entered in the multiple discriminate analysis.

BIS scores positively correlate with emotional stability, moral reasoning, and inner directedness, and negatively correlate with anxiety (Travis, Arenander, & DuBois, 2004). Also, BIS scores were significantly higher in professional athletes who won gold medals in Olympic and National games, compared to professional athletes who did not consistently place (Harung et al., 2011), and in top-level managers compared to middle-level managers. (Harung & Travis, 2012). High scores on the BIS were also reported to positively correlate with faster conflict resolution on the Stroop color-word test, faster detection times on a P300 odd ball task, and higher levels of creativity in Swedish product development engineers (Travis & Lagrosen, 2014).

Research on TM over the past 45 years has shown that practitioners achieve a high level of brain integration both during and after practice (Dillbeck & Bronson, 1981; Travis et al., 2010). In randomized controlled research, increased structural and functional connectivity between brain areas and decreased reactivity to stress was observed in those practicing the TM technique compared to controls (Travis et al., 2009). Thus, the Brain Integration Scale appears to reflect brain patterns important for success in different areas of life.

The study hypotheses were that subjects randomly assigned to learn the Transcendental Meditation technique, compared to control subjects, would show increased brain integration and decreased psychological distress.

2. Material and methods

2.1. Participants

Participants for the study were recruited from Fall 2009 through Spring 2010 from supervisors and administrative staff working in the central offices of the San Francisco Unified School District (SFUSD) who were interested in being part of a workplace wellness program. Interested participants were asked to attend an informational meeting to learn about the wellness project. Those who wanted to be part of the study were then scheduled for baseline testing. This research has been carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki). Institutional Review Board (IRB) approval was given on August 31, 2009 by the Maharishi University of Management IRB prior to the start of the study.

Inclusion criteria included: 18 years or older, an employee of SFUSD, attendance at an informational meeting on the TM program, and willingness to be randomly assigned to either active treatment or control group. Exclusion criteria included having already learned Transcendental Meditation, and not being available to attend treatment and testing sessions.

Ninety-six supervisors and administrative staff completed written informed consent, followed by baseline testing on an online version of the Profile of Mood States (POMS). Subjects were also offered the opportunity to have their EEG recorded as part of the study.

Subjects completed the POMS online at their convenience. However, the EEG recording was done individually and took 1 to 1½ h plus travel time. Thus, while 96 subjects completed the POMS, 17 subjects were not able to find the extra time for the EEG recording. This resulted in 79 subjects in the EEG-subgroup.

After the baseline recordings of all measures, the subjects were randomly assigned to either immediate start of the TM program (n = 48) or to a delayed start wait-list control group (n = 48). In the EEG subgroup, this resulted in 38 TM Ss and 41 wait list controls.

2.2. Intervention: the transcendental meditation technique

The Transcendental Meditation technique is a mental technique practiced 15–20 min, twice a day sitting comfortably. Transcendental Meditation practice involves a mantra. However, unlike most mantra meditations, the mantras used during Transcendental Meditation practice are meaningless. Also, unlike most mantra meditations, the Transcendental Meditation technique is not a process of concentration—keeping the mantra in awareness or continued mental rehearsal of the mantra. Rather, Transcendental Meditation practice is a process of effortless transcending—using the mantra as a vehicle to take attention from the ordinary thinking level to the least excited state of consciousness—consciousness without content called pure consciousness (Maharishi Mahesh Yogi, 1969; Travis & Pearson, 2000). (see (Travis et al., 2002) and (Travis & Parim, 2017) for a discussion of the concept of effortless transcending.)

The Transcendental Meditation technique was learned in a standardized seven-step course (over 5 sessions): an introductory and preparatory lecture and personal interview (session one), and four consecutive days of instruction (sessions two to five)—1½ h each session (Roth, 2002). The four days of instruction include individual instruction followed by three group meetings. After the initial instruction, students came in individually for verification of correctness of their meditation practice once a month throughout the study. Also, weekly knowledge meetings were available to discuss experiences during meditation practice, application of TM practice to different areas of life, or scientific research on meditation effects.

2.3. Outcome measures

2.3.1. Brain integration scale

The BIS score included the three EEG measures used in the 2002 study. However, there were small changes to these measures. Broadband frontal (F3-F4) coherence calculated during the choice reaction time task which was used in the original study was also used in this study. CNV difference scores were calculated ($CNV_{simple} - CNV_{choice}$), but CNV was averaged from Fz, and C3, Cz and C4 sensors rather than nine frontal, central and parietal sensors. This scalp distribution better fits the topography of the CNV. Frontal, central and parietal alpha relative power was the third factor. Alpha relative power is the EEG power in the alpha frequency divided by the total power. This controls for individuals who may have very high or very low EEG power overall. These changes in the BIS calculation evolved in the process of applying the BIS across different subject populations.

2.3.2. Profile of Mood States (POMS)

Psychological distress was measured with the online version of the Profile of Mood States. This instrument yields a score for total mood disturbance and subscale scores for tension/anxiety, depression/

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