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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/

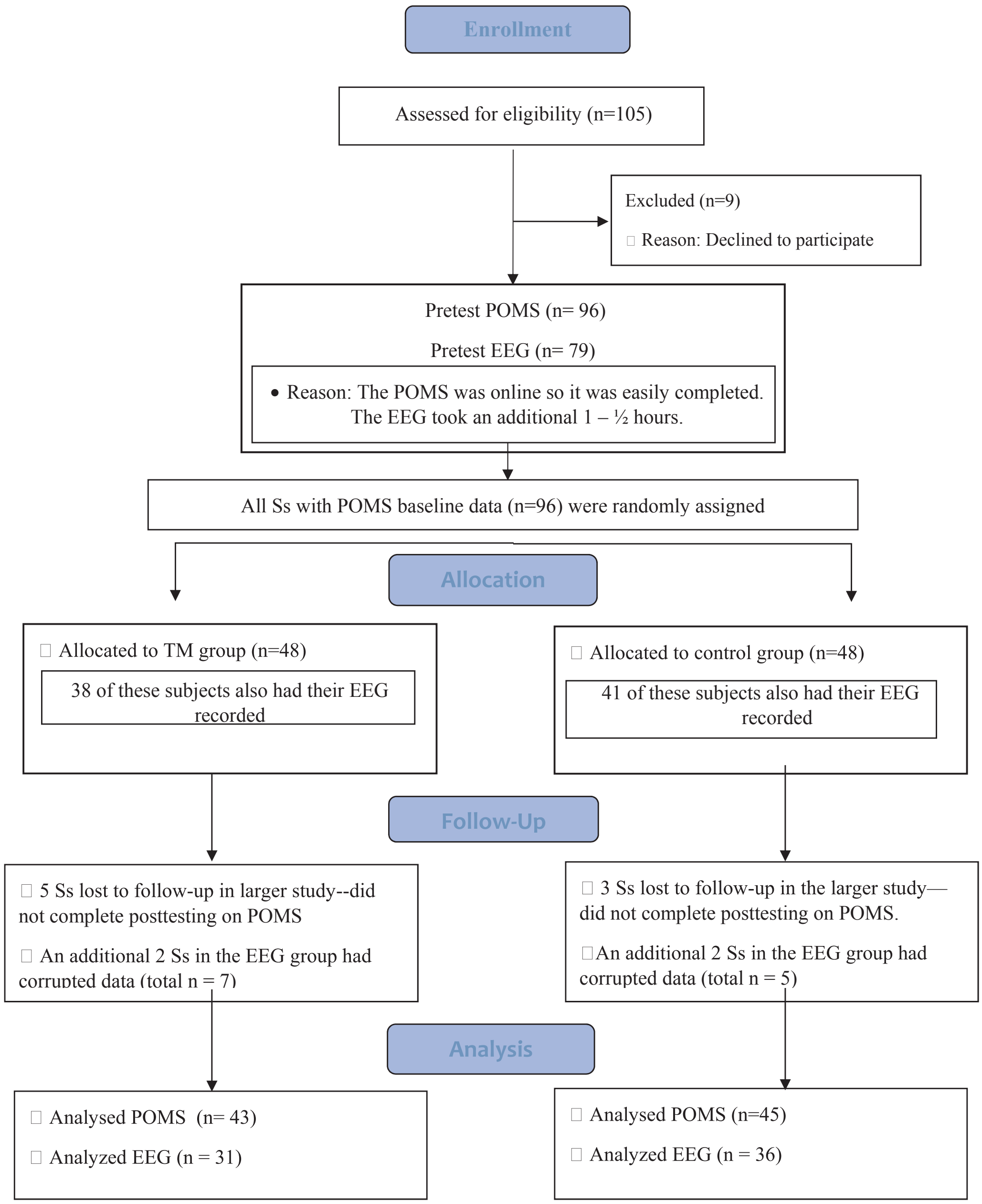

Fig. 1. Consolidated standards of reporting trials (CONSORT) flow diagram.

dejection, and anger/hostility subscales. The POMS was scored by the Multi-Health Systems, the publishers of the POMS. The Total Mood Disturbance composite, and subscale scores for each subject were then electronically transmitted to the research staff for inclusion in the project database (McNair, Lorr, & Droppleman, 1971). Internal consistency coefficients range from 0.90 to 0.95 (McNair et al., 1971).

2.4. Procedure

Subjects first completed the online POMS questionnaire and then had their EEG recorded. Participants came individually for their EEG recording to a room in the San Francisco administrative offices that had been set up with the equipment necessary to record EEG. During EEG recording, active-sensors were applied in the 10–10 system with a forehead ground, and sensors on the left and right earlobe for re-referencing offline. EEG was recorded with the BIOSEMI ActiveTwo System (www.BIOSEMI.COM). All signals were digitized on line at 256 points/s, with no high or low frequency filters, and stored for later analyses using Brain Vision Analyzer. Data collection and data analysis were conducted blind to group membership.

Following pretest recordings on all measures, the 96 subjects were randomized to either the TM program or wait-list control groups. Subjects were post-tested at four months.

2.4.1. EEG recording: Paired reaction time tasks

EEG was recorded during two reaction time tasks. The first reaction-time task contained 16 paired simple reaction-time trials that lasted for 2-min. Each trial included a warning asterisk (150 ms duration, 1 cm in height) in the center of a computer screen, followed 1.5 s later by a continuous computer-generated tone (1200 Hz, 85 dB). Subjects were asked to press the button in their right hand as soon as they heard the tone.

The second reaction-time task contained 24 paired choice reaction time trials that lasted for 4-min. Each trial included a one or two-digit number (150 ms duration, 1 cm in height), a 1.5-s blank screen, and then another one- or two-digit number (150 ms duration, 1 cm in height), and were asked to press a left- or right-hand button to indicate which number was larger in value.

2.5. Data analysis: EEG

2.5.1. Coherence and power

Coherence and power were calculated from the EEG recorded during the choice reaction-time task, which loads perceptual, cognitive, and response systems and so should accentuate any group differences. Mathematically, coherence reflects the similarity of electrical activity from different parts of the brain.

The data during the choice reaction-time task was visually scanned, and any epochs with movement of body, electrode, or eye artifacts were manually marked and not included in the spectral analyses. The artifact-free data were digitally filtered with a 2–45 Hz band pass filter, and fast Fourier transformed in 2-s epochs, using a Hanning window with a 20% onset and offset. Coherence was calculated in 0.5 Hz bins. Frontal coherence (F3–F4) was averaged from 8 to 45 Hz. EEG power (uV^2/Hz) was calculated for the 32 recording sites. Relative alpha power (8–12 Hz) was averaged at frontal, central and parietal sites.

2.5.2. Contingent negative variation

Artifacts were visually marked and removed from the spectral analyses. The artifact-free data were digitally filtered with a 0.01–6 Hz band pass filter and averaged. The 200 ms before the second stimuli, the late CNV, was averaged during both reaction-time tasks and the CNV difference-score calculated. A better match between task demands and CNV would be indicated by higher CNV during the simple reaction time task, since the correct answer is clear after the first stimuli, and lower CNV during the choice reaction time tasks, since the participant needed more information before responding—i.e. the 2nd number.

2.5.3. Brain integration scale calculation

Frontal coherence, frontal, central and parietal relative alpha power, and the frontal and central simple/choice difference scores were converted to z-scores, compared to the normative database and summed to yield a single value for each person tested (Travis et al., 2002).

2.6. Statistical analyses

Analysis of covariance (ANCOVA) of BIS change scores covarying for the baseline BIS scores was used to test differences on the BIS. MANCOVA of changes on the POMS subscales covarying for the baseline POMS subscales was used to test differences on the POMS. Effect sizes were calculated with Cohen's *d* (mean difference between groups divided by pooled standard deviation at baseline). For the primary outcome, BIS scores, significance was set at $p < .05$, two-tailed; for all secondary outcomes significance was set at $p < .01$ to compensate for multiple measures.

Fig. 1 presents the Consolidated Standards of Reporting Trials (CONSORT) Flow Diagram for the design of this study. Random assignment was applied to all S's with POMS baseline data, regardless of whether they also had EEG data.

3. Results

3.1. Baseline data

There were no differences in age, gender proportion, and POMS baseline scores in the 88 subjects who completed both the pretest and posttest on the POMS, or in the age, gender proportions and BIS scores in the 69 subjects who had both pretest and posttest EEG recordings. Table 1 presents the baseline data for these subjects.

Table 1
Mean Baseline Scores for demographics and scores on the POMS subscales (all subjects) and the BIS (subset of all subjects).

Variable	Control	Transcendental meditation	P-value
N = 88: Completed pretest and posttest POMS			
Age	45.5 ± 9.5	45.8 ± 11.2	.885
Gender (% female)	82%	80%	.871
POMS: Total Mood Disturbance	19.0 ± 25.0	27.4 ± 23.6	.117
Anxiety	9.1 ± 5.5	10.8 ± 5.4	.147
Anger	5.9 ± 4.9	8.1 ± 7.3	.104
Depression	6.8 ± 6.0	9.4 ± 7.9	.076
Fatigue	8.4 ± 6.4	8.6 ± 5.6	.073
Vigor	16.7 ± 6.1	14.6 ± 6.2	.110
Confusion	6.5 ± 3.7	7.1 ± 4.0	.478
N = 69: Completed pretest and posttest BIS as well as POMS			
Age	46.6 ± 9.8	45.5 ± 10.7	.658
Gender (% female)	80%	81%	.821
Brain integration scale	1.5 ± 1.1	1.3 ± 1.2	.821

Note: *Mean ± SD, POMS = Profile of Mood States.

3.2. Outcomes

Eighty-eight participants (92%) completed posttest POMS (TM, *n* = 43 and WL, *n* = 45). In the EEG subgroup, 69 of 79 (88%) who were tested at baseline on the BIS completed posttest EEG evaluation (TM, *n* = 37 and WL, *n* = 32).

An ANCOVA of BIS change scores covarying for baseline scores showed a significant main effect for TM compared to controls on the BIS ($F(1, 66) = 4.22$, $p = .044$). A MANCOVA with POMS change scores covarying for baseline scores showed a significant main effect for TM compared to controls (Wilks lambda = .725 ($F(7, 72) = 3.9$, $p = .001$). Adjusted mean scores, p-values and effect size for the BIS (N = 69) and POMS sub scales (N = 88) are presented in Table 2.

3.2.1. Effect of gender imbalance

Gender was added as a dummy variable in the analyses of BIS and POMS change scores. There were no significant interactions between gender and BIS scores ($F(1, 66) = 1.6$, $p = 0.21$) or with the POMS subscales (all $F(1, 83) < 2.0$, and $p > 0.20$). Thus, the unequal gender proportion in this research did not appear to affect these findings.

3.2.2. Correlation of POMS and BIS change scores

A Pearson correlation was conducted on the POMS and BIS change scores. The correlation matrix is presented in Table 3. Changes in the POMS subscales all positively and significantly correlated with each other. Changes in BIS negatively correlated with the changes in the

Table 2
Adjusted mean change scores by group.

Variable	Control	Transcendental meditation	P-value	Effect size
N = 69				
BIS	−0.07 ± 0.17	0.44 ± 0.18	0.04	0.30
N = 88				
POMS TMD	3.00 ± 2.47	−11.65 ± 2.53	< 0.0001	0.91
Anxiety	0.05 ± 0.80	−4.17 ± 0.82	< 0.001	0.74
Anger	0.63 ± 0.79	−2.94 ± 8.11	0.002	0.58
Depression	2.31 ± 1.63	−4.54 ± 1.19	< 0.001	0.96
Fatigue	−0.01 ± 0.73	−4.03 ± 0.75	< 0.001	0.67
Vigor	−0.61 ± 0.64	4.27 ± 0.66	< 0.001	0.79
Confusion	0.83 ± 0.60	−2.87 ± 0.61	< 0.001	0.99

Note: Adjusted mean scores ± standard error; BIS = Brain Integration Scale; POMS TMD = profile of mood states total mood disturbance; Effect size = Cohen's *d*.

Table 3
Correlation table of change scores for the POMS subscales and BIS for all subjects with complete data at pre- and post-tests (N = 69).

		BIS	POMS Tension	POMS Depress	POMS Anger	POMS Vigor	POMS Fatigue	POMS Confused
POMS Tension	Pearson Correlation	− .18						
	Sig. (1-tailed)	.080						
POMS Depress	Pearson Correlation	− .13	.75					
	Sig. (1-tailed)	.157	.000					
POMS Anger	Pearson Correlation	− .06	.62	.67				
	Sig. (1-tailed)	.324	.000	.000				
POMS Vigor	Pearson Correlation	.02	− .43	− .58	− .17			
	Sig. (1-tailed)	.458	.000	.000	.089			
POMS Fatigue	Pearson Correlation	− .07	.78	.62	.42	− .52		
	Sig. (1-tailed)	.291	.000	.000	.000	.000		
POMS Confused	Pearson Correlation	− .09	.71	.70	.44	− .58	.61	
	Sig. (1-tailed)	.246	.000	.000	.000	.000	.000	
POMS TMD	Pearson Correlation	− .04	.89	.91	.71	− .66	.81	.82
	Sig. (1-tailed)	.392	.000	.000	.000	.000	.000	.000

POMS subscales except for vigor—that was the predicted direction. However, none reached statistical significance.

3.3. Compliance

Regularity of Transcendental Meditation practice was determined by asking the 88 subjects, who attended the 4-month posttest, to estimate their regularity. 93% of the subjects reported that they practiced TM program at least once a day on average.

4. Discussion

BIS scores significantly increased in the TM group compared to controls, as did POMS vigor subscale. POMS Total Mood Disturbance and anxiety, anger, depression, fatigue, and confusion subscales significantly decreased in the TM group compared to controls.

The results of this study indicate beneficial effects of the TM program on emotional stability and brain integration in workplace administrators and staff. The present study advances prior research by demonstrating such beneficial effects in the context of the workplace. The ability to better cope with environmental workplace demands may impact psychological distress in such a way to support the cardiovascular health of the individual as suggested by previous research on coping, stress, and blood pressure (Nidich et al., 2009).

Prior research on TM found reduced psychological and physiological response to stress factors, including decreased sympathetic nervous system and hypothalamic–pituitaryadrenal axis over-activation, and reductions in elevated cortisol (stress hormone) levels (Barnes, Treiber, & Davis, 2001; MacLean et al., 1997; Walton, Schneider, & Nidich, 2004). Research also showed a more coherent and integrated style of brain functioning, evidenced by EEG imaging associated with lower stress reactivity (Travis et al., 2009).

The physiological changes reported as a result of Transcendental Meditation practice in this and other studies suggest that transcending during TM practice affects perceptual processing. Transcending leads to a subjective state described as “consciousness without content” or “pure consciousness” (Travis & Pearson, 2000), and to a style of brain functioning marked by higher integration. These transformations in inner experience and in brain functioning could change how one deals with challenges in life. Challenges remain, but one is not overshadowed by them. This is suggested by college students who meditated over the semester, and at the end of the semester—during finals week—showed higher brain integration along with less stress reactivity in the highly stressful time of final’s week (Travis et al., 2009). A different style of processing is also suggested in this study with the school administrators who showed higher scores on the Brain Integration Scale and higher happiness and reduced anger, anxiety, depression and Total Mood Disturbance. Their job demands had not changed over this time. However, the inner changes in subjective experience and brain functioning could have allowed them to see their world differently.

It is interesting that BIS changes had a low correlation with the change scores in the POMS subscales. The correlations were in the predicted direction—increases in BIS scores correlated with decreases in the POMS subscale except for vigor, which was positively correlated. However, these correlations were low (r = - 0.18 and lower) and the strongest significance was a trend. It is possible that brain integration and Profile of Mood States are accessing different levels of functioning. Brain integration could represent the global context that supports more localized processing, such as emotional states.

4.1. Strengths and limitations

The strength of the study is that it used a randomized controlled trial, and included measures on the POMS and the BIS, both before and after the intervention in administrators and staff working in the same organizational setting. The control group was a wait-listed control, in which participants are eligible to receive the intervention after completion of the study. This may facilitate both recruitment and retention. All subjects were tested under the same conditions. Compliance with the meditation home practice was high.

One limitation to the generalizability of these findings is that women made up 83% of the participants in this study. However, when gender was entered into the F-tests, there were no significant interactions.

Future research is encouraged to utilize a larger-designed, multi-site study, with a more active control group to control for time and attention. The control group was a delayed start group who continued their usual daily routine. Future research could investigate whether simple relaxation would also affect POMS and BIS scores. Future studies should have equal balance of males and females to more adequately evaluate the effects of meditation on gender. In addition, a measure of job performance may be useful to determine relationships between mental health factors, such as Mood Disturbance, and brain health factors, such as brain integration, and job performance.

5. Conclusion

The results of this study indicate improved brain integration and reduced mood disturbance in administrators and staff due to practice of Transcendental Meditation (TM). These results have implications for organizations interested in improving the mental health and neurocognitive behavioral competencies of employees.

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Authors' Contributions

FT and SN, participated in the study design, overview of EEG recording, statistical analysis, and drafting and critical review of the final manuscript. LV and JL participated in the study design, on-site study supervision, and drafting and critical review of the final manuscript. AK participated in the data collection, management of data, and critical review of the manuscript. JL and RS participated in data management and analysis, and the writing and review of the final manuscript. JS participated in the final review of the manuscript and preparation for submission. All authors have given final approval to the manuscript.

Disclosure statement

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References

Barnes, V. A., Treiber, F. A., & Davis, H. (2001). Impact of Transcendental Meditation on cardiovascular function at rest and during acute stress in adolescents with high normal blood pressure. *Journal of Psychosomatic Research, 51*(4), 597–605.

Dillbeck, M. C., & Bronson, E. C. (1981). Short-term longitudinal effects of the Transcendental Meditation technique on EEG power and coherence. *International Journal of Neuroscience, 14*, 147–151.

Dillbeck, M. C., & Orme-Johnson, D. W. (1987). Physiological differences between Transcendental Meditation and rest. *American Psychologist, 42*, 879–881.

Eppley, K., Abrams, A. I., & Shear, J. (1989). Differential effects of relaxation techniques on trait anxiety: A meta-analysis. *Journal of Clinical Psychology, 45*(6), 957–974.

Harung, H. S., & Travis, F. (2012). Higher mind-brain development in successful leaders: Testing a unified theory of performance. *Cognitive Processing, 13*(2), 171–181. http://dx.doi.org/10.1007/s10339-011-0432.

Harung, H. S., Travis, F., Pensgaard, A. M., Boes, R., Cook-Greuter, S., & Daley, K. (2011). Higher psycho-physiological refinement in world-class Norwegian athletes: Brain measures of performance capacity. *Scandinavian Journal of Medicine and Science in Sports, 21*(1), 32–41. http://dx.doi.org/10.1111/j.1600-0838.2009.01007.

Hebert, R., Lehman, D., Tan, G., Travis, F., & Arenander, A. (2005). Enhanced EEG alpha time-domain phase synchrony during Transcendental Meditation: Implications for cortical theory. *Signal Processing, 85*(11), 2213–2232.

MacLean, C., Walton, K., Wenneberg, S., Levitsky, D., Mandarino, J., Waziri, R., & Schneider, R. H. (1997). Effects of the Transcendental Meditation program on adaptive mechanisms: Changes in hormone levels and responses to stress after 4 months of practice. *Psychoneuroendocrinology, 22*(4), 277–295.

Maharishi Mahesh Yogi (1969). *On The Bhagavad-Gita A New Translation And Commentary: Chapters 1–6.* Baltimore: Penguin Books Inc.

McNair, D. M., Lorr, M., & Droppleman, L. F. (1971). *Manual for the Profile of Mood States.* San Diego, CA: Education and Testing Service.

Muse, L., Harris, S., & Field, H. (2003). Has the inverted-U Theory of stress & job performance had a fair test? *Human Performance, 16*, 349–364.

Nidich, S., Rainforth, M., Haaga, D., Hagelin, J., Salerno, J., Travis, F., & Schneider, R. (2009). A randomized controlled trial on effects of the transcendental meditation program on blood pressure, psychological distress, and coping in young adults. *American Journal of Hypertension, 22*, 1326–1331.

Orme-Johnson, D., & Barnes, V. (2013). Effects of the transcendental meditation technique on trait anxiety: A meta-analysis of randomized controlled trials. *Journal of Alternative and Complementary Medicine, 19*, 1–12.

Roth, R. (2002). *Maharishi Mahesh Yogi's transcendental meditation.* Washington, DC: Primus.

Tecce, J. J. (1972). Contingent negative variation (CNV) and psychological processes in man. *Psychological Bulletin, 77*(2), 73–108.

Thatcher, R. W., Krause, P. J., & Hrybyk, M. (1986). Cortico-cortical associations and EEG coherence: A two-compartmental model. *Electroencephalography and Clinical Neurophysiology, 64*(2), 123–143.

Travis, F. (2001). Autonomic and EEG patterns distinguish transcending from other experiences during Transcendental Meditation practice. *International Journal of Psychophysiology, 42*(1), 1–9.

Travis, F., Arenander, A., & DuBois, D. (2004). Psychological and physiological characteristics of a proposed object-referral/self-referral continuum of self-awareness. *Consciousness and Cognition, 13*(2), 401–420.

Travis, F., Haaga, D. A., Hagelin, J., Tanner, M., Arenander, A., Nidich, S., & Schneider, R. H. (2010). A self-referential default brain state: Patterns of coherence, power, and eLORETA sources during eyes-closed rest and Transcendental Meditation practice. *Cognitive Processing, 11*(1), 21–30.

Travis, F., Haaga, D. A., Hagelin, J., Tanner, M., Nidich, S., Gaylord-King, C., & Schneider, R. H. (2009). Effects of Transcendental Meditation practice on brain functioning and stress reactivity in college students. *International Journal of Psychophysiology, 71*(2), 170–176.

Travis, F., & Lagrosen, Y. (2014). Creativity and brain-functioning in product development engineers: A canonical correlation analysis. *Creativity Research Journal, 26*(2), 239–243.

Travis, F., & Parim, N. (2017). Default mode network activation and Transcendental Meditation practice: Focused Attention or Automatic Self-transcending? *Brain and Cognition, 111*, 86–94 S0278-2626(16)30098-7.

Travis, F., & Pearson, C. (2000). Pure consciousness: Distinct phenomenological and physiological correlates of "consciousness itself". *International Journal of Neuroscience, 100*(1–4).

Travis, F., & Shear, J. (2010). Focused attention, open monitoring and automatic self-transcending: Categories to organize meditations from Vedic, Buddhist and Chinese traditions. *Consciousness and Cognition, 19*(4), 1110–1118.

Travis, F., Tecce, J., Arenander, A., & Wallace, R. (2002). Patterns of EEG coherence, power, and contingent negative variation characterize the integration of transcendental and waking states. *Biological Psychology, 61*, 293–319.

Walton, K., Schneider, R., & Nidich, S. (2004). Review of controlled research on the Transcendental Meditation program and cardiovascular disease - risk factors, morbidity and mortality. *Cardiology in Review, 12*(5), 262–266.

World Health Organization (2013). Guidelines for the management of conditions specifically related to stress. Geneva: WHO.

Yamamoto, S., Kitamura, Y., Yamada, N., Nakashima, Y., & Kuroda, S. (2006). Medial prefrontal cortex and anterior cingulate cortex in the generation of alpha activity induced by transcendental meditation: A magnetoencephalographic study. *Acta Medica Okayama, 60*(1), 51–58.