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# CHANGES IN TRAIT BRAINWAVE POWER AND COHERENCE, STATE AND TRAIT ANXIETY AFTER THREE-MONTH TRANSCENDENTAL MEDITATION (TM) PRACTICE

**Helena Tomljenović[1], Dražen Begić[2,3] & Zora Maštrović[4]**

[1]*Department of Psychology, Centre for Croatian Studies, University of Zagreb, Zagreb, Croatia*
[2]*Department of Psychiatry, University Hospital Center Zagreb, Zagreb, Croatia*
[3]*School of Medicine, University of Zagreb, Zagreb, Croatia*
[4]*Nuclear medicine specialist and research assistent, retired*

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## SUMMARY

***Background:*** *The amount of studies showing different benefits of practicing meditation is growing. EEG brainwave patterns objectively reflect both the cognitive processes and objects of meditation. This study aimed to examine the effects of transcendental meditation (TM) practice on baseline EEG brainwave patterns (outside of meditation) and to examine weather TM reduces state and trait anxiety.*

***Subjects and methods:*** *Standard EEG recordings were conducted on volunteer participants (N=12), all students or younger employed people, before and after a three-month meditation training. Artifact-free 100-second epochs were selected and analyzed by Fast Fourier Transformation (FFT) analysis. Endlers Multidimensional Anxiety Scales (EMAS) were used to assess anxiety levels. Power ($\mu V^2$) and coherence levels were compared in the alpha, beta, theta and delta frequency band.*

***Results:*** *Changes in EEG patterns after meditation practice were found mostly in the theta band. An interaction effect was found on the left hemisphere ($p<0.10$). Theta power decreased on the left, but not on the right hemisphere. Increased theta coherence was found overall and in the central, temporal and occipital areas ($p<0.10$). Decrease in alpha power was found on channels T3 ($p<0.10$), O1 ($p<0.05$) and O2 ($p<0.10$). An interaction effect was found in the delta frequency band ($p<0.06$), too. A trend for power decreasing was found on the left, and a trend for power increasing on the right hemisphere. Also, power decreased on channel O1 ($p<0.10$). In the beta frequency band, a decrease was found on channel O2 ($p<0.10$). Trait anxiety did not differ, but a decrease in state anxiety and cognitive worry was found ($p<0.05$).*

***Conclusions:*** *Obtained results confirm the effects of TM on some baseline EEG brainwave patterns and state anxiety, suggesting that the left hemisphere is more sensitive to meditation practice. Most of the changes were found in the occipital and temporal areas, less in the central and frontal areas. State anxiety decreased after TM practice. Findings suggest TM practice could be helpful in treating different kinds of disorders, especially anxiety disorders.*

***Key words:*** *transcendental meditation (TM) – qEEG - brainwave coherence - state anxiety - trait anxiety*

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## INTRODUCTION

Practice of different meditation types has become increasingly popular in clinical settings over the past 30 years (Dakwar & Levin 2009). Assumed therapeutic benefits of meditation are being backed up by growing empirical evidence. It has been the most widely evaluated alternative treatment and is the first mind-body intervention adopted by mainstream health care providers, and incorporated into evidence-based therapeutic programs (Ader 2001, as cited in Dakwar & Lewin 2009). Different psychological benefits of meditation have been meta-analytically proven – the overall effect is medium size, and greater for negatively emotional than cognitive variables (Sedlmeier et al. 2012). Although the evidence for meditation efficiency in psychiatric settings is inconclusive at the present, possible benefits may include both psychological and psychosomatic problems, such as anxiety, addiction, aggression, suicidality, depression, chronic pain, insomnia, and hypertension (McGee 2008). A meta-analysis by Alexander et al. (1994) suggests positive effects on substance abuse and a later meta-analysis on general health (Grossman et al. 2004). On the other hand, there is a lack of elaborated psychological theories to predict exactly what can be expected after meditation practice, followed by considerable inconsistency in defining meditation, probably due to different types of meditation. Transcendental meditation (TM) is a meditation technique categorized in the self-transcending type (Travis 2010). It is unique for its goal of reaching the state of consciousness free of ordinary mental activity and cognitive control; *transcending* involves minimal individual control of ongoing experience and attention moves from the state of attention on an object to a state of object-free awareness or pure subjectivity. Most studies on TM investigated how it decreases anxiety levels. Meta-analyses suggest TM leads to greater decreases in trait anxiety than other types of meditation or relaxation (Eppley & Abrams 1989, Orme-Johnson & Barnes 2013). Furthermore, the authors emphasize a surprising lack of relation between the length of meditation and its effect size. They explain it via repeated measure studies which show the greatest decrease in anxiety comes in the first week or two of meditation (Ballou 1977, Gore et al. 1984). A pilot study found a significant decrease in PTSD symptoms after only ten days of TM practice (Rees et al. 2013). Findings also suggest the experience during TM practice is a physiological opposite to anxiety (Orme-Johnson & Barnes 2013). Studies found experienced meditators show a decreased activation of autonomic and endocrine systems: lower breathing rates, heart rhythm, skin conductance, plasma lactate, catecholamine and cortisol levels (Dilbeck et al. 1987, Infante et al. 2001, Jones 2001), followed by increased immune responses (Davidson et al. 2003). Another study showed long-term meditators have decreased baseline cortisol levels but an increased level during acute stress response, indicating TM protects against chronic stress (Maclean et al. 1997). If we consider that around 43% of adults in the USA suffer from health conditions caused by stress (Louise 2008; as cited in Adhia et al. 2010), and that 300 billion dollars are spent repairing its negative consequences, it is obvious why scientific research focusing on simple do-it-yourself techniques, like TM, is useful. Chronic stress may play an important role in both initiating and maintaining hypertension; a meta-analysis investigating blood-pressure in response to TM concludes this practice leads to blood pressure reductions which are likely to significantly reduce risk for cardiovascular disease (Anderson et al. 2008). Regular TM practice is also linked to a better nervous system functioning: faster neural transmission (Dillbeck et al. 1981a), perceptual processing (So Kam-Tim 1995), decision making and performance speed (Cranson et al. 1991). EEG, ERP and neuroimaging studies of meditation show there is an overall slowing of EEG brain activity due to meditation and alpha and theta bands seem to be most sensitive to meditation practice (Cahn & Polich 2013). An increase in alpha power is most commonly found, both during meditation and outside meditation, which confirms that both state and trait changes occur in EEG patterns. On the contrary, some relaxation group controlled studies found no such increase in alpha power, and some even found a decrease (Travis & Wallace 1999, Saggar et al. 2012). Other studies suggest a change in the theta band is linked to meditation efficiency (Aftanas & Golocheikene 2001), and some that it only occurs in advanced practitioners (Kasamatsu & Hirai 1966). Increased brainwave coherence is found in the alpha-theta span, both inter and intra hemisphericaly during meditation (Cahn & Polich 2013), similar patterns are found in meditators during rest and cognitive tasks. TM is marked by frontal alpha 1 power and coherence, and increased frontal blood flow, accompanied by decreased brainstem blood flow (Travis 2013). Experience during TM correlates with increased EEG coherence which becomes part of the baseline EEG after a few months. A study using MEG located the sources of alpha activity in the medial prefrontal cortex and anterior cingulate cortex (Yamamoto et al. 2006). Another study (Travis et al. 2010) identified the sources of alpha 1 activity in medial cortical regions overlapping with the *Default mode network*. Overall results do not show complete consistency regarding alpha power changes. On the contrary, increases in alpha and theta band coherence are well-established findings. No reports on the delta band exist, and reports witnessing beta band changes are scarce.

This study adopted a more innovative design and aimed to particularly investigate the trait changes in EEG patterns, since many studies confirmed the state changes in EEG during meditation. We were interested to verify what changes could be expected in baseline trait EEG patterns outside of meditation and to clarify previous inconsistent results in the alpha and theta bands. Second, we wanted to examine a claim by Orme Johnson & Barnes (2013) that a major decrease in anxiety levels occurs within the first week or two of TM practice. We suggest this decrease relates only to state anxiety, since trait anxiety is more stable and is not likely to change within only a couple of weeks.

## SUBJECTS AND METHODS

### Subjects

This study included 12 volunteer participants (7 men) with an average age of 26.5 years (*sd*=5), all students or younger employed people. They gave an informed consent. All of them declared themselves right-handed and free of serious head injuries, psychotropic drugs or other disorders which could affect the EEG pattern. Nine of the participants were recruited from the Centre for Croatian Studies, University of Zagreb, as students or their friends, and never practiced any meditation technique before the study (*meditation naive group*). Three participants (*non-naive group*) were additionally recruited from Croatia's TM Centre in Zagreb (www.tmsavez.hr), with the shortest period of meditation practice as the selection criteria.

### Methods

The study was quasi-experimental with a repeated measures design. EEG recordings were conducted before a three-month TM practice, to establish the participants' baseline EEG patterns, and after the three-month TM practice. Anxiety levels were measured at two points – after two weeks of starting TM practice and at the end of the three-month practice. Transcendental meditation is a mental technique which is practiced twice a day for 15-20 minutes, sitting comfortably with eyes closed. In includes a Sanskrit *mantra* which is subvocally repeated during the practice and is free of semantic meaning. A standardized TM teaching course was conducted by an experienced TM teacher *pro bono.* The quality and quantity of the practice was recorded via diaries the participants filled out. All study participants underwent conventional EEG registration, it included short epochs with eyes opened, photo-stimulation and hyper-ventilation. The subjects were awake but not meditating, in supine position with their eyes closed (except in the short eyes open epoch). EEG recordings were performed with a Nicolet's BEAM device in the morning hours, after the participants had breakfast. To avoid other sources of artifacts, like drowsiness, they were instructed to get a good night's sleep and not consume any alcohol the day before recording. Electrodes were placed according to the international "10-20" system using linked-ears as a reference. Signals were digitized at 256 samples channel second with a low-frequency filter of 0.5 and a high-frequency filter of 30 Hz, and impedance levels were ≤5 kΩ. All EEG recordings were performed by the same EEG technician. Epochs contaminated by blinks, eye movements, and movement-related artifacts were excluded from analysis simultaneously by the EEG technician, via an oculogram and later by direct visual inspection of the raw data. Artifact-free 100 seconds period were selected from the recorded material, eyes opened, photo-stimulation, hyperventilation and post-hyperventilation period excluded, and analyzed using Fast Fourier Transformation (FFT). The results were presented as absolute spectral power values ($\mu V^2$) for individual segments of EEG spectrum (delta (0.5-4.0), theta (4.0-8.0), alpha (8.0-13.0), and beta (13.0-30.0)). The observed regions included Fp1, Fp2, C3, C4, T3, T4, O1, and O2. State and trait anxiety were measured by an adapted version of Endler's Multidimensional anxiety scales EMAS-S and EMAS-T (Sorić 2002). EMAS-S evaluates the subjective state of anxiety during testing; it consists of 20 items and measures two factors: cognitive worry (EMAS-S-CW) and autonomic-emotional symptoms (EMAS-S-AE), but also gives an overall measure of state anxiety (EMAS-S-TOT). The cognitive worry factor includes feelings of insecurity, helplessness, inadequacy, self-consciousness, and problems with concentration. Autonomic-emotional symptoms include feelings of tension, feeling flushed, perspiring, damp hands, irregular breathing, racing heartbeat, and dry mouth. Internal consistency is high (Cronbach alpha 0.83-0.96). EMAS-T includes 60 items and evaluates four types of relatively stable situationally determined anxiety proneness – anxiety due to threat in social evaluation or interpersonal situations (EMAS-T-SE), threat of physical danger (EMAS-T-PD), ambiguous threat anxiety (EMAS-T-AM), and anxiety while engaged in innocuous activities or daily routines (EMAS-T-DR). In our study, Cronbach's alpha was .99 and .84 for EMAS-T and .83 and .62 for EMAS-S, at the first and second point. The decrease at the second point is due to zero variability of some items.

### Statistical Analysis

All statistical analyses were conducted on log-transformed results. Repeated measures analyses of variance were conducted separately for different frequency bands and for trait and state anxiety. Due to specific results, in the theta and delta bands another ANOVA 2x2 was conducted with meditation (before and after) and brain hemisphere (left and right) as variability sources. Coherence levels in different frequency bands were calculated as Pearson's bivariate correlation between according channels on the left and right hemisphere (FP1-FP2, C3-C4, T3-T4, O1-O2), and as an average overall correlation between all channels. Since coherence levels the alpha and theta band were itself high before TM practice, preventing a possibility for a statistically significant increase to be found, they were calculated differently. In the alpha band, the overall coherence level represents an average correlation between all channels which correlated $r<0.75$ before TM practice (correlations between channels FP1-C4, Fp1-O1, T3-O1, T3-FP2, T3-C4, T3-O2) and in the theta band between all channels which correlated $r<0.70$ before TM practice (FP1-FP2, FP1-C4, FP1-T4, FP1-O2, C3-FP1, C3-C4, C3-T4, C3-O2, T3-FP2, T3-C4, T3-T4, T3-O2, O1-FP2, O1-C4, O1-T4, O1-O2). $r<0.75$ and $r<0.70$ are the lowest thresholds which could have been set. Due to a small sample size but moderate or high effect size, results with $p<0.10$ were considered marginally statistically significant, and results with $p<0.05$ significant. All the analysis were conducted in SPSS version 18.

## RESULTS

Preliminary analysis showed the non-naive meditation group, which practiced TM before the first EEG recording (on average for two months), had systematically different results than the meditation naive group. Since that group's size does not allow statistical analysis, results are shown only for the meditation naive group ($N$=9). Since the study was longitudinal and demanded all subjects to be intrinsically motivated and actively participate in it daily, we had trouble enlarging our sample. Meditation diaries and the final evaluation of the study confirm all participants practiced TM regularly and successfully. The amount of practice varies among participants, though, and is mostly due to technical reasons. The most common experience during TM was a feeling of inner happiness, followed by an unawareness of the body or surroundings.

### Anxiety

As shown in Figure 1, a trend for decrease is seen in all factors of both state and trait anxiety. ANOVA results confirm a significant decrease in overall state anxiety ($F(1)=5.52$; $p<0.05$, $\eta^2=0.44$ ) and in cognitive worry ($F(1)=5.27$; $p<0.05$, $\eta^2=0.43$). No significant difference is found in the autonomic-emotionality factor ($F(1)=2.17$; $p>0.10$, $\eta^2=0.24$) or any of the trait anxiety scales ($p>0.10$).

***Alpha frequency band***

As seen in Figure 2, a trend for decreasing alpha power is observable on all channels on both hemispheres. ANOVA results confirm the decrease to be significant on channel O1 ($F(1)=6.18$; $p<0.05$, $\eta^2=0.44$) and marginally significant on channels T3 ($F(1)=4.12$; $p<0.10$, $\eta^2=0.34$) and O2 ($F(1)=3.35$; $p<0.10$, $\eta^2=0.29$). Table 1 shows coherence levels before and after TM. All measures failed to reach even marginal significance ($p>0.10$).

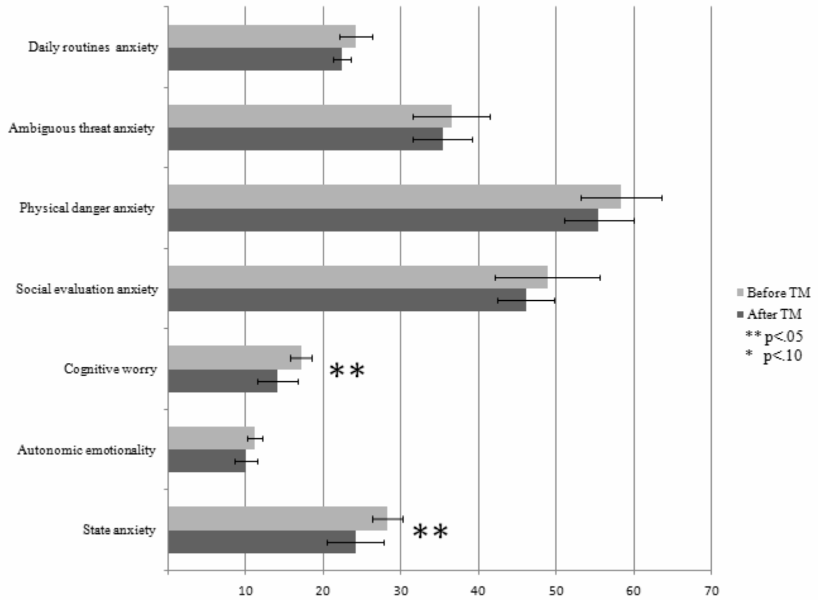


**Figure 1.** Different trait and state anxiety factor levels before and after TM practice

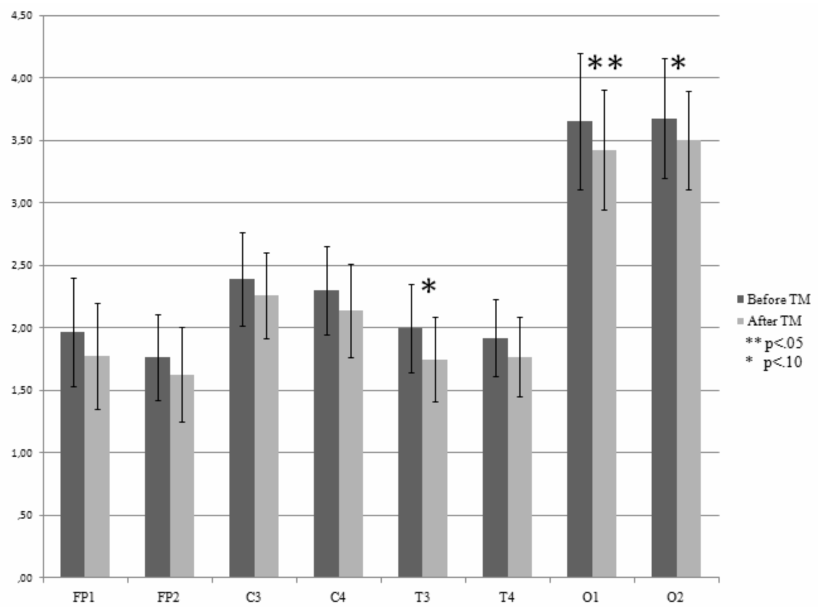


**Figure 2.** Alpha band power ($\mu V^2$) before and after TM practice

**Table 1.** Alpha band coherence before and after TM practice

| Correlating channels | Before TM | After TM | After-before difference | Pearson-Fillon Z | *p* |
|---|---|---|---|---|---|
| Fp1-Fp2 | 0.89*** | 0.97*** | 0.08 | 1.12 | 0.13 |
| C3-C4 | 0.84*** | 0.93*** | 0.09 | 0.81 | 0.21 |
| T3-T4 | 0.83*** | 0.86*** | 0.03 | 0.23 | 0.41 |
| O1-O2 | 0.95*** | 0.93*** | -0.02 | -0.32 | 0.37 |
| Average of all channels correlating $r<0.75$ | 0.72** | 0.86*** | 0.14 | 0.78 | 0.22 |

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

***Beta frequency band***

Changes in the beta band are presented in Figure 3. A marginally significant decrease in beta band power was found on channel O2 ($F(1)=3.92$; $p<0.10$, $\eta^2=0.33$). Coherence levels did not differ after TM practice ($p>0.10$).

***Theta frequency band***

As seen in Figure 4, a trend for theta band power decrease is observable only on the left hemisphere. ANOVA 2x2 (Table 2) confirms a marginally significant interaction on the frontal ($F(1)=4.21$; $p<0.10$, $\eta^2=0.34$), temporal ($F(1)=3.38$; $p<0.10$, $\eta^2=0.30$) and occipital areas ($F(1)=4.42$; $p<0.10$, $\eta^2=0.36$). Marginally significant decrease in theta band power was found on channels FP1 ($F=4.34$), C3 ($F=3.64$), T3 ($F=3.97$) and O1 ($F=5.01$), with effect size being large on all channels ($\eta^2>0.26$). Theta band coherence levels tend to increase (Table 3) on the central, temporal and occipital areas ($p<0.10$). Overall theta coherence also tends to increase from $r=0.61$ to $r=0.89$ ($Z=1.28$, $p<0.10$).

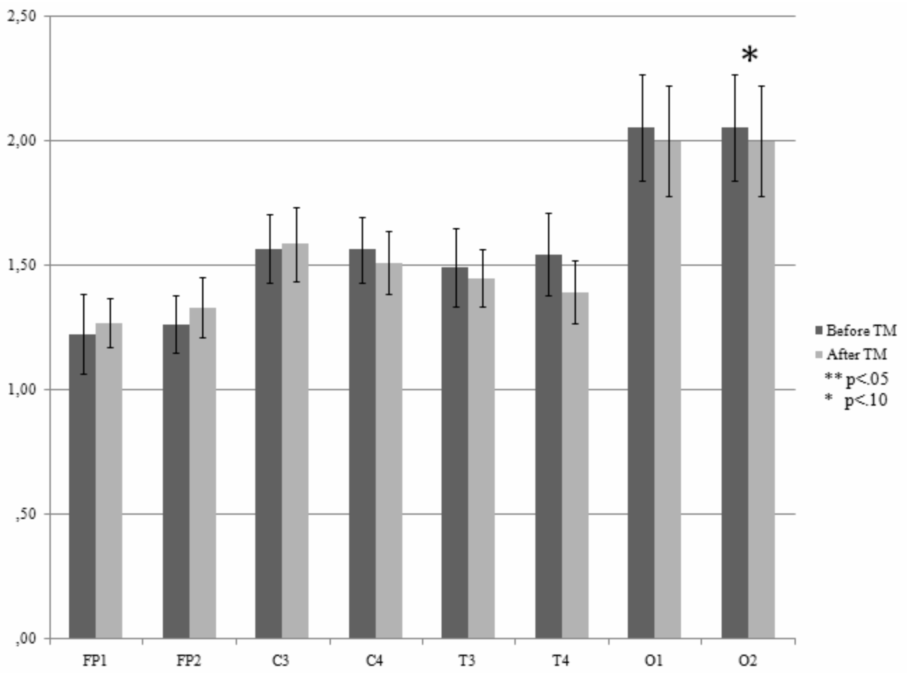


**Figure 3.** Beta band power ($\mu V^2$) before and after TM practice

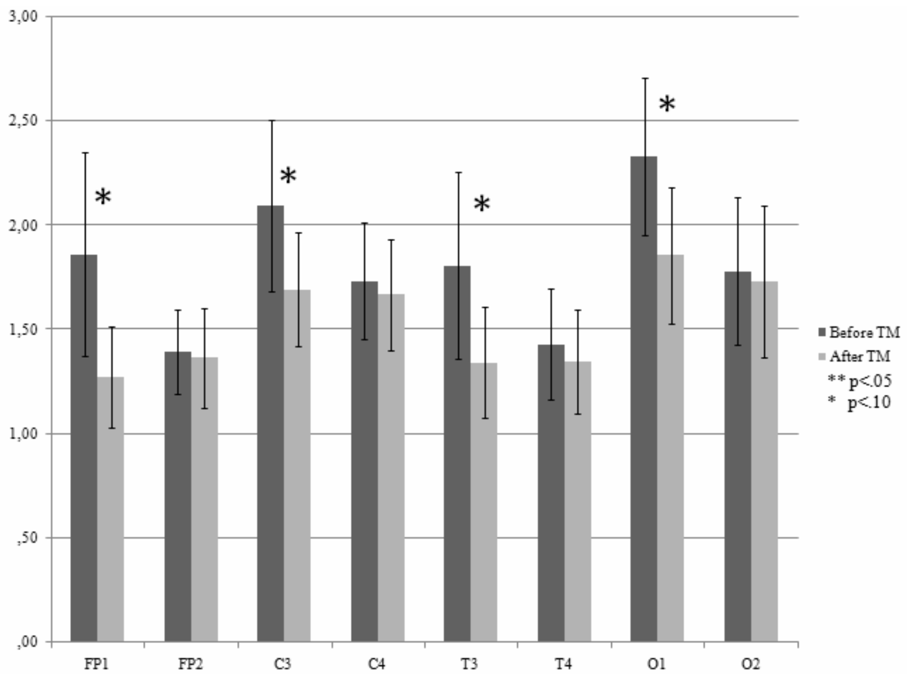


**Figure 4.** Theta band power ($\mu V^2$) before and after TM practice

**Table 2.** ANOVA results with brain hemispheres and meditation as variability sources and theta band power as dependent variable

| | Channel | *Df* | *F* | *p* | $\eta^2$ |
|---|---|---|---|---|---|
| Meditation and hemispheres interaction effect | FP | 1 | 4.21 | 0.07* | 0.34 |
| | C | 1 | 2.92 | 0.13 | 0.27 |
| | T | 1 | 3.38 | 0.10* | 0.30 |
| | O | 1 | 4.42 | 0.07* | 0.36 |

*** $p$<0.01,  ** $p$<0.05,  * $p$<0.10

**Table 3.** Theta band coherence before and after TM practice

| Correlating channels | Before TM | After TM | After-before difference | Pearson-Fillon Z | *p* |
|---|---|---|---|---|---|
| Fp1-Fp2 | 0.61* | 0.87*** | 0.26 | 1.14 | 0.13 |
| C3-C4 | 0.67** | 0.96*** | 0.29 | 1.54 | 0.06* |
| T3-T4 | 0.64* | 0.94*** | 0.30 | 1.48 | 0.07* |
| O1-O2 | 0.71** | 0.93*** | 0.22 | 1.29 | 0.10* |
| Average of channels correlating $r$<0.70 | 0.61* | 0.89*** | 0.28 | 1.28 | 0.10* |

*** $p$<0.01,  ** $p$<0.05,  * $p$<0.10

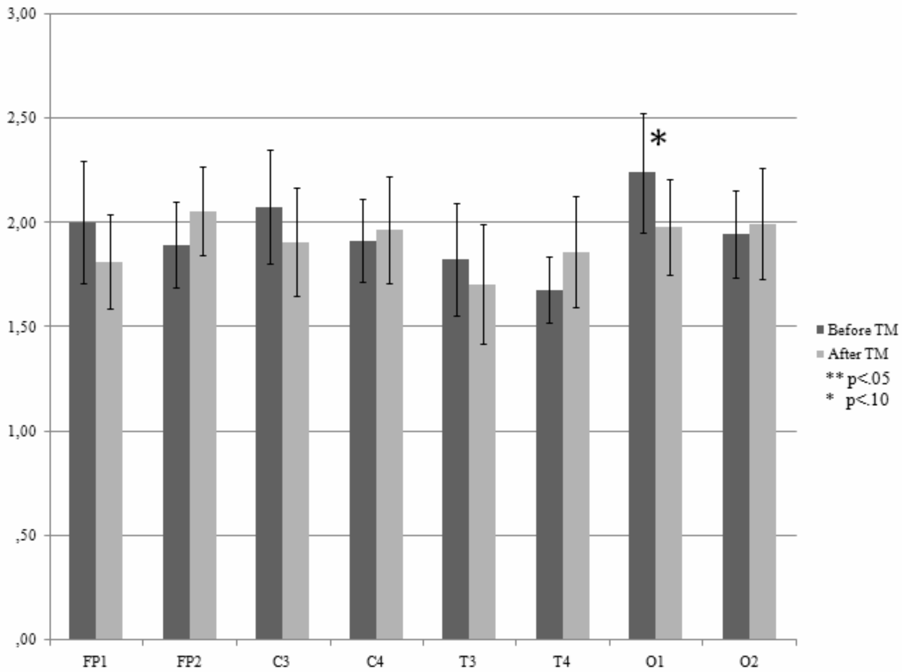


**Figure 5.** Delta band power ($\mu V^2$) before and after TM practice

**Table 4.** ANOVA results with brain hemispheres and meditation as variability sources and delta band power as dependent variable

| | Channel | *Df* | *F* | *p* | $\eta^2$ |
|---|---|---|---|---|---|
| Meditation and hemisphere interaction effect | FP | 1 | 5.36 | 0.05** | 0.40 |
| | C | 1 | 2.48 | 0.15 | 0.24 |
| | T | 1 | 4.70 | 0.06* | 0.37 |
| | O | 1 | 6.16 | 0.04** | 0.43 |

*** $p$<0.01, ** $p$<0.05, * $p$<0.10

### *Delta frequency band*

An interaction was found in the delta band, too, on the frontal ($F$=5.36; $p$<0.05) and occipital area ($F$=6.16; $p$<0.05), and marginally significant on the temporal area ($F$=4.70; $p$<0.10). There seems to be a trend for power decrease on the left and a trend for power increase on the right hemisphere (Figure 5). Second ANOVA (Table 4) confirms the decrease on channel

O1 to be marginally significant $F(1)=4.39$; $p<0.10$, $\eta^2>0.26$). No changes were found in delta band coherence levels ($p>0.10$).

## DISCUSSION

Our goal was to clarify the effects of TM on the alpha and theta band EEG patterns. Other studies repeatedly suggest TM increases alpha band coherence (Travis 2013, Travis 2010, Travis et al. 2010, Travis & Arenander 2006, Travis & Wallace 1999, Dillbeck & Bronson 1981b). Some suggest alpha coherence is negatively linked to state anxiety and positively to self-esteem, creativity, concept learning and moral reasoning (Hebert et al 2005, Sauseng et al. 2008, Palva & Palva 2007, Dilbeck et al. 1981b, Nidich et al. 1983, Orme Johnson & Haynes 1981, Travis & Arenander 2006, Travis et al. 2009). Our results also found a trend for alpha coherence increase, in the frontal region alpha coherence after TM practice is almost complete ($r=0.97$), but none of the changes reached even marginal significance. But our coherence levels were calculated primitively, without an adequate program, and did not partialize all the inter-correlations among channels. Another question remaining is the different result found in three non-naive participants. Most of the differences relate to alpha power changes. Namely, the non-naive group showed trends for alpha power increase. Therefore, a possibility for interaction or cumulative effects in alpha band is indicated. Due to effect size being mostly moderate or large, it is just to presume more significant alpha band changes could be found in a larger sample. Another limitation is the fact that this study did not differentiate between alpha 1 and alpha 2 bands, and certain findings suggest such selective effects (Travis et al. 2010). Changes in the beta and delta band are rarely mentioned in available literature, still we have found a marginally significant decrease in beta power on channel O2 and an interaction in the delta band significant on the occipital and frontal regions and marginally significant on the temporal area; with a trend for power decrease on the left and a trend for power increase on the right hemisphere, followed by a marginally significant decrease on channel O1, all with large effect size. Given results confirm previous suggestion that theta band is most sensitive to meditation practice. Our most important is finding that the theta band is more sensitive to meditation practice than the alpha band. Certain studies found theta band coherence increasing in meditators in the frontal-central regions (Aftanas & Golocheikene 2001, 2002, 2003). Such findings are linked to the experience of positive emotions during meditation; namely, some studies found increased coherence during the experience of positive vs. negative emotions (Aftanas et al. 1998). Although theta band changes are linked mostly to experienced meditators, it is arguable when one becomes an experienced meditator. Given results suggest theta changes occur after three months of practice, reflecting the experience related neuroplasticity and integration of the experience during meditation in everyday waking activities (Travis et al. 2001; as cited in Travis 2010). Some authors have hypothesized different effects of meditation on the left and right hemisphere (Pagano & Frumkin 1977, Delmonte 1984). Our overall results suggest the left hemisphere is more sensitive to meditation practice. Furthermore, the most consistent and most robust neural abnormality in the ADHD is increased theta band power (Tye et al. 2014). One study investigating TM effects on ADHD adolescents found increased frontal, parietal and anterior-posterior theta, alpha and beta 1 coherence after three months of practice (Travis et al. 2011). Authors linked such results to a previous study which found concentration and emotional control improving after three months of TM in ADHD children (Grosswald et al 2008). Our results confirm theta power decreasing and theta coherence increasing after TM practice. Therefore, TM could be especially beneficial in both anxiety and attention deficit hyperactivity disorders. Another study, especially on epileptic patients, found that the practice of TM reduced the presence of 3.5 HZ epileptic spikes in the EEG, which were replaced with the dominance of normal alpha waves. The study reported the epileptic seizures became less frequent and less severe (Orme-Johnson 2006). Our second goal was to investigate the dynamics in which TM effects anxiety. Our results show trait anxiety did not differ after two weeks and three months of TM practice. On the contrary, state anxiety and cognitive worry symptoms decreased. Since Orme-Johnson and Barnes (2013) claim a major decrease in anxiety occurs during the first few weeks of TM practice we hypothesized that state anxiety after two weeks and three months won't differ, because the potential decrease would happen in the first two weeks. We also expected a decrease in trait anxiety to be found because it is unlikely for it to change in only two-weeks' time, but maybe could in a few months. An interaction effect could explain such inconsistent results. Orme-Johnson and Barnes (2013) explain the effect size TM has in decreasing anxiety is greater for patients with anxiety levels in the 90th percentile and such findings are not rare – population with higher initial levels give a greater effect size. Therefore, it is possible for the anxiety levels decrease to be slower among the healthy population, like our participants.

Helmainiak (1981) consolidated six mechanisms possibly responsible for the effects of meditation. They include relaxation, systematic desensitization, release of repressed psychic material, unstressing, dissolution of habitual patterns of perception and cosmic consciousness (*samadhi, nirvana*). Young & Taylor (1998) hypothesized meditation induces a hypometabolic state which serves as estivation or hibernation and allows for successful adaptation and plasticity in the midst of environmental change and stress, and may also have health-promoting and restoral benefits, as well as positively affect neural plasticity. Hussain & Bhushan (2010) say the profound effect of TM on brain functioning is reflected in the form of increasing orderliness, integration and coherence. Regular meditators also show an ability to moderate the intensity of negative emotional excitement and EEG patterns of an overall lower excitement and a tendency for focusing their attention internally (Aftanas & Golosheykin 2005). Dakwar & Levin (2009) deliberate the potential benefits of meditation practice in substance use disorders. Findings about lower cortisol levels in meditators (Dillbeck et al. 1987, Infante et al. 2001, Jones 2001) implicate a role for meditation in addressing craving states; it may potentially reduce stress-induced craving, dampen the resilience of drug craving and increase craving tolerance. Such potential is backed up by more recent studies investigating how white and gray brain matters alter in meditators. A meta-analysis showed consistent changes found in eight regions crucial for meta-consciousness, exteroceptive and interoceptive body awareness, consolidation and reconsolidation of memory, self and emotional regulation, and intra- and inter-hemispheric communication (Fox et al. 2014). Furthermore, cardiovascular diseases represent a major comorbidity with depression, anxiety and posttraumatic stress disorders (Kapfhammer 2011). TM is shown to be beneficial for these disorders. An important idea for future studies is to clarify the psychosomatic-somatopsychic causal relationship and TM. A major limitation of our study has been the small sample size. Secondly, there was no control group or a group of patients undergoing some other form of treatment. Participants were self-selected, and thereby biased (as in almost all meditation research). Other factors which could change EEG patterns, like impulsivity, amount of sleep the night before EEG recording, drowsiness, drug or alcohol use, were not strictly measured but only explicitly instructed to the participants. Anxiety was the only psychopathological entity that was examined in this study. Additional limitation would be the lack of standard psychiatric interviews as screening measures for potential psychiatric disorders, since EEG abnormalities are commonly present in psychiatric patients (Coburn et al. 2006, Begić 2011). Still, meditation shows great potential in benefiting different clinical conditions but further research needs to be done in order to determine its benefits, mechanisms and limitations more properly and more conclusively.

## CONCLUSIONS

Our results show that a three-month transcendental meditation practice changes certain baseline EEG brainwave patterns, suggesting trait EEG patterns are affected by meditation. Findings also suggest the left hemisphere is more sensitive to meditation practice. Most of the changes were found in the theta band, power decreased on the left hemisphere and theta coherence increased. Furthermore, trait anxiety did not differ after TM practice. On the contrary, after TM practice, overall state anxiety and cognitive worry symptoms decreased. Findings suggest TM practice could be helpful in treating different kinds of disorders, especially anxiety disorders or attention deficit hyperactivity disorder.

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*Correspondence:*
*Helena Tomljenović, MA*
*Department of Psychology, Centre for Croatian Studies, University of Zagreb*
*Borongajska cesta 83d, Zagreb, Croatia*
*E-mail: helena_tomljenovic@hotmail.com*