Appl Psychophysiol Biofeedback (2008) 33:39–47
DOI 10.1007/s10484-008-9050-5

Electroencephalographic (EEG) Measurements of Mindfulness-based Triarchic Body-pathway Relaxation Technique: A Pilot Study

Agnes S. Chan · Yvonne M. Y. Han ·
Mei-chun Cheung

Abstract
Objective The “Triarchic body-pathway relaxation technique” (TBRT) is a form of ancient Chinese mindfulness-based meditation professed to give rise to positive emotions and a specific state of consciousness in which deep relaxation and internalized attention coexist. The purpose of this study was to examine the EEG pattern generated during the practice of this mindfulness exercise, and compare it to music listening which has been shown to induce positive emotions.
Methods Nineteen college students (aged 19–22 years) participated in the study. Each participant listened to both the TBRT and music audiotapes while EEG was recorded. The order of presentation was counterbalanced to avoid order effect. Two EEG indicators were used: (1) alpha asymmetry index, an indicator for left-sided anterior activation, as measure of positive emotions, and (2) frontal midline theta activity, as a measure for internalized attention.
Results Increased left-sided activation, a pattern associated with positive emotions, was found during both TBRT exercise and music conditions. However, only TBRT exercise was shown to exhibit greater frontal midline theta power, a pattern associated with internalized attention.
Conclusions These results provided evidence to support that the TBRT gives rise to positive emotional experience, accompanied by focused internalized attention.

Keywords Mindfulness · Meditation · EEG · Emotion · Attention

Introduction

The use of meditation practices is becoming more common among psychologists and medical professionals for helping their clients to reduce stress and is shown to be effective as a complementary treatment for many disorders, such as hypertension, anxiety and insomnia (Jacobs and Friedman 2004; Stetter and Kupper 2002). Meta-analyses of meditation support the idea that meditation is associated with physiological signs of altered activation of the autonomic and endocrine systems, evident in, for example, the increased level of skin resistance and the reduced levels of heart rate, blood-lactate level, cortisol, and respiration rate (Benson et al. 1974; Dillbeck and Orme-Johnson 1987; Infante et al. 2001; Jones 2001). Nevertheless, further research on the acute central effects of meditation have suggested that these systemic physiological changes are in fact secondary to the acute effects of complex mental processes that involve changes within the central nervous system (CNS) (Jacob and Friedman 2004).

EEG studies have widely reported increased theta activity during meditation (Aftanas and Golosheikine 2001, 2002; Jacobs and Lubar 1989). Some have suggested that the elevated levels of theta activity are associated with alterations in CNS arousal commonly observed in meditation practitioners (Canteros et al. 2002; Jacobs and Friedman 2004). Others have found increased frontal

---

A. S. Chan (✉) · Y. M. Y. Han
Neuropsychology Laboratory, Department of Psychology,
The Chinese University of Hong Kong, Shatin,
New Territories, Hong Kong SAR
e-mail: aschan@psy.cuhk.edu.hk

M.-c. Cheung
Institute of Textiles and Clothing, The Hong Kong Polytechnic
University, Hunghom, Kowloon, Hong Kong

midline theta power during meditation, and have drawn parallels between this acute change in the theta band to the theta EEG pattern in non-meditation-related studies of sustained attention (Cahn and Polich 2006). Given that most major meditation traditions involve strategies that manipulate one's attentional focus (Dunn et al. 1999), the increased frontal theta activity found to be associated with meditation suggests that attention might well be the primary psychological domain mediated by meditative practice. In support of it, neuroimaging results have shown increased cerebral blood flow and significantly increased activations in the anterior cingulate cortex and dorsolateral prefrontal areas during meditation (Lazar et al. 2000; Pizzagalli et al. 2003), indicating that the practice of meditation activates neural structures involved in attention. A related cross-sectional study assessing the effect of Transcendental meditation (TM) have demonstrated enhanced level of attention in children practicing TM relative to a cohort of age- and sex-matched controls (Rani and Rao 1996). Similarly, clinical study of adolescents with attention-deficit/hyperactivity disorder practicing yogic concentrative meditation have also reported substantial improvement in measures of attention after 6 weeks of meditation intervention (Harrison et al. 2004).

Recently, the ancient Chinese "Triarchic body-pathway relaxation technique" (TBRT) is becoming increasingly popular among local Chinese in Hong Kong, as a self-regulatory approach in stress management due to the ease of its practice. It is a form of ancient Chinese mindfulness exercise that requires no special training and can be conveniently practiced anywhere and anytime in a seated position. Unlike other mind-body exercise, such as Tai Chi, Yoga or mindfulness-based stress reduction (MBSR), which requires the individual to carry out movement routines, the TBRT guides the practitioner to simply attend to thoughts and sensations of the three pathways that run along the front, back and two sides of the body (SanLu or Triarchic body-pathway). Through this, the practitioner focuses his/her attention, without judgment, as they traverse along the field of awareness. It is believed that through regulating the Triarchic body-pathway, the mind and body can be guided to attain thorough relaxation. Because of its simplicity, this 15-min meditative practice is suitable for people from all walks of life, and is particularly useful for individuals suffering from serious illnesses which limit their mobility.

Like other mindfulness form of meditation (Astin et al. 2003), the TBRT is believed to be able to elicit a specific consciousness state in which relaxation and internalized attention coexist. Indeed, accounts of increased sense of calmness and enhanced level of clarity were reported among practitioners of TBRT. However, the neurophysiology of this mindfulness exercise remains elusive. Given that regulation of attention is central to the TBRT, and that attention has been shown to be related to frontal theta activity, it is reasonable to assume that the neurophysiological pattern associated with TBRT should involve increased theta activity in the frontal attentional system during this mindfulness practice.

In addition to its effect on attention, some forms of mindfulness practice such as Sahaja Yoga and MBSR also profess to induce the feeling of bliss or happiness (Aftanas and Golosheikine 2005; Davidson et al. 2003), evidenced by increased positive affect, reduced anxiety, and decreased negative affect observed amongst practitioners of mindfulness meditation (Murata et al. 2004; Shapiro et al. 1998). Electrophysiological studies on affective processes have widely suggested that different emotions are associated with different EEG patterns in the frontal regions of the brain (Ekman et al. 1990; Fox 1991). Specifically, activation asymmetries in the anterior regions are reported to differentiate between affective states, of which positive emotion is observed to be coupled with greater left-sided activation (Davidson et al. 2003; Urry et al. 2004) while negative emotion is accompanied by greater right-sided activation (Davidson et al. 1990, 2000b). In support of it, clinically depressed adults were found to show greater right-sided anterior activation (Henriques and Davidson 1990), while enhanced adaptive response to stressful events and faster recovery from provocation were noted in individuals with greater left-sided anterior activation (Davidson 2000; Davidson et al. 2000a). Since the TBRT is presumed to be a form of mindfulness meditative exercise that could give rise to positive affect, it is postulated that participants should show increased left-sided anterior activation during this meditative practice.

Thus, the purpose of this study was to examine how the TBRT affects the function of the CNS, with specific focus on the complex mental functions of attention and positive emotion. Given that attention has been reported to be related to greater frontal midline theta, and positive emotions to greater left-sided anterior activation, we hypothesized that this ancient Chinese mindfulness exercise would result in acute EEG changes that would involve increased frontal midline theta power and increased left-sided anterior activation compared with the baseline.

To further highlight TBRT's effect in inducing a specific consciousness state where both relaxation and internalized attention coexist, we compared TBRT with music listening. Classical music has been empirically demonstrated to have effects on tension reduction and relaxation (Chafin et al. 2004). We expected that while both the TBRT and music would induce increased left-sided anterior activation suggestive of a relaxation effect, only the TBRT would induce increased frontal midline theta power which is suggestive of focused internalized attention.

Method

Participants

A total of 19 (11 females and 8 males) healthy, right-handed university students between the ages of 19 and 22 years were recruited to participate in the present study. The experimental procedure was approved by the Research Ethics Committee of The Chinese University of Hong Kong and informed consent was obtained for each participant prior to commencement of the study.

Procedure

Participants were tested individually in a sound and light attenuated room. In addition to the mindfulness-based TBRT, participants were also asked to listen to a musical audiotape while EEG was recorded. The audiotape consisted of three taped segments of classical music: “Spring–Allegro” by Vivaldi, “Barcarolle” from Tales of Hoffman by Offenbach, and “Canon” by Pachelbel. This selection of classical music was chosen as a comparison condition to the mindfulness practice due to its demonstrated effects on tension reduction (Allen and Blascovich 1994; Chafin et al. 2004; Knight and Rickard 2001), decreased autonomic activity (Barnason et al. 1995; Grey 2001), and reduced anxiety (Mornhinweg 1992; Scheufele 2000; Thayer 1996).

Since none of the participants had experienced any form of mindfulness exercise but were more familiar with the music chosen for this study, a 5-min sample segment of the TBRT audiotape was played in the background while the experimental procedures were explained to the participants, for the purpose of desensitization to the meditative practice (Jacobs and Friedman 2004).

After explaining the experimental procedures, participants were fitted with a Lycra stretchable Electro-cap and were instructed to sit quietly with their eyes closed throughout the EEG recording session. EEG was first collected during baseline eyes-closed condition for 5 min (Time 1), and then for 12 min when the participants listened to either the music or TBRT audiotape (Time 2). Both the TBRT and the musical audiotapes were of the same length (12 min). The sequence of the music/TBRT conditions was counterbalanced to avoid order effect, where 10 participants were randomly assigned to undergo the music condition first followed by TBRT, and nine in the reverse sequence. Upon completion of the first testing condition (music/TBRT), participants were given a 5-min break before proceeding to the other test condition. After the break, participants were again asked to sit quietly with their eyes closed and EEG measurement was repeated for the second baseline (5 min) and treatment (12 min) conditions. EEG was recorded during the treatment session instead of after completion of a treatment program (Davidson et al. 2003), for reason that we intended to measure acute neurophysiological effects during meditation, rather than the more long-term neurophysiological changes after a period of meditation practice.

EEG Recording

EEG was recorded using a Lycra stretchable cap with 19 electrodes positioned across the scalp according to the International 10–20 System (Jasper 1958). The EEG data collected from the 19 scalp sites was referenced to linked ears and all electrode impedances were below 10 kΩ. The EEG signal was digitally filtered at 0.5 and 100 Hz and sampled at 256 samples per second, with a high-frequency limit pass band of 30 Hz. The data was stored on computer, and a log book was kept to record any body movements that would cause disturbances in the EEG signal for off-line analyses.

Data Analysis

EEG records were displayed on computer and visually examined for eye movements and muscle artifacts. If artifact was present on a particular channel, all concurrent data from the remaining channels were manually removed prior to analysis. In addition, the first and the last 2 min of the EEG recordings of the two 12-min treatment (music/TBRT) conditions were also discarded to alleviate probable “settling” and “ending” artifact (Jacobs and Friedman 2004). The artifact-free data were then spectrally processed using the fast Fourier transformation (FFT) to compute power data for the theta (4–7.5 Hz) and alpha (8–12 Hz) bands under the 5-min eyes-closed baseline (Time 1) and the two 8-min treatment conditions (Time 2).

Relative Theta

EEG data recorded from the 19 electrode sites were averaged to obtain grand means for the anterior (FP1, FP2, F3, F4, F7, F8, Fz, T3, T4, C3, C4, Cz), posterior (T5, T6, P3, P4, O1, O2, Pz), left (FP1, F3, F7, T3, T5, C3, P3, O1) and right (FP2, F4, F8, T4, T6, C4, P4, O2) regions for further analysis. Relative power was used for analyses on the theta band based on previous findings linking relative power measures to better estimates for the theta band because (1) relative power measurements tend to give larger estimates for the dominant frequency range (Klimesch 1999), and (2) individual variations are eliminated by computing the proportion of an individual frequency band relative to the others (Chan et al. 2007). To examine the changes in relative theta power in response to the two treatment conditions, a $2 \times 2 \times 4$ (*Condition*× *Time*× *Area*) three-way analyses of variance (ANOVA) with repeated measures was performed, with *Condition* (two levels: music, TBRT), *Time* (two levels: baseline, during treatment condition), and *Area* (four levels: anterior, posterior, left, right) as within-subject factors. This was followed by post hoc *t*-tests on the relative power of the theta band. To control for inflated type I error as a result of multiple post hoc comparisons, Bonferroni correction with the adjusted alpha level of 0.006 was employed.

Source Analysis

Previous findings implicated the anterior cingulate cortex as a generator for frontal midline theta activity in the human brain (Asada et al. 1999; Ishii et al. 1999; Pizzagalli et al. 2001). To localize the sources of the theta activity in response to the two treatment conditions (music/TBRT) in the present study, we employed low-resolution electromagnetic tomography (LORETA) (Pascual-Marqui et al. 1994, 1999). The sources of the theta band computed from scalp electrical potentials were expressed as three-dimensional cortical current density according to the Talairach brain atlas. All EEG data used for FFT were analyzed with LORETA for each treatment condition.

Frontal EEG Asymmetry

Among the different methods proposed to measure the level and direction of asymmetry, the alpha asymmetry index derived from subtracting the log-transformed alpha power of two homologous electrodes is most commonly used (Davidson et al. 2000b). Empirically, the measure of alpha asymmetry has been shown to be effective and reliable in discriminating positive and negative emotions (Davidson et al. 2003; Field et al. 1998), and greater activation is generally associated with desynchronization or decrease in alpha power (Klimesch 1999; Pivik et al. 1993; Urry et al. 2004).

On the basis of Davidson's (2003) paradigm which links frontal asymmetric activation to positive emotion, the changes in asymmetric activation at four anterior electrode sites (F3/4, F7/8, T3/4, and C3/4) in response to the two treatment conditions (music/TBRT) were examined using the asymmetry index. The asymmetry index is calculated by subtracting the log-transformed absolute alpha power of the left hemisphere from the analogous log-transformed right hemisphere alpha power (log right–log left). Since alpha power is inversely associated with activation, a positive asymmetry score that denotes greater alpha activity on the right and less alpha power on the left would suggest greater left-sided activation. On the contrary, a negative score would represent greater activation on the right. ANOVA with repeated measures with *Condition* (music/TBRT) and *Time* (Time 1 being the eyes-closed baseline, and Time 2 being the two respective treatment conditions) as within-subject factors were performed for each of the four anterior asymmetry measures.

Results

Relative Theta

All 19 students completed the EEG measurements of music and TBRT. All data obtained from the experiment was suitable for analysis and the theta profiles of the two treatment conditions, music and TBRT, across the 19 electrode sites are presented in Fig. 1. Visual examination showed that relative theta power was sharply elevated across multiple channels during TBRT. ANOVA results for the four cortical regions (anterior, posterior, left, and right) indicated a significant *Condition* × *Time* interaction for the theta band, $F(3,54) = 3.621$, $p < .05$. Hence, subsequent *t*-tests were performed to explore the simple effects of *Condition* (music, TBRT) in the anterior, posterior, left and right regions, with the adjusted alpha level of $p < .006$ to control for inflated type I error. Means (*SD*) for relative theta percentage (%) are presented in Table 1. There was no significant difference for the theta band between the two baselines (music-pre, TBRT-pre) in the two *Conditions* (music, TBRT). The TBRT has shown significantly increased relative theta power across the anterior, posterior as well as the left and right regions as compared to the baseline eyes-closed condition (ranges of t values = -3.737 to -4.825, p's $< .002$). On the contrary, the music condition only showed significant increase in relative theta power over the posterior region when compared to the baseline condition ($t = -3.162$, $p < .006$) (Fig. 2).

Localization of Theta Activity

Source analysis of the changes in the theta band from Time 1 (Baseline) to Time 2 of the two different treatment conditions (music, TBRT) was computed as voxel-by-voxel *t*-value. As shown in Fig. 3, LORETA analysis has revealed that for the TBRT, the highest increase of theta activity as indicated by the maximal difference in current density of theta power, was located in the anterior cingulate cortex whereas that for the music condition was in the parietal region.

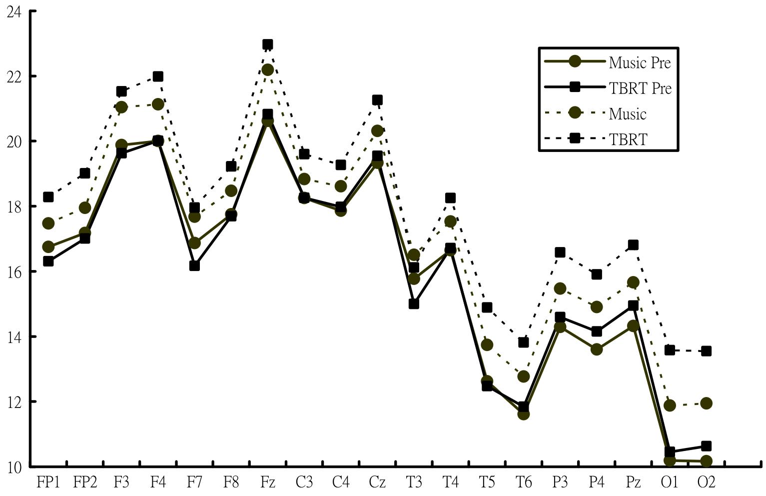

Fig. 1 Changes of mean relative theta power across the 19 channels from the two corresponding baselines (music-pre, TBRT-pre) to that of the music (music) and mindfulness exercise (TBRT) conditions

Table 1 Mean (*SD*) relative theta power values for music and mindfulness exercise (TBRT)

Region	Music		TBRT	
	Mean	(*SD*)	Mean	(*SD*)
Anterior				
Baseline	18.08	(*4.27*)	17.93	(*4.01*)
During	18.98	(*4.14*)	19.62	(*4.38*)*
Posterior				
Baseline	12.40	(*5.00*)	12.73	(*5.69*)
During	13.76	(*5.76*)*	15.02	(*6.57*)*
Left				
Baseline	15.58	(*4.44*)	15.36	(*4.46*)
During	16.58	(*4.62*)	17.32	(*5.03*)*
Right				
Baseline	15.60	(*4.23*)	15.75	(*4.62*)
During	16.66	(*4.45*)	17.62	(*5.07*)*

Italicised values are standard deviations in (). * different from baseline, p<.006

Frontal EEG Asymmetry

During the baseline assessment, no significant difference was found between the baselines of the two treatment conditions for any of the four anterior electrode sites (F3/4, F7/8, T3/4, C3/4). To investigate changes in the four anterior electrode sites during the treatment conditions, ANOVAs with *Condition* and *Time* as factors were computed and the main effects and interactions were examined. In spite of the fact that no difference in alpha power asymmetry was found in the central region (C3/4), significant main effects for *Time* were found in the frontal areas (F3/4 [$F_{(1,18)} = 5.425$, $p = .032$] and F7/8 [$F_{(1,18)} = 8.401$, $p = .010$]) as well as at the anterior temporal region (T3/4) [$F_{(1,18)} = 6.483$, $p = .02$]. These results indicated that both treatment conditions, TBRT and music, were associated with less left anterior alpha power (i.e. more left-sided activation) when compared with their respective baseline eyes-closed conditions. Furthermore, although TBRT was shown to be associated with less left anterior alpha power, hence more left-sided activation, than music

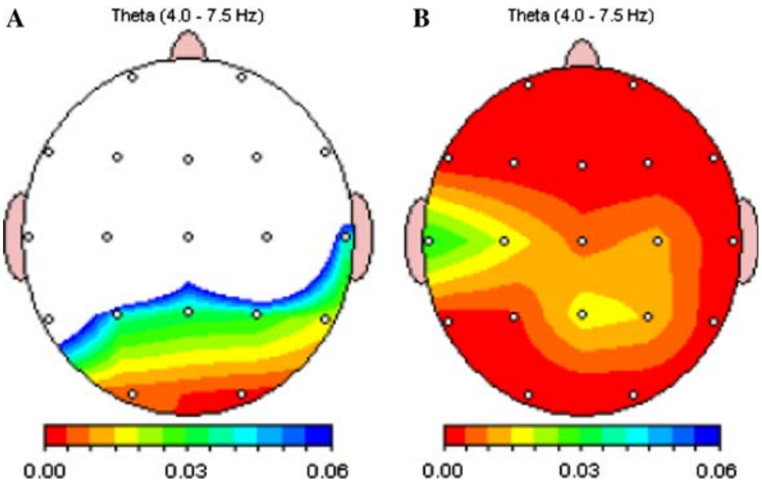

Fig. 2 Topographic maps demonstrating the *p*-values of the relative power paired *t*-tests of theta between (**a**) the baseline eyes-closed (music-pre) and the music (music) conditions and (**b**) the baseline eyes-closed (TBRT-pre) and mindfulness exercise (TBRT) conditions

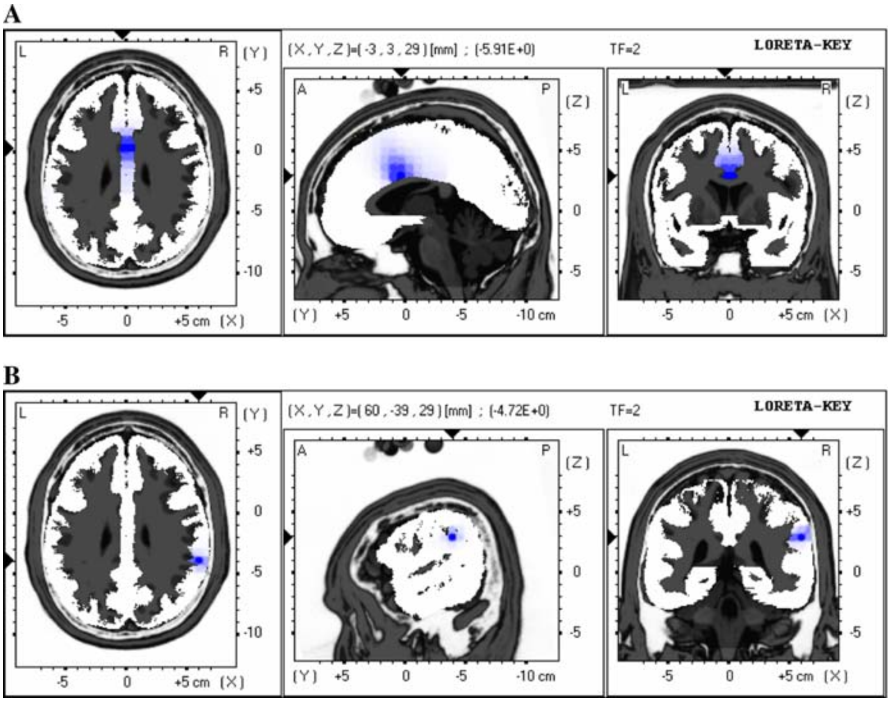

Fig. 3 *T*-statistics of theta activity during (**a**) TBRT mindfulness exercise (Time 2) as compared to the baseline eyes-closed condition (Time 1). The location of voxel is defined by the Talairach coordinates (*X*, *Y*, *Z*) and the most pronounced increase in theta activity between Time 1 and Time 2 was found in the anterior cingulate cortex. [Brodmann area 33; $t = 5.87$ ($p < .05$)] during TBRT, and (**b**) in the parietal region [Brodmann area 40, $t = 5.87$ ($p < .05$)] during the music condition

across the three anterior electrode sites (F3/4, F7/8 and T3/4) (Fig. 4), this difference failed to reach significance as shown by the non-significant *Time* × *Condition* interaction effect for any of the anterior regions.

Discussion

The main purposes of the present study were to examine the EEG pattern generated during the practice of the mindfulness-based TBRT and whether these changes in EEG pattern was associated with the frontal attentional network. Our results extended those of previous EEG studies of meditation (Aftanas and Golosheikine 2001; Inanaga 1998; Jacobs and Friedman 2004; Lou et al. 1999), and showed that the TBRT was associated with significantly greater relative theta power in both anterior and posterior regions of the brain when compared with the music condition. Although this result seems to be in line with previous findings that attribute the widespread increase in theta power to general reductions in the brain arousal systems (Canteros et al. 2002; Jacobs and Friedman 2004), the relatively poor spatial resolution of scalp-recorded brain electrical activity does not provide definitive inference with respect to the generator source of the increased theta activity (Davidson et al. 2000; Pivik et al. 1993).

Our results from EEG-based LORETA analysis have shown that the significantly increased theta activity during TBRT was generated by the anterior cingulate cortex, an area that has been widely reported to be involved in attention (Asada et al. 1999; Ishii et al. 1999; Pizzagalli et al. 2003). Our findings are in agreement with previous studies that reported increased frontal midline theta during attention-demanding tasks (Asada et al. 1999; Ishii et al. 1999), and is found to be closely associated with the concentrative aspect of meditation (Aftanas and Golosheikine 2002; Dunn et al. 1999; Kubota et al. 2001; Lazar et al. 2000; Pan et al. 1994). Collectively, these results support the idea that attention, rather than general reductions in cortical arousal, is likely to be the principal psychological response elicited by the ancient TBRT mindfulness meditative exercise.

In addition to the attentional aspect of the TBRT, results from this study also bear on the electrophysiological changes associated with positive emotions as indexed by frontal asymmetry. Recent studies have suggested that greater left-sided anterior activation, indexed by decreased alpha activity on the left hemisphere, is associated with reduction in anxiety, higher levels of positive affect, and feeling of well-being (Davidson et al. 2000b; Urry et al. 2004). Our results indicated that the TBRT and music were both associated with significant increases in left-sided anterior activation, thus supporting our hypothesis that the TBRT is associated with increased positive emotions. These results are also in line with findings from previous studies that demonstrated the therapeutic effects of meditation (Davidson et al. 2003) and music (Baranason et al. 1995; Field et al. 1998).

Taken together, our results revealed some electrophysiological findings that are consistent with the general

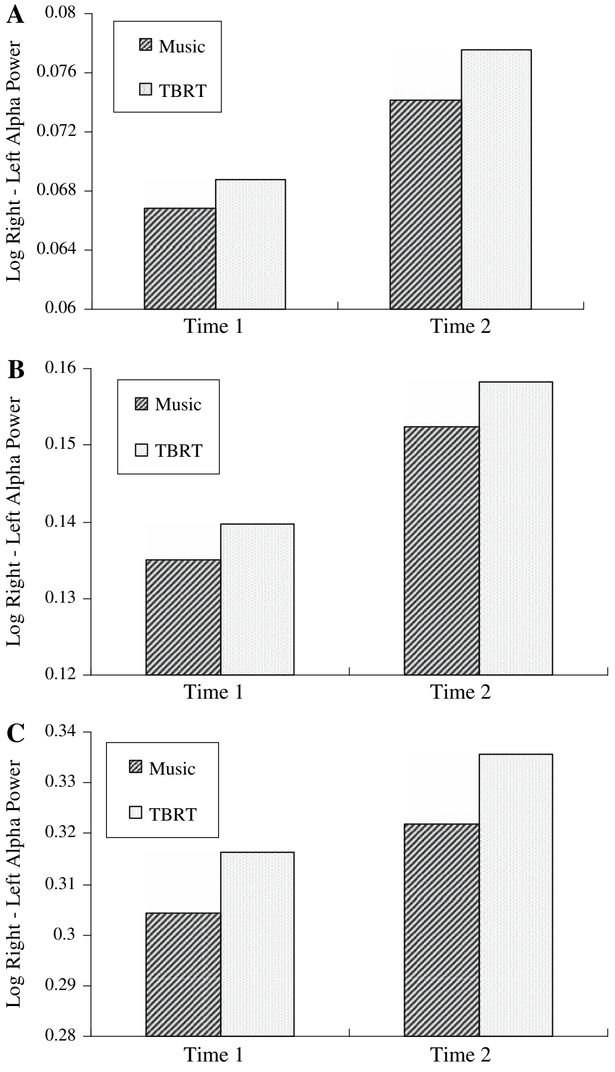

Fig. 4 Alpha asymmetry during baseline (Time 1) and treatment (Time 2) conditions for music (music) and mindfulness exercise (TBRT). The ordinate represents a standard index that denotes right minus left log-transformed alpha power in $\mu V^2/Hz$ from (**a**) F3/4, (**b**) F7/8, and (**c**) T3/4 electrode sites. Higher values of this index indicate greater left-sided activation

understanding of the psychophysiological nature of meditation, where theta and alpha activation were found to be related to changes in attentional allocation and positive affect (Aftanas and Golosheikine 2001; Cahn and Polich 2006; Dunn et al. 1999; Davidson et al. 2003). It is of interest that we observed comparable results of increased anterior left-sided activation during both TBRT and music conditions, suggesting that both conditions were able to induce positive emotions. However, increased frontal midline theta activity suggesting the involvement of the attentional network was observed only during the practice of TBRT. In agreement with the findings in prior studies of mindfulness-based interventions (Astin et al. 2003; Dunn et al. 1999; Shapiro et al. 1998), our results suggested that different EEG patterns were generated by the two different relaxation methods, i.e., while music demonstrated merely the relaxation effect, the ancient Chinese TBRT not only relaxes but also induces a unique "mindfulness" state in which relaxation and internalized attention coexist (Aftanas and Golosheikine 2005; Creswell et al. 2007; Rai 1993). In other words, mindfulness is a process whereby the brain is calm and relaxed, yet being awake and alert at the same time.

Although this study showed demonstrable effects of the mindfulness-based TBRT, there are several limitations and suggestions for future research. Since this study only examined the acute electrophysiological changes produced during TBRT practice on young healthy college students, further studies are needed to investigate the effects of TBRT on other age cohorts and on clinical populations across different conditions and diseases. For example, it will be of interest to investigate the effects of TBRT to reduce stress in patients with anxiety disorders; increase positive affect in clinical depression; or improve attention in children with attention-deficit hyperactivity disorder.

Although no structural change has been reported to be associated with regular meditation practice (Aftanas and Golosheikine 2005), longitudinal study of the long term effects of TM has shown faster decision time and performance speed in experienced TM practitioners (Cranson et al. 1991). In light of these results suggesting that meditation produces positive long-term changes in brain function, it will be very useful for future research to examine whether extended practice of the mindfulness-based TBRT would enhance the functioning of the neural structures underlying this ancient form of meditative practice.

Conclusion

Our study showed that during the practice of TBRT, an ancient form of Chinese mindfulness meditation, participants were found to have significantly increased left-sided anterior activation and frontal midline theta activity. These results provided evidence to support that the TBRT gives rise to positive emotional experience, accompanied by focused internalized attention.

References

Aftanas, L. I., & Golosheikine, S. A. (2001). Human anterior and frontal midline theta and lower alpha reflect emotionally positive state and internalized attention: high-resolution EEG investigation of meditation. *Neuroscience Letters, 310*, 57–60.

Aftanas, L. I., & Golosheikine, S. A. (2002). Non-linear dynamic complexity of the human EEG during meditation. *Neuroscience Letters, 330*, 143–146.

Aftanas, L., & Golosheikine, S. (2005). Impact of regular meditation practice on EEG activity at rest and during evoked negative emotions. *International Journal of Neuroscience, 115*, 893–909.

Allen, K., & Blascovich, J. (1994). Effects of music on cardiovascular reactivity among surgeons. *Journal of the American Medical Association, 272*(11), 882–884.

Asada, H., Fukuda, Y., Tsunoda, S., Yamaguchi, M., & Tonoike, M. (1999). Frontal midline theta rhythms reflect alternative activation of prefrontal cortex and anterior cingulated cortex in humans. *Neuroscience Letter, 274*, 29–32.

Astin, J. A., Shapiro, S. L., Eisenberg, D. M., & Forys, K. L. (2003). Mind-body medicine: state of the science, implication for practice. *Journal of the American Board of Family Practice, 16*, 131–147.

Barnason, S., Zimmerman, L., & Nieveen, J. (1995). The effects of music interventions on anxiety in the patient after coronary artery bypass grafting. *Heart & Lung Journal of Critical Care, 24*(2), 124–132.

Benson, H., Beary, J. F., & Carol, M. P. (1974). The relaxation response. *Psychiatry, 37*, 37–46.

Cahn, B. R., & Polich, J. (2006). Meditation states and traits: EEG, ERP, and neuroimaging studies. *Psychological Bulletin, 132*(2), 180–211.

Canteros, J. L., Atienza, M., Stickgold, R., & Hobson, J. A. (2002). Nightcap: A reliable system for determining sleep-onset latency. *Sleep, 25*, 238–245.

Chafin, S., Roy, M., Gerin, W., & Christenfeld, N. (2004). Music can facilitate blood pressure recovery from stress. *British Journal of Health Psychology, 9*, 393–403.

Chan, A. S., Sze, S. L., & Cheung, M. (2007). Quantitative electroencephalographic profiles for children with autistic spectrum disorder. *Neuropsychology, 21*(1), 74–81.

Cranson, R. W., Orme-Johnson, D. W., Gackenbach, J., Dillbeck, M. C., Jones, C. H., & Alexander, C. H. (1991). Transcendental meditation and improved performance on intelligence-related measures: A longitudinal study. *Personality and Individual Differences, 12*(10), 1105–1116.

Creswell, J. D., Way, B. M., Eisenberger, N. I., & Lieberman, M. D. (2007). Neural correlates of dispositional mindfulness during affect labeling. *Psychosomatic Medicine, 69*, 560–565.

Davidson, R. J. (2000). Affective style, psychopathology, and resilience: brain mechanisms and plasticity. *American Psychologist, 55*, 1196–1214.

Davidson, R. J., Ekman, P., Saron, C., Senulis, J. A., & Friesen, W. V. (1990). Approach-withdrawal and cerebral asymmetry: emotional expression and brain physiology, I. *Journal of Personality and Social Psychology, 58*, 330–341.

Davidson, R. J., Jackson, D. C., & Kalin, N. H. (2000a). Emotion, plasticity, context, and regulation: perspectives from affective neuroscience. *Psychological Bulletin, 126*, 890–909.

Davidson, R. J., Jackson, D. C., & Larson, C. L. (2000b). Human electroencephalography. In J. T. Cacioppo, L. G. Tassinary, & G. G. Berntson (Eds.), *Handbook of psychophysiology* (2nd ed., pp. 27–52). New York: Cambridge University Press.

Davidson, R. J., Kabat-Zinn, J., Schumacher, J., Rosenkranz, M., Muller, D., Santorelli, S. F., Urbanowski, F., Harrington, A., Bonus, K., & Sheridan, J. F. (2003). Alterations in brain and immune function produced by mindfulness meditation. *Psychosomatic Medicine, 65*, 564–570.

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

Dunn, B. R., Hartigan, J. A., & Mikulas, W. L. (1999). Concentration and mindfulness meditations: Unique forms of consciousness? *Applied Psychophysiology and Biofeedback, 24*(3), 147–165.

Ekman, P., Davidson, R. J., & Friesen, W. V. (1990). Duchenne's smile: emotional expression and brain physiology, II. *Journal of Personality and Social Psychology, 58*, 342–353.

Field, T., Martinez, A., Nawrocki, T., Pickens, J., Fox, N. A., & Schanberg, S. (1998). Music shifts frontal EEG in depressed adolescents. *Adolescence, 33*(129), 109–116.

Fox, N. A. (1991). If it's not left, it's right. *American Psychologist, 46*, 863–872.

Grey, P. (2001). The music of nature and the nature of music. *Science, 291*, 52–56.

Harrison, L. J., Manoch, R., & Rubia, K. (2004). Sahaja yoga meditation as a family treatment programme for children with attention deficit-hyperactivity disorder. *Clinical Child Psychology and Psychiatry, 9*, 479–497.

Henriques, J. B., & Davidson, R. J. (1990). Regional brain electrical asymmetries discriminate between previously depressed and healthy control subjects. *Journal of Abnormal Psychology, 29*, 22–31.

Inanaga, K. (1998). Frontal midline theta rhythm and mental activity. *Psychiatry and Clinical Neurosciences, 52*, 555–566.

Infante, J. R., Torres-Avisbal, M., Pinel, P., Vallejo, J. A., Peran, F., & Gonzalez, F. (2001). Catecholamine levels in practitioners of the transcendental meditation technique. *Physiology and Behavior, 72*, 141–146.

Ishii, R., Shinosaki, K., Ukai, S., Inouye, T., Ishihara, T., Yoshimine, T., Hirabuki, N., Asada, H., Kihara, T., Robinson, S. E., & Takeda, M. (1999). Medial prefrontal cortex generates frontal midline theta rhythm. *NeuroReport, 10*, 675–679.

Jacobs, G. D., & Lubar, J. F. (1989). Spectral analysis of the central nervous system effects of the relaxation response elicited by autogenic training. *Behavioral Medicine, 15*, 125–132.

Jacobs, G. D., & Friedman, R. (2004). EEG spectral analysis of relaxation techniques. *Applied Psychophysiology and Biofeedback, 29*, 245–254.

Jasper, H. H. (1958). The 10–20 electrode system of the international federation. *Electroencephalography and Clinical Neurophysiology , 10*, 371–375.

Jones, B. M. (2001). Changes in cytokine production in healthy subjects practicing Guolin Qigong: a pilot study. *BMC Complementary and Alternative Medicine, 1*(1), 8. Retrieved July 19, 2007 from http://www.biomedcentral.com/1472-6882/1/8.

Klimesch, W. (1999). EEG alpha and theta oscillations reflect cognitive and memory performance: a review and analysis. *Brain Research Reviews, 29*(2–3), 169–195.

Knight, W. E., & Rickard, N. S. (2001). Relaxing music prevents stress-induced increases in subjective anxiety, systolic blood pressure, and heart rate in healthy males and females. *Journal of Music Therapy, 38*(4), 254–272.

Kubota, Y., Sato, W., Toichi, M., Murai, T., Okada, T., & Hayashi, A. (2001). Frontal midline theta rhythm is correlated with cardiac autonomic activities during the performance of an attention demanding meditation procedure. *Cognitive Brain Research, 11*, 281–287.

Lazar, S. W., Bush, G., Gollub, R. L., Fricchione, G. L., Khalsa, G., & Benson, H. (2000). Functional brain mapping of the relaxation response and meditation. *NeuroReport, 11*(7), 1581–1585.

Lou, H. C., Kjaer, T. W., Friberg, L., Wildschiodtz, G., Holm, S., & Nowak, M. (1999). A ^{15}O-H_2O PET study of meditation and the resting state of normal consciousness. *Human Brain Mapping, 7*(2), 98–105.

Murata, T., Takahashi, T., Hamada, T., Omori, M., Kosaka, H., Yoshida, H., & Wada, Y. (2004). Individual trait anxiety levels characterizing the properties of Zen meditation. *Neuropsychobiology, 50*, 189–194.

Mornhinweg, G. C. (1992). Effects of music preference and selection on stress reduction. *Journal of Holistic Nursing, 10*, 101–109.

Pan, W., Zhang, L., & Xia, Y. (1994). The difference in EEG theta waves between concentrative and non-concentrative qigong states: Power spectrum and topographic mapping study. *Journal of Traditional Chinese Medicine, 14*, 212–218.

Pascual-Marqui, R. D., Lehmann, D., Koenig, T., Kochi, K., Merlo, M. C. G., Hell, D., & Koukkou, M. (1999). Low resolution brain electromagnetic tomography (LORETA) functional imaging in acute, neuroleptic-naïve, first-episode, productive schizophrenia. *Psychiatry Research-Neuroimaging, 90*, 169–179.

Pascual-Marqui, R. D., Michel, C. M., & Lehmann, D. (1994). Low resolution electromagnetic tomography: a new method for localizing electrical activity in the brain. *International Journal of Psychophysiology, 18*, 49–65.

Pivik, T., Broughton, R., Coppola, R., Davidson, R. J., Fox, N. A., & Nuwer, R. (1993). Guidelines for quantitative electroencephalography in research contexts. *Psychophysiology, 30*, 547–548.

Pizzagalli, D. A., Oakes, T. R., & Davidson, R. J. (2003). Coupling of theta activity and glucose metabolism in the human rostral anterior cingulate cortex: an EEG/PET study of normal and depressed subjects. *Psychophysiology, 40*, 939–949.

Pizzagalli, D., Pascual-Marqui, R. D., Nitschke, J. B., Oakes, T. R., Larson, C. L., Abercrombie, H. C., Schaefer, S. M., Koger, J. V., Benca, R. M., & Davidson, R. J. (2001). Anterior cingulate activity as a predictor of degree of treatment response in major depression: evidence from brain electrical tomography analysis. *American Journal of Psychiatry, 158*, 405–415.

Rai, U. C. (1993). *Medical science enlighted*. London-New York: Life Eternal Trust.

Rani, N. J., & Rao, P. V. K. (1996). Meditation and attention regulation. *Journal of Indian Psychology, 14*, 26–30.

Scheufele, P. M. (2000). Effects of progressive relaxation and classical music on measurements of attention, relaxation, and stress responses. *Journal of Behavioral Medicine, 23*(2), 207–227.

Shapiro, S. L., Schwartz, G. E., & Bonner, G. (1998). Effects of mindfulness-based stress reduction on medical and premedical students. *Journal of Behavioral Medicine, 21*(6), 581–599.

Stetter, F., & Kupper, S. (2002). Autogenic training: a meta-analysis of clinical outcome studies. *Applied Psychophysiology and Biofeedback, 27*, 45–98.

Thayer, R. (1996). *The origins of everyday moods*. New York: Guilford Press.

Urry, H. L., Nitschke, J. B., Dolski, I., Jackson, D. C., Dalton, K. M., Mueller, C. J., Rosenkranz, M. A., Ryff, C. D., Singer, B. H., & Davidson, R. J. (2004). Making a life worth living: neural correlates of well being. *Psychological Science, 15*(6), 367–372.