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AN 8-WEEK TAOIST MEDITATION TRAINING ALTERED BRAIN ACTIVITY AT REST, BUT NOT DURING MEDITATION

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Abstract. Numerous recent studies have revealed changes in brain activity due to the practice of meditation. In our prior research (Volodina et al., 2021), two distinct physiological approaches to meditation were identified among experienced meditators. To determine whether an individual physiological approach can be detected in the early stages of meditation training, this study examined changes in brain activity parameters following 8 weeks of Taoist meditation course (2 sessions per week). The aim was to notice any changes in physiological processes during meditation after the training period and, if so, to identify whether they were associated with changes in resting state indicators. While we did not observe changes in the dynamics during meditation, we found changes in resting-state EEG after the course. We suggest that 8 weeks of training may not have been enough to reveal changes during meditation. However, 16 hours of training resulted in a significant increase in delta and theta power in the resting brain activity of the meditators.

Keywords: neurodynamics, taoist meditation, EEG, brain activity, mindfulness

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Introduction

Numerous recent studies reveal changes in human brain activity due to the practice of meditation. One typical change during meditation is the simultaneous increase in power of the theta and alpha rhythms, which may be an indication of a state of relaxed alertness, as noted in studies by Lomas et al. (2015) and Aftanas and Golosheykin (2005). There are also a number of studies examining the effects of meditation training on individuals who are new to the practice. For example, Dunn conducted a study in which beginners were trained to perform concentration and mindfulness meditation, and found that the mean alpha and beta-1 amplitudes were higher during mindfulness meditation compared to relaxation (Dunn et al., 1999). In our prior research (Volodina et al., 2021), two distinct physiological approaches to meditation among experienced meditators were identified. This has led to a hypothesis that individual predisposition plays a role in determining different meditation strategies. To further extend the knowledge about the effects of meditation, this study examined changes in brain activity parameters following eight weeks of Taoist meditation training (two sessions per week).

Method

The study included 25 participants divided into two groups: an experimental group of 12 participants (3 men and 9 women, an average age of 28.08 ± 5.45 years), and a control group of 13 participants (4 men and 9 women, an average age of 27.69 ± 5.68 years). None of the participants had any prior experience of practicing meditation. Additionally, they did not consume any medications that impact the central nervous system, such as sedatives or antidepressants, and were not diagnosed with any mental illness or brain disorder.

Before the experiment, we analyzed various physiological parameters, as well as gender and age, the meditators and the control group were similar in all indicators.

EEG data were recorded using a wireless EEG system (SmartBCI, Mitsar, Russia). The system had 30 channels with a sampling rate of 250 Hz. To establish a reference for all EEG data channels, the averaged ear signal was used. The EEG data was synchronized precisely with audio instructions delivered through standard in-ear headphones. A Python script was used to simultaneously present the audio instructions and collect EEG data. The EEG data was preprocessed as follows: bandpass filter with 1 – 40 Hz, a 50 Hz notch filter. Independent component analysis was then performed to identify and remove components related to eye movements and muscle activity. The data was reviewed and artifacts were cut out. For subsequent data processing, MNE-Python was utilized. EEG power spectra were computed using the Welch method, using a window size of 1 s with no overlap for each meditation stage separately. Next, we averaged power spectral density profiles within the following five bands: Delta: 1 – 4 Hz, Theta: 4 – 8 Hz, Alpha: 8 – 14 Hz, Beta: 14 – 25 Hz, and Gamma: 25 – 40 Hz. To reduce multiple comparisons, the 30 EEG channels were grouped into six topographic brain regions: Frontal area (Fp1, Fp2, F7, F3, Fz, F4, F8), Central area (FC1, FC2, Cz, CP1, CP2), Parietal area (P7, P3, Pz, P4, P8), Left central area (FC5, C3, Cp5, T7), Right central area (FC6, C4, CP6, T8), and Occipital area (O1, O2, Oz, PO3, PO4).

Prior to the start and after the completion of the course, all participants underwent EEG testing with an interval of 8 weeks. The course involved Taoist meditation, and participants attended group meetings twice a week for a duration of 8 weeks. During the meetings, the participants from the experimental group practiced the meditation with the guidance of a certified instructor and the control group participants listened to audiobooks. Both groups received the course/lectures in the same auditorium for 1 hour, 2 days per week, in the evening.

The testing involved a specific audio-guided meditation protocol, where participants were given audio instructions. Each stage of meditation lasted approximately 2 minutes, and the end of each audio instruction marked the beginning of a new stage. For statistical analysis purposes, the meditation intervals were combined into 6 stages as follows:

1. Resting state: Pre-meditation resting state
2. Combined stages 1 – 4 (relaxation, body scan, taking position)
3. Combined stages 5 – 7 (stopping internal dialogue)
4. Combined stages 8 – 10 (visualization)

5. Combined stages 11 – 14 (coming back, focus on breathing and body)
6. Post-meditation resting stage

A complete guide to meditation that describes all stages can be viewed in our previous article (Volodina et al., 2021).

Results

A linear mixed effects (LME) model was used to assess the impact of group (control vs. meditators) and time point (before and after training) on variables separately for each particular band and brain region. For the variables that exhibited a significant interaction between these factors, we conducted a Wilcoxon test to compare the pre- and post-intervention values. In order to account for multiple comparisons, we employed FDR correction using the B-H procedure to obtain the corrected *p*-values.

In the resting state with open eyes the results indicated a significant increase in parietal ($p = .036$, mean ± *SE* at baseline 6.26 ± 0.73 and 7.53 ± 1.11 after) and right central delta power ($p = .036$, mean ± *SE* at baseline 4.37 ± 0.48 and 5.37 ± 0.61 after), as well as parietal ($p = .036$, mean ± *SE* at baseline 2.45 ± 0.57 and 3.39 ± 0.92 after) and occipital ($p = .049$, mean ± *SE* at baseline 2.26 ± 0.46 and 3.01 ± 0.71 after) theta power in the meditators group. Also we observed a trend of decreased parietal delta power in the control group ($p = .077$, mean ± *SE* at baseline 6.51 ± 0.54 and 5.29 ± 0.45 after).

In the resting state with closed eyes, we observed an increasing trend ($p = .06$) in right central delta ($p = .06$, mean ± *SE* at baseline 4.09 ± 0.47 and 5.97 ± 0.97 after) and theta power ($p = .06$, mean ± *SE* at baseline 2.12 ± 0.42 and 3.06 ± 0.74 after), as well as an increase in frontal alpha power ($p = .06$, mean ± *SE* at baseline 4.19 ± 1.18 and 5.91 ± 1.76 after) in the meditators group. The LME model indicated a significant interaction between "group" and "time point" while evaluating EEG data during meditation. Nevertheless, the interaction between "time point" and "meditation stage" did not remain statistically significant after adjusting for multiple comparisons.

Discussion and Conclusions

In conclusion, an 8-week training course of Taoist meditation caused changes in brain activity (increase in delta and theta power) in resting state. There is evidence supporting the theory that delta oscillations are associated with basic motivational processes and may be involved in the continuous monitoring of internal and external stimuli, including those that are not consciously perceived (Knyazev, 2012). Previous research has shown that positive emotional states and internalized attention during meditation are associated with the increase in local theta and reduced alpha power (Aftanas, Golosheykin, 2005). The increase in theta and alpha power observed in the meditators group after the intervention is a typical change that has been previously reported in studies of meditation, as was mentioned before. However, unlike previous studies, we did not observe an increase in alpha power during the resting state in the eye-open condition. No significant

changes were observed in the indicators' dynamics during the very meditation process, which could be explained by the short training duration. The course did not affect the brain activity changes trajectory during meditation initiation, so no conclusions can be drawn about predisposition to specific meditation strategy in our participants.

Limitations

Based on our findings, it can be inferred that undergoing 16 hours of instructed meditation training over an 8-week period is insufficient to produce consistent and objectively registered changes in neurodynamics during the mediation process.

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ВОСЬМИНЕДЕЛЬНЫЙ КУРС ДАОССКОЙ МЕДИТАЦИИ ПРИВЕЛ К ИЗМЕНЕНИЮ АКТИВНОСТИ МОЗГА В СОСТОЯНИИ ПОКОЯ, НО НЕ ВО ВРЕМЯ МЕДИТАЦИИ

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Аннотация. Многочисленные исследования показывают изменения в мозговой активности людей в результате практики медитации. В нашем предыдущем исследовании (Volodina et al., 2021) были выявлены два различных физиологических подхода к медитации у опытных медитаторов. Чтобы выяснить, обнаруживается ли на ранних стадиях обучения медитации предрасположенность к одному из физиологических подходов, в данном исследовании мы изучили изменения параметров активности мозга после

восьминедельного курса даосской медитации (2 занятия в неделю). Нашей задачей было выявить изменения динамики физиологических процессов во время медитативной практики после прохождения обучения и выяснить, есть ли связь между этими изменениями во время медитации и физиологическими показателями в состоянии покоя. В результате мы обнаружили изменения в состоянии покоя после прохождения курса, но не увидели изменений в динамике во время медитации. Мы предполагаем, что восьминедельного обучения недостаточно для выявления изменений во время медитации. Тем не менее, 16 часов тренинга медитации привели к значительному увеличению у участников мощности дельта- и тета-ритма в состоянии покоя.

Ключевые слова: нейродинамика, медитация, ЭЭГ, активность мозга, практика осознанности

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