

The effectiveness of mindfulness meditation on the time perception and brain waves using a temporal bisection task in the student population

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Abstract

Introduction: Time perception is a category stimulating intelligent human curiosity for scientific manipulation and cognition. The present study aimed to investigate the effects of mindfulness on the time perception and brain waves using the temporal bio-section task.

Methods: This research was carried out using a randomized controlled clinical trial, which was lasted from autumn 2018 to 2020. One hundred forty-three students of the Science and Research Branch of Islamic Azad University participated voluntarily in the experiments. In a structured clinical interview for the DSM-5 (SCID-5-CV) psychiatric disorder, thirty-one undergraduate students were assessed for mental health and brain disease. Their mindfulness ability was moderate based on the Freiburg questionnaire, and they were assigned randomly into experimental and control groups, containing sixteen and fifteen participants, respectively. The experimental and control groups were played a 13-minute mindfulness audio file and a neutral file. 19-channel EEG signals during the temporal bio-section task were recorded from participants, while the power of brain waves in different frequency bands in channels C3, C4, Cz, F3, F4, Fz, and Pz was calculated before and after presenting the independent variable in two groups.

Results: The results showed an increase in beta, delta, and theta power in different channels. Alpha power changes were obtained inconsistently. The gamma power and theta to beta ratio were significantly reduced in the experimental group. Behavioral findings showed an increase in the number of long responses (Percentage long response) and a decrease in the bio section point (Bisection point).

Conclusion: The results revealed that the variable of mindfulness is influential in the process of cognitive processing of time perception and causes overestimation in time perception by changing the above electrophysiological measures, which indicate a decrease in arousal, increased internal concentration, increased motor inhibition, and increased physical awareness and emotional regulation.

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Extended Abstract

Introduction

Time Perception is a category that stimulates human's intelligent curiosity for scientific manipulation and cognition. Differences in cognitive function of time perception in different areas such as time awareness, time perspective,

and time estimation concerning different variables such as age, different emotional and mental states, different personality traits, and different psychiatric disorders have been studied.

In this regard, the relationship between altered states of consciousness and time perception is one of the essential and new areas of attention. In this area, the altered states of consciousness due to meditation exercises have attracted a lot of attention. The mindfulness technique is one of the meditation techniques that affect human cognitive function, including time perception.

The studies that have been done in this field are primarily in the field of cognitive, behavioral, and perceptual. However, very little research has been done on the electrophysiological mechanisms of the effect of mindfulness on the time perception.

This study aimed to investigate the effects of mindfulness on the time perception and brain waves using a bio section task with a controlled group experimental design.

Methods

This research was carried out through a randomized controlled clinical trial, which was lasted from autumn 2018 to 2020. 143 students of the Science and Research Branch of Islamic Azad University participated voluntarily in the experiments. In a structured clinical interview for the DSM-5 (SCID-5-CV) psychiatric disorder, thirty-one undergraduate students were assessed for mental health and brain disease. Their mindfulness ability was moderate based on the Freiburg questionnaire, and they were assigned randomly into experimental and control groups, containing sixteen and fifteen participants, respectively. The experimental and control groups were presented a 13-minute mindfulness audio file and a neutral file to 19-channel EEG signals during the temporal bio section task was recorded from participants, while the power of brain waves in different frequency bands were calculated before and after presenting the independent variable in two groups in channels C3, C4, Cz, F3, F4, Fz, and Pz.

F3, Fz, F4, F3, C3, Cz, C4, and Pz channel signals from 19 channels, in 7 conditions, and two pre-test and post-

test stages were used for analysis. ICA removed the EMG and EOG artifacts and blinking. Spectral analyzes in the range of 0.5 to 40 Hz were considered. Finally, the signals were visually examined, and the artifact was removed using amplitude thresholding.

The Welch power spectrum density estimation method performed power extraction, hamming window 400 ms, 50% overlap, and 0.25 Hz resolution. Frequency bands, Delta 0.5-4, Theta 4-8, Alpha 1: 8-10, Alpha 2: 10-12, Beta 12-30, Gamma 1: 30-35, and Gamma 2: 35-40 Hz were considered. Signal segments were defined from the start of the stimulus display to the response moment in each trial. 500 milliseconds before the trial, and the reference interval was considered. The normalized power was calculated from the relation (signal segment absolute power minus reference absolute power divided by reference absolute power), representing the percentage increase in power from the reference interval to the excitation interval.

Subjects were selected with scores (-1Z - +1Z) on the Freiburg scale. An independent t-test assessed no significant difference between the two groups. Data beyond 1.5 times the interquartile range were defined as an outlier and removed. Normalized power of different frequency bands extracted from target channels was compared between two groups before and after presenting the independent variable using both ANCOVA and MANCOVA tests.

Results

Based on the findings of the ANCOVA test, mindfulness-based intervention decreased BP scores and increased the percentage of long responses in the experimental group compared to the control group.

Mindfulness intervention has increased beta power at C3, F4, and Fz, delta at F3, Fz and Pz, theta at C4, F4 and Fz, and theta-to-beta size at C4, Cz, and Pz.

Alpha power decreases in C3, F3, F4, and Fz, and increases in Cz and C3; alpha 1 decreases in C4 condition 1; Fz

decrease in C4 condition 2 and 3; Cz and Pz decrease, and alpha 2 decreases in C3 condition 2 and C3 condition 7; C4 and F4 it has increased. Therefore, the alpha changes in C3 and F4 were contradictory, and it is impossible to make an integrated inference from the power changes of this wave in C3 and F4. Nevertheless, alpha power increased at C4, Cz, and Pz and decreased at F3 and Fz.

Decreased gamma power was observed in F3, F4, and Fz, gamma 1 in F3, gamma 2 in C3, Cz, F3, F4, and Fz. As a result, it can be hypothesized that mindfulness may also improve temporal function by increasing motor inhibition.

Conclusion

Thus, mindfulness has led to an increase in the percentage of long responses (Plong) and a decrease in the bio section points (Bp), resulting in an overestimation of time perception.

Mindfulness increases beta, delta, and theta power, resulting in decreased arousal. The decrease in gamma, which indicates an increase in motor inhibition, physical awareness, and emotional regulation, was also proven in this study.

The reduction in the theta-to-beta size, indicating an increase in internal focus, also shows in this study that mindfulness overestimates time by changing the outward-inward focus of attention.

Therefore, these changes seem to be the electrophysiological mediators of the effect of mindfulness meditation on the process of cognitive processing of time perception in an overestimated way in time perception.

Changes in alpha power were obtained inconsistently, requiring further research by examining the distinctive effect of alpha on the hemispheres.

According to the results of this study, people estimate longer time intervals after performing mindfulness exercises by decreasing arousal, increasing attention to internal stimuli, and increasing motor inhibition. This effect

occurs with the increasing power of beta, delta, and theta, and decreasing gamma, which are possible electrophysiological mediators in this process. Based on the contradictory alpha results, a more detailed study of alpha changes in the hemisphere is suggested.

Ethical Considerations

Compliance with ethical guidelines

An ethical consent form approved by Tabriz University was obtained from all subjects. The present study consisted of data analysis, and it was approved by the Faculty of Educational Sciences and Psychology, University of Tabriz.

Authors' contributions

Mohammad Ali Nazari, Mohammad Reza Feizi Derakhshi, and Touraj Hashemi guided the idea generation and design phase. Shahnaz Sabouri has done all the performing steps, sampling, and writing. Maryam Houry Pasand was involved in constructing the bio section task and its execution. Zeynab Khodakarami assisted in signal processing and data extraction, Behzad Golizadeh in statistical processing, and Homa Hashemi in typing and editing.

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Conflict of interest

The authors declare no conflict of interest.