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Original Article

Emotion Regulation Effect of Baduanjin on College Students: A Pilot Event-Related Potential Study on Late Positive Potential

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Abstract

Objective: This study aimed to investigate the emotion regulation effect of Baduanjin Qigong on college students. **Methods:** The late positive potential (LPP) components were recorded while performing emotional pictures from 12 college students with Baduanjin Qigong experience and 12 with no experience of any mind–body exercises. **Results:** Under positive emotional stimuli, greater LPP amplitudes were observed in the experimental group in the frontal, central, and temporal areas than in the control group. Under negative emotional stimuli, greater LPP amplitudes were found in the experimental group in the prefrontal area and smaller amplitudes in the occipital area than in the control group. **Conclusion:** The results reveal the emotion regulation effect on the event-related potential of Baduanjin Qigong to college students. The findings suggest that the regulatory effect of Baduanjin Qigong on emotional stimulation may be a possible reason for reducing the symptoms of depression and anxiety.

Keywords: Baduanjin, emotion, event-related potential, mind–body exercises, qigong

Introduction

Nowadays, psychological problems are becoming increasingly common among college students because going to college can be stressful for many students.[1-3] Many college students report that they experience great stress and feel overwhelmed and exhausted at the same time.[4] Not only do students have to cope with academic pressure, but some students also have to deal with family-related matters, while others may have to take on a lot of work.[5] It is not difficult to speculate that college students are prone to depression and anxiety in a high-pressure atmosphere.[6-8]

Emotional regulation refers to the process of which emotions we have and how we feel and express emotions.[9] Adequate emotional control is essential for mental health. Previous studies have shown that mental problems, such as depression and anxiety, have complex associations with emotion regulation.[10,11] Hence, appropriate methods of emotion regulation are crucial to improving the mental state of college students and are particularly worthy of academic investigation. In the East, there have been many ways to regulate emotions since ancient times,[12-15] and Baduanjin Qigong is one of them which is widely spread in China.[16] Baduanjin Qigong is a representative traditional Chinese Qigong practice that focuses on the adjustment of the body, breath, and mind. Previous studies have shown that Baduanjin Qigong could improve physical and psychological status[17-19] and significantly increase the volume of gray matter in multiple brain regions.[20] However, the underlying mechanisms of emotion regulation in Baduanjin Qigong remain unclear.

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The event-related potential (ERP) is a specific component extracted from the electroencephalogram (EEG). Unlike functional magnetic resonance imaging, ERP has a very high time resolution and can reflect rapid changes in the nerves.[21] Previous studies have examined the effects of traditional sports on ERP. Studies of Taijiquan and meditation have shown that the amplitude of the P3b ERP is larger than that of the sedentary control.[22] ERP is sensitive to reflect the emotional processes of stimuli, especially pictures, and thus provides a suitable research tool for emotional responses.[23] The presumptive emotion regulation of traditional Eastern training has aroused great interest in the scientific community, especially in the field of neuroscience.[24,25] Among ERP components, the late positive potential (LPP) is the most relevant to emotional regulation, which is a slow-wave component that becomes obvious approximately 300 ms after the stimulation begins. Previous studies have found that, compared to neutral pictures, the amplitudes of LPP are larger after the presentation of both positive and negative pictures.[21,26-29] Reappraisal instructions that reduce negative emotions can reduce LPP, and reappraisal instructions that enhance negative emotions can increase LPP.[30,31]

Therefore, we need more data to explore the impact of psychosomatic exercise on emotional processing, especially for college students. This study aimed to explore the effect of Baduanjin Qigong on LPP, which elicited affective pictures. The LPP data obtained in this study would provide more evidence for the application of Baduanjin in emotion regulation.

Methods

Participants

The study design was approved by the Medical and Animal Experimental Ethics Committee of the Beijing University of Chinese Medicine (BJZYYDX-LL2014005). The study was conducted following the Helsinki Declaration, and all participants were informed of the entire process of the experiment and signed a consent form. Twenty-four right-handed college students (19–21 years old) were recruited from the Beijing University of Chinese Medicine. Twelve participants (6 males and 6 females) with 1-year experience (at least three 20 min weekly training sessions) of Baduanjin Qigong training, who had learned and practiced Baduanjin Qigong from the Medical Qigong class, were assigned to the experimental group. Another 12 participants (6 males and 6 females) with no experience of any mind–body exercises were assigned to the control group. All participants had normal eyesight (or wore corrective glasses), were not currently taking any medication, and had no history of substance abuse or mental health disorders.

Event-related potential experiment

Stimuli

Ninety pictures were selected from the Chinese Affective Picture System,[32] a Chinese localized picture stimulation system based on the compilation of the International Affective Picture System.[33] A total of 90 pictures were selected for this study. Among them, there were 30 positive pictures (flowers, lovely babies, interesting animals, etc.), 30 neutral pictures (office supplies, furniture, daily necessities, etc.), and 30 negative pictures (spiders, accident scenes, sad expressions, etc.). The three types of pictures were significantly different in the valence dimension. These stimuli were displayed on a color computer monitor with E-prime 2.0 software (Psychology Software Tools, Inc.) to accurately control the duration of the stimuli. Each picture was displayed at the center of the monitor at a viewing distance of approximately 80 cm.

Procedure

During the ERP test, the participants sat on a wooden chair in a dark room. After the sensor was installed, participants were instructed to watch emotional pictures. Participants have plenty of time to read the test requirements and follow the instructions for keystrokes.

Figure 1 shows the sample test sequences for this task. All emotional pictures were shown on a white background. Each trial began with 800 ms (+), followed by an emotional picture of 1500 ms. Different kinds of emotional pictures (positive, negative, and neutral) are arranged in a pseudorandom order.

Participants were then asked to evaluate the picture they had just seen with a key on the keyboard. Press the "F" button if you have just seen a positive picture, press the "J" button if you have just seen a negative picture, and press the "Space" button if you have just seen a neutral picture. To reduce the artifacts caused by physical activity, participants were asked not to press buttons before the picture disappeared. After the participants completed the keystroke, a blank screen with a random duration of 800–1200 ms appeared and began a new round of trails.

In the test, all selected pictures are shown twice. Participants were required to view 186 pictures. The first six pictures were used for learning operations and were not used for the data analysis. After viewing every 60 pictures, a 1 min break was arranged.

Data collection and analysis

The EEG signals were recorded using NeuroScan NuAmps acquisition amplifiers (NeuroScan Inc., USA) with 30 Ag/AgCl electrodes, which were fixed on an elastic cap. The grounding electrode was arranged on the midline of the prefrontal lobe, and the reference electrode was located on the left mastoid. The vertical ophthalmic electrodes were located at the superior and inferior 1 cm of the left eye, and the horizontal ophthalmic electrodes were located 1 cm from the left eye corner and the outer corner of the right eye. The impedance of all electrodes decreased to 5 kΩ.

The sampling rate of EEG signal acquisition was 1000 Hz, and the range of the band-pass filter was 0.01100 Hz. The processing software for the EEG signal was Scan 4.5 package (NeuroScan Inc.). When the data were processed offline, the reference electrode was converted to the average value of the left and

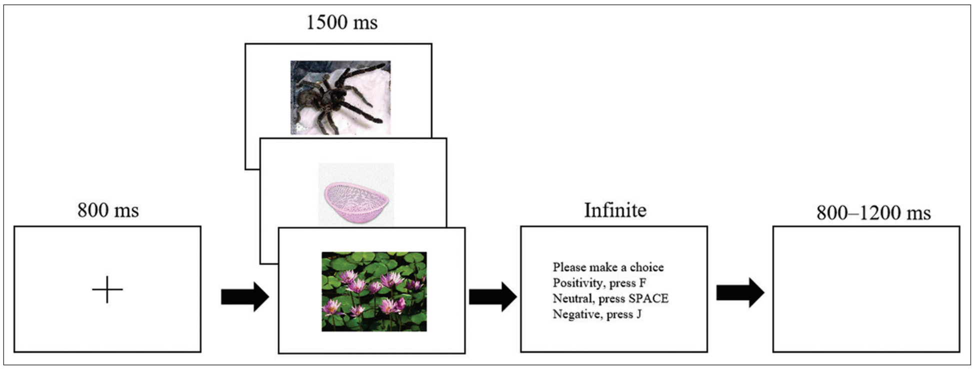

Figure 1: Schematic diagram of the stimulation of affective pictures

right mastoids. After the operation step of reference electrode conversion, the reduction of eye artifacts was carried out to eliminate the effect of eye movement on the EEG data. Then, low-pass filtering was performed on the EEG data, and the allowable frequency was below 30 Hz. The EEG signal of each trial was segmented, and the duration of each data segment was 1700 ms, from the 200 ms beginning of the emotional picture to the end of the 1500 ms. The data would be removed if there was a value >100 μV or <100 μV in the segmented data.

All electrodes on the scalp were analyzed. The 200 ms before the appearance of the emotional pictures was used for baseline correction. In the 1500 ms data after the appearance of emotional pictures, we selected 300–1200 ms data for the analysis. We further divided the data into three time windows (300–600 ms, 600–900 ms, and 900–1200 ms) to reveal the time characteristics of the LPP changes. The average amplitudes of the three time windows were then calculated.

To reduce the individual differences of the subjects when looking at the pictures, the mean voltages of emotional pictures were used minus the mean voltages of neutral pictures (positive–neutral, negative–neutral). A 2 (between-subjects factor: group) ×2 (within-subjects factor: emotion) repeated-measures ANOVA was performed for each electrode and each time window. The Greenhouse–Geisser method was used to correct for significant differences in sphericity. The Bonferroni method was used for the correction of multiple comparisons. The data were processed using the SPSS software (Version 22.0, IBM, Armonk, NY, USA).

Results

Figures 2 and 3 show the topographic maps depicting the spatial distribution of mean LPP differences (positive–neutral, negative–neutral) between the two groups, from 300 to 1200 ms after picture onset.

The repeated-measures ANOVA results of 300–600 ms time window showed significant main effects for group on CP4, $F(1,22) = 4.302$, $P = 0.050$, $\eta^2 = 0.164$; F8, $F(1,22) = 4.803$, $P = 0.039$, $\eta^2 = 0.179$; and FT8, $F(1,22) = 5.431$, $P = 0.029$, $\eta^2 = 0.198$. Multiple comparisons showed that LPP differences in CP4, F8, and FT8 in the control group were significantly lower than those in the experimental group. In addition, significant group × emotion interactions were found on C4, $F(1,22) = 6.537$, $P = 0.018$, $\eta^2 = 0.229$; CP4, $F(1,22) = 5.138$, $P = 0.034$, $\eta^2 = 0.189$; F8, $F(1,22) = 9.842$, $P = 0.005$, $\eta^2 = 0.309$; FT8, $F(1,22) = 10.474$, $P = 0.004$, $\eta^2 = 0.323$; and TP8, $F(1,22) = 8.063$, $P = 0.010$, $\eta^2 = 0.268$. Multiple comparisons showed that LPP differences of positive-neutral on C4, CP4, F4, F8, FC4, FCZ, FT8, and TP8 in the control group were significantly lower than those in the experimental group, and no significant effects were found between the two groups.

The results of 600–900 ms time window showed significant main effects for Group on C4, $F(1,22) = 4.703$, $P = 0.041$, $\eta^2 = 0.176$; F8, $F(1,22) = 4.527$, $P = 0.045$, $\eta^2 = 0.171$; O2, $F(1,22) = 5.040$, $P = 0.035$, $\eta^2 = 0.186$. Multiple comparisons showed that LPP differences of the experimental group were significantly greater on CP4 and F8 and significantly smaller on O2 than the control group. In addition, significant group × emotion interactions were found on C4, $F(1,22) = 4.786$, $P = 0.040$, $\eta^2 = 0.179$; CP4, $F(1,22) = 4.434$, $P = 0.047$, $\eta^2 = 0.168$; TP8, and $F(1,22) = 5.481$, $P = 0.029$, $\eta^2 = 0.199$. Multiple comparisons showed that LPP difference of positive–neutral on C4, CP4, F8, and TP8 of the control group was significantly lower than that of the experimental group. LPP differences of the negative–neutral of the experimental group on FP2 were significantly greater, and those on O1 and O2 were significantly smaller than those in the control group. No significant results were observed for the other electrodes.

The results of 900–1200 ms time window showed significant main effects for group on F7, $F(1,22) = 5.228$, $P = 0.032$, $\eta^2 = 0.192$; F8, $F(1,22) = 6.172$, $P = 0.021$, $\eta^2 = 0.219$; and O2, $F(1,22) = 4.564$, $P = 0.044$, $\eta^2 = 0.172$. Multiple comparisons showed that LPP differences of the experimental group were significantly greater on F7 and F8 and significantly smaller on O2 than the control group. In addition, significant group × emotion interactions were found on T6, $F(1,22) = 4.960$, $P = 0.036$, $\eta^2 = 0.184$ and TP8, $F(1,22) = 4.764$, $P = 0.040$, $\eta^2 = 0.178$. Multiple comparisons showed that LPP differences of positive–neutral on C4, F8, and TP8 in the control group were significantly lower than those in the

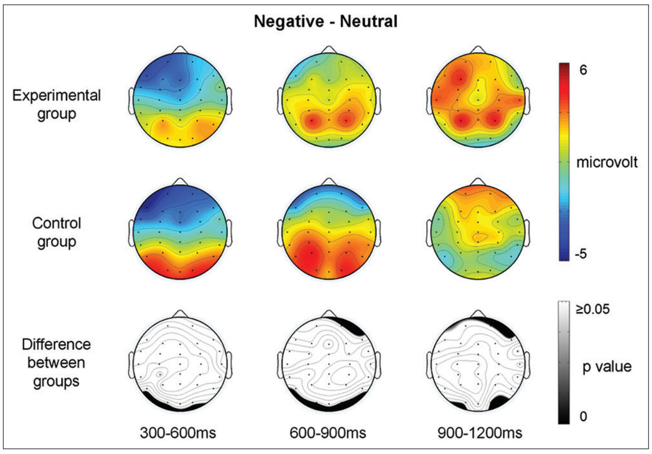

Figure 2: Topographic maps depicting the spatial distribution of LPP differences between two groups for negative pictures minus neutral pictures, from 300 to 1200 ms after picture onset

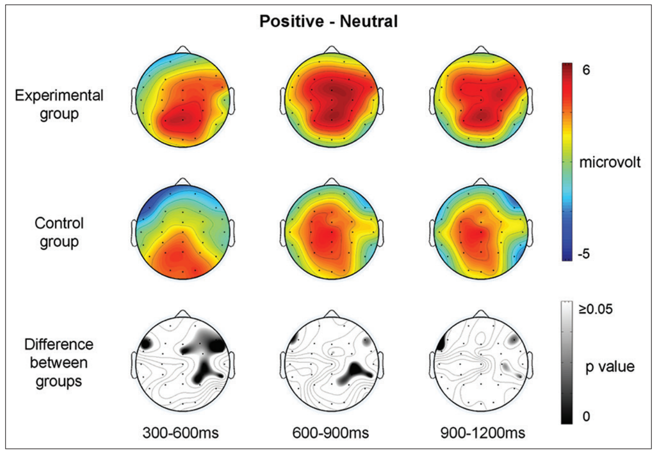

Figure 3: Topographic maps depicting the spatial distribution of LPP differences between two groups for negative pictures minus neutral pictures, from 300 to 1200 ms after picture onset

experimental group. LPP differences of the negative-neutral of the experimental group on FP2 were significantly greater, and those on O2 were significantly smaller than those in the control group. No significant results were observed for the other electrodes.

Discussion

In this study, we aimed to explore the emotion regulation effect of Baduanjin Qigong on college students by observing LPP responses to emotional pictures. Our results revealed that the students with Baduanjin Qigong experienced characteristic different LPP responses to emotional stimuli compared to the nonexperienced students. At present, some studies have found that Baduanjin Qigong training has a positive effect on the psychology of adults.[34-37] The meta-analysis indicated that the Baduanjin Qigong exercise has the effect of emotional regulation, which can significantly reduce the symptoms of depression and anxiety in patients with physical or mental disorders.[38] Furthermore, Baduanjin Qigong can improve the physical and psychological well-being of college students.[39]

In our results, under positive emotional stimuli, greater LPP amplitudes could be found in the experimental group in the frontal, central, and temporal areas than in the control group. This trait is more pronounced in the right hemisphere in the 300–600 ms, 600–900 ms, and 900–1200 ms time windows. A previous study indicated that male college students with high psychopathic traits could not maintain higher-order processing.[40] The depressed individuals show some unusual characteristics when they look at positive pictures, and the activity of the right anterior cingulate and left insula becomes lower.[41] Previous research has shown that the cause of positive emotional arousal disorder may be related to decreased activity in the middle prefrontal cortex (PFC) and hippocampus.[42] According to our findings, under positive emotional stimuli, the experimental group showed greater LPP amplitudes in multiple areas in all time windows. This phenomenon supports the hypothesis that college students improve their sensitivity to positive emotions through Baduanjin Qigong training, which may help reduce the risk of depression and anxiety.

Under negative emotional stimuli, greater LPP amplitudes were observed in the experimental group on the FP2 electrode than in the control group. FP2 is located in the right PFC, which plays an important role in emotional processing and is closely related to depression.[43-46] Some scholars believe that the blood flow in the PFC is closely related to the response of depression to repetitive transcranial magnetic stimulation.[47] Recent neuroimaging findings support the view that more rapid increases in BA10 and right dorsolateral PFC activity when regulating negative emotions are related to the most rapid decrease in depression symptom severity.[48] In a study of Tibetan Buddhist practice, it was found that under negative emotional stimulation, the enhancement of right amygdala activity was negatively correlated with depression scores.[49] Accordingly, our observation of increased LPP amplitudes (600–900 ms and 900–1200 ms) in the right PFC in the experimental group suggests that Baduanjin Qigong makes the right PFC more active in regulating negative emotional stimuli. This may be beneficial in reducing the risk of depression among college students.

In addition, the experimental group demonstrated smaller LPP amplitudes in the occipital cortex (O1 and O2) under negative emotional stimuli compared to the control group. The occipital cortex is closely related to the visual function.[50] In some functional neuroimaging studies, it was found that, compared with neutral pictures, the activity of the visual cortex increased significantly after receiving emotional picture stimulation.[51,52] The study of affective and cognitive processes found that emotional stimulation can induce the central parietal subcomponent, but nonemotional stimulation is related to occipital subcomponent activity.[53] Some scholars believe that the activation of the occipital cortex may originate from the projection of the amygdala, and the processing of emotion is related to the activity of the amygdala.[54] Hence, based on our findings of decreased LPP amplitudes (600–900 ms and 900–1200 ms) in the visual cortex in the experimental group, we infer that Baduanjin Qigong may reduce the sensitivity and cognitive demands of college students to negative emotional stimuli.

Baduanjin Qigong could regulate the positive and negative emotions of college students. Our results support findings from the literature, emphasizing that Baduanjin exercise can relieve the related symptoms of depression and anxiety.[38,55,56] The LPP of college students who have practiced Baduanjin is different in the face of emotional stimulation. This study lays a foundation for research on the emotional regulation effect of Baduanjin and its clinical application in the future. However, some limitations should be noted. Due to the disadvantage of EEG, we did not obtain data with a high spatial resolution. The current evidence of the emotion regulation effect of Baduanjin Qigong was not strong enough because of the results of a cross-sectional study with a limited sample size. Our team will conduct a large sample randomized controlled trial study in the future, and the synchronous detection method of functional magnetic resonance imaging and EEG will be used to improve the spatial resolution while maintaining the high temporal resolution to study the emotional regulation of Baduanjin Qigong more comprehensively. We will collect related emotion scales simultaneously to conduct a deep analysis of knowledge integration.

Conclusion

To summarize, this study reveals the emotion regulation effect of Baduanjin Qigong on college students by observing LPP responses to emotional pictures. The results showed that Baduanjin Qigong made multiple areas more active to improve sensitivity to positive emotions. Furthermore, Baduanjin Qigong made the right PFC more active and the occipital cortex less active when college students face negative emotions. The findings suggest that the regulatory effect of Baduanjin Qigong on emotional stimulation may be a possible reason for reducing the symptoms of depression and anxiety.

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Conflicts of interest

There are no conflicts of interest.

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