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ORIGINAL RESEARCH

# The Effect of Long-Term Learning of BaduanJin on Emotion Regulation: Evidence from Resting-State Frontal EEG Asymmetry

Xiaozhi Li[1], Yue Leng[2], Zhiheng Xiong[3], Jing Liu[4]

[1]Department of Physical Education, Southeast University, Nanjing, 211189, People's Republic of China; [2]School of Biological Sciences and Medical Engineering, Southeast University, Nanjing, 211189, People's Republic of China; [3]School of Humanities, Southeast University, Nanjing, 211189, People's Republic of China; [4]WuShu Department, Nanjing Sports Institute, Nanjing, 210046, People's Republic of China

Correspondence: Yue Leng, School of Biological Sciences and Medical Engineering, Southeast University, Nanjing, 211189, People's Republic of China, Email lengyue@seu.edu.cn



**Purpose:** Baduanjin, as a Chinese traditional fitness exercise, can help people regulate emotions and promote their physical and psychological health. However, the underlying neural mechanisms have not been thoroughly explored. This study aimed to examine the effects of differences in the level of Baduanjin learning on individuals' brain and psychological response related to emotion regulation.

**Methods:** Twenty-two participants with long-term Baduanjin learning (for more than one year), and 21 participants with short-term Baduanjin learning (for approximately three months) were recruited. All participants were asked to do a complete 12-minute set of Baduanjin. Before and after doing Baduanjin, their resting-state EEG signals were collected, besides, the Emotion Regulation Questionnaire (ERQ) and the Profile of Mood States-Short Form (POMS-SF) were used to assess participants' emotion regulation strategies and abilities.

**Results:** The results of psychological measurement indicated that participants in the long-term group were more likely to use cognitive reappraisal as an emotion regulation strategy compared to participants in the short-term group ($p<0.05$). Moreover, the analysis of the frontal alpha asymmetry (FAA) showed that participants in the long-term group rather than the short-term group exhibited significant left lateralization after doing Baduanjin ($p<0.05$).

**Conclusion:** The findings provide preliminary evidence for the neural mechanism underlying how long-term Baduanjin learning promotes individuals' emotion regulation indexed by FAA. The study provides a new paradigm for research on how Baduanjin affects emotional regulation.

**Keywords:** emotion, sport, resting state electroencephalogram, frontal alpha asymmetry

## Introduction

Emotions are one's subjective experiences of attitudes towards external things, which arise in conjunction with cognitive and conscious processes. They often reflect the relationship between objective external stimuli and subjective demands, and serve as psychological activities mediated by individual needs.[1,2] Emotions are closely related to an individual's physical and mental well-being, brain development, and social adaptability. Previous studies have found that positive emotions can facilitate psychological activities such as cognition, attention, and memory, while negative emotions can impair attention, memory, and the efficiency of cognitive functions, as well as affect interpersonal relationships and social interactions.[3,4] Given the prevalence and severity of emotional problems, it is particularly important to find effective ways to regulate emotions. In the face of negative life events, people often actively adopt strategies to regulate their emotions and cognition. Cognitive reappraisal and expressive suppression are two of the most common emotion regulation strategies.[5] Cognitive reappraisal is the process of altering one's view, perspective, or attitude about an event to gain a new understanding of the situation.[6,7] Several studies have demonstrated that cognitive reappraisal has a significant positive impact on negative emotions.[8–10] Therefore, cognitive reappraisal is frequently viewed as an adaptive emotion regulation strategy.

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As a structured form of physical activity, physical exercise plays a significant role in promoting individual physical and mental health.[11,12] In recent years, psychological research has further revealed the close relationship between physical exercise and emotion regulation.[13] By combining physical exercise with emotion regulation strategies, people can not only improve their physical fitness but also significantly alleviate and improve their negative emotions.[14,15] Baduanjin, a traditional fitness qigong from China, consists of eight well-designed decomposed movements.[16] Each action focuses on a specific part of the body, and a healthy balance of the whole body is achieved through the coordinated regulation of different parts.[17] Similar to exercise such as tai chi and yoga, Baduanjin is also an aerobic exercise.[18,19] However, Baduanjin has lower physical and cognitive demands and is more characterized by simplicity, ease of learning and moderate intensity.[20] It is more suitable for the fitness needs of modern people and is considered an effective form of exercise for promoting physical and mental health.[21] Previous studies have shown that Baduanjin could help improve people's anxiety and depression.[22,23] However, the neural mechanism of its improvement in negative emotions is still unclear, and whether its effects differ from those of other exercises needs to be further explored.

Resting state EEG (rsEEG) is the rhythmic, spontaneous neural electrical activity that reflects the intrinsic connectivity of the brain, which is recorded on the surface of the scalp when a person is awake and relaxed.[24] With a resolution of milliseconds, it can precisely monitor the functional state and intrinsic activity patterns of the brain when no external stimuli or tasks are applied.[25] It is an advanced technology in current research on brain structure and function and can offer insights into comprehending individual differences in emotional and cognitive traits. Frontal alpha asymmetry (FAA), also referred to as frontal alpha wave lateralization, is used to measure the differences in frontal alpha wave activity (8~13Hz) between an individual's left and right brain hemispheres, typically by comparing the three sets of electrode sites Fp1/Fp2, F3/F4, and F7/F8.[26] This asymmetry reflects the varying levels of activity in different regions of the brain because the intensity of alpha wave activity is inversely proportional to the intensity of activity in the corresponding cortical brain region. Therefore, stronger alpha wave activity often indicates weaker activity in that brain region.[27] Extensive research has found a strong relationship between resting frontal alpha asymmetry (FAA) and emotion regulation.[28,29] Good emotion regulation is often associated with greater activity in the left frontal lobe (ie, left lateralization), while poor emotion regulation or disorders of emotion regulation are often correlated with greater activity in the right frontal lobe (ie, right lateralization).[30–32] In research on brain mechanisms that explain how exercise improves emotions, the frontal asymmetry hypothesis was first proposed by Davidson et al.[27] According to this theory, positive emotions are associated with an increase in an individual's left prefrontal arousal level induced by a stimulus, while negative emotions are associated with an increase in the right prefrontal arousal level.[27] Based on this hypothesis, sport psychology researchers speculate that the mechanisms by which exercise enhances positive emotions and improves negative emotions may involve increased left frontal activation, thus contributing to positive emotions.[33] Therefore, the degree of frontal alpha wave lateralization in resting state EEG can serve as a neurophysiological marker of emotion regulation.

Previous studies have primarily focused on the developmental stage from beginner to initial mastery of Baduanjin, which have examined the positive effects of its practice process on physical and mental health.[34–36] However, there are relatively few studies on the effects of long-term Baduanjin learning on the brain's emotion regulation mechanisms. The present study aimed to use electroencephalography (EEG) technology and psychometric tools to investigate the differences in emotion regulation during skill mastery in long- and short-term Baduanjin exercisers systematically. The intrinsic connection between Baduanjin learning skills and emotion regulation would also be explored. Additionally, this study expected to enhance the understanding of how long-term Baduanjin learning influences the emotion regulation of the brain by analyzing the relationship between different levels of Baduanjin practice and emotion regulation. The findings could provide a theoretical basis for promoting and popularizing Baduanjin exercise.

## Materials and Methods

### Participants

The required sample size for this study was calculated using G*Power 3.1. Repeated measures ANOVA was used to explore the main effects and interactions, with $\alpha$ set at 0.05 and medium effect size set at 0.25.[37] A minimum of 36 participants was necessary to achieve a statistical test power of 0.95 in this study. Forty-six participants with experience in learning Baduanjin were initially recruited from a public physical education class in a general university. The participants practiced once a week for 1.5 hours and were divided into a long-term group and a short-term group based on their practice duration. Both groups would undergo strict evaluation by professionally qualified Baduanjin coaches to determine whether their Baduanjin learning movements were standardized.

The long-term group consisted of participants who had more than one year's experience of learning Baduanjin and were still actively exercising. The short-term group consisted of participants who had only received an approximately three-month Baduanjin curriculum at school and had not previously undergone similar physical training. All participants had normal or corrected visual acuity and were right-handed. They did not have any sleep disorders, history of psychological or psychiatric illnesses, and reported good sleep quality in the past week. Three participants were excluded from the analysis due to poor EEG data segments of more than 30%. Finally, data from 22 participants in the long-term group (age: 19.68 ± 1.13 years, 8 males and 14 females) and 21 participants in the short-term group (age: 19.90 ± 0.70 years, 12 males and 9 females) were included in the analysis. All participants provided their personal information, including gender, age, and educational years. Independent samples *t*-tests showed no significant differences in age and educational years between the two groups, while a chi-squared test showed no significant difference in gender. Thus, this study could rule out demographic factors as potential confounding variables that could affect the experimental results. The study has received approval and consent from the Ethics Committee of Zhongda Hospital Southeast University, following the Declaration of Helsinki. All participants signed an informed consent before the experiment and received 100 RMB as remuneration at the end of the study.

## Research Tools

### Subjective Evaluation

The Emotion Regulation Questionnaire (ERQ) is a 10-item scale that assesses an individual's tendency to adopt cognitive appraisal or expressive suppression strategies. [5] A 7-point Likert scale was used in this questionnaire, and the scores of two items were summed separately, with higher scores indicating more habitual use of that strategy. In this study, the internal consistency of the two sub-dimensions, cognitive reappraisal and expressive suppression, was 0.88 and 0.86, respectively.

The Profile of Mood States-Short Form (POMS-SF) is an effective and reliable tool that has been widely applied in clinical and psychological research.[38] Participants rated how much they had felt about the word in recent times, which was used to assess their brief mood state. Seven dimensions were measured in this scale, including tension, anger, fatigue, depression, vigor, confusion, and esteem-related affect. With a 5-point Likert response scale, a higher score for each subscale represented a higher corresponding mood state. All the subscales of POMS-SF demonstrated the internal consistency ranging from 0.65 to 0.92 in this study.

## EEG Recording and Data Processing

To thoroughly investigate the effects of short-term Baduanjin learning, we designed a series of experimental procedures. First, participants were required to complete a detailed questionnaire and provide demographic information before the study began. Then, they were asked to play a full set of 12-minute Baduanjin according to the standard procedure. This session was particularly crucial because it directly reflected the actual learning effect of Baduanjin. Before and after the practice, we recorded 3 minutes of resting state EEG data from the participants with their eyes closed, respectively. By comparing the changes in brain waves before and after the practice, we examined the effects of Baduanjin on brain activity. To ensure the accuracy of the data, we combined the self-reports of the participants and the wave amplitude fluctuations captured by the EEG equipment and determined that the participants needed to rest for 3 minutes after completing a full set of Baduanjin. This rest period could help to reduce the interference of physiological factors such as body temperature, heart rate, and blood flow on the EEG. During the test, participants were asked to close their eyes, place their hands naturally on either side of their body, and minimize movements such as swallowing to maintain a steady state.

Data in this study were collected using a 32-channel EEG system from ANT Neuro (Germany), with electrode placement following the international 10–20 system standard. To ensure data quality, the scalp impedance was kept below 10 kΩ for all participants. Parameters were set as follows: bandpass filtering from 0.05 to 100 Hz, reference electrode at Cpz, and online data sampled at a DC sampling rate of 1000 Hz. The EEG data preprocessing was performed using open-source toolbox

EEGLAB in MATLAB.[39] First, the collected data was checked carefully and data with significant artifacts were excluded. Then, the EEG data were preprocessed by re-referencing to the mean of the left and right mastoids (M1+M2)/2. The re-reference data were band-pass filtered from 0.1 to 30 Hz and divided into epochs with 2000 points (2 s). Independent component analysis (ICA) was used to eliminate artifacts such as frequent blinking and muscle artifacts, and segments with amplitudes greater than ±100 μV were excluded. After data preprocessing, the time domain signals were transformed into frequency domain signals with a Fast Fourier transform (FFT), and power spectral density (PSD, $\mu V^2$ /Hz) was computed. Three electrode pairs were selected in the prefrontal region: (FP1, FP2), (F3, F4), and (F7, F8). The alpha PSD values of the FP1, F3, and F7 electrodes were overlaid and averaged to obtain the left frontal region alpha mean PSD values, while the alpha PSD values of the FP2, F4, and F8 electrodes were overlaid and averaged to obtain the right frontal region alpha mean PSD values. Additionally, the alpha asymmetry score values were calculated using the following formula:[26]

$$\text{Alpha asymmetry score value} = \ln[\text{right frontal alpha PSD}] - \ln[\text{left frontal alpha PSD}]$$

## Statistical Analysis

Independent samples *t*-tests were conducted to compare the ERQ and POMS-SF scores between the two groups (long-term and short-term). Cohen's d served as an indicator of effect size. Pearson correlation analyses were performed to examine the relationships between the cognitive reappraisal dimension of ERQ and sub-dimensions (esteem-related affect, vigor, confusion, tension, depression, fatigue, and anger) of POMS-SF in long-term and short-term groups.

Three-factor repeated measures analysis of variance was performed on the alpha PSD data with group (long-term, short-term) as a between-group variable, test time (pre-test, post-test) and electrode location (left, right) as within-group variables, and PSD as the dependent variable. Paired-sample *t*-tests were conducted to compare the alpha lateralization values of participants in the long-term and short-term groups, before and after the experiment. Greenhouse-Geisser was used for correction, and post-hoc multiple comparisons were performed using the Least Significant Difference (LSD) method. Partial eta-squared ($\eta_p^2$) and Cohen's d were used as the indicators of ANOVA and *t*-test effect sizes, respectively. All statistical analyses were computed in SPSS 26.0.

# Results

## Questionnaire results

Descriptive statistics are shown in Table 1.

**Table 1** Descriptive Statistical Results of the Two Groups

| Sub-Dimension | Long-Term Group (M±SD) | Short-Term Group (M±SD) | t | p | Cohen's d |
|---|---|---|---|---|---|
| ERQ-cognitive reappraisal | 33.68±5.16 | 29.62±4.86 | 2.65 | 0.01* | 0.81 |
| ERQ-expressive suppression | 15.73±5.65 | 13.57±4.20 | 1.41 | 0.16 | 0.43 |
| POMS - tension | 10.55±4.00 | 10.48±4.12 | 0.06 | 0.96 | 0.02 |
| POMS - anger | 10.05±4.38 | 9.76±4.05 | 0.22 | 0.83 | 0.07 |
| POMS - fatigue | 9.09±3.66 | 10.52±3.97 | −1.23 | 0.23 | 0.37 |
| POMS - depression | 8.68±4.24 | 9.29±4.19 | −0.47 | 0.64 | 0.14 |
| POMS - vigor | 18.95±4.73 | 18.95±4.34 | 0.00 | 1.00 | 0.00 |
| POMS - confusion | 8.91±3.42 | 9.10±3.82 | −0.17 | 0.87 | 0.05 |
| POMS - esteem-related affect | 13.86±3.44 | 13.43±2.96 | 0.44 | 0.66 | 0.13 |

**Note**: $^*p < 0.05$.

The results (see Figure 1) showed that only cognitive reappraisal was negatively correlated with POMS-anger ($r = -0.43$, $p = 0.04$) and POMS-depression ($r = -0.45$, $p = 0.03$) in the long-term group. No significant correlation was found in other relationships.

## Alpha Power Spectral Density

Repeated measures ANOVA results revealed a significant main effect of time ($F_{(1,\ 41)} = 6.33$, $p = 0.02$, $\eta_p^2 = 0.13$). Post-hoc tests revealed that the mean alpha PSD during the post-test (4.95μV) was significantly higher than during the pre-test (4.02μV). No statistical significance was found among other main or interaction effects.

Alpha lateralization was calculated for three symmetrical electrode pairs (Fp1/Fp2, F3/F4, F7/F8) of both groups. Paired samples *t*-tests were conducted to compare pre- and post-test scores (see Figure 2). Results revealed that the long-term group showed a significant tendency towards left lateralization at electrode pairs Fp2-Fp1 ($t = 2.26$, $p = 0.03$, *Cohen's d* = 0.49) and F4-F3 ($t = 2.32$, $p = 0.03$, *Cohen's d* = 0.38) at post-test compared to pre-test. In contrast, the short-term group showed no significant differences between pre-test and post-test scores for any of the electrode pairs.

To provide more intuitive evidence of the asymmetry patterns in the pre- and post-tests for both groups, the mean PSD was calculated for the left (Fp1, F3, F7) and right (Fp2, F4, F8) frontal regions (see Figure 3). Results showed that the long-term group showed a significant increase in PSD value in the alpha band of the right frontal lobe in the post-test

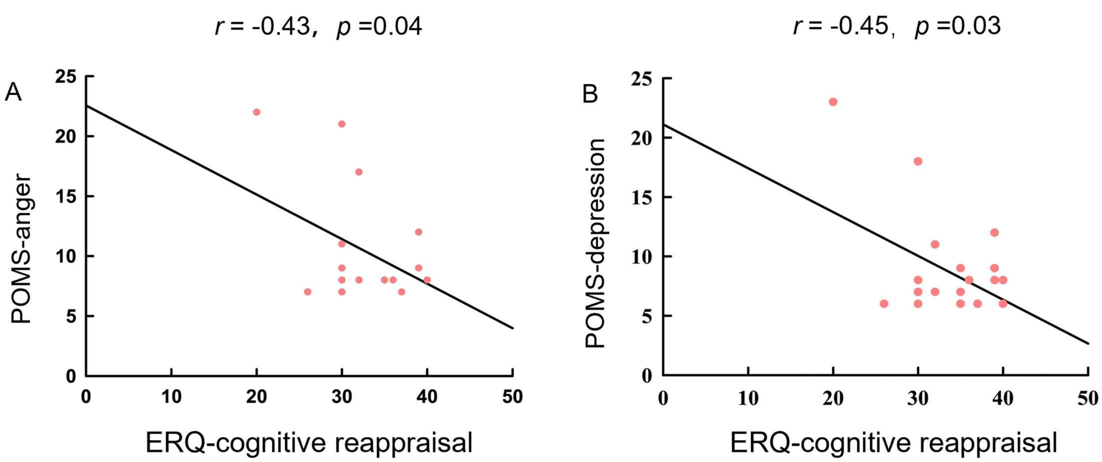


**Figure 1** (**A** and **B**) Correlation analysis. (**A**) Negative correlation between cognitive reappraisal and anger in the long-term group. (**B**) Negative correlation between cognitive reappraisal and depression in the long-term group.

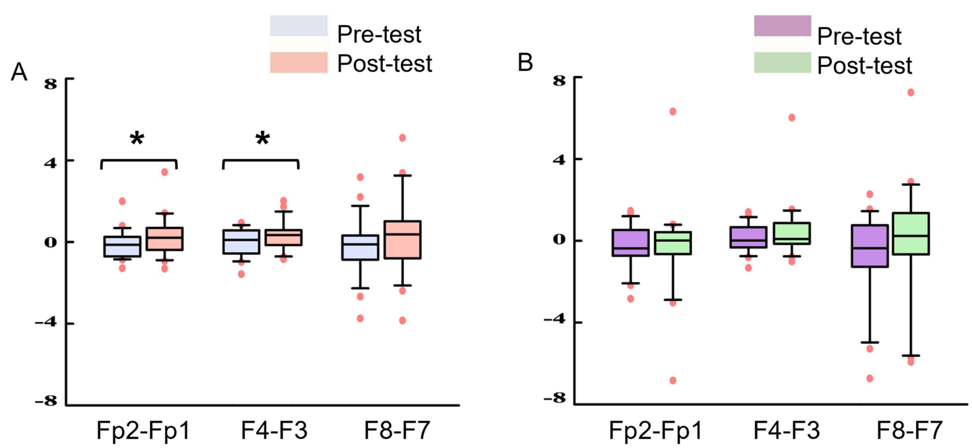


**Figure 2** (**A** and **B**) Frontal lobe lateralization in two groups. (**A**) Frontal lobe lateralization at three sets of electrode sites (Fp1/Fp2, F3/F4, F7/F8) in the long-term group between pre-test and post-test (**B**) Frontal lobe lateralization at three sets of electrode sites (Fp1/Fp2, F3/F4, F7/F8) in the short-term group between pre-test and post-test *$p < 0.05$.

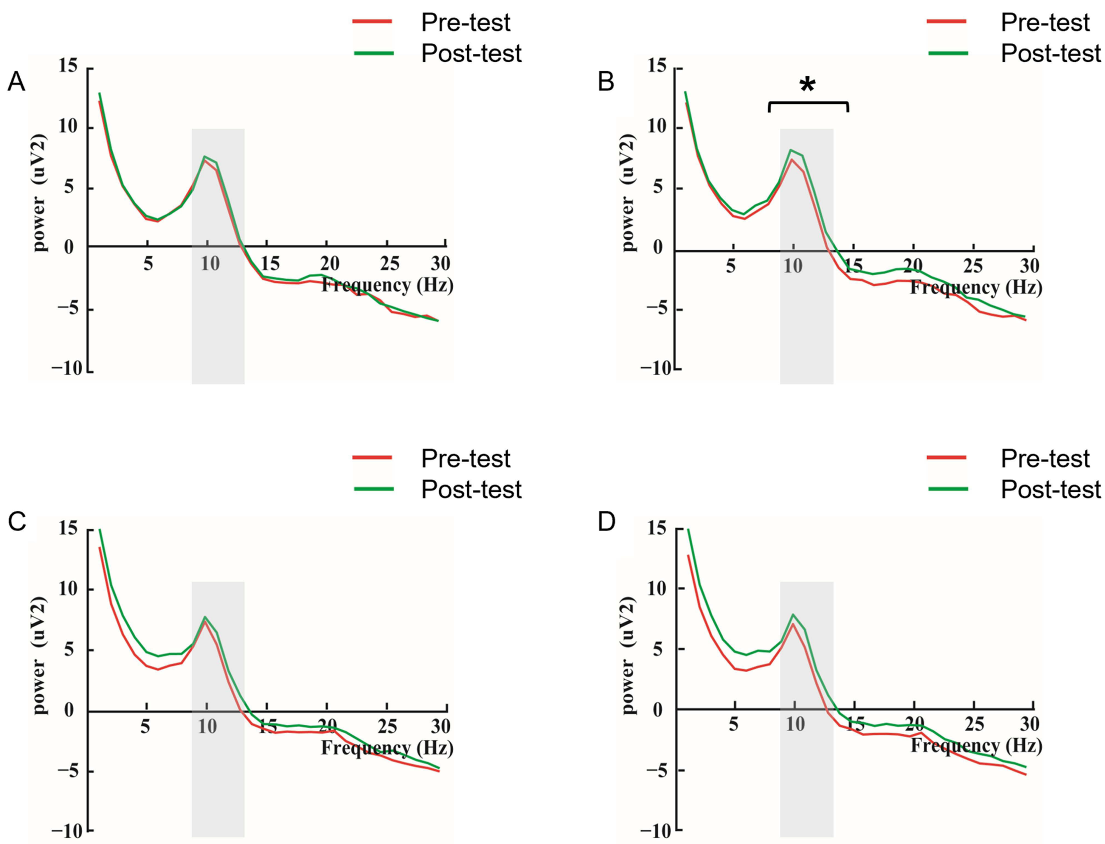


**Figure 3** (**A**–**D**) Mean PSD in the left and right frontal lobe of the two groups. (**A**) Pre- and post-test differences in the mean PSD of the three electrode sites in the left frontal lobe (Fp1, F3, F7) in the long-term group (**B**) Pre- and post-test differences in the mean PSD of the three electrode sites in the right frontal lobe (Fp2, F4, F8) in the long-term group (**C**) Pre- and post-test differences in the mean PSD of the three electrode sites in the left frontal lobe (Fp1, F3, F7) in the short-term group (**D**) Pre- and post-test differences in the mean PSD of the three electrode sites in the right frontal lobe (Fp2, F4, F8) in the short-term group *$p$ < 0.05.

compared to the pre-test ($t$ = 2.14, $p$ = 0.04, *Cohen's d* = 0.37). In contrast, the short-term group showed no significant differences between pre-test and post-test scores for the left and right frontal lobes in the alpha band.

## Discussion

This study used psychological questionnaires and resting state EEG techniques to investigate the differences in emotion regulation strategies and abilities among individuals who practiced Baduanjin for varying lengths of time. The results indicated that the level of Baduanjin learning influenced the selection bias of their emotion regulation strategies. Individuals who had been practicing Baduanjin for an extended period were more likely to employ cognitive reappraisal strategies for regulating their emotions ($p$<0.05). Regarding the neural indicator of EEG lateralization, it was observed that individuals in the long-term group showed a significant increase in the tendency of left lateralization of the frontal alpha wave after completing a set of Baduanjin compared to before practice ($p$<0.05). This finding suggested that long-term Baduanjin learning could enhance individuals' sensitivity to Baduanjin exercise, thus improving their emotion regulation at the neural level.

Exercise, as a prescribed physical activity, benefits both the body and the mind.[40,41] For example, it can effectively reduce negative emotions such as anxiety and depression, and also impact brain plasticity at a deeper level.[42–45] Several studies have confirmed that aerobic exercise positively affects emotion-related brain structures and functions.[46,47] In terms of the selection of intensity for aerobic exercise, studies have shown that moderate-intensity aerobic exercise has a greater impact on improving mood.[48,49] This may be due to the fact that moderate-intensity aerobic exercise can effectively stimulate the brain to release pleasure hormones, such as endorphins, which can alleviate stress and enhance mood states.[50] Baduanjin, as a typical moderate-intensity aerobic exercise, combines breathing and movements to guide practitioners into a state of relaxation.[51] This exercise not only enhances physical fitness but also deepens the individual's inner experience, helping people remain calm and optimistic in the face of stress and challenges.[16,17] Therefore, long-term Baduanjin learning could not only promote the use of cognitive reappraisal strategies for emotion regulation, but also reduce participants' anger and depression, compared to short-term learning. Cognitive reappraisal refers to the process of bringing about emotional change by re-evaluating one's thinking to gain a new perspective on the emotional situation, thereby reducing negative emotions.[52] Previous studies have found that cognitive reappraisal was positively associated with positive expression and positive emotional experiences, and negatively associated with negative expression and negative emotional experiences.[53,54] Individuals with high cognitive reappraisal often exhibited more stable autonomic and endocrine system responses to negative stimuli and viewed negative events as opportunities for growth and learning rather than as pure threats or challenges.[5,55] These studies consistently showed that cognitive reappraisal, as an adaptive emotion regulation strategy, was related to an individual's psychological well-being.[5,55] This also explains why long-term Baduanjin learners with extensive exercise experience are more likely to adopt cognitive reappraisal strategies in social interactions, reducing the negative emotions (eg, anger, depression) in daily life and recovering from these emotions more easily. In other words, long-term Baduanjin participants may be more adept at perceiving and understanding the negative emotional stimuli they encounter, enhancing their ability to cope with stress, and ultimately alleviating physiological responses in negative contexts.

The study also found that long-term Baduanjin learning influenced the tendency to select cognitive reappraisal strategies. It also significantly enhanced the tendency to left lateralization of alpha waves of frontal region in the resting state of long-term participants after exercise, compared to before a single session of Baduanjin exercise. The power changes of resting state EEG across frequency bands often reflect the spontaneous processing of brain activity. Alpha bands (8–13Hz) are the basic rhythm of normal human brain waves and are most prominent during wakefulness, rest and with eyes closed.[56] Frontal lobe EEG asymmetry examines the activity of left and right frontal alpha waves, typically comparing the differences in alpha activity between three electrode pairs (ie, Fp1/Fp2, F3/F4, F7/F8).[26] Frontal alpha power value has been proven to be negatively correlated with frontal cortex activity and to be associated with the ability of regulating negative emotions.[57] The higher the value of alpha waves, the weaker the activation in the corresponding brain region, whereas the lower the value of alpha waves, the stronger the activation in the corresponding brain region.[58] Previous studies have found a relationship between frontal alpha asymmetry and emotion regulation, with better emotion regulation often associated with greater activity in the left frontal lobe.[59,60] Specifically, the frontal lobe serves as the brain's regulatory centre for cognition and emotion and its asymmetry may reflect differences in emotion processing and cognitive function across individuals.[61] Therefore, frontal asymmetry can be regarded as an important indicator for revealing the functional link between the frontal lobes and the amygdala. This could help people gain a deeper understanding of the complex mechanisms of the brain in emotion processing and cognitive function.

The findings indicated that long-term Baduanjin learning could have a positive effect on frontal left lateralization. Long-term Baduanjin participants could improve their emotion regulation abilities even after a single practice, as evidenced by their greater left frontal alpha wave activity. This finding was consistent with previous studies. For example, Wei et al found greater left lateralization in the frontal lobe of the long-term group compared to the short-term group, suggesting that long-term Baduanjin learning may enhance individuals' emotion regulation abilities to some extent.[62] Goodman's study found that increased relative left frontal activity is associated with reduced emotional reactivity to negative stimuli through emotion regulation.[60] This explanation was consistent with the suggestion that relatively greater left frontal activity is primarily involved in positive emotions related to approach motive (eg, happiness), whereas right frontal activity is associated with negative emotions related to avoidance motive (eg, fear and disgust).[63] A developmental study showed that infants born to depressed mothers had less brain activity in the left frontal hemisphere compared to the right frontal hemisphere, a pattern often associated with more withdrawn behavior in childhood.[64] In healthy adolescents, a negative association between left frontal brain activation and higher levels of depressive symptoms was also proved.[65] Furthermore, in healthy older adults, a relationship has been found between right frontal activity and greater depressive symptoms compared to the left frontal activation.[66] Similar findings have been reported in studies of mindfulness interventions, where participants engaged in mindfulness meditation practices showed greater alpha wave activation in the left frontal lobe, indicating stronger emotion regulation abilities.[67] Research on people with depression has found that adolescents with major depression have greater right frontal alpha activity compared with healthy short-term group, suggesting weaker emotion regulation.[65] These studies in different populations may help to explain emotional and affective disorders in terms of individual differences.[57] In addition, research on exercise has found some changes in physiological indices before and after short-duration aerobic exercise, which may not only improve short-term cognitive function, but also have a beneficial effect on long-term emotion regulation abilities.[68] In conclusion, the prefrontal lobe plays a crucial role in regulating emotions by activating the regions of sensation and movement in a top-down manner. The different activation patterns of frontal regions in the resting state may serve as a reliable predictor of an individual's ability to regulate their emotions.

Several limitations should be considered in the present study. Firstly, this study mainly used a cross-sectional design. Although it helped to explore the association between Baduanjin learning and emotional health at a specific point in time, it was difficult to completely eliminate the potential impact of individual differences on the results. It was also difficult to exclude the interference of other confounding factors on the research results during long-term exercise. Therefore, to gain a more comprehensive and in-depth understanding of the effects and mechanisms of Baduanjin in promoting emotional health, future research could include longitudinal studies. Secondly, a control group that participates in other exercises or a baseline group should also be added. Such controlled studies can provide a more scientific basis for the promotion of emotional health through Baduanjin.

## Conclusion

This study explored the effects of long-term Baduanjin learning on negative emotions and its underlying neural mechanisms. The results indicated that long-term Baduanjin learning could help participants choose more effective cognitive reappraisal strategies and significantly improve their emotion regulation. From a neuroscientific perspective, Baduanjin exercise promoted left frontal alpha lateralization, which reflected changes in the neuroplasticity of the brain in terms of emotion regulation. The neurological level of emotion regulation mechanism provided strong support for exercise intervention and clinical treatment of individuals' emotional disturbance, particularly depression.

## Data Sharing Statement

The data can be obtained by contacting the corresponding author for reasonable requests.

## Ethical Approval

The study is in accordance with the Declaration of Helsinki, and this research was approved by the Research Ethics Committee of Affiliated Zhongda Hospital, Southeast University (2019ZDSYLL073-P01).

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## Disclosure

The authors report no conflicts of interest in this work.

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