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Emotional processing changes of qigong on college students: A pilot ERP study of a randomized controlled trial

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ABSTRACT

Objective: To investigate the influence of qigong on late positive potential, which was elicited by affective pictures.

Methods: College students who met the inclusion criteria were enrolled and randomly allocated to the qigong group, which received a four-week training ($n = 41$) or the control group ($n = 41$). All participants were assessed before and after the training for event-related potential, which was elicited by negative, neutral, and positive pictures. Electrodes at the centerline position of the frontal area (FCz), parietal area (Pz), and occipital area (Oz) were analyzed.

Results: Negative, neutral, and positive pictures demonstrated statistically significant differences on FCz ($P < .001$), Pz ($P < .001$), and Oz ($P < .001$). The interaction between the group factor and time factor was statistically significant on Pz ($P = .028$). The pairwise comparison of Pz on the time factor and group factor showed that the amplitudes of the qigong group after training were smaller than before ($P < .001$), and the amplitudes of the control group were not statistically significant ($P = .355$).

Conclusion: Our results supported the conclusion that qigong practices could affect the emotional regulation of college students. Qigong exercise weakens the emotional regulation of late positive potential, which is sensitive to top-down affective modulation. The findings imply that the regulating effect of qigong on emotions may be part of the reason why it is effective in reducing depression and anxiety symptoms.

Introduction

The emotional problems of college students are becoming increasingly serious.[1,2] Emotional disorders can cause a series of problems, such as depression, anxiety, and sleep disturbance.[3] Depressive symptoms are important psychological problems concerning college students.[4] Over 43.2% of college students reported feeling very depressed and having difficulty working properly at least once a year.[5] This seriously affects the quality of their study and life. Severe depression can lead to suicide.[6] Therefore, sufficient attention should be paid to the prevention of and intervention for the emotional problems of college students.

Recent studies have found that emotion regulation is a key cause of depression and it is critically disrupted in those suffering from depression.[7,8] Effective methods of emotion regulation can be found in mind-body exercises that can reduce depression and anxiety symptoms.[9–11] Therefore, the presumptive emotion regulation of mind-body exercises has aroused great interest in the scientific community, especially in the field of neuroscience.[12–14] Studies have shown that the influence of meditation might transfer to the non-meditative state, and meditation could reduce the interference of negative emotions and make emotion regulation easier.[15–17]

The mind adjustment of qigong is also known as the refining of the spirit or self-training, which aims at changing the daily state of mind from the extrovert to the introvert state.[18] In previous studies we found that qigong can induce the alpha band rhythm response and it may relieve emotional tension.[19–21] Therefore, we assume that qigong practice will influence the emotional processing of

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college students when they are in the daily state.

Event-related potential (ERP) can sensitively reflect the emotional process of stimuli, especially pictures, and provide an appropriate tool for the study of emotional responses.[22,23] In particular, the late positive potential (LPP), which is a slow-wave ERP component, becomes apparent about 300 ms after the stimulus onset and is larger in both positive and negative pictures than in neutral pictures.[24] Recent studies have shown a strong correlation between the amplitudes of LPP and emotional regulation.[25,26] In cognitive reappraisal studies, when subjects were instructed to reduce negative emotions, the LPP amplitude decreased, and when subjects were instructed to enhance negative emotions, the LPP amplitude increased.[27,28]

The LPP findings provide support for the view that meditation affects emotional regulation. At high levels of processing, Buddhist meditators were less affected by negative emotions.[15] Dispositional mindfulness meditators demonstrated lower amplitudes of LPP which were elicited by high arousal negative stimuli.[29] However, Sahaja yoga meditators found no differences in the LPP responses to emotional images.[30] Moreover, depressed individuals have sensitive responses to affective pictures.[31] Thus, we need more reliable data to draw conclusions about the influence of mind-body exercises on emotional processing. The goal of this study was to investigate the effect of qigong on the LPP response to affective pictures. We aimed to capture the changes on college students before and after four weeks of qigong practice.

Methods

Ethical approval

The study design was approved by the Ethics Committee of Beijing University of Chinese Medicine (BJZYYDX-LL2014005). All participants were informed about the entire experiment procedure and voluntarily signed a consent form. In accordance with the Declaration of Helsinki, all participants had the right to withdraw from the experiment at any time, and those who withdrew would be treated as dropouts.

Trial design

This was a parallel randomized controlled trial. A set of random numbers used for allocation were generated using a computer program. According to the random number, participants were assigned to either the qigong practice group or the control group.

In this study, participants were not clinical patients but ordinary college students with no serious illnesses. We did not administer any drug or provide any other clinical intervention to the participants. The ERP data collection caused no harm or pain. Because this was a pilot study for the emotional regulation mechanism and not a clinical trial, the protocol was not registered on a public platform.

Sample size

This was an exploratory experiment on the mechanism of emotion regulation of qigong. Since there were no previous ERP studies on qigong as a means of emotion regulation, we referred to the minimum clinical sample size and intervention efficiency and dropout rate of previous studies. [19–21] This study planned to select 35 people for each group based on previous intervention experience. Anticipating a 10% dropout rate, the final sample size was 80 in the two groups.

Participants

Inclusion criteria

The inclusion criteria were as follows: (1) college students aged between 18 and 25; (2) volunteering to take part in the experiment; (3) voluntarily signing the informed consent form and being able to attend the qigong training on time; (4) promising to fill in the training record form and cooperate with data collection; and (5) being right-handed.

Exclusion criteria

The exclusion criteria were as follows: (1) having long experience in qigong, yoga, mindfulness, or any other kind of mind-body exercise; (2) being a psychosis patient, having a history of psychosis, or having a family history of psychosis; (3) having infectious diseases; (4) having severe diseases of the respiratory, circulatory, digestive, or motor systems; and (5) participating in any other clinical trials.

Qigong training

At first, participants in the qigong group attended a 2-h class to study the methods and skills of qigong. Subsequently, they were required to practice qigong together every day from 21:00 to 21:30 for four weeks in a classroom. We used an audio recording to guide the participants doing qigong. The audio recording contained three parts. The first part was relaxing guidance to help the participants prepare for the meditation. The second part was mind adjustment for qigong including the guidance about scene creation, scene operation, and scene immersion. The third part was guidance to help the participants emerge from the scene that they had created by themselves and return from the qigong state to the normal state. The qigong instructors were required to attend the daily training and answer questions from the participants.

The content for qigong mind adjustment was the same as that in our previous research, and contained a three scene operation ("The spring sunshine is warming my body," "I am walking in the rose bushes," and "Every pore of mine is breathing freely").[19] The specific operation of qigong mind adjustment is as follows: (1) Preparation: Follow the guide words and sit comfortably. Press the tongue to the roof of the mouth, unfurl the brows, and close the eyes. Relax all parts of the body one by one from top to bottom. Switch the daily breathing pattern to deep breathing. (2) Scene formation: Recall a scenary from the image presented during training, and picture the scenary in a "in-the-moment" manner. (3) Scene operation: Transform the "in-the-moment" scene into a self-perceived 'real' dimension, without the unnecessary background, keeping only elements which makes you calm and relaxed, and magnify its presence. (4) Self immersion: Place yourself in this clear and comfortable scene; immerse yourself in the experience and feeling of this scene. Try to be one with the scene you imagined, which reflects who you are, and forget all your stress and frustrations. (5) Return to normal: With the guide word, slowly take yourself out of the scene, gently open your eyes, and rub your hands and face.

The schematic video of the relevant content of the qigong mind adjustment mentioned above (scene formation, scene operation and self immersion) can be found in the Supplementary Data.

Supplementary video related to this article can be found at https://doi.org/10.1016/j.jtcms.2021.01.005

ERP experiment

All the participants were required to attend the ERP experiment twice. The first experiment was performed before the qigong group started training. The second experiment was conducted four weeks later after the qigong group finished training.

Stimuli

One hundred and twenty pictures were selected for this ERP experiment from the Chinese Affective Picture System, which contains standardized emotional stimulation material created in China based on the International Affective Picture System.[32,33] These included 40 positive pictures, such as those of babies, cute animals, and beautiful moments in sports; 40 neutral pictures, such as those of stationery, daily necessities, and architecture; and 40 negative pictures, such as those of snakes, disasters, and accident scenes. The stimuli were presented in the center of the color display using E-prime 2.0 (Psychology Software Tools Inc., Sharpsburg, PA). The distance between the participants' eyes and the screen was approximately 80 cm.

Procedure

The ERP experiment was carried out in a soundproof room with dark curtains to avoid light. The temperature was maintained at 22–26 °C and the humidity was 22–42%. The participants were required to wash their scalps and enter the test room after their hair was dried. Scrub cream was used to remove the skin cutin. During the experiment, participants sat in comfortable chairs and were required to turn off their mobile phones. After the experiment began, no sound or conversation was allowed except when participants felt unwell.

After wearing the electrode cap, participants were asked to look carefully at the information that appeared on the screen and follow the given instructions, which described the experimental procedure.

Fig. 1 illustrates the single trial sequence flow of this experiment. All the stimuli were displayed on a white background. Each trial began with a fixation (+) visible for 800 ms, followed by a neutral, positive, or negative picture for 1500 ms. The different categories of pictures were presented in a pseudorandom order. Subsequently, participants would assess the picture that had just disappeared by pressing a button on the keyboard: the "SPACE" key denoted neutral pictures, the "F" key denoted positive pictures, and the "J" key denoted negative pictures. Participants were requested to not press the button before the picture disappeared to avoid the artifact from upper limb movement affecting the LPP. After the choice was made, a blank screen appeared for a random duration (800–1200 ms), followed by a fixation for the next trial.

All 120 pictures were presented twice during the task. There were 246 trials in total. The first six trials were not used for further analyses. There was a break of 1 min after every 60 trials.

Data collection and analysis

The electroencephalogram signals were collected by the Nuamps 40-channel EEG/ERP signal recording and analysis system produced by Neuroscan Inc. (Charlotte, NC), and Ag/AgCl electrode caps (QUIK-CAP 37) for the 10–20 system were used. The reference electrode was placed at the left mastoid and the ground electrode was placed on the medial frontal area. The two electrodes for recording an electrooculogram (EOG) signal were placed 1 cm above the left eyebrow and 1 cm below the left eye, and the two electrodes for recording the horizontal EOG were placed 1 cm beside the outer canthus of each eye. The impedance of each electrode was reduced to less than 5 kΩ for a time not exceeding 30 min. The sampling rate of the EEG recording was 1000 Hz. For the off-line analysis, the reference electrode was converted from the left mastoid to the average of the bilateral mastoid (A1, A2). Blink artifacts were corrected with the ocular artifact reduction procedure.[34] The low pass filtering was set at 30 Hz. The raw EEG data were segmented by markers of different stimuli categories (negative, neutral, and positive). For each epoch, the data for 600 ms after each stimuli marker were included in the analysis, and that for 200 ms before the stimuli marker were taken as baseline data. The epochs containing or exceeding ±100 μV amplitudes were excluded.

Statistical analyses

The time window selected for the LPP average amplitude was 300–600 ms. The data of the frontal area (FCz), parietal area (Pz), and occipital area (Oz) were included in the analysis (Fig. 2). We measured the mean amplitude values for each category (negative, neutral, and positive) for the qigong group and control group. A 2 (qigong group and control group) × 3 (negative, neutral, and positive emotional stimuli) × 2 (before and after qigong training) repeated-measures analysis of variance were performed for the FCz, Pz, and Oz electrodes. The Greenhouse-Geisser procedures were used to correct for significant differences in sphericity and Bonferroni procedures were used to correct for pairwise comparison. $P < .05$ was considered statistically significant. The demographic data of the participants were expressed as mean (standard deviation). The ERP data were expressed as mean (standard error of the mean) using SPSS software (Version 22.0, IBM, Armonk, NY).

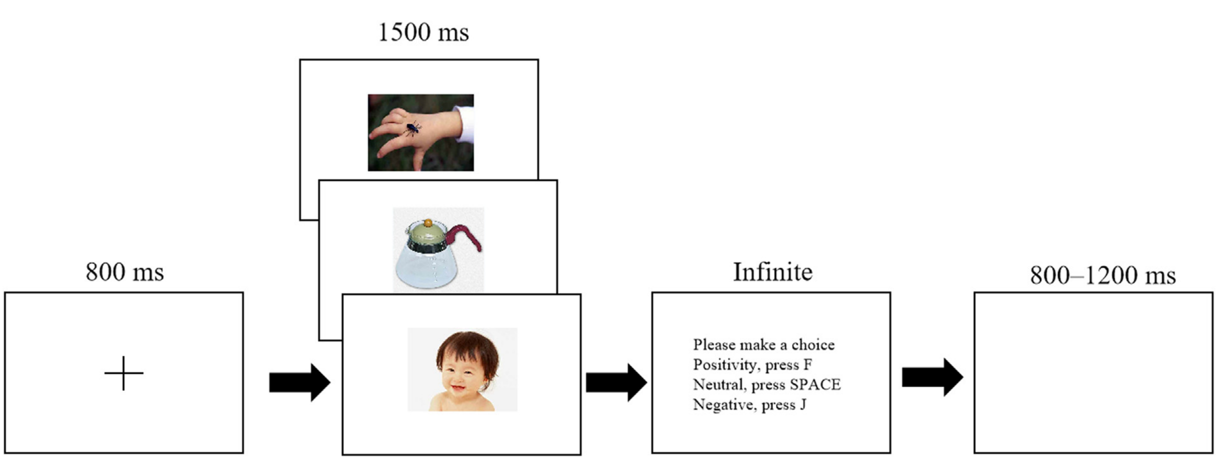

Fig. 1. Procedure used in the event-related potential experiment.

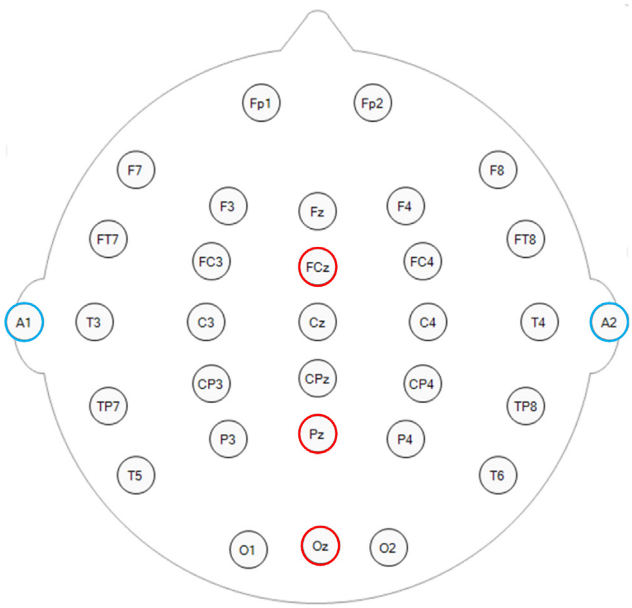

Fig. 2. Electrodes distribution of scalp.

Results

Participant flow diagram

The participants were recruited from the Beijing University of Chinese Medicine (Beijing, China) in March 2017. Of the 108 cases, 21 did not satisfy the inclusion criteria, and 5 could not finish the tests. Finally, 82 participants were recruited and randomly allocated to the qigong group ($n = 41$) or the control group ($n = 41$). Four participants dropped out of the study due to personal reasons in the qigong group, and three participants could not be contacted in the control group. Therefore, the ERP data of these seven participants could not be collected after the training. In order to be able to perform repeated-measures ANOVA, the seven participants were not included in the analysis. The final number of participants was 37 (26 females; 21.02 (2.36) years old) in the qigong group and 38 (26 females; 21.45 (2.51) years old) in the control group. The qigong group received 30 min of qigong training daily for four weeks. The control group did not receive any training and their lifestyle was unaltered (Fig. 3).

Event-related potential

In this study, we selected three types of pictures including positive, neutral, and negative, which were significantly different in the valence dimension ($F = 1295.93$, $P < .05$; 7.02 (0.28), 5.52 (0.33), and 2.43 (0.57) in positive, neutral, and negative, respectively). The within-subjects effect analysis of variance showed that there was a statistically significant difference on the emotional stimuli factor of the FCz ($F = 21.756$, $P < .001$), Pz ($F = 91.233$, $P < .001$), and Oz ($F = 70.831$, $P < .001$). The pairwise comparison of each electrode on emotional stimuli is depicted in Fig. 4. The within-subjects effect analysis of variance showed that there was a statistically significant difference on the time factor of the FCz ($F = 17.368$, $P < .001$), Pz ($F = 12.649$, $P = .001$), and Oz ($F = 4.364$, $P = .04$). The pairwise comparison of the FCz on the time factor showed that the mean amplitudes after training was smaller than before ($P < .001$), the pairwise comparison of the Pz on the time factor showed that the mean amplitudes after training was smaller than before ($P = .001$), and the pairwise comparison of the Oz on the time factor showed that the mean amplitudes after training was larger than before ($P = .04$). The interaction between the time factor and group factor was statistically significant on the Pz ($F = 5.053$, $P = .028$). The pairwise comparison of the Pz on the time factor and group factor showed that the mean amplitudes of the qigong group after training was smaller than before ($P < .001$), and the mean amplitudes of the control group was not statistically significant ($P = .355$). The interaction between the emotional stimuli factor, time factor, and group factor was not statistically significant on the FCz ($F = 2.275$, $P = .11$), Pz ($F = 0.134$, $P = .866$), and Oz ($F = 0.360$, $P = .678$). Pairwise comparison of each electrode before and after training on different emotional stimuli is depicted in Fig. 5.

Safety assessment

No adverse reactions related with qigong training were reported.

Discussion

Qigong is a part of the essence of traditional Chinese culture and is considered a treasure of the Chinese nation. Qigong therapy is an important part of traditional Chinese medicine. With thousands of years of development history, qigong therapy is still applied in clinical practice and has attracted increasing attention from medical science.[18] Most scholars define qigong as the skill of a mind and body exercise that integrates the three adjustments of mind, body, and breath into one.[35] One of the main applications of the qigong mind-regulating technology in modern times is to regulate emotions, that is, through the use of consciousness and perception on the theme of thinking, benign thinking content gradually replaces the disorderly psychological activities in consciousness and achieves the mental realm of the integration of mind and body in the scene, in order to get rid of the interference of emotions.[19]

The present visual ERP study provided evidence of the brain's emotional processing in college students before and after qigong practice. In contrast to the control participants, we found that the students who received the intervention of qigong training showed significant differences on the LPP components of visual ERP using affective pictures. ERP is a complex indicator of brain function mechanism, and its waveform contains a great deal of information. The results were different because of the inherent differences in people, stimuli, and tasks.[36] Different emotional pictures can induce different ERP components. One of the components of ERP closely related to emotion is LPP.[24] Compared with neutral pictures, larger LPP amplitudes can be elicited using pleasant and unpleasant pictures.[37] Our results also confirmed a pattern wherein the three types showed a statistically significant difference on emotional stimuli, and the mean amplitudes elicited by the neutral stimuli were smaller than those elicited by the negative and positive stimuli on the FCz, Pz, and Oz. The FCz electrode was located on the prefrontal cortex, which plays an important role in emotional processing. Neuroimaging studies of major depression have identified neurophysiological abnormalities in the prefrontal cortex.[38–41] People with depression have an impaired ability to divert their attention. This attentional control process is associated with the dysfunction of the dorsolateral prefrontal cortex,[42] and blood flow in the prefrontal cortex can predict the response of depression to repetitive transcranial magnetic stimulation.[43] Qigong exercise weakens the emotional regulation of the LPP, which is sensitive to the top-down affective modulation.[44] The qigong group demonstrated lower positivity after the training than the control group, indicating that qigong may reduce the demand of cognitive and emotional processing of the affective picture.[36,45]

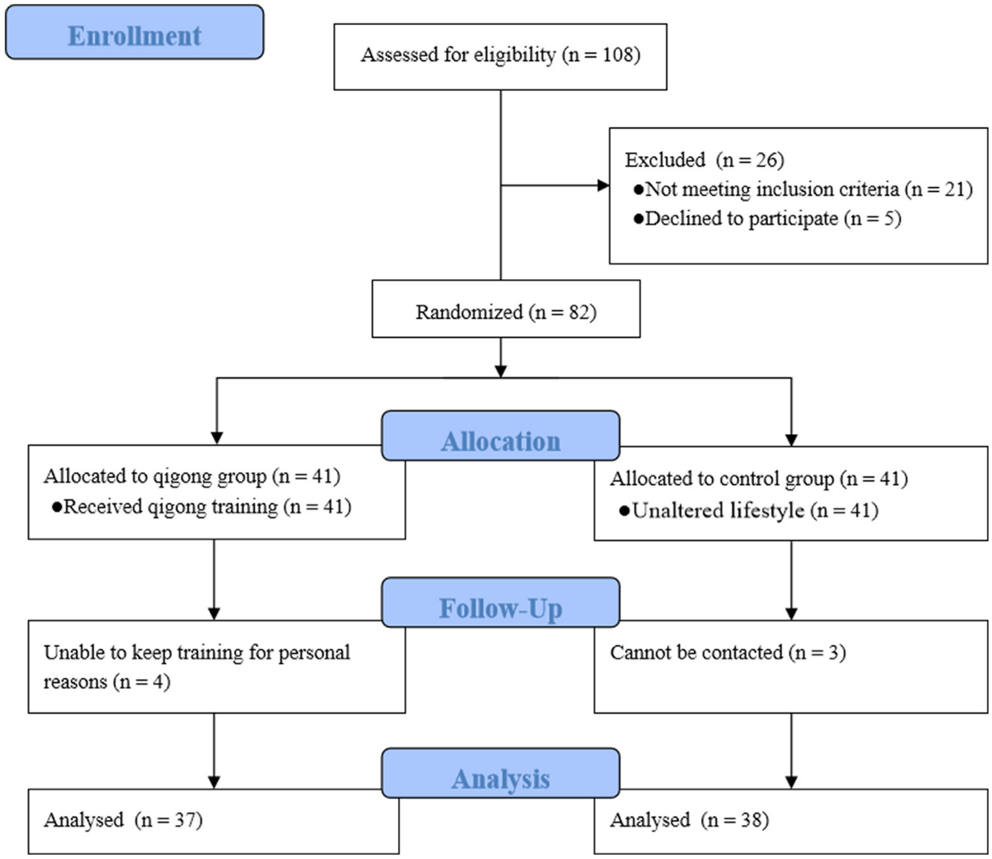

Fig. 3. Flow diagram of study subject recruitment.

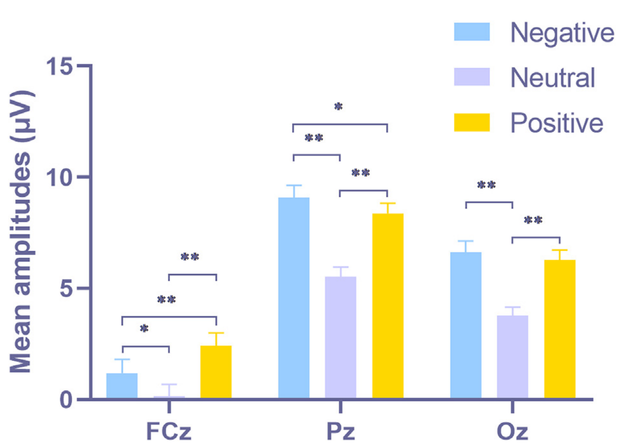

Fig. 4. Pairwise comparisons of late positive potential mean amplitudes of the FCz, Pz, and Oz electrodes on negative, neutral, and positive stimuli.
Notes: FCz, Pz, and Oz refer to the middle line of frontal central area, parietal area, and occipital area.
Data are expressed as mean (standard error of the mean) using repeated-measures analysis of variance
*$P < .05$, **$P < .01$ indicate comparisons between negative, neutral, and positive stimuli in three areas with statistical significance.

Mindful attention also demonstrates a similar phenomenon wherein reduced activity of the amygdala in response to affective stimuli could be found in people who have been trained in mindful attention.[16]

In addition to the FCz, the Pz electrode, which is located above the parietal cortex, is closely related to emotion.[46] The parietal cortex is responsible for regulating sensation, taste, touch, sexual impulse, physical coordination, body cognition, cognitive processing of sensory language, spatial perception, and other functions. The lateral parietal cortex is directly associated with other regions of the brain, such as the prefrontal cortex and temporal cortex, and it receives projected fibers from the lateral medial nasal side and lateral medial temporal lobe. Recent research has found that the posterior parietal cortex is a core area associated with emotional regulation.[47] Studies show that maximum amplitudes can be found on the parietal cortex, which is related to emotional brain circuits and depressive state regulation.[36,48,49] An fMRI study about cognitive regulation of depression found that participants with depression symptoms showed smaller activations in the parietal cortex when they did not focus on the emotional stimuli.[50] In our results, the qigong group demonstrated smaller amplitudes of the Pz on negative, neutral, and positive stimuli after the training than the control group. Combined with the specific function of the parietal region, it can be concluded that qigong training may reduce the feelings experienced by college students when faced with affective stimuli. However, we did not find a statistically significant difference between the two groups before and after training for the Oz electrode, which was located above the visual cortex. This may be because qigong training mainly regulates emotional processing rather than weakening the processing of visual signals.

Meanwhile, some limitations of this study should be noted. The duration of qigong training was four weeks. Additional effects may be found from long-term training. Moreover, because of the disadvantages of an EEG, we did not obtain data with high spatial resolution. Our team will conduct a study with a longer intervention period as the next step to explore the emotional regulation

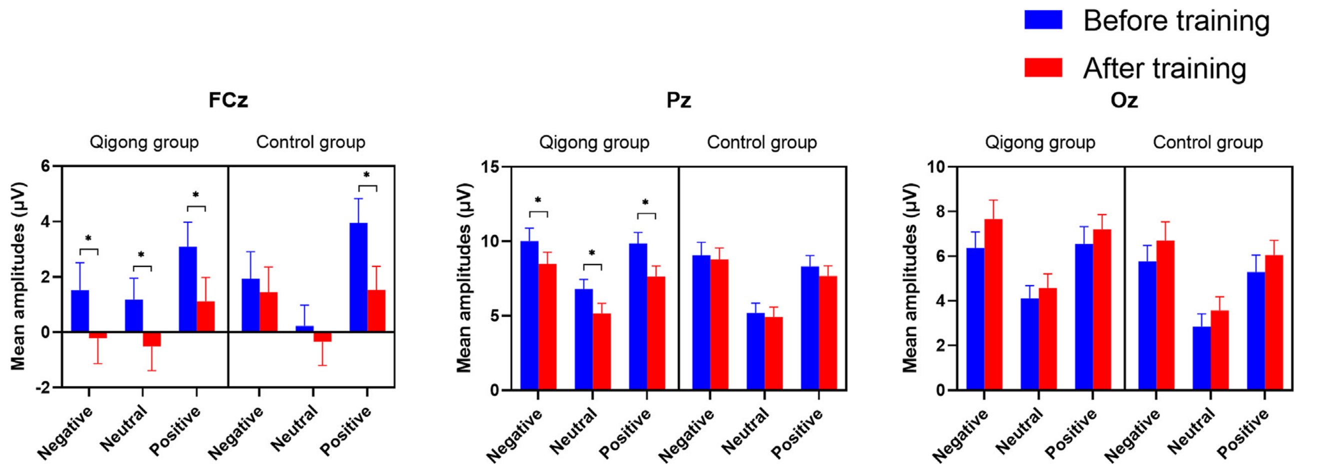

Fig. 5. Pairwise comparison of late positive potential mean amplitudes of the FCz, Pz, and Oz electrodes in two groups before and after training on negative, neutral, and positive stimuli.
Notes: FCz, Pz, and Oz refer to the middle line of frontal central area, parietal area, and occipital area.
Data are expressed as mean (standard error of the mean) using repeated-measures analysis of variance.
**P* < .05 indicates intragroup comparisons with statistical significance.

effect of qigong, and the EEG-fMRI synchronous detection method will be used to increase spatial resolution.

Conclusion

The results of this study support the concept that qigong practices improve the capacity for emotional regulation in college students. Our ERP evidence suggested that qigong exercise weakens the emotional regulation of LPP, which is sensitive to the top-down affective modulation. In this study, we attempted to explore the emotional regulation effect of qigong on college students from the perspective of neuroscience, and laid a foundation for further explaining the mechanism of qigong mind adjustment and its clinical application.

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CRediT authorship contribution statement

Qingchuan Hu: Conceptualization, investigation, data curation, visualization, and writing – original draft. **Kevin Chen:** Methodology and writing – review & editing. **Jialei Zhang:** Formal analysis, software, and investigation. **Xiaoqian Shao:** Investigation, data curation, and methodology. **Yulong Wei:** Conceptualization, methodology, project administration, supervision, and funding acquisition.

Declaration of competing interest

None declared.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jtcms.2021.01.005.

References

1. Lew B, Kõlves K, Osman A, et al. Uicidality among Chinese college students: a cross-sectional study across seven provinces. *PloS One*. 2020;15(8), e0237329.
2. Shermeyer L, Morrow MT, Mediate N. College students' daily coping, mood, and quality of life: benefits of problem-focused engagement. *Stress Health*. 2019;35(2):211–216.
3. Xiao LY, Zhang S, Li WY, et al. The mediating effect of sleep quality on the relationship between emotional and behavioral problems and suicidal ideation. *Int J Environ Res Publ Health*. 2019;16(24):4963.
4. Song YQ, Liu ZR, Chen HG, Guo Q, Huang YQ. Incidence and risk factors of depressive symptoms in Chinese college students. *Neuropsychiatric Dis Treat*. 2020;16:2449–2457.
5. Hill RM, Yaroslavsky I, Pettit JW. Enhancing depression screening to identify college students at risk for persistent depressive symptoms. *J Affect Disord*. 2015;174:1–6.
6. Park Y, Ammerman BA. How should we respond to non-suicidal self-injury disclosures?: an examination of perceived reactions to disclosure, depression, and suicide risk. *Psychiatr Res*. 2020;293:113430.
7. Zuzama N, Fiol-Veny A, Roman-Juan J, Balle M. Emotion regulation style and daily rumination: potential mediators between affect and both depression and anxiety during adolescence. *Int J Environ Res Publ Health*. 2020;17(18):6614.
8. Everaert J, Joormann J. Emotion regulation habits related to depression: a longitudinal investigation of stability and change in repetitive negative thinking and positive reappraisal. *J Affect Disord*. 2020;276:738–747.
9. Zou LY, Yeung A, Quan XF, et al. Mindfulness-based Baduanjin exercise for depression and anxiety in people with physical or mental illnesses: a systematic review and meta-analysis. *Int J Environ Res Publ Health*. 2018;15(2):321.
10. Chan SHW, Tsang HWH. The beneficial effects of Qigong on elderly depression. *Int Rev Neurobiol*. 2019;147:155–188.
11. An T, He ZC, Zhang XQ, et al. Baduanjin exerts anti-diabetic and anti-depression effects by regulating the expression of mRNA, lncRNA, and circRNA. *Chin Med*. 2019;14:3.
12. Wadden KP, Snow NJ, Sande P, Slawson S, Waller T, Boyd LA. Yoga practitioners uniquely activate the superior parietal lobule and supramarginal gyrus during emotion regulation. *Front Integr Neurosci*. 2018;12:60.
13. Zhang YF, Fu RF, Sun L, Gong YL, Tang DH. How does exercise improve implicit emotion regulation ability: preliminary evidence of mind-body exercise intervention combined with aerobic jogging and mindfulness-based yoga. *Front Psychol*. 2019;10:1888.
14. Deng XM, Yang M, An S. Differences in frontal EEG asymmetry during emotion regulation between high and low mindfulness adolescents. *Biol Psychol*. 2020;158:107990.
15. Sobolewski A, Holt E, Kublik E, Wróbel A. Impact of meditation on emotional processing–A visual ERP study. *Neurosci Res*. 2011;71(1):44–48.
16. Desbordes G, Negi LT, Pace TWW, Wallace BA, Raison CL, Schwartz EL. Effects of mindful-attention and compassion meditation training on amygdala response to emotional stimuli in an ordinary, non-meditative state. *Front Hum Neurosci*. 2012;6:292.
17. Robins CJ, Keng SL, Ekblad AG, Brantley JG. Effects of mindfulness-based stress reduction on emotional experience and expression: a randomized controlled trial. *J Clin Psychol*. 2012;68(1):117–131.
18. Liu TJ, Chen KW. *Chinese Medical Qigong*. London: Singing Dragon; 2010:194.

19. Hu QC, Li SY, Wang WW, et al. Timing characteristics analysis of the tranquilizing effects of *Imaginary Working* based on the alpha band electroencephalogram power. *J Beijing Univ Tradit Chin Med*. 2016;39(2):128–131 [Chinese].
20. Li SY, Hu QC, Wang WW, et al. Spatial distribution analysis of the tranquilizing effect of *Image Thinking* based on the alpha band EEG power. *J Beijing Univ Tradit Chin Med*. 2016;39(7):562–567 [Chinese].
21. Wang WW, Wei ZR, Hu QC, et al. Specificity analysis of psychological adjustment of *Imaginary Working* based on electroencephalographical power spectra. *J Beijing Univ Tradit Chin Med*. 2016;39(3):222–229 [Chinese].
22. Desatnik A, Bel-Bahar T, Taylor L, et al. Emotion regulation in adolescents: influences of internal representations of relationships - an ERP study. *Int J Psychophysiol*. 2020;160:1–9.
23. Hoid D, Pan DN, Wang Y, Li XB. Implicit emotion regulation deficits in individuals with high schizotypal traits: an ERP study. *Sci Rep*. 2020;10(1):3882.
24. McLean MA, Van den Bergh B, Baart M, Vroomen J, van den Heuvel MI. The late positive potential (LPP): a neural marker of internalizing problems in early childhood. *Int J Psychophysiol*. 2020;155:78–86.
25. Wilson KA, MacNamara A. Savor the moment: willful increase in positive emotion and the persistence of this effect across time. *Psychophysiology*. 2020, e13754.
26. Cui LX, Dong XF, Zhang S. ERP evidence for emotional sensitivity in social anxiety. *J Affect Disord*. 2021;279:361–367.
27. Moser JS, Hajcak G, Bukay E, Simons RF. Intentional modulation of emotional responding to unpleasant pictures: an ERP study. *Psychophysiology*. 2006;43(3):292–296.
28. Moser JS, Most SB, Simons RF. Increasing negative emotions by reappraisal enhances subsequent cognitive control: a combined behavioral and electrophysiological study. *Cognit Affect Behav Neurosci*. 2010;10(2):195–207.
29. Lin YL, Fisher ME, Roberts SMM, Moser JS. Deconstructing the emotion regulatory properties of mindfulness: an electrophysiological investigation. *Front Hum Neurosci*. 2016;10:451.
30. Reva NV, Pavlov SV, Loktev KV, Korenyok VV, Aftanas LI. Influence of long-term Sahaja Yoga meditation practice on emotional processing in the brain: an ERP study. *Neuroscience*. 2014;281:195–201.
31. Lee BT, Cho SW, Khang HS, et al. The neural substrates of affective processing toward positive and negative affective pictures in patients with major depressive disorder. *Prog Neuro-Psychopharmacol Biol Psychiatry*. 2007;31(7):1487–1492.
32. Bai L, Ma H, Huang YX, Luo YJ. The development of native Chinese Affective Picture System-A pretest in 46 college students. *Chin Ment Health J*. 2005;19(11):719–722 [Chinese].
33. Huang JW, Xu DR, Peterson BS, et al. Affective reactions differ between Chinese and American healthy young adults: a cross-cultural study using the international affective picture system. *BMC Psychiatr*. 2015;15:60.
34. Semlitsch HV, Anderer P, Schuster P, Presslich O. A solution for reliable and valid reduction of ocular artifacts, applied to the P300 ERP. *Psychophysiology*. 1986;23(6):695–703.
35. Guo Y, Xu MM, Wei ZR, et al. Beneficial effects of *Qigong Wuqinxi* in the improvement of health condition, prevention, and treatment of chronic diseases: evidence from a systematic review. *Evid Based Complement Alternat Med*. 2018;2018:3235950.
36. Olofsson JK, Nordin S, Sequeira H, Polich J. Affective picture processing: an integrative review of ERP findings. *Biol Psychol*. 2008;77(3):247–265.
37. Schupp HT, Cuthbert BN, Bradley MM, Cacioppo JT, Ito T, Lang PJ. Affective picture processing: the late positive potential is modulated by motivational relevance. *Psychophysiology*. 2000;37(2):257–261.
38. Barbas H. Connections underlying the synthesis of cognition, memory, and emotion in primate prefrontal cortices. *Brain Res Bull*. 2000;52(5):319–330.
39. Brooks JO, Bonner JC, Rosen AC, et al. Dorsolateral and dorsomedial prefrontal gray matter density changes associated with bipolar depression. *Psychiatr Res*. 2009;172(3):200–204.
40. Drevets WC. Functional anatomical abnormalities in limbic and prefrontal cortical structures in major depression. *Prog Brain Res*. 2000;126:413–431.
41. MacNamara A, Ferri J, Hajcak G. Working memory load reduces the late positive potential and this effect is attenuated with increasing anxiety. *Cognit Affect Behav Neurosci*. 2011;11(3):321–331.
42. Vanderhasselt MA, De Raedt R, Baeken C, Leyman L, D'Haenen H. A single session of rTMS over the left dorsolateral prefrontal cortex influences attentional control in depressed patients. *World J Biol Psychiatr*. 2009;10(1):34–42.
43. Weiduschat N, Dubin MJ. Prefrontal cortical blood flow predicts response of depression to rTMS. *J Affect Disord*. 2013;150(2):699–702.
44. Hajcak G, Moser JS, Simons RF. Attending to affect: appraisal strategies modulate the electrocortical response to arousing pictures. *Emotion*. 2006;6(3):517–522.
45. Kompus K, Hugdahl K, Ohman A, Marklund P, Nyberg L. Distinct control networks for cognition and emotion in the prefrontal cortex. *Neurosci Lett*. 2009;467(2):76–80.
46. Engelen T, de Graaf TA, Sack AT, de Gelder B. A causal role for inferior parietal lobule in emotion body perception. *Cortex*. 2015;73:195–202.
47. Hua JPY, Trull TJ, Merrill AM, McCarty RM, Straub KT, Kerns JG. Daily-life affective instability in emotional distress disorders is associated with function and structure of posterior parietal cortex. *Psychiatry Res Neuroimaging*. 2020;296:111028.
48. Sabatinelli D, Lang PJ, Keil A, Bradley MM. Emotional perception: correlation of functional MRI and event-related potentials. *Cerebr Cortex*. 2007;17(5):1085–1091.
49. van Honk J, Schutter DJLG, Putman P, de Haan EH, d'Alfonso AA. Reductions in phenomenological, physiological and attentional indices of depressive mood after 2 Hz rTMS over the right parietal cortex in healthy human subjects. *Psychiatr Res*. 2003;120(1):95–101.
50. Beevers CG, Clasen P, Stice E, Schnyer D. Depression symptoms and cognitive control of emotion cues: a functional magnetic resonance imaging study. *Neuroscience*. 2010;167(1):97–103.