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Mechanisms of the role of calligraphy training on emotion regulation and mental health improvement among college students in the digital era

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SUMMARY: *College students face multiple challenges such as distraction and learning pressure in the course of their intense academic life. This study investigated whether calligraphy training, which originates from traditional culture, can serve as an effective intervention mechanism to improve college students' emotional regulation and mental health. The study utilized a pre- and post-test experimental design, and 106 college students were exposed to a 40-day calligraphy training intervention. The mental health and emotion assessments of the two groups of college students were conducted using the Mental Health Quality Questionnaire for College Students and the Emotion Regulation Scale, and the mediating effect of emotion regulation on mental health in calligraphy training was analyzed by the SPSS macro program PROCESS. The results of the study showed that calligraphy training could significantly improve the overall mental health quality and emotion regulation ability of college students, among which the effect of line calligraphy training in promoting students' psychological relaxation was more significant. The mediating effect analysis further revealed that calligraphy training also had an indirect positive effect on college students' psychological health by enhancing students' cognitive reappraisal and reducing expressive inhibition. This paper provides a reference for developing scientific psychological intervention programs for college students.*

KEYWORDS: *Calligraphy training; Mental health quality; Emotional regulation ability; Mediating effect*

1 Introduction

Calligraphy is a traditional art of the Chinese nation with a long history, and has always been regarded as an important activity for nationals to cultivate their bodies and nourish their temperament [1]. At the same time, calligraphy practice also has the function of cultivating sentiment and expressing emotions, which can promote the psychological health of individuals [2-4]. In recent years, the psychology of calligraphy as a cross-discipline has attracted more and more scholars' attention [5]. Although many literati have noticed the influence of calligraphy on the individual's "heart" since ancient times, there is still no specific and systematic research on the mechanism of calligraphy training on the regulation of emotions and the improvement of mental health.

The physical and psychological effects of practicing calligraphy on individuals are supported by physiological and psychological studies. For example, Kao et al. concluded that Chinese calligraphy practice, as a traditional practice, has systematic effects at the mental and physical levels; it not only enhances visual concentration and activates cognitive functions, but

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also promotes the slowing down of physiological rhythms, calms emotions, and leads to positive adjustments in behavioral patterns; these multifaceted changes collectively form an interrelated cluster of effects [6]. A study by Wang and Tang showed that calligraphy activity was significantly and positively correlated with both the experience of mind-flow and inner peace, and that calligraphy practice could effectively promote college students' experience of concentration and emotional balance, which not only directly enhanced the level of self-concern, but also indirectly exerted a positive influence through the mediation of psychological state [7]. Bin et al. conducted a two-year follow-up with 170 elementary school students and found that long-term participation in calligraphy practice not only enhances students' levels of positive emotions, but also helps to develop more adaptive emotion regulation strategies, which in turn supports the development of their mental health [8]. The above studies illustrate that during calligraphy practice, writers will show a characteristic physiological state, especially regular calligraphy practitioners, who will slow down their breathing, decrease their heart rate, and lower their blood pressure while writing, and this relaxation state can promote the individual's emotional regulation and cognitive development, which is conducive to the improvement of mental health [9-12].

In addition, the practice of calligraphy can also promote emotional regulation and improvement, the most significant help to individuals in the practice of brush calligraphy is manifested in the emotional function, and many studies have confirmed that the practice of calligraphy has the effect of regulating emotions [13]. For example, Chen et al. explored the relationship between calligraphy education and students' academic emotions, and observed that calligraphy training interacted with positive psychological traits on academic emotions, especially on the negative emotions of “positive low arousal” and “negative high arousal” (e.g., anxiety, irritability), These findings provide an empirical basis for understanding the role of calligraphy education in emotional development [14]. Based on a sample of 1,460 high school students, Wang et al. found that students who practiced calligraphy on a daily basis showed higher levels of positive affect; in addition, by conducting a short-term calligraphy training for college students over a period of six days, the results showed that the positive affective enhancement was even more pronounced, and that the practice of calligraphy was effective in promoting the positive affective development of adolescents, which provides further support for the promotion of calligraphy in mental health improvement [15]. Through a systematic review and meta-analysis, Chu et al. showed that calligraphy therapy significantly reduced psychotic symptoms, anxiety and depression levels, and had positive effects in improving cognitive function and modulating neurofeedback; moreover, the therapy demonstrated a significant alleviation of both positive and negative symptoms of schizophrenia [16]. Calligraphy practice not only helps individuals to regulate their emotions, but individuals' emotions can also be reflected through calligraphy practice [17]. In a happy emotional state, college students who participated in calligraphy practice would pay more attention to the standardization, roundness and fluency of Chinese character writing; while in an angry emotional state, college students showed attention to the strength and fullness of writing [18]. This also suggests that the process of calligraphy practice can actually be used as a process of emotional catharsis for individuals, through which individuals can better perceive their own emotional state and make appropriate catharsis to realize emotional regulation.

As for the research on the specific mechanism of action of calligraphy psychotherapy, a study by Xing et al. showed that calligraphy practice can alleviate anxiety by significantly reducing beta-band power, and its mechanism of action is similar to the reduction of attentional focus and external distractions observed in meditation, thus suggesting that the two may share some of the psychological mechanisms, and this study provides a neuroscientific basis for the clinical application of calligraphy in emotion regulation [19]. A research experiment by Hsiao

et al. showed that calligraphy practice can effectively activate brain function, improve cognition, alleviate psychological symptoms, and enhance hand stability, and that as a low-cost and culturally appropriate activity, daily calligraphy practice has positive health-promoting implications for older adults with mild cognitive impairment [20]. Chen et al. explored the effects of long-term calligraphy training on anxiety levels, attentional functions, and brain structure, and found that calligraphy training helped to improve individuals' selective and allocative attention; moreover, in terms of brain structure, long-term calligraphy trainers had smaller gray matter volumes in the right precuneus/posterior cingulate gyrus cortex; furthermore, through region-of-interest analyses, it was found that the differences between the two groups were only in the brain areas related to meditation. The results suggest that calligraphy training may improve attention and affect the structure of specific brain regions through mental processes such as meditation [21]. Through the above research status, we found that theoretical studies on the effects of calligraphy training on emotion regulation and mental health have been abundant. However, there are still a number of significant limitations, including the fact that most of the studies stayed in the simple correlation analysis between calligraphy practice and psychological indicators and lacked empirical testing of their intrinsic pathways of action; in addition, the specificity of the digital era was ignored, and the interaction between calligraphy practice and the digital era was less explored, and these limitations make it difficult for the existing studies to comprehensively reveal the complex mechanisms by which calligraphy training affects mental health in the digital era.

While the digital era brings convenience to college students' life and study, it also brings problems such as online social anxiety, psychological pressure and emotional distress. In order to scientifically verify the improvement effects and related mechanisms of calligraphy training on the mental health and emotional regulation of college students in the digital era. In this study, 120 college students were recruited using a mixed between-group and within-group experimental design, and after screening out 14 students who accidentally dropped out of the experiment, the remaining students were randomly assigned into two groups. The difference in effects between the control and experimental groups before and after the experiment was assessed using the Mental Health Quality Questionnaire for College Students and the Emotion Regulation Scale. The heart rate variability data of college students in the state of resting, copying running script and regular script were also collected. The mediating effect of emotion regulation on mental health quality was also verified.

2 Research design

2.1 Subjects

A total of 120 students in the third year of university in X College were randomly selected and divided into calligraphy group and control group according to the voluntary choice of the subjects, of which 14 withdrew from the experiment halfway due to accidents, and the actual number of completed experiments was 106, with an average age of 21.2 years old and an effective rate of 90%. The actual number of subjects who completed the experiment in each group of the calligraphy and control groups was 53. There was no significant difference in the age and years of school enrollment of the subjects in the two groups, none of them had long-term brush writing experience, and none of them had a history of mental illness.

2.2 Experimental materials

The quiz uses the Emotion Regulation Scale and the Mental Health Quality Questionnaire. Each person in the Calligraphy Group will be given a medium-case sheep's hair brush and a set of regular script calligraphy posters.

2.3 Experimental design and procedure

A mixed between-group and within-group experimental design was used. Compare the mood changes before and after the experiment between the two groups of subjects themselves, respectively. Compare the mood effects between the three groups of subjects. The experiment lasted for a total of 40 days. The subjects in the calligraphy group were asked to write different Chinese characters according to the regular script for 45 minutes every day at a designated place. When writing, the subjects were required to concentrate on their thoughts, keep their mind on the end of the brush, sit with their chests erect, move their brushes forcefully, and match the speed of the brush with their breathing, i.e., exhale when stuttering and moving the brush, inhale when lifting the brush, and match the speed of the brush with their even breathing. The so-called concentration and meditation, the intention of the end of the pen, that is, before writing carefully read the post, with the idea of writing the word in the mind first stroke by stroke, writing eyes on the tip of the pen, focus on the tip of the pen, the requirements of the pen, each stroke must be used in the center, and strive for the strokes of the clear and strong rich and fat, the interstices of the frame is neat and dense. The control group did not participate in any writing practice. The SCL-90 questionnaire was used to test the mood changes of the two groups of subjects on the 1st, 20th and 40th days of the experiment, respectively. All data were processed by SPSS17.0 statistical package.

2.4 Research tools

The Mental Health Quality Questionnaire for College Students (MHQC) was compiled by relevant researchers, and the revised MHQC with the college student population as the subjects included four dimensions: cognitive quality, personality quality, emotional quality, and adaptive quality. Using a five-point Likert scale (from 1="strongly disagree" to 5="strongly agree"), the higher the total score of mental health quality indicates the higher the mental health quality of college students. In this study, the alpha coefficient of the total questionnaire was 0.82, and the alpha coefficients of the sub-dimensions were 0.78 (cognitive quality), 0.73 (emotional quality), 0.76 (personality quality), and 0.85 (adaptive quality). The fit indices after validated factor analysis were: X^2/df=3.03, RMSEA=0.06, SRMR=0.02, GFI=0.94, AGFI=0.97, XFI=0.94, IFI=0.96, NFI=0.98, which met the statistical standard, indicating that the questionnaire had good reliability and validity.

Emotion Regulation Scale (ERS): the emotion regulation scale developed by relevant researchers was used, which was based on the theoretical foundation of Gross's emotion regulation process model and measured two emotion regulation strategies: cognitive reappraisal and expressive inhibition. Each strategy consists of 7 questions, with a total of 14 questions, including two dimensions of cognitive reappraisal and expressive inhibition, ranging from “completely disagree” to “completely agree” on a 7-point scale. The Cronbach's alpha coefficient of the scale was 0.88 in this study.

3 Findings

3.1 Effects of Calligraphy Training on the Quality of Emotion Regulation and Mental Health of University Students

3.1.1 Descriptive statistics of pre- and post-test measurement data

The valid data were entered into SPSS17.0 to be analyzed, and the descriptive statistics are shown in Table 1. From the descriptive statistics, it can be seen that after 40 days of experiment, the level of mental health quality of students in the experimental class (M=18.42) is higher than the level of mental health quality at the pre-test (M=13.45), and the level of mental health quality of college students in the control group (M=13.38) is lower than the level of mental health quality at the pre-test (M=13.41). The level of emotional regulation of the experimental class (M=91.45) was higher than the level of emotional regulation at the pre-test (M=45.24), and the level of emotional regulation of the control group of university students (M=45.11) was lower than the level of emotional regulation at the pre-test (M=45.26). From the repeated-measures ANOVA, the effects of calligraphy training on the mental health quality and emotion regulation of college students were all significant ($p<0.01$), which can be obtained by comparing the experimental class with the control class, and the calligraphy training can promote the development of the mental health quality and emotion regulation of college students.

Table 1: Descriptive statistics

	Premeasurement		Posttest	
	Experimental group (N=53)	Control group (N=53)	Experimental group (N=53)	Control group (N=53)
Mental health	13.45±1.33	13.41±1.25	18.42±1.12	13.38±1.29
Cognitive quality	3.13±0.34	3.12±0.35	4.52±0.36	3.11±0.39
Personality quality	3.19±0.36	3.17±0.35	4.59±0.38	3.13±0.39
Emotional quality	3.28±0.34	3.29±0.36	4.57±0.44	3.22±0.34
Adaptive quality	3.01±0.15	3.02±0.19	4.35±0.31	3.03±0.32
Emotional regulation	45.24±0.14	45.26±0.13	91.45±0.15	45.11±0.19
Cognitive review	22.21±0.14	22.28±0.14	42.78±0.36	22.25±0.59
Expression inhibition	22.26±0.14	22.25±0.13	13.44±0.14	22.21±0.17

3.1.2 Effects of Calligraphy Training on Emotional Regulation and Mental Health Qualities

The final valid data of the pre-test and post-test were analyzed by repeated measures ANOVA, and the results were obtained as shown in Table 2. The p-value of calligraphy training on the mental health quality and emotion regulation of college students was 0.003 and 0.008, respectively, and the effects of calligraphy training on the mental health quality and emotion regulation of college students were both significant ($p<0.01$).

Table 2: The effect of training on emotional adjustment and mental health

	df	MS	F	P	Partial Eta Squared
Mental health	1	262.151	8.956	0.003**	0.112
Cognitive quality	1	163.211	7.189	0.008**	0.094
Personality quality	1	145.151	8.154	0.005**	0.106
Emotional quality	1	138.541	1.225	0.007**	0.107
Adaptive quality	1	180.089	2.193	0.004**	0.098
Emotional regulation	1	127.451	7.854	0.008**	0.105
Cognitive review	1	128.055	24.505	0.005**	0.162
Expression inhibition	1	124.212	25.644	-0.003**	0.108

In terms of the four dimensions of mental health quality: After 40 days of experiment, the cognitive quality of college students in the experimental class (M=4.52) was higher than that in the pre-test (M=3.13), and the cognitive quality of college students in the control class (M=3.11) was slightly lower than that in the pre-test (M=3.12). From the repeated measures ANOVA, it is concluded that calligraphy training has a significant effect on the cognitive quality of college students' mental health qualities ($p<0.01$), and it can be concluded by comparing the experimental class with the control class that calligraphy training promotes the development of cognitive quality of college students' mental health qualities.

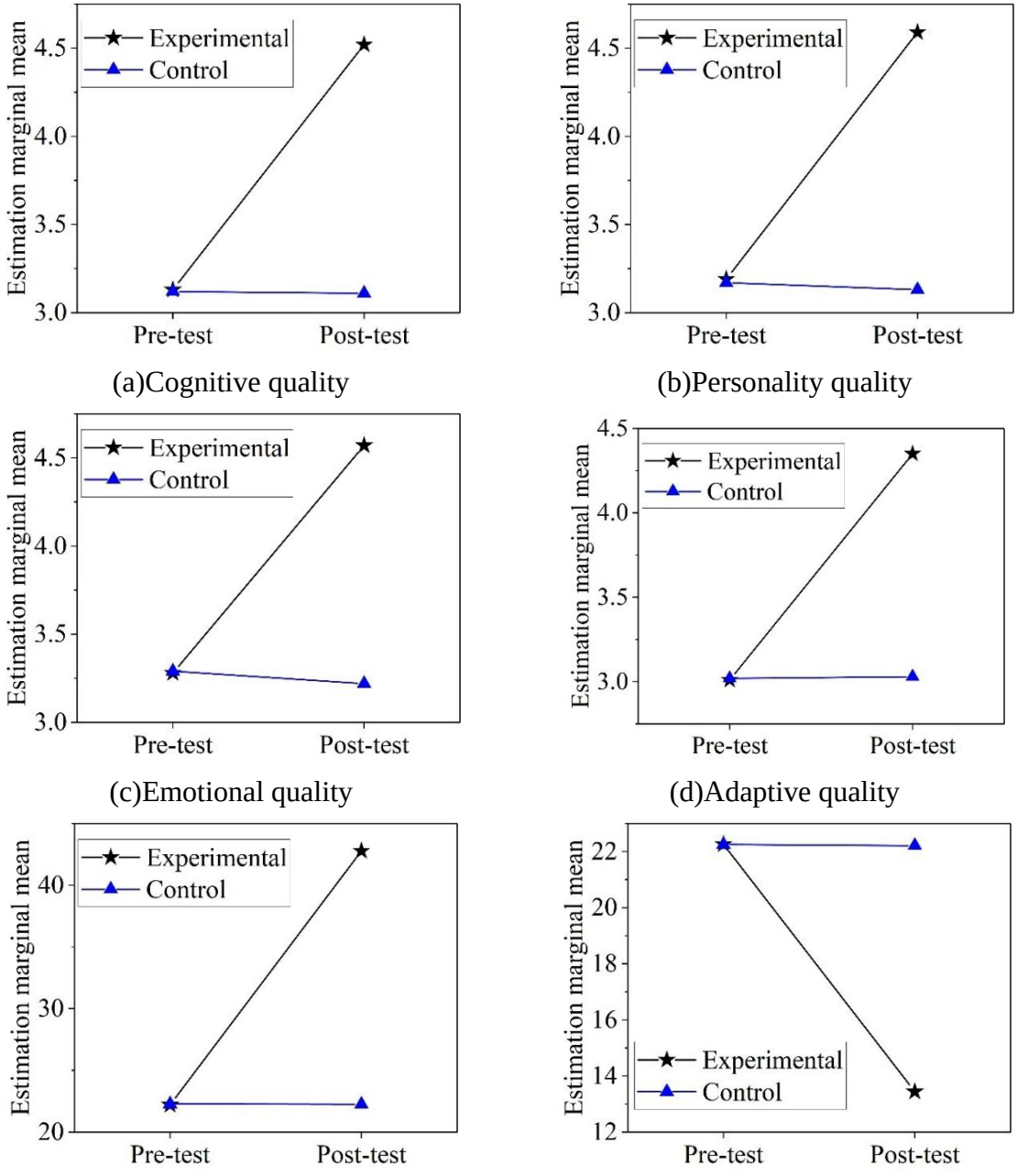
The personality quality of college students in the experimental class (M=4.59) was higher than that in the pre-test (M=3.19), and the personality quality of college students in the control class (M=3.13) was lower than that in the control class in the pre-test (M=3.17). Repeated-measures ANOVA showed that the effect of calligraphy training on the personality quality of college students' mental health qualities was significant ($p<0.01$), and calligraphy training could promote the development of personality quality of college students' mental health qualities.

The emotional quality dimension of college students in the experimental class (M=4.57) was higher than that in the pre-test (M=3.28), and the emotional quality dimension of college students in the control class (M=3.22) was lower than that in the pre-test (M=3.29). The effect of calligraphy training on the emotional quality dimension of mental health of college students was significant ($p<0.01$).

The adaptive quality of college students in the experimental class (M=4.35) was higher than the adaptive quality at the pre-test (M=3.01), and the adaptive quality of college students in the control group (M=3.03) was slightly higher than the adaptive quality at the pre-test (M=3.02). From the repeated-measures ANOVA, it was concluded that calligraphy training had a significant effect on the quality of adaptation of college students' mental health qualities ($p<0.01$).

The cognitive reappraisal of the college students in the experimental class (M=42.78) was higher than that in the pre-test (M=22.21), and there was not much difference between the cognitive reappraisal of the college students in the control class and the level of cognitive reappraisal in the pre-test. Both experimental and control class students performed lower on expression inhibition than the pre-test expression inhibition level, but the reduced level in the control class was not significant. From the repeated measures ANOVA, it was concluded that the effect of calligraphy training on both cognitive reassessment and expression inhibition of college students' emotion regulation was significant ($p<0.01$), and that calligraphy training could promote the development of cognitive reassessment of college students' emotion regulation, and at the same time reduce the level of expression inhibition of college students, which was conducive to the full expression of college students' selves and the cultivation of their own interpersonal communication skills. The changes over time of the sub-dimensions of mental health quality and emotion regulation in the experimental and control groups are shown

in Figure 1, and Figures (a) to (f) show the results of the changes over time of cognitive quality, emotional quality, personality quality, adaptive quality, cognitive reappraisal and expression inhibition, respectively.



(a)Cognitive quality (b)Personality quality

(c)Emotional quality (d)Adaptive quality

(e)Cognitive review (f)Expression inhibition

Figure 1: The changes of the subdimensions

3.2 Test results of HRV when copying different calligraphic styles

In the study on heart rate variability, only the short-term heart rate variability study was conducted, and the analysis method used was the linear analysis method, including the time domain analysis method and the frequency domain analysis method. The computational indexes of the time-domain analysis method include SDNN, rMSSD, and pNN50. The computational indexes of the frequency-domain analysis method include high frequency (HF) and low frequency (LF).

3.2.1 Test results based on the time domain analysis method

SDNN is the standard deviation of the N-N interval of sinus heart rate, which is an indicator of the overall changes in autonomic function. The normality test was performed on the SDNN values collected from the subjects in the three states of resting, copying regular script, and copying running script. The results of the normality test are shown in Table 3, and the data of SDNN indicators in each group did not obey normal distribution ($p<0.05$).

Wilcoxon rank sum test in nonparametric test was performed on SDNN indicators, and the results are shown in Table 4. The median and quartiles of the SDNN indexes of the subjects increase when writing regular and running script works, which suggests that writing regular and running script works may increase the excitability of the autonomic nerves and contribute to the elevation of heart rate variability, and that writing running script works is more important for raising the value of SDNN than that of writing regular script works. In this case, the difference in the change in SDNN values from the baseline SDNN values when writing running script works was statistically significant ($p<0.05$), while although writing regular script works also increased autonomic excitability, the difference in the change from the baseline values was not statistically significant ($p>0.05$). Also in terms of numerical comparison, the SDNN values when writing running script works were higher than the SDNN values when writing regular script works, suggesting that writing running script works may be more likely to elicit autonomic excitability.

Table 3: The normal test of the SDNN index

Experimental stage	N	Statistic	df	P
Base line	53	0.134	53	0.001
Regular script	53	0.107	53	0.021
Book writing	53	0.115	53	0.014

Table 4: Wilcoxon rank and test results

Experimental stage	MD of SDNN	Z	P
Base line	40.745		
Regular script	43.154	-0.365	0.716
Book writing	70.431	-5.944	0.000

rMSSD is the root-mean-square value of the difference between adjacent N-N intervals of a full normal heartbeat. Its physiological significance is to reflect the activity of parasympathetic nerves. The results of the normality test are shown in Table 5, except for the rMSSD values at the time of line writing, which conformed to normal distribution ($p>0.05$), the other two groups did not obey normal distribution ($p<0.05$).

The Wilcoxon rank sum test in the nonparametric test was performed on the rMSSD index, and the results are shown in Table 6. By comparing with the baseline values collected in the resting state, the rMSSD values of the subjects were higher than the baseline rMSSD values when they were writing running script calligraphic works and after writing regular script works, which indicated that writing regular script works inhibited the parasympathetic excitability, and the difference of the change was statistically significant ($p<0.05$), whereas writing running script works enhanced the parasympathetic excitability, but the change of the difference is not statistically significant ($p>0.05$).

Table 5: The normal test of the rMSSD index

Experimental stage	N	Statistic	df	P
Base line	53	0.112	53	0.013
Regular script	53	0.136	53	0.001
Book writing	53	0.098	53	0.065

Table 6: Wilcoxon rank and test results

Experimental stage	MD of rMSSD	Z	P
Base line	38.546		
Regular script	32.021	-3.398	0.001
Book writing	38.677	-0.055	0.955

The pNN50 is the number of adjacent normal interbeat intervals with a difference of more than 50 milliseconds. Its physiological significance is to reflect the activity of parasympathetic nerves. The results of the normality test are shown in Table 7, the pNN50 index data obeyed the normal distribution ($p>0.05$) while the rest of the two groups of pNN50 index data did not obey the normal distribution ($p<0.05$) when they were performing the copying of running script calligraphic style.

The Wilcoxon rank sum test in the nonparametric test was still performed on the pNN50 indexes, and the results of the Wilcoxon rank sum test are shown in Table 8. Compared with the mean values of pNN50 indicators collected during the resting period, the pNN50 values when copying the regular script and the pNN50 values when copying the running script both showed a decrease, which suggests that copying the regular script works and copying the running script works can inhibit the parasympathetic excitability. The difference in pNN50 values when copying regular script works was statistically significant ($p<0.05$), while the difference in pNN50 values when copying running script works was not statistically significant ($p>0.05$).

Table 7: The normal test of the pNN50 index

Experimental stage	N	Statistic	df	P
Base line	53	0.102	53	0.043
Regular script	53	0.176	53	0.000
Book writing	53	0.096	53	0.075

Table 8: Wilcoxon rank and test results

Experimental stage	MD of pNN50	Z	P
Base line	22.783		
Regular script	7.698	-7.776	0.000
Book writing	22.325	-7.776	0.000

3.2.2 Test results based on the frequency domain analysis method

HF means high-frequency power, and its changes in heart rate variability indexes are mainly affected by vagal tone, reflecting the regulatory function of the vagus nerve. The results of the normality test are shown in Table 9. It shows that the data of HF indexes in all groups do not obey normal distribution ($p<0.05$).

The Wilcoxon rank sum test in the nonparametric test was performed on the HF indexes, and the test results are shown in Table 10.The HF values were higher than the baseline values,

which indicated that writing regular script works and writing running script works could increase the excitability of the vagus nerve, and that writing running script works was more important for increasing the HF values than writing regular script works. In this case, the difference between the changes from the baseline values of writing regular script works and writing running script works, respectively, was statistically significant ($p<0.05$). In addition, when observed from the perspective of mean values, writing running script style improved the HF values more than writing regular script style.

Table 9: The normal test of the HF index

Experimental stage	N	Statistic	df	P
Base line	53	0.215	53	0.000
Regular script	53	0.177	53	0.000
Book writing	53	0.198	53	0.000

Table 10: Wilcoxon rank and test results

Experimental stage	MD of HF	Z	P
Base line	34.88		
Regular script	1055.08	-7.768	0.000
Book writing	1223.25	-5.523	0.000

LF is low frequency power, and its role in heart rate variability indexes mainly reflects the regulatory function of sympathetic nerves. The results of the normality test are shown in Table 11, and the data of LF indexes in each group did not obey the normal distribution ($p<0.05$).

The Wilcoxon rank sum test in the nonparametric test was performed on the LF indexes. The results of the test are shown in Table 12, by comparing the means, the LF values of the subjects increased compared to the baseline values after writing regular and running scripts respectively, and the difference of the changes was statistically significant ($p<0.05$), which indicated that writing regular and running scripts increased the excitability of sympathetic nerves, and the sympathetic nerve tone rose. Meanwhile, from the comparison of the mean values, it was found that the LF values were higher when writing regular script than when writing running script, suggesting that the level of sympathetic nerve tone rise was higher when writing regular script than when writing running script.

Table 11: The normal test of the LF index

Experimental stage	N	Statistic	df	P
Base line	53	0.285	53	0.000
Regular script	53	0.226	53	0.000
Book writing	53	0.299	53	0.000

Table 12: Wilcoxon rank and test results

Experimental stage	MD of LF	Z	P
Base line	22.368		
Regular script	1252.254	-7.768	0.000
Book writing	7.749	-5.523	0.000

3.3 Mediating role of emotion regulation

3.3.1 Comparison of Differences in Emotion Regulation on Different Dimensions of Mental Health

The average score of cognitive reappraisal was used as the cut-off point to divide into high cognitive reappraisal group and low cognitive reappraisal group. The mean score of expression inhibition was used as the cut-off point to divide into high expression inhibition group and low expression inhibition group. A t-test was conducted on the scores of different levels of cognitive reappraisal and expression inhibition regarding different dimensions of mental health, and the results are shown in Table 13.

The data in the table show that there is a significant difference in the scores of the different subgroups of the cognitive reassessment on the total mental health, self-affirmation, non-depression, and non-anxiety. College students with high cognitive reappraisal scores have higher levels of self-affirmation and lower levels of depression and anxiety than those with low cognitive reappraisal scores. There was a significant difference between the scores of different subgroups of college students on total mental health, self-affirmation, non-depression, and non-anxiety. College students with high scores on the Expressive Inhibition scale had lower levels of self-affirmation and higher levels of depression and anxiety than those with low scores on the Cognitive Reassessment scale.

Table 13: T test results

	Cognitive review(M±SD)		t	Expression inhibition(M±SD)		t
	Scoring group	Low group		Scoring group	Low group	
Cognitive quality	5.78±1.21	4.64±1.29	7.985***	4.92±2.25	5.56±2.29	-3.925***
Personality quality	5.42±1.12	4.92±1.24	6.112***	4.97±1.47	5.38±2.25	-4.921***
Emotional quality	4.11±1.26	3.65±1.18	5.561***	3.75±1.65	4.14±1.33	-3.445***
Adaptive quality	4.25±1.24	3.78±1.45	5.678***	3.78±2.21	4.56±2.11	-3.568***
Mental health	19.56±3.28	16.99±4.45	8.885***	17.42±3.27	19.64±4.27	-5.489***

3.3.2 Analysis of the mediating effects of emotion regulation

This study explored the relationship between calligraphy training, cognitive reappraisal and expressive inhibition in emotion regulation strategies, and psychological well-being. In this study, we used the SPSS macro program PROCESS to select the model corresponding to the simple mediated effect, and adopted the bias-corrected nonparametric percentile Bootstrap method to estimate the mediated effect value by taking 4000 Bootstrap samples to obtain the Bootstrap 95% confidence interval, if the confidence interval does not include 0 it means that there is statistical significance and the mediated The mediating effect was established. The mediating role of cognitive reappraisal in the effects of calligraphy training on mental health was tested and analyzed controlling for gender and expression suppression. To test and analyze the mediating effect of cognitive reappraisal on the effects of calligraphy training on mental health, controlling for gender and expression inhibition. The results of the test of the mediating effect of cognitive reassessment in the process of the influence of calligraphy training on mental

health are shown in Table 14.

After putting in both the independent variable calligraphy training and the mediator variable cognitive reassessment, both calligraphy training and cognitive reassessment significantly and positively predicted mental health. The results of the mediation effect analysis are shown in Table 15, and combined with the results of the mediation effect analysis, it can be seen that the mediation effect value of cognitive reassessment is 0.11, and its 95% Bootstrap confidence interval is [0.064, 0.131]. Therefore, cognitive reassessment plays a partial mediating role between calligraphy training and college students' mental health.

Table 14: The mediation effect of cognitive review is tested

Regression equation		Integral fitting index			The regression coefficient is significant		LLCI	ULCI
Result variable	Predictor variable	R	R^2	F	β	t		
Cognitive review	Calligraphy training	0.25	0.06	23.45	0.55	7.65***	0.38	0.65
	Expression inhibition				0.21	5.11***	0.15	0.32
	Gender				0.26	0.55	-0.65	1.19
Mental health	Calligraphy training	0.55	0.32	101.88	0.44	12.53***	0.38	0.55
	Cognitive review				0.17	11.02***	0.14	0.20
	Expression inhibition				-0.12	-4.47***	-0.13	-0.06
	Gender				-0.44	-1.85	-0.88	0.04

Table 15: The result of the mediation effect analysis

	Indirect effect	Boot standard error	Boot CI Lower limit	Boot CI Upper limit	Relative intermediation effect
Mediation effect	0.11	0.015	0.064	0.131	17.5%

Controlling for gender and cognitive reassessment conditions, the mediating effect of expression inhibition in the effect of calligraphy training on mental health was tested and analyzed as shown in Table 16, and after putting in both the independent variable, calligraphy training, and the mediating variable, expression inhibition, calligraphy training significantly and positively predicted mental health, while expression inhibition significantly and negatively predicted mental health. The results of the mediation effect analysis are shown in Table 17, and the mediation effect value of Expression Inhibition is -0.003, and its 95% Bootstrap confidence interval is [-0.044, -0.013]. Therefore expression suppression plays a partial mediating role between calligraphy training and college students' mental health.

Table 16: The mediation effect of Expression inhibition is tested

Regression equation		Integral fitting index			The regression coefficient is significant		LLCI	ULCI
Result variable	Predictor variable	R	R^2	F	β	t		
Expression inhibition	Calligraphy training	0.35	0.14	43.25	-0.35	7.15***	0.25	0.45
	Cognitive review				0.12	5.41***	0.08	0.17
	Gender				-2.06	-6.27***	-2.99	-1.66
Mental health	Calligraphy training	0.56	0.31	101.86	0.44	12.53***	-0.78	-0.65
	Expression inhibition				-0.12	-4.47***	-0.12	-0.02
	Cognitive review				0.17	11.02***	0.07	0.13
	Gender				-0.44	-1.85	-0.35	0.46

Table 17: The result of the mediation effect analysis

	Indirect effect	Boot standard error	Boot CI Lower limit	Boot CI Upper limit	Relative intermediation effect
Mediation effect	-0.03	0.009	-0.044	-0.013	3.4%

4 Conclusion

In this paper, a pre- and post-test experiment was designed to investigate whether the improvement effects of calligraphy training on emotion regulation and mental health are real, and to further reveal the specific mechanism of action. Then the mediating effect model was used to verify the mediating role of emotion regulation.

The results of the calligraphy training intervention for the experimental group of college students showed that the total scores and the scores of the dimensions of the mental health quality of the realized group of college students were significantly improved compared with those of the pre-training and control groups. It shows that 40 days of calligraphy training can significantly affect the development of mental health quality and emotion regulation level of college students. Further, from the statistical results, it can be concluded that the elementary school students in the control group who did not undergo 40 days of calligraphy training showed a decreasing trend in their mental health quality and emotion regulation level. It shows that in the fast-paced and fragmented digital era, the mental health quality and emotion regulation level of college students at this stage are decreasing over time, and calligraphy training, as a kind of practice activity with high concentration, can effectively promote the positive development of college students' mental health and the gradual improvement of their emotion management ability.

The results of HRV when copying different styles of calligraphy showed that copying calligraphy could increase SDNN and HF values, which indicated that calligraphy training could enhance the overall activity of autonomic nerve and vagus nerve tone, and promote the physical and mental relaxation of college students. The effect of copying running script was better than that of copying regular script in enhancing the overall excitability of autonomic nerves. The reason may be that the copying of running script is more fluent, which is more conducive to college students' stress release.

Cognitive reappraisal and expressive inhibition partially mediated the relationship between calligraphy training and psychological health. The partial mediating role of expressive

inhibition was realized by reducing the excessive inhibition of college students' emotions. It is shown that college students' calligraphy training can influence the level of college students' emotion regulation to a certain extent and improve their psychological health.

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