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Leyi Mental Training: Bridging Ancient Wisdom and Modern Science to Reduce Anxiety via Altered Brain Dynamics

Xiaofei Jia[1,2] and Changle Zhou[2]*

[1]Department of Psychology, Qufu Normal University, Qufu, China

[2]Department of Cognitive Science, Xiamen University, Xiamen, China

ABSTRACT

Leyi is a set of physical and mental cultivation methods established by Professor Changle Zhou after many years of practice. It combines modern psychological adjustment and Chinese ancient Buddhist practice methods, including relaxation, breathing, meditation, koan, and cognitive regulation. Its purpose is to achieve the state of enlightenment (a high-level ideology in Buddhism). More than ten years of practical experience has proved that Leyi Mental Training can improve people's physical and mental health, especially most participants reported that their anxiety reduced after training. Before and after the training, we recorded the participants' EEG during the task of judging emotional pictures and administered the POMS Scale to them after the task. The results showed that their anxiety subscale scores were significantly reduced after training, and the accompanying brain activity was that the power of frontal gamma was reduced considerably. Studies have found that frontal gamma power is related to DMN activity, and a decrease in frontal gamma power indicates a reduction of internal network activity. We speculate that this may be because Leyi's training changed the way of self-referential processing, which in turn affected the activities of the internal network, which may be one of the brain mechanisms for reducing anxiety.

***Corresponding author**

Xiaofei Jia, Department of Psychology, Qufu Normal University, Qufu, China, email: jxiaofei2008@126.com

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Introduction

Meditation is a psychological training practice. According to the meaning of Chinese traditional culture, it is Mental Cultivation Methods. It covers various types and methods, as well as the "psychological/mental state" that can be achieved through these types of training [1]. Some of the main goals of meditation are to achieve an attitude that transcends one's mind, relaxed state, and attention regulation [2]. For thousands of years, people from different cultures and regions has been engaged in various types of practice. However, it was not until the 1950s that empirical studies on meditation appeared [3, 4].

Meditation can be roughly divided into two main types, namely focused attention (FA) and open monitoring (OM) [5]. The basis of FA practice is to focus on specific objects (for example, breathing, spells, or visual objects) and ignore irrelevant stimuli. In the OM meditation technique, practitioners try to focus on all feelings, emotions, and thoughts without paying attention to any of them.

Mindfulness meditation (MM) is a type of OM meditation and is the most studied type of meditation so far, originally derived from the Buddhist Theravada tradition [1, 6]. MM is characterized by the present moment, non-judgmental consciousness [7]. As a treatment method, MM exercises have become very popular worldwide. Over time, mindfulness-based stress reduction (MBSR), mindfulness-based cognitive therapy (MBCT), and mindfulness-based relapse prevention (MBRP) have also been developed to provide specific training programs for therapeutic purposes [7, 8]. A growing body of evidence shows that it helps strengthen emotional regulation, including reducing stress and improving mood and well-being [9, 10]. Many studies have also shown that it may benefit non-emotional cognitive operations, including attention and working memory [5, 11].

The Leyi Mental Training method is a set of physical and mental adjustment methods established by Professor Changle Zhou after years of practice. Mindfulness meditation is its core component. The most remarkable feature of the Leyi Mental Training method can be summarized as taking the Tao as the purpose, the Buddhist meditation, and Confucianism as the method to carry out inner cultivation. It contains technical elements such as relaxation, breathing, meditation, koan, and discourse (a type of cognitive regulation). More than ten years of practical experience has proven that Leyi Mental Training can improve people's physical and mental health, especially most participants reported that their anxiety level was significantly reduced after training [12].

In modern society, economic and life pressures are getting worse, and anxiety is a common problem that plagues most people. Anxiety disorder is a common clinical mental disorder characterized by unprovoked anxiety [13]. Anxiety is related to self-attention and reflection [14]. Thinking about the past or planning the future is the cognitive ability of the human brain.

Although this ability is an extraordinary evolutionary achievement that allows people to learn, reason, and plan, it may incur emotional costs [15, 16]. Buddhist philosophy claims that living in the present is happiness [17]. When practicing meditation, the practitioner learns to resist his mind wandering and "only focus on the present". Compared with matched controls, MM practitioners' anxiety level was significantly reduced [1, 18-20].

Studies on the brain mechanism of anxiety have found that DMN changes in several psychopathological states, such as anxiety and depression [21, 22]. DMN is a unique brain network determined by functional magnetic resonance imaging (fMRI). It is mainly composed of the anterior/posterior cingulate cortex (PCC), medial prefrontal cortex (MPFC), and medial, lateral, and inferior Occipital cortex, collectively referred to as the default mode network (DMN) [23-26]. DMN is characterized by several areas that are anatomically connected and is related to the function when the participant is not involved in a specific task [27, 28]. For example, DMN activation decreases in goal-oriented or attention-demanding tasks, while activation increases during rest. At the same time, it is related to a person's internal mental state-such as feelings, thinking, memory, and desires [23, 29, 30]. About 50% of our waking time is spent on mind-wandering, which is considered related to the activation of DMN [31]. Therefore, when a person's mind is engaged in introspective thinking, including past memories and future simulations, DMN is most active; when engaged in specific external tasks, it is less active [32-34].

More than ten years of practical experience has proven that Leyi Mental Training can improve people's physical and psychological health. However, as scientific research, it is necessary to analyze and study it from a quantitative perspective and give a scientific and reasonable explanation. Since mindfulness meditation is the core component of the Leyi Mental Training method, practitioners have learned to resist mind wandering during the practice process and only focus on the present, so we speculate that this is the main reason why Leyi Mental Training can reduce anxiety. The leading cause of anxiety is excessive self-attention and reflection. DMN is collectively referred to as an internal network and is most active when engaged in reflective thinking. The change of DMN is one of the brain mechanisms of anxiety. We speculate that Leyi Mental Training can "calm" the activities of the internal network, thereby reducing DMN activation.

DMN is mainly studied by brain imaging, but researchers found that the gamma power of frontal and midline areas is an indicator of DMN activity through EEG research [35]. If this conclusion is reliable, we can speculate that Leyi Mental Training can reduce frontal gamma power. One of our ASL studies on Leyi Mental Training found that the participants' cerebral blood flow in Middle Frontal Gyrus decreased after training [37]. We speculated this might be a sign that Leyi Mental Training reduces DMN activities. If this hypothesis is confirmed, these two results will form a mutual proof, supporting Aviva's conclusion, proving that it is reliable to use gamma power as an indicator of DMN activity. EEG equipment is portable and cheaper than brain imaging equipment, which will significantly facilitate future researchers.

Method

Participants

A total of 64 participants who had never participated in any meditation were selected for the experiment; all were aged between19-43 years old. They were divided into two groups by random, with 32 subjects each in the experimental group and the control group (the average age of the experimental group was 31.9 years, and the average age of the control group was 29.1 years), and the attributes were matched in all aspects. Each group was composed of 16 males and 16 females. They were healthy, had no history of mental disease or brain trauma, had normal or corrected to normal vision, and were right-handed. All subjects participated voluntarily and signed the written informed consent following a research protocol approved by the IRB board of Xiamen University before training.

Mental Training Process

The experimental group was given closed meditation training for seven days, and the control group was free to move during the training period. The meditation process mainly includes enlightenment, sitting meditation, walking meditation, chanting of mantras, Zen case-solving, and benefit-requesting. These all are the various training methods (derived from the ancient Chinese Buddhist tradition) used to achieve enlightenment (a higher state of consciousness). During the training period, all participants have unified activities and unified schedules.

Research Methods and Data Analysis

Both the experimental group and the control group took part in the test before and after the training. The test included two parts, an EEG test, and a psychological scale test. After the subjects entered the laboratory, the EEG experiment was performed first, and then complete the psychological scale.

Participants sat on a sofa in an electromagnetically shielded soundproof room facing the computer screen. Before the pictures were presented, the resting EEG was recorded for 5 minutes. During the process, they were asked to relax, close their eyes quietly, and eliminate distracting thoughts. The experiment uses the picture perception paradigm to present emotional pictures, and the subjects are required to pay attention to the pictures first. After the picture disappears, press the corresponding key to judge whether it is positive, negative, or neutral. We used a 32-lead EEG system of NeuroScan company for EEG recording, and the electrodes were arranged according to the international extended 10-20 system. Take the nose's tip as the recording reference, and use the bilateral mastoid signals' average value as an offline reference. Electrodes were placed on the outside of both eyes to record the horizontal electrooculogram (HEOG). They were put up and down of the left eye to record the vertical electrooculogram (VEOG). The band pass filter is set at 0.1-100Hz, AC sampling is adopted, the sampling rate is 1000Hz, and the scalp impedance is less than 5KΩ. After the EEG experiment, all subjects completed the POMS scale on the computer.

EEG offline analysis uses EEGLAB14.1.1 software. Use the average value of the bilateral mastoid signal as an offline reference. Epochs started 200ms before the stimulus's onset and continued to 800ms after its appearance. Perform baseline correction based on the average voltage value of -100~0ms. The offline filter uses a band pass filter (0.1~45Hz). An independent component analysis (ICA) was used to remove Ocular artifacts. Error responses and responses with amplitude greater than ±100μV were excluded from the superimposed average. The data discarded due to artifacts is less than 10% of the total data.

Perform fast Fourier transform on the segmented data to obtain the power value of each ROI ('Frontal', 'Central', 'Temporal', 'Occipital') and each band (delta(0.5-4Hz), theta(4-8Hz), alpha (8-13Hz), beta (13-30Hz), gamma (30-45Hz)) (unit: μv2). After

superimposing and averaging the power values of each group, further statistical analysis was performed. Statistical analysis uses R software.

Results

Power Results

A two-factor ANOVA (tests (2) *group (2)) is performed on the obtained power data. The results show that both test and group have main effects ($F(1,2400) = 21.32$, $p<0.001$; $F(1),2400) = 3.22$, $p=0.07$), there is no interaction between them ($F(1,0) = 1.91$, $p>0.1$). Contrast analysis found that there was no significant difference between the pretest of the experimental group and the control group: 0.80 vs. 0.79 μV, $t(1.05) = 1.18$, $p>0.1$, and there was no significant difference between the pre and posttest of the control group: 0.79 vs. 0.77 μV, $t(0.09) = 0.23$, $p>0.5$, there is a significant difference between the pre and posttest of the experimental group: 0.80 vs. 0.64 μV, $t(0.06) = 2.77$, $p<0.01$ (the overall power is reduced). In order to further clarify which factors are different, we performed a rois (4 levels: 'Frontal', 'Central', 'Temporal', 'Occipital') *frequencies (5 levels: 'delta, 'theta', 'alpha', 'beta', 'gamma') * tests (2 levels: 'Pre', 'Post') ANOVA on the data of experimental group. It was found that the areas with significant differences between the pre and posttest appeared in: delta-Fro, gamma-Fro, gamma-Tem (pre vs. post: 0.79 vs. 0.99 μV, $t(0.08) = -2.43$, $p<0.05$; pre vs. post: 0.79 vs. 0.51 μV, $t(0.08) = 3.42$, $p<0.001$; pre vs. post: 0.79 vs. 0.56 μV, $t(0.08) = 2.84$, $p<0.005$). Gamma-Fro is what we care about (Figure 1 and Figure 2).

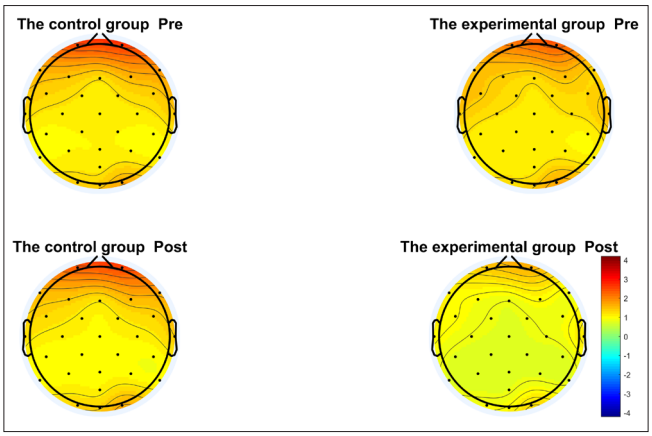

Figure 1: Changes in Gamma Power of the Experimental Group and the Control Group before and after Training

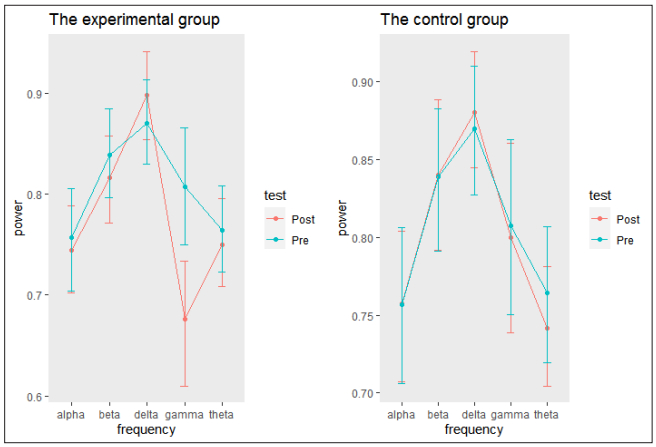

Figure 2: Each Band's Power Changes in the Frontal Regions of the Experimental Group and the Control Group before and after Training

Results of POMS Scale

Before and after the training, the two groups were tested using the POMS scale. The POMS scale is a questionnaire used to reflect the participants' emotional state characteristics in the neurobehavioral test combination. The results contain seven subscale scores, including tension-anxiety, anger-hostility, fatigue-inertia, depression-dejection, vigor-activity, confusion-bewilderment, and self-related emotions. We use the tension-anxiety subscale scores as a measure of the participants' anxiety. The statistical analysis adopts R software. The results are shown in Table 1 and Table 2:

Table 1: Changes in the Scores of each Subscale of the Experimental Group before and after Training *: $p<0.05$, **: $p<0.01$

Subscale	Before	After	t	Significance
Tension–anxiety	6.48	2.83	4.50	0.000**
Anger–hostility	4.61	2.00	2.64	0.015*
Fatigue–inertia	5.96	2.48	4.11	0.000**
Depression–dejection	4.13	1.48	3.65	0.001**
Confusion–bewilderment	4.87	2.78	3.37	0.003**
Vigor–activity	10.83	15.00	-4.29	0.000**
Self-related emotions	8.35	10.43	-2.85	0.009**

Table 2: Changes in the Scores of each Subscale of the Control Group before and after Training

Subscale	Before	After	t	Significance
Tension–anxiety	4.00	2.81	1.21	0.246
Anger–hostility	3.13	2.44	0.60	0.555
Fatigue–inertia	4.25	3.75	0.50	0.627
Depression–dejection	1.94	1.94	0.00	1.000
Confusion–bewilderment	4.00	2.75	1.87	0.081
Vigor–activity	12.38	15.63	-1.82	0.089
Self-related emotions	8.94	10.81	-1.36	0.194

Training

From the above table, we can see that after Leyi Mental Training, the control group's anxiety subscale scores did not show significant change. In contrast, the experimental group's anxiety subscale scores reduced significantly after the training, and anxiety was relieved considerably. It can be seen that Leyi Mental Training has a very significant effect in reducing anxiety.

Discussion

It can be seen from the results of the POMS scale that, consistent with the participants' subjective report, Leyi Mental Training can significantly reduce anxiety. And the performance in brain activity is that it substantially reduces the frontal gamma power, which is a marker of DMN activity.

Consistent with our predictions, mindfulness meditation, as a crucial component of the Leyi Mental Training, emphasizes not making conceptual judgments, focusing only on the current mental training, which cultivated a kind of non-reactive perception. As the saying goes, "Its heart is like a mirror, and nothing will be unwelcome," allowing all things and feelings to flow freely without any explanation or change. It is precisely because of this kind of training that the leading cause of anxiety is removed. A series of negative emotions, such as anxiety, will not arise without excessive contemplation and reflection on one thing.

Since too rich and tangled inner activities cause anxiety, individuals with anxiety symptoms are accompanied by the activation of the internal network, DMN. Since Leyi Mental Training can reduce anxiety, it will inevitably also reduce DMN activities. The results of the power analysis confirmed our prediction. Lee et al. calculated the brain activity patterns of various forms of meditation reported in the literature. He found that in these meditation exercises, the gamma activity in the frontal region was similar, but its activity in the Occipital and occipital region was different [36]. We speculate that it may be precisely because the frontal gamma is related to DMN activities, and various forms of meditation have changed the DMN activities. Hence, frontal gamma shows a consistent activation pattern.

There is a critical process in Leyi Mental Training called breaking "ego-mind", that is, breaking up conceptual distinctions and not evaluating everything. If you do not judge, everything will not be classified by whether it is good or bad for you. Any stimulus is just ordinary and objective existence, and emotional reactions will not arise. This is also consistent with the results of neuroscience research. Some research indicates that mindfulness meditation may change the way of self-referential processing. The previous self-referential processing of narrative and evaluation form is replaced by higher consciousness. This change in self-awareness is one of the primary mechanisms by which mindfulness meditation has a beneficial effect.

Due to mindfulness meditation practicing, evaluative self-referential processing is believed to be reduced, and people's awareness of the present experience is believed to be enhanced. A study reported that after mindfulness training, the right insula was separated from the medial PFC, and the connection between the right insula and the dorsolateral PFC increased. The authors interpret their findings as that, self-referential processing has shifted to a more independent and objective analysis of internal and external perception events rather than emotional or subjective self-referential value [1]. Through meditation practice, self-centered and evaluative self-reference is gradually replaced by non-self-centered and objective self-reference. When we experience terrible things or uneasy again, we can treat them more rationally. As our meditation practice increases, our anxiety will gradually decrease. This is the neuroscientific explanation of breaking the ego-mind. The Leyi Mental Training also includes training for participating in case-solving, which is a unique content from ancient Chinese Buddhism. Master set up some seemingly absurd problems for disciples to answer, driving disciples into a desperate logical thinking situation, so as to achieve the purpose of eliminating intellectual and rational thinking and guiding them to a higher state of consciousness (zero-reservoir or no-self). The various ways of our training, including meditation and case-solving, are all methods used to achieve this goal. Although it is difficult to reach this state, which requires a lot of training, the various methods we use certainly help transform self-reference, that is, from emotional and evaluative self-reference to more objective and independent analysis of events.

This is also in line with the interpretation of the ABC theory of emotions. A represents an inducing event, and B represents an individual's views and interpretations of this event. C represents the emotions and behaviors generated by oneself. It is precise because we often have some unreasonable beliefs (that is, unreasonable evaluation and explanation of B) that make us emotionally disturbed. The meditation training just blocked or changed process B, that is, without evaluation or judgment; without this internal psychological process (this is also called the self-referencing process), it will naturally reduce the activation of the internal network DMN.

As for what we found in our experiments, the laterality of the brain activation, that is, the reduction of the left frontal gamma is more significant. This may be because the left hemisphere is the area where the language center is located. When we contemplate and introspect, it is often accompanied by internal language processes, and meditation training will resist the wandering of thinking, so the left hemisphere gamma power decreases significantly. In the past, research on DMN was mainly carried out through brain imaging. Some studies have explored the possibility of studying DMN with electrophysiological methods [35]. This article is also one attempt to study DMN with EEG methods. It proves that gamma power as an indicator of DMN activity is reliable, and we look forward to more studies using brain imaging to prove it in the future further.

In summary, this article uses empirical research to prove that Leyi Mental Training can effectively reduce anxiety and initially explores its neural mechanism. The decreased activation of DMN caused by no-reaction perception is one of its brain mechanisms. Many meditation-based psychological intervention methods have been developed in the West, such as mindfulness-based stress reduction (MBSR), mindfulness-based cognitive therapy (MBCT), and mindfulness-based relapse prevention (MBRP). From the perspective of modern psychological science, these methods are of great help for improving psychological quality. Meditation comes from the Buddhist tradition, but there are few such treatments today in the birthplace of meditation. In fact, from Confucius to Xizhai Yan in the Qing Dynasty, the most core ideological content of Chinese traditional culture is the doctrine of the heart [12]. The Leyi Mental Training is a set of physical and mental intervention methods developed based on inheriting the essence of the Chinese ancient mental cultivation method. It is rooted in Chinese culture and more accessible to practice and master. We expected that it would benefit the public in the future.

Conclusion

The Leyi Mental Training method is a comprehensive physical and mental adjustment method that incorporates technical components such as relaxation, breathing, meditation, koan, and cognitive regulation. It combines modern psychological adjustment techniques and Chinese ancient Buddhist practices. It lies in reaching a state of enlightenment. The most direct benefit of practicing Leyi Mental Training is that it can change our self-referential processing, thereby reducing anxiety and improving mood. The present research has reached the following conclusions: 1. Leyi Mental Training can effectively reduce anxiety, proving the Leyi Method's effectiveness in emotional intervention; 2. The reduction of DMN activation is the brain mechanism of Leyi Mental Training to relieve anxiety. 3. The power of gamma in the frontal region is an indicator of DMN activity, which allows the study of DMN with EEG methods in the future.

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