Effects of Neurofeedback on Panic Disorder Patients' anxiety

Yan LU[1], Chunmei WANG[1], Lingjin SU[1], Zhiwen MA[1], Sijin LI[2], Yulan Fan[1]*

ABSTRACT

To examine the effectiveness of a 7-weeks neurofeedback training programme to improve increased range of alpha band and abnormal anxiety in patients with panic disorder. Randomized controlled trial, conducted at a psychiatric clinic in Southern China. Participants were randomly assigned to a neurofeedback training (n = 10) and a control group (n = 8). The neurofeedback group received a 20-session training to improve abnormal anxiety, but the control group received only routine care with no neurofeedback. Using a two-way MANOVA, the changes in mean abnormal anxiety were significantly higher in the neurofeedback group than in the control group. Furthermore, the changes in mean increased range of alpha band were significantly higher in the neurofeedback group than in the control group. An intervention involving neurofeedback significantly improved abnormal anxiety in crowded places and public places.

Key Words: abnormal anxiety, intervention, neurofeedback, increased range of alpha band

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Introduction

The prevalence of mental disorders is increasing in developing countries. Studies have found the prevalence of anxiety disorder in general population to be between 15% and 35%, and adolescent between 10% and 20% (Kendall *et al*., 2010). Many studies have reported one-year prevalence of anxiety disorders using questionnaire and interview, such as Kessler *et al*. (1994): panic disorder %2.3, agoraphobia 2.8%, social phobia 5.9%, simple phobia 8.8% and generalized anxiety 3.1%, and Reiger *et al*. (1998): panic disorder %1.3, agoraphobia 5.8%, social phobia 4.2%, simple phobia 4.2% and obsessive-compulsive disorder 2.1%. In addition, Kessler *et al*. (1994) found significantly higher anxiety levels for women (30.5% in lifetime) compared with men (19.2% in lifetime).

Anxiety is an unpleasant emotional experience with at least three theoretically components (Noys and Hoehn-Saric, 1998; Borkovec and Lyonfields, 1993): anxiety causes (such as danger, lack of support or unfamiliar stimuli), normal anxiety (such as deal with unpleasant situations), abnormal anxiety (such as inconsistency between severity, time and possible damage), and anxiety outcomes such as Physical (muscular: vibration, eclipse and muscle weakness, or automatic: sweating, palpitations, flushing, stench, dyspnea, chest tightness, palpitations, nausea, and severe need for urination and feces), psychological (tension and fear, panic disorder, distress in dealing with the situation, uncertainty about the future, worry, or expecting disaster) and hyperarousal symptoms (distractibility or inability to focus and attention). Normal anxiety makes people ready to deal with threats, and abnormal anxiety disrupts people's general performance (Noys and Hoehn-Saric, 1998).

Corresponding author: Yulan Fan
Address: [1] Linyi mental health center, Linyi, 276005, CHINA; [2] Jining Medical University, Jining, 272067, CHINA
e-mail ✉ luyan766@126.com
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Worly (2000) showed the negative effects of high anxiety on academic performance, learning, ability, flourishing talents and mental health. He concluded in their review that higher anxiety lead to illness, and is barrier to a healthy and flourishing life.

Panic attack is a mental illness associated with anxiety disorders that is characterized by sudden onset of horror or fear of its reappearance in patient (Zargham, 2003). The attacks is associated with symptoms like heartbeat, sweat, feeling chest tight, tremble, feeling losing balance, or confusion, although they happen in a few minutes. The patient, fear of the emergence of a new attack, may get into anticipatory anxiety and refusing to go to hideous places. Panic disorder is often associated with agoraphobia, and is afraid of being alone in public places especially places that are difficult to exit quickly from there caused by a panic attack on the person (Carl, 2010;Ola 2017, Li,2017). Zargham (2003) reported that panic attack can occur after injuring stress mental disorders, depression disorders and medical illnesses such as drug discontinuation or its poisoning.

Although different drug and psychological therapies for panic disorder are developing and have shown acceptable effects in several trials, the treatments have not been effective in most cases to prevent mood, and the patients remained at the same problem by residual symptoms of the disorder such as persistence of anxious thought (Mack, 2004; Hofmann *et al*. 2010). Another source of patients' abnormal anxiety is cognitive behavioral-related attacks such as low self-esteem and inability to deal with adverse effects of the disorder (Kessler *et al*., 2005; Vandesmet,2017; Okyay 2016). Kessler *et al*. (2005) raised coping strategies for Cognitive-Behavioral Therapies such as applied relaxation, cognitive therapy, gradual exposure, and training in self-assertiveness and problem -solving.

External anxiety causes might be antecedents in explaining psychological problems that lead to the regulation of emotions, physical symptoms, thoughts and behaviors. Neurofeedback techniques might be helpful to foster such explaining psychological problems. Neurofeedback-based therapies might function as a kind of coping strategy to help panic disorder patients to adjust to external anxiety causes. We can result that external anxiety causes should not result in higher levels of abnormal anxiety. In this regard, Fleischman and Othmer (2006) described neurofeedback as a serious issue in the treatment of a range of disorders such as depression, anxiety, post-traumatic stress, addiction and obsession. Many studies have recommended neurofeedback techniques to explain and treat mental and neurological diseases (Lawrence *et al*., 2013) and improving brain (subjective) ability (Masterpasqua and Healey, 2003), but previous literature published on the effectiveness of neurofeedback training programmes is scant.

Neurofeedback is a comprehensive educational system for patients, and leads to changes, enhancements, modifications and enhancement of brain cells (Wang, 2017; Shanshan and Zichao, 2017). In fact, neurofeedback is a knowledge that is not dependent on a particular lab, and it's done exclusively by someone specializing in the field. Neurofeedback technology helps patients who need psychotherapy and rehabilitation of perception and recognition or those who are weak in mental skills (Masterpasqua and Healey, 2003). In neurofeedback therapy, patients learn how they boost metabolic changes in their brain to reduce or limit drug use (Fernandez, 2007). In another definition, neurofeedback is a way in which a person learns to change his brain wave pattern by operant conditioning (Becerra *et al*., 2006). The aim of neurofeedack training is abnormal electrical waveform correction in the brain that leads to improve behavioral and cognitive performance in individuals.

Researchers have found relationships between neurofeedback and different indicators of abnormal anxiety. Agnihotri, Paul & Sing (2007) investigated two methods of biofeedback in in anxious people. He assigned 45 participants to different groups: Electro-magnetic biofeedback exercise group, neurofeedback group and control group. After a 12-session exercise, their findings showed lower anxiety levels in the electro-magnetic biofeedback exercise group and the neurofeedback group compared with the control group. Further, they observed similar results in the post hoc test. In a literature review study, Moore (2000) investigated the effectiveness of neurofeedback training program on anxiety disorders levels. He reviewed eight studies on generalized anxiety disorder, three studies on phobias disorder, two studies on obsessive-compulsive disorder and one study on post-traumatic stress report, and resulted that training in increasing alpha and theta have extra effects

beyond placebo and are considered as effective treatments for anxiety disorders.

The occupational context shows that neurofeedback therapy is a predictor of abnormal anxiety, and increased range of alpha band is a mediator between neurofeedback therapy and abnormal anxiety. We expect that neurofeedback therapy leads to increase alpha band; increasing increased range of alpha band should lead to less abnormal anxiety and better performance. The purpose of this study was to evaluate the efficacy of neurofeedback training programme in decreasing abnormal anxiety in patients with panic disorder in crowded places and public places. As an indicator of abnormal anxiety, we used the variables *mental symptoms, physical symptoms* and *fear* (Beck, Apstein & Brown, 1988;Romas,2016). Furthermore, we included *increased range of alpha band* as an important brain waves-related outcome variable (Agnihotri, Paul & Sing, 2007; Moor, 2000;Nazari,2017). For our sample of patients with panic disorder, we hypothesized growing external attacks in crowded places and public places. Therefore, we used the variable *attacks*.

The aim of the present study was to develop and examine an intervention training to investigate the relationships among abnormal anxiety, increased range of alpha band and attacks in crowded places and public places. We hypothesized that (1) patients with panic disorder will report an increase in attacks in crowded places and public places, (2) mental symptoms, physical symptoms and fear will increase in the control group, but not in the intervention group, (3) increased range of alpha band should increase in the intervention group, but remain unchanged or even decrease in the control group.

Methods

Study design

Our study used a randomised controlled trial that assigned subjects randomly into experimental (neurofeedback) and active control groups. We distributed the sample evenly to the groups by a computer-generated unrepeated randomization list. Participants of the intervention group received a 20-session training of neurofeedback, but the control group received only routine care with no neurofeedback. The experimental and active control groups received the same care, except for neurofeedback therapy.

Sample and setting

All participants were selected from psychiatric clinic centers in Southern China. Participants were student (about 50%), employee (about 16.7%) and other (about 33.3%). There were 21 participants: 12 in the experimental group (M=29; F=33), with a mean age of 32.65 years (SD=7.11); and 9 in the active control group (M=24; F=41) with a mean age of 33.17 years (SD=5.19). Two of these participants from the intervention group and one from the active control group withdrew from the study. We tried to select participants of similar sexes (intervention group: 40% female, 60% male; control group: 50% female, 50% male), age (intervention group: M= 32.65, SD = 7.11; control group: M= 33.17, SD = 5.19), and Job (intervention group: 50% student, 20% employee, 30% other; control group: 50% student, 12.5% employee, 37.5% other) types. Fig. 1 illustrates the participant flow and analysis used in this study.

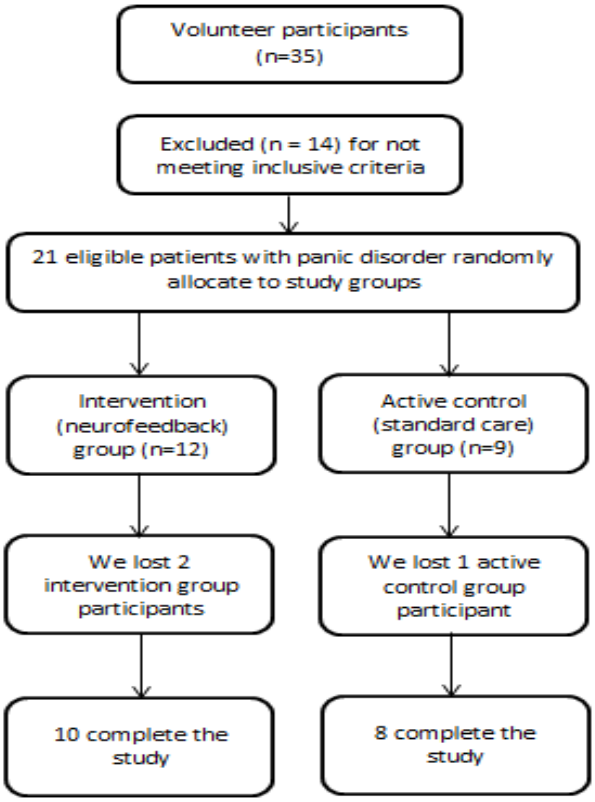

Figure 1. Selection of patients with panic disorder through each trial stage.

Measures

External attacks was measured using the scale attacks (Kessler *et al*. 2005), which consisted of six items. The reliability and validity of the scale was previously shown. We obtained internal

consistency (Cronbach's alpha) coefficient of 0.83 at time 1 and of 0.79 at time 2 for the Chinese attacks.

Anxiety was measured using the Beck Anxiety Inventory Questionnaire (BAIQ) (Beck, Apstein & Brown, 1988), which consisted of three components: mental symptoms, physical symptoms and fear. The reliability and validity of the scale was previously shown (Noyes & Hoehn-Saric, 1998;Rajab 2017). We obtained internal consistency (Cronbach's alpha) coefficient of 0.77 at time 1 and of 0.78 at time 2.

Increased range of alpha band was measured using a Canadian device with dual-channel model (procomp2) of Thought Technology Company, which is applicable by computer system and software. The feedback is routinely provided to people through voice or video and thus the individual recognizes the proper change in the activity of his brain waves.

Data collection procedures

We solicited a consecutive sample from psychiatric clinic centers in Southern China. After admission to the psychiatric clinic centers and on the third day, our participants were familiarized with the clinic environment, and we explained our purposes and procedure. We assessed the participants by the BAIQ and their disease history (mental, obsessive-compulsive, etc.). We randomly assigned the participants med the inclusion criteria to either a neurofeedack group or an active control group. We collected data for time 1 the five day after admission to the psychiatric clinic centers. Data for time 2 were collected four days after the training.

Intervention

The intervention was a 7-weeks neurofeedback training programme designed to complement advice provided by the company Thought Technology. We developed a kind of self-regulation in participants using the recording of electrical brain waves and giving feedback to them. We put sensors called electrodes on the patient's scalp. The sensors recorded the brain's electrical activity of participants and showed it in the form of brain waves, mostly simulated in the form of a computer game or video. Video playback or computer game guidance was performed without the use of hands and only with brainwaves. In this way, the individual found the favorable or unfavorable conditions of their brain waves by seeing progress or stopping the game, getting bonuses, losing points or changes created in sound or movie playback, and tried to modify the state of his brainwaves by directing the game or the movie.

Results

Sample characteristics

First we assessed 35 volunteer participants. 14 were not eligible and were excluded from the study. 21 participants were eligible and were randomly assigned to the neurofeedack group (n=12) and the control group (n=9). Two of these participants from the neurofeedack group and one from the active control group withdrew from the study. According to Fig. 1, 10 participants in the neurofeedack group and 8 participants in the active control group completed the study.

As can be seen in Table 1, the mean gender of the participants was 55.5% male and 44.5% female with a mean age of 32.9 (SD= 2.8) years. They all had a good job (50% students, 16.7% employee, 33.3% other).

Table 1. Characteristics of participants (age, gender, job, and education).

Variables		All		Intervention		Control	
		n = 18		n = 10		n = 8	
		n	%	n	%	n	%
Age, mean (SD)		32.9	2.8	32.65	7.11	33.17	5.19
Gender	Male	10	55.5	6	60	4	50
	Female	8	44.5	4	40	4	50
Job	Student	9	50	5	50	4	50
	Employee	3	16.7	2	20	1	12.5
	other	6	33.3	3	30	3	37.5
Education	High school / vocational	3	16.6	2	20	1	12.5
	College, university / graduate school	15	83.4	8	80	7	87.5

Table 1. Means, standard deviations, and zero-order correlations at baseline (n = 18).

Variables	Mean	SD	1	2
Attacks	3.33	0.55		
mental symptoms	2.46	0.45	0.56*	
physical symptoms	2.51	0.46	0.51*	0.42*
Fear	2.32	0.41	0.54*	0.44*
Range of alpha band	4.11	0.61	-0.46*	-0.35*

* p<0.01

The effect of neurofeedback training programme on panic disorder patients' anxiety was measured using the 2 × 2 MANOVA. The correlations between the five dependent variables

at baseline (pretest, five day after admission) were shown in Table 1.

We observed the mean and standard deviation scores at baseline (pretest) and post-test in both groups (Table 2). The average scores of anxiety show that the mean changes for mental symptoms, physical symptoms and fear are significantly lower in the intervention group than in the control group.

Table 2. Average scores of anxiety for intervention and control group.

Variables		Intervention (n=10)		Control (n=8)	
		Mean	SD	Mean	SD
Mental symptoms	Baseline	1.88	0.45	1.79	0.57
	Post-test	1.82	0.51	2.16	0.63
Physical symptoms	Baseline	2.23	0.47	2.19	0.43
	Post-test	2.18	0.49	2.34	0.51
Fear	Baseline	2.09	0.52	1.99	0.46
	Post-test	1.94	0.55	2.18	0.49

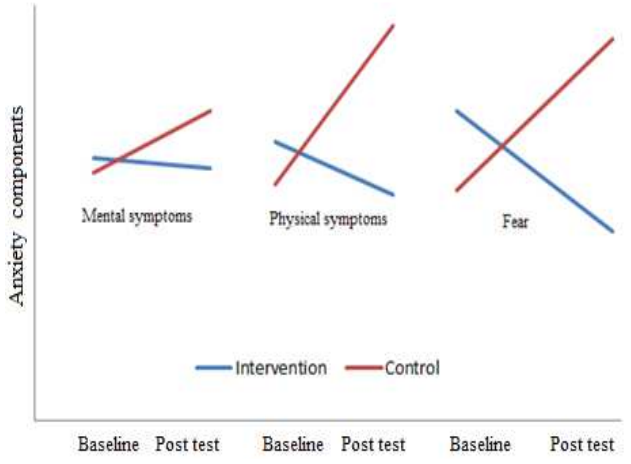

Figure 2. Changes in mental symptoms, physical symptoms and fear over time at baseline and post-test.

Table 3. Multiple analysis of variance for training and time

		Variable		
		Training	Time	Time × Training
Attacks	Partial η^2	0.01	0.02	0.02
	F	0.71	4.47*	0.64
Mental symptoms	Partial η^2	0.02	0.01	0.01
	F	0.83	5.26*	3.43*
Physical symptoms	Partial η^2	0.03	0.05	0.02
	F	0.26	3.44**	5.29**
Fear	Partial η^2	0.02	0.04	0.05
	F	0.42	3.94**	3.24**
Range of alpha band	Partial η^2	0.03	0.01	0.04
	F	0.37	0.71	5.17*
Overall	Partial η^2	0.05	0.00	0.01
	F	0.49	4.16**	4.19**

*$p < 0.05$, **$p < 0.01$

In Table 3, the results for the overall effects shows a significant time effect, $F(5,15)=4.16$, and a significant time × training effect, $F(5,15)=4.19$, but no significant training effect. Our data for the attacks effects shows the significant time effect for increase of attacks, $F(1,19)=4.47$, mental symptoms, $F(1,19)=5.26$, physical symptoms, $F(1,19)=3.44$, and fear, $F(1,19)=3.94$. However, in the overall MANOVA, the interaction effect (group difference and time) resulted due to a significant interaction concerning mental symptoms, physical symptoms and fear, as well as range of alpha band.

Discussion

Fig. 1 showed that a large number (60%) of participants were high panic. The mean BAIQ scores show that the changes for mental symptoms, physical symptoms and fear are significantly lower in the intervention group than in the control group. These results show that patients with panic disorder experience a significant anxiety in crowded places and public places. Previous research has indicated that anticipatory anxiety is related to agoraphobia and afraid of being alone in public places (Carl, 2010).

The results show that while patients with panic disorder reported an increase of attacks in crowded places and public places in the control group, a tendency of increased attacks was found in the intervention group as no significant effect. So, our first hypothesis, patients with panic disorder will report an increase in attacks in crowded places and public places, could be partially supported. It is quite reasonable that the sudden onset of panic to the patient and his fear of re-emerging and other sudden problems are potential abnormal anxiety for most of the patients.

With respect to the second hypothesis, our study shows that panic disorder patients' anxiety in the neurofeedback group improved significantly compared with the control group. This result is consistent with previous panic disorder research results, showing that neurofeedback can effectively improve patients' anxiety (Simkin, Thatcher and Lubar, 2014; Benioudakis *et al.*, 2016; Hammond, 2005). According to Complementary Alternative Medicine (CAM), we can result that neurofeedback is a complementary alternative therapy for common unpleasant anxiety disorders. Through neurofeedback, the patients learn how to strengthen their brain metabolic

changes to limit the medicine consumption. Recent research has confirmed that neurofeedback therapy is effective in regulating metabolic function in brain (Birbaumer *et al*., 2013;Chen et al.,2016) and drug abuse (Sokhadze et al., 2008).

As expected, range of alpha band in the neurofeedback group improved significantly compared with the control group (hypothesis 3). This study did not examine increased range of alpha band and abnormal anxiety at different points of measurement after the neurofeedback training programme with a time lag. Therefore, the assumption, the attendance at the intervention led to an increase in increased range of alpha band which led to a decrease in abnormal anxiety, cannot be proved.

Although our study focused on mental symptoms, physical symptoms, fear and increased range of alpha band as dependent variables, future research should estimate the impact of neurofeedback training interventions on performance types (educational, learning, mental health, and etc.).

Compared with other neurofeedback studies to promote panic disorder patients' anxiety, it is necessary to consider the integration of neurofeedback therapies in psychiatric clinic centers, especially for patients with panic disorder, who suffer from brain problems. Our results shows that neurofeedback training programme appear to be a helpful tool.

Conclusion

This is the first experimental study on the effects of neurofeedback therapy on common symptoms of anxiety, mental symptoms, physical symptoms and fear, in patients with panic disorder. Results show that intervention involving electroencephalography (EEG) is more effective in relieving panic disorder patients' anxiety than routine care. However, the intervention helps patients who need psychotherapy and rehabilitation of perception and cognitive, or those who are weak in mental skills. Psychiatric clinics should encourage patients interested in complementary therapies to obtain training in this technique and teach panic disorder patients' families in clinical settings.

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