

Effects of Neurofeedback Training on Anxiety Symptoms Among University Students

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ABSTRACT

Previous studies reported that university students are a population at risk of that mental health problems. The most common intervention for anxiety disorders are pharmacological and/or nonpharmacological strategies such as psychotherapies. Besides that, there is a growing interest neurofeedback training for various mental health conditions including depression, Post Traumatic Stress Disorder (PTSD), stress and anxiety. Therefore, the objective of this study is to determine the effectiveness of neurofeedback training in reducing symptoms of anxiety. A quasi-experimental study with a pretest-posttest design was employed in this study. Thirty eight students ($M= 22.47$ years, $SD= .69$ years) with moderate and severe anxiety symptoms based on the Beck Anxiety Inventory (BAI) and Generalized Anxiety Disorder-7 (GAD-7) were randomly assigned to either neurofeedback training or waiting list. The neurofeedback group undergone a total of 20 neurofeedback training (3 sessions per week). The post test results indicated that neurofeedback training significantly reduce symptoms of anxiety in the neurofeedback group than those of in the waiting list group in both BAI and the GAD-7 instruments with effect size ranged from .49 to .62. Wilcoxon signed-rank test was conducted to assess the statistical differences between the pre-scores and post-scores of BAI and GAD-7 measurements within the NFT group. Significant differences within the NFT group was found between the pre-test and post-test scores in the BAI and GAD-7 measurements. In general, the current study suggest that neurofeedback was an effective treatment for anxiety symptoms among university students.

Keywords: *Anxiety, Mental Health, Neurofeedback, University Students.*

1. INTRODUCTION

Psychological wellbeing is very important to function in daily life. Mental health problem such as depression and anxiety may impair a person daily function. The World Health Organization (WHO) reported that the number of people experiencing mental health problems are increasing worldwide [1]. The Malaysian National Health and Morbidity Survey 2017 [2] reported that every two in five adolescents are anxious, one in five adolescents are depressed and every one in ten adolescents are stressed. The NHMS 2017 reported a drastic increase of mental health problems among Malaysian as compared to the survey done in 2012. Similar trend is observed globally. The World Health Organization estimated the total number of people suffer from anxiety disorders worldwide is 264 million. About 23% or 60.05 million are from the South East Asian region [1].

Anxiety disorders is the most prevalent mental health conditions and can be just as disabling as other mental health disorders if not treated well [3]. Excessive worry, hyperarousal and fear are the common characteristics of symptoms. Anxiety symptoms ranged from mild to severe [1]. Panic disorder, generalized anxiety disorder (GAD), post-traumatic stress disorder (PTSD), and social anxiety disorder are types of anxiety disorders [4][5][6][7].

Studies showed that university students are vulnerable to mental health problem because they are in a phase of adapting to a new environment such as independent living, decision making, financial management, academic challenges and coping with new social life [8][9][10][11]. These stressors may affect their everyday life, life satisfaction, physical health, emotional stability, academic achievement as well as their relationship with friend and family. Continuous stress can lead to serious mental health such as anxiety and depression which may affect their future after university life [10][12][13].

Depression and anxiety are the most prevalence mental health problems among the public including university students. A study done on among 506 university students involving four public universities in the Klang Valley, Malaysia reported that the prevalence of anxiety is higher than depression and stress. Specifically, 29% had severe and extremely severe anxiety; and 18.6% reportedly had moderate anxiety [11]. A recent study in Malaysia on the prevalence of anxiety by [14] involving a total of 1821 university students across Malaysia revealed that the prevalence of anxiety was 29%. Studies on the prevalence of mental health problems among university students across the globe showed a similar trend. A previous meta-analysis conducted on global prevalence of anxiety among medical students indicated anxiety was most prevalent among medical students from the Middle East and Asia [15]. A study on first year university students in Hong Kong revealed that 41% had moderate severity or above symptoms of anxiety, notably 7.6% extremely severe anxiety, 11.3% severe anxiety, and 22.3% moderate anxiety [16].

Generally, the interventions for anxiety disorders are pharmacotherapy or/and psychotherapy depending on the severity of the condition [17][18]. Pharmacological intervention is often used to treat anxiety disorder besides psychotherapy. Medication such as antidepressants, benzodiazepines or anxiolytic drugs are often prescribed for anxiety disorders [18][19]. The most common drugs are the selective serotonin reuptake inhibitors and serotonin-norepinephrine reuptake inhibitors but not everyone response well to medication [17][20][21][22]. Some experience adverse effects such as jitteriness, nausea, restlessness, headache, fatigue, increased or decreased appetite, weight gain, weight loss, tremor, sweating, sexual dysfunction, diarrhoea, constipation, urination problems, and other side effects [20][21]. Even though Benzodiazepines is safer than barbiturate, it is not recommended for routine use because it can also cause other side effects such as withdrawal, forgetfulness, confusion and worsened the anxiety disorder [19][20], [23]. Therefore, a safer alternative and non-invasive intervention such as neurofeedback training should be considered to help alleviate anxiety disorder.

The most common psychotherapy treatment for anxiety disorders is Cognitive Behavioural Therapy (CBT) due to its highest level of empirical evidence. Many controlled studies reported the efficacy of CBT for most anxiety disorders [24][25]. Therefore, CBT is widely implemented as the primary options of

psychotherapy for anxiety disorders [26][27][28]. Other types of psychotherapy treatment for anxiety disorders are psychoanalysis, psychodynamic psychotherapy, talk psychotherapy, and eye movement desensitization and reprocessing (EMDR) [29].

It was known that anxiety disorders have to do with functional brain abnormalities [22][30][31]. Anxiety is associated with reduced left-hemisphere and increased right-hemisphere activity. A study reported that anxious individuals in their study showed a larger asymmetry in the left hemisphere and selective increase in the right parietal activity [31]. Studies also reported the linked of anxiety disorders with several neurotransmitter system and certain brain areas [30].

Neurofeedback or also known as Electroencephalography (EEG) feedback was originally developed as a relaxation technique [32]. Neurofeedback training operate using operant conditioning technique [33][34] by altering the brainwaves at certain location of the brain which are related to emotional or behavioural problem [35]. Individual undergoing neurofeedback training learn to control their brain waves consciously based on the visual or/and audio feedback [17][36]. In a neurofeedback session, electrodes are connected to certain part/s of the head and ears. These electrodes are then connected to a computer which is installed with a neurofeedback software and an amplifier to get real time response of the brain waves activities. The neurofeedback training changes the brainwaves activities using visual and/or audio feedback. Better pattern of brainwaves can be obtained with consistent feedback and training [37].

A study done by Singer [38] using neurofeedback training on two dancers to reduce their performance anxiety reported a significant decrease in anxiety symptoms. Both dancers were assessed using the State Trait Anxiety Inventory (STAI) before and after their neurofeedback session and each major performance. The state and trait scores of both dancers reduced significantly after underwent 20 neurofeedback sessions. However, the limitations of this study are its small sample size, same protocol for both dancers and no control group to ascertain the effectiveness of the neurofeedback training in reducing anxiety symptoms.

Another study done by [39] to examine the effects of neurofeedback training in two patients diagnosed with anxiety disorder. The patients undergone 30 neurofeedback sessions. The Symptom Checklist-90-

Revised (SCL-90-R) and patients' self-reports showed a significant reduction in anxiety-related symptoms. Additionally, the results of SCL-90-R showed all clinical scales within normal range after a one-year follow-up. Patient self-reports indicated that the patients were symptom free as well. Overall, the study demonstrated that neurofeedback is an effective modality of treatment for anxiety disorder. However, the study lack of control group and lack of placebo.

This study is an extension of a preliminary study done previously to assess the effectiveness of neurofeedback training to improve symptoms of anxiety in among 20 university students in Malaysia [37]. The participants were assigned to either the neurofeedback group or control group. The participants anxiety symptoms were assessed using the DASS-21, The Beck Anxiety Inventory (BAI) and the State Trait Anxiety Inventory (STAI) measurements before the training and after the training. The findings showed an overall improvement in all the psychological measurements in the neurofeedback group hence provide additional evidence to the field of neurotherapy that neurofeedback training is a viable option to improve anxiety symptoms among university students. However, the current study employed an individualized training protocol based on the arousal checklist taking into consideration that everyone is different in the arousal symptoms.

1.1 Objective

The main objective of this study is to investigate the effectiveness of neurofeedback training in reducing anxiety symptoms among university students.

2. METHOD

This study employed a quasi-experimental method with a pretest-posttest design involving 38 university students ($M=22.47$ years, $SD= .69$ years) at a local university in east Malaysia. The study was conducted following approval by the University Malaysia Sabah Ethic Committee (JKEtika 2/18(7)). Anxiety symptoms was measured using the Beck Anxiety Inventory (BAI) and Generalized Anxiety Disorder-7 (GAD-7). Participants with moderate and severe anxiety symptoms based on the BAI ad GAD-7 questionnaire were randomly assigned to either neurofeedback training or waiting list. The neurofeedback group attended 20 sessions (three times a week) of approximately 30 minutes

(including preparations) individual neurofeedback training in a span of eight weeks. Both groups completed the BAI and GAD-7 self-reported questionnaires before (week 0) and after the intervention (week 8). Participants were evaluated in terms of effectiveness of neurofeedback training in reducing anxiety symptoms based on the pretest-posttest results.

2.1 Participants

A total of 38 participants who scored mild and severe level of anxiety symptoms based on the BAI and scored 8 points and above on the GAD-7 participated in the study. The participants were randomly assigned to either the neurofeedback group ($n=18$; mean age = 22.44, $SD = .78$) or waiting list group ($n=20$; mean age = 22.5, $SD = 0.61$). Table 1 displays the participants data.

Table 1. Demographic and characteristics of the neurofeedback group and the waiting list group

	Neurofeedback Group (n=18)		Waiting List Group (n=20)	
	Mean	SD	Mean	SD
Age	22.4	.78	22.5	.61
Sex	(n)	(%)	(n)	(%)
	Male	5 27.78	6 30	
	Female	13 72.22	14 60	
BAI	26.61	9.91	26.7	8.59
GAD-7	12.39	3.62	12.55	2.63

All participants (neurofeedback and waiting list group) neither had neurofeedback training previously, not clinically diagnosed of having history of psychiatric and neurological disorders, free from substance abuse, do not have any history of seizures and concussions, and free of psychotropic medication.

Written informed consent was obtained from participants after a thorough description of the study procedures and requirements. The study was conducted following approval by the University Malaysia Sabah Ethic Committee (JKEtika 2/18(7)).

2.2 Instruments

2.2.1 The Beck Anxiety Inventory (BAI)

The Beck Anxiety Inventory (BAI) is a self-reported instrument consisting of 21 items measuring common symptoms of anxiety (emotions, physiology,

and cognitive) which focuses on somatic symptoms of anxiety that have occurred over the past week. It was developed for individuals aged 17 to 80 years old. Higher scores indicating more severe anxiety symptoms. The symptoms rated on a four-point scale, ranging from “not at all” (0) to severely (3). The instrument has excellent internal consistency ($\alpha=.92$) and high test-retest reliability ($r=.75$) in previous study [40]. The current study employed the Bahasa Malaysia version (BAI-Malay) [41] with the Cronbach alpha coefficients (α) ranged from 0.66 to 0.89 with satisfactory overall alpha value of .91.

2.2.2 The Generalized Anxiety Disorder-7 (GAD-7)

The Generalized Anxiety Disorder (GAD-7) [42] (Spitzer et al., 2006) consists of seven items measuring worry and anxiety symptoms. Each item is scored on a four-point Likert scale (0–3) with total scores ranging from 0 to 21 with higher scores reflecting greater anxiety severity. The GAD-7 has shown good reliability and construct validity [42], [43]. This study employed the GAD-7 (Malay Version) by [44]. The Malay version of the GAD-7 was found to have good internal reliability (Cronbach’s $\alpha = 0.74$) with good sensitivity, specificity, concurrent and convergent validity [44]. Participants scored 8 points and above were classified as having anxiety disorders on the GAD-7.

2.3 Neurofeedback Training

The neurofeedback training utilized the EEGer Neurofeedback software by EEG Spectrum International Education and Research, Inc. and Thought Technology LTD manufactured amplifier. Participants in the neurofeedback group underwent a total of 20 neurofeedback training (twice a week) for a duration of eight weeks. Each session took approximately 30 minutes including preparations. The training protocol employed for each participant were individualized based on the arousal checklist. The training site is either at C3-A1 site or C4-A4 site depending on the participants’ response on the arousal checklist. The training protocol intended to teach participants to decrease the power spectrum of slow (2-5 Hz and 6-9 Hz) and fast (22-36 Hz) activity while at the same time increasing mid-range (12-15 Hz) activity. Impedance was measured for both active and reference electrodes and maintained below 12 kOhms. Training involved game-like format training which utilized both visual and auditory feedback as

reinforcement. The waiting list group did not receive any intervention during the study.

2.4 Data Analysis

The data were analysed using IBM SPSS Statistics 25 for Windows. Since the number of participants is small nonparametric analysis was conducted to analyse the results. Mann-Whitney *U* test was conducted to assess statistical differences in the scores of BAI and GAD between the neurofeedback group and waiting list group. In order to assess the statistical differences between the pre-scores and post-scores of BAI and GAD-7 within the neurofeedback group, the nonparametric Wilcoxon signed-rank test was conducted.

3. RESULT

In order to evaluate the effect of neurofeedback training, the neurofeedback group and waiting list group filled up the self-reported BAI and GAD-7 measurements before the intervention and after the intervention. The data were analysed using nonparametric (Mann-Whitney *U* test and Wilcoxon Signed-Ranks test) analyses. The nonparametric Mann-Whitney *U* test did not show any statistical difference in the BAI and GAD-7 measurements before the intervention. However, the Mann-Whitney *U* test indicated that there are significant differences between the neurofeedback group (*Mean Rank*= 13.83, $n=18$) and the waiting list group (*Mean Rank*= 20.13, $n= 20$) in the BAI ($U=78.00$, $z= -2.99$, $p= .003$) measurements. This effect can be described as large ($r=.49$). As in the GAD-7 measurement, the Neurofeedback group also showed significant difference (*Mean Rank*= 12.31, $n= 18$) as compared to the waiting list group (*Mean Rank*= 25.98, $n= 20$), $U=50.5$, $z= -3.80$, $p= .000$ with large effect size ($r=.62$). Table 2 displays the Mann-Whitney *U* Test between the neurofeedback group and the waiting list group.

Table 2. Comparisons between neurofeedback group and waiting list group of pre-test and post-test in BAI and GAD-7

	Mean Rank		U		Z		p	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
BAI								
NF (n=18)	18.81	13.83	167.5	78.0	-3.66	-2.99	.718	.003
WL (n=20)	20.13	24.25						
GAD-7								
NF (n=18)	18.44	12.31	161.0	50.5	-.562	-3.80	.593	.000
WL	20.45	25.98						

(n=20)

Note: NF =Neurofeedback Group; WL=Waiting List Group

In order to assess the statistical differences between the pre-scores and post-scores of BAI and GAD-7 measurements within the NFT group, the nonparametric Wilcoxon signed-rank test was conducted. As depicted in Table 3, there are significant differences between the pretest and posttest scores for the neurofeedback group before and after the intervention for both BAI ($Z=-.3.11$, $p=.002$) and GAD-7 ($Z=-.3.26$, $p=.001$) measurements.

Table 3. Comparisons of pretest and posttest scores BAI and GAD-7 within the neurofeedback group and waiting list group

	N	Median	Z	P
BAI				
Neurofeedback	18			
Pre		24.00	-3.11	.002
Post		14.0		
Waiting List	20			
Pre		27.0	-1.59	.112
Post		25.5		
GAD-7				
Neurofeedback	18			
Pre		11.00	-3.26	.001
Post		6.00		
Waiting List	20			
Pre		12.0	-1.22	.224
Post		12.5		

The analysis indicated that the anxiety symptoms based on the post-test scores was significantly reduced in all measurements among the NFT participants after the neurofeedback training. The effect size for the pre and post-test of the BAI measurement within the neurofeedback group is $r=.73$. In addition, the effect size for the pre and post test scores of the GAD-7 measurement within the neurofeedback group is $r=.77$. These effect size can be considered large. Therefore, the hypothesis that stated that there is a significant difference in anxiety symptoms before and after the intervention for the neurofeedback group is supported.

3.1. Discussion

Anxiety can affect one’s everyday life and may contribute to psychological and physical wellbeing. The aim of this study is to examine the effect of neurofeedback training on reducing anxiety symptoms among university students. According to the results, significant difference was in the pre and posttest scores for the neurofeedback group as compared to the waiting list group. This result showed that neurofeedback training may be a promising treatment for anxiety related disorders. Overall, the study indicated that participants’ anxiety symptoms based on the BAI and the GAD-7 scores reduced significantly. This result is consistent with other studies done by other researchers on different samples and different neurofeedback protocol [39], [45], [46], [47].

It is worth to note that the training protocol is not the same for participants in the neurofeedback group. Since the participants are non-clinical population, they are trained at either C3-A1 site or C4-A4 site depending on the participants’ response on the arousal checklist. It is unreasonable to expect that a “one-size-fits-all” approach in neurofeedback training as the brain complex and differ for everyone. Other studies used different training protocol such as increase alpha activity with increased theta activity or increase alpha and beta and to inhibit beta 2 at different sites and different populations [22], [39], [48].

Neurofeedback training generally aim to alter abnormalities in brain electrical activity identified through comparisons to a normative EEG database. Unfortunately, this study was not able to assess change in targeted EEG parameters. Future research may need to consider this aspect.

Positive reinforcement using operant and classical condition techniques in the neurofeedback training is used by using games, animations or analogical feedback was employed. Participants can choose which type of feedback according to their preferences apart from minimal verbal prompts from the neurofeedback trainer. Future research may analyse the usage of different feedback in the treatment outcomes.

The participants faced different life stressors that may influenced the results of the study. Two participants (one in each experimental group) self-reported that they lost their loved ones during the study. The participants were at various degree programs and years. The first-year participants may

experience adaptation to new university life and the final year participants may experience more academic stressors than other participants. Inconsistency in attendance of the weekly neurofeedback training due to health problems may be a source of confounding variables.

Lastly, results need to be interpreted by considering a few limitations of the study such as small sample size and lack of randomization. The small sample size may influence the statistical power to differentiate the efficacy of the neurofeedback training. Thus, larger sample size with appropriate effect size and randomized controlled trial design are warranted.

Despite the mentioned limitations, this study was an effectiveness study in which the intervention was employed in a non-clinical setting with complex participants. The study also employed the same neurofeedback trainers to carry out the neurofeedback training for each participant. Therefore, the improvement in the participants' symptoms can be attributed to protocols of treatment, and not to the trainer effect.

3.2. Conclusion

The alarming numbers of university students in particular facing mental health problems such as stress, anxiety and depression make them a population at risk [49]. Even though the application of neurofeedback as one of the methods of treatment for anxiety disorder, especially in the area of ADHD and autism spectrum disorder, it is a potential intervention to significantly improve anxiety symptoms. More rigorous methodological research needed to be done as an additional nonpharmacological treatment alongside other standard treatment.

AUTHORS' CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design: Jasmine Adela Mutang, Chua Bee Seok, Guan Teik Ee; data collection: Jasmine Adela Mutang; analysis and interpretation of results: Jasmine Adela Mutang, Chua Bee Seok.; draft manuscript preparation: Jasmine Adela Mutang, Guan Teik Ee. All authors reviewed the results and approved the final version of the manuscript.

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