Effects of Increase in Amplitude of Occipital Alpha & Theta Brain Waves on Global Functioning Level of Patients with GAD

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A B S T R A C T

Introduction: The basic objective of this study is to investigate the effects of alpha and theta brain waves amplitude increase in occipital area on reducing the severity of symptoms of generalized anxiety disorder and to increase the global functioning level in patients with GAD.

Methods: This study is a quasi-experimental study with pre-test and post-test with two groups. For this purpose, 28 patients who had been referred to Sohrawardi psychiatric and clinical psychology center in Zanjan were studied based on the interview with the psychiatrist, clinical psychologist and using clinical diagnostic criteria for the Diagnostic and Statistical Manual of Mental Disorders text revision - the DSM-IV-TR Fourth Edition diagnosis of GAD, 14 subjects were studied in neurofeedback treatment group and 14 subjects in the waiting list group. Patients in both groups were evaluated at pre-test and post-test with General Anxiety Disorder Scale (GAD-7) and Global Assessment Functioning Scale (GAFs). The treatment group received fifteen 30-minute alpha training sessions and fifteen 30-minute theta brain training sessions in occipital area by neurofeedback training (treatment group). This evaluation was performed according to the treatment protocol to increase the alpha and theta waves. And no intervention was done in the waiting list group. But due to ethical issues after the completion of the study all the subjects in the waiting list group were treated.

Results: The results showed that increase of alpha and theta brain waves amplitude in occipital area in people with GAD can increase the global functioning level and can reduce symptoms of generalized anxiety disorder in a treatment group, but no such change was observed in the waiting list group.

Discussion: Increase of alpha and theta brain waves amplitude in occipital area can be useful in the treatment of people with GAD.

1. Introduction

Generalized Anxiety Disorder (GAD) is one of the most common psychological disorders characterized by excessive and uncontrollable worry and it has a high co-morbidity with other anxiety disorders and depression (Barlow, 2002). Fourth Diagnostic and Statistical Manual of Mental Disorders - Text Revised (DSM-IV-TR American Psychiatric Association 2000) defines GAD as the intense anxiety and worry about several events or activities that persists most days during at least 6 months and it is difficult to be controlled and in addition, it is alongside with physical symptoms such as muscle tension, irritability,

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difficulty sleeping, and restlessness. Annual prevalence of GAD has been reported between 3 to 8% and the lifetime prevalence rate is approximately 7.5 percent (Kessler and Walters and Wittchen, 2004: 29-50). Almost 25 percent of people who refer to the anxiety disorders clinics and about 12% of patients who refer to the psychiatric clinics have GAD (Kessler et al., 2004). According to the chronic high prevalence and comorbidity of GAD with other psychological disorders, the disorder has been proposed as one of the most disabling disorders for adults (Borkovec, 2006: 273-287). For this purpose, psychological intervention in Generalized Anxiety Disorder has a special place.

Coping strategies which are used in CBT such as treatment homework doing, applied relaxation, cognitive structuring, regarded exposure, assertiveness training and problem solving can cause self-confidence and enhance the patient strategy for coping with harmful effect resulting from the disorder. But acquiring coping skills calls for attempt, and some of GAD patients may lack the necessary motivation for doing this treatment process (Kessler et al., 2005). Therefore, Pharmacotherapy may be preferred by those patients who are not willing to benefit from psychological intervention. Since this approach is not dependent much on motivational factors and because in some cases comorbidity depression is viewed as a comorbidity disorder, pharmacotherapy along with anti-depressants are considered effective in alleviating both anxiety and depression symptom, however pharmacotherapy cannot make any fundamental changes and symptoms recurrent in GAD patients is prevalent matter (Tyrer, 1999).

On the other hand, according to the information currently existing on brain and operating brain capabilities, practitioners in various medical situations are increasingly emphasizing on the brain-centered treatment. Recent advances imply the understanding of functional brain abnormalities in anxiety disorders including generalized anxiety disorder (Nainian et al., 2012).

Neurofeedback is a comprehensive educational system that promotes brain growth and changes at the cellular level. Neurofeedback is a form of biofeedback that can facilitate localized changes in brain waves, as well as changes in local cerebral blood flow (rCBF). This method enhances connectivity between neurons and increases the acceptance of mental flexibility. Each practitioner is trained according to the treatment protocol related to his disorder and at this stage, improvements are visible for the trainee. This method has been successful in treating a wide range of disorders such as depression, anxiety,

post-traumatic stress disorder (PTSD), personality disorders, addictions and emotional problems (Demos, 2005).

Hammond, (2011) studied the literature relating to the treatment of anxiety disorders through Neurofeedback training. Encouraging preliminary research has been published for the effectiveness of neurofeedback in treating anxiety with 10 controlled studies that have been identified. Out of the eight studies of anxiety that were reviewed, seven were found with positive changes. A randomized, blinded, controlled study (Egner & Gruzelier, 2003) was done with performance anxiety at London's Royal College of Music. They evaluated the ability of alpha-theta neurofeedback to enhance musical performance in high-talented musicians when they were performing under stressful conditions. When compared with alternative treatment groups (physical exercise, mental skills training, Alexander Technique training, and two other neurofeedback protocols that focused more on enhancing concentration), only the alpha- theta neurofeedback group resulted in enhancement of real-life musical performance under stress. Similar randomized controlled studies reducing performance anxiety have been conducted with musical performance (Egner & Gruzelier, 2003), ballroom dance performance (Raymond, Sajid, Parkinson, & Gruzelier, 2005), and performance in singing (Kleber, Gruzelier, Bensch, & Birbaumer, 2008; Leach, Holmes, Hirst, & Gruzelier, 2008). In a randomized, placebo-controlled study with medical students (Raymond, Varney, Parkinson, & Gruzelier, 2005) neurofeedback enhanced mood, confidence, feeling energetic and composed.

Watson, Woolley-Hart, and Timmons (1979) carried out alpha-enhancement in 32 anxious patients using eyes-open visual feedback. There were six sessions at weekly intervals together with home practice. Because this was a pilot study, there were no controls. The authors preferred eyes-open training, so that patients could maintain alpha enhancement in the state in which they experienced most of their anxiety. Since anxious patients do not habituate, and they continue to react to stimuli, the visual feedback was not given until the alpha had been sustained. More than half of the patients improved clinically. Since increased alpha and decreased anxiety were correlated, the authors concluded that the outcome was more than a placebo effect. Alpha increased before anxiety decreased. Patients were not aware of the level of alpha success or failure, and they all had a long history of anxiety without improvement.

Moor (2005) studied the literature relating to the treatment of anxiety disorders through neurofeedback

training. Eight studies were done on generalized anxiety disorder, three studies were done on phobia anxiety disorder, two studies were done on OCD and one report was done on post-traumatic stress disorder. The studies by Moor suggested the placebo effect in this study, but the increase in alpha and theta training had additional effects beyond the placebo and they were considered as effective treatments for anxiety disorders.

In order to study the impact of the theta neurofeedback training in GAD treatment, Vanathy, Sharma and Kumar trained 15 patients (alpha increase and theta increase) with GAD diagnostic criteria, after evaluating the baseline. Post treatment evaluating indicated that alpha and theta training caused considerable reduction in personal report indices and in ranked anxiety scale.

Neurofeedback training alters how the brain works, and when the skills were trained it appears to have a sustained impact. Follow-up studies show long-term changes in brain function after the neurofeedback training. Long-term pharmacotherapy is more costly than the neurofeedback training, while there could be less side effects for neurofeedback training than the pharmacotherapy.

The present study has been designed in the range of the restrictions listed in the field of pharmacotherapy and psychological treatments for people with GAD. The present study is based on the fact that whether the increase in alpha and theta waves in the occipital region could reduce the symptoms of generalized anxiety disorder in Iranian samples.

2. Methods

This study is a quasi-experimental study with pre-test and post-test with two groups. 28 patients attended Suhrawardi psychiatric and clinical psychology institute in Zanjan and were randomly assigned to treatment and control groups. After informing the patients of the study and getting the written consent of the patients, they were randomly assigned to one of the groups with regard to the inclusion and exclusion criteria.

Including criteria consisted of: having GAD diagnostic criteria diagnosed by psychiatrist based on diagnostic interview and by clinical psychologist based on GAD-7. Not being exposed to psychological intervention and no use of the drugs by the patient at least one month before being included in the study. Age between 18-50 and being educated at least up to the third grade of junior high school. Excluding criteria consisted of having other

psychological disorder in Axis-I, having serious suicide ideation which makes the fixed dose of the drugs impossible, and having the complete personality disorder criteria in Axis-II diagnosed by psychiatrist based on diagnostic interview.

In the treatment group, according to the protocol (Moor, 2005) 30 minutes of training alpha waves increase in the occipital area and 30 minutes of training theta waves increase in the occipital area (O1 or O2) were applied using neurofeedback procomp- 5 device and the control group did not receive any intervention. According to the international 20-10 system, in order to record the activity of alpha and theta waves, an active Electroencephalography electrode (EEG) (procomp- 5) in the O1 and O2 area and two electrons of reference and ground were placed on the right and left ears while the patient is sitting in a comfortable chair with eyes wide open in front of the screen. Each patient attended 15 neurofeedback sessions training increase in alpha and theta brain waves amplitude. All the neurofeedback sessions consisted of 5 minutes devoted to attainment of preparatory relaxation, 2 minutes devoted to recording EEG baseline data and 60 minutes devoted to training process. Audio reward presentation was contingent on providing predetermined criteria which had been explained to the patients. The patients were told to try to recognize the mental status leading to audio reward. The patients received audio feedback in response to the cognitive strategy for enhancing alpha and theta amplitude higher than determined thresholds. Then quantitative criteria of the alpha and theta wave based on time average and in terms of wave amplitude were recorded automatically by the neurofeedback device in the scale of microvolt. For collecting data the following instruments were used. A PhD clinical psychologist who had been received enough training administered the instruments.

2.1. GAFs

GAFs for treatment plan decision and effect has been used. Scoring is done based on global functioning level ranging from 0-100. The higher score indicate a better global functioning (Sadock and Sadock, 2007).

2.2. GAD-7

Due to the defects in existing anxiety measurement scales, such as their length and their inefficiency as diagnostic scales, GAD questioner has been designed. (Spitzer et al., 2005). It consists of 7 items. Each of which has score ranging from 0-3. The range of the total scale is 0-21. (Spitzer et al., 2005) report its internal

consistency to be excellent (α=0/92) and its test-retest reliability to be good (r=0/83). Sensitivity and specificity of the scale in 10 or higher cut off points exceeds 80%. GAD-7 scale correlations with subscale SF-20 has been reported 39-91% and its correlations with to BAI has been reported to be 72% and its correlations with anxiety subscale SCL-90 has been reported to be 74%. The GAD scales of psychometric properties in the study conducted on Iranian populations were studied. Its cronbach's alpha was equal to 85% and the test retest reliability in this sample was (r=48%). These values show expectable reliability and internal consistency for the scale in Iranian sample. By examining its correlations with Spilberger state-trait anxiety questionnaires (for state 71%, for trait-state=52%) and by calculating its correlations with 12 item anxiety subscales included in clinical symptoms check list SCL-90, its concurrent validity has been obtained (r=0/63, P≤0.01.). This value also shows expectable validity in Iranian society.

2.3. Neurofeedback Device

Neurofeedback is a comprehensive health care system that works directly with the brain; neurofeedback is device that breaks the raw signals received from the brain into the different frequency waves.

This frequency brain waves is known as delta, theta, alpha and beta. During neurofeedback, electrodes were placed on the scalp according to the 20-10 international system. Usually, two electrodes are placed in areas where the EEG activity in comparison with the EEG of normal people involves higher standard deviation.

The patient is placed in front of the computer and what the computer shows can be like a video game - computer or display on which a two column chart view shows the brain wave activity. This allows the patients to focus their attention on the computer screen. When inappropriate activity slightly decreased and appropriate activity increased, a voice was heard. At first the changes in brainwaves are transient. But with repeated sessions, and with the evolution of the threshold for inhibition of inappropriate activities and as the activity of healthy brain waves strengthen by the therapist, sustainable changes gradually become conditioned (Demos, 2005).

Once the assessment is complete and treatment goals have been established, most commonly one or more electrodes are placed on the scalp and one or more on the earlobes for neurofeedback training sessions (Figure 1). The trainee then usually watches a display on the computer screen and listens to audio tones, sometimes while doing a task such as reading. These training sessions are designed to assist the person to gradually change and retrain their brainwave patterns. For example, some persons may need to learn to increase the speed or size of brainwaves in specific areas of the brain, whereas other individuals need training to decrease the speed of and amplitude of their brainwaves. Common initial improvements begin to be noticed within the first 5 to 10 sessions. Length of treatment may only be 15 to 20 sessions for anxiety or insomnia, but with other conditions such as ADD=ADHD or learning disabilities, it will more often involve 30 to 50 sessions, depending on the severity of the problem. Once the equipment is attached each session usually lasts about 20 to 25 min. In treating very complex conditions or when multiple disorders or diagnoses are present, a clinician cannot always stipulate in advance how many treatment sessions may be required (Hammond, 2011).

3. Results

The Kolmogorov-Smirnov test was used to determine the normal distribution of data. Due to the normality of data distribution, parametric tests were used to analyze the data.

In analyzing the data, descriptive statistics including frequency, mean, standard deviation and inferential statistics, including a set of covariance (ANCOVA) and t-test for two independent samples were used.

Table 1 shows Mean, SD independent t-tests on the variables of age, education, disease duration, and baseline variables. Given the lack of significance of differences in group means, it seems that all three groups were homogeneous in these variables before intervention.

After eliminating the grades of the severity of the disorder in the pre-test (pre-intervention) which were considered as covariates, Table 2 shows one-way analysis of covariance on the severity of generalized anxiety disorder (GAD-7), the Global Assessment Functioning Scale (GAFs), and the amplitude of alpha and theta waves in the occipital region in the post-test (after intervention). The results of this table indicate that they there are statistically significant.

4. Discussion

The results of the current study show that means of alpha and theta brain waves amplitude increased in the group who received alpha and theta brain waves amplitude training after fifteen neurofeedback training. The
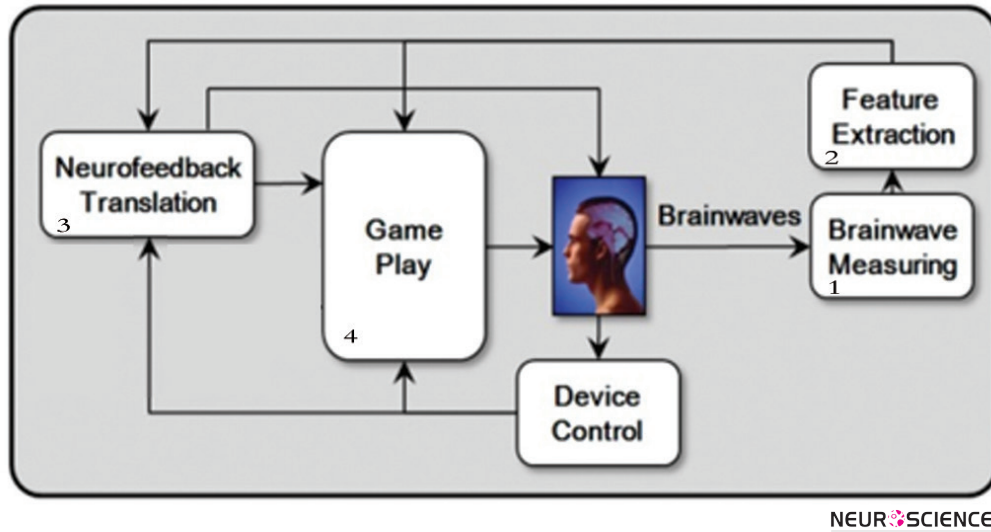
Figure 1. The stages of neurofeedback training: 1. Measuring brainwaves 2. Extraction of patterns and distribution of alpha and theta waves in O1 and O2 3. Transformation of brain waves into feedback (eg. game play) 4. Monitoring of feedbacks by subjects. In all stages, neurofeedback device control the process of game play transforming brain waves to feedbacks.

mean amplitude of alpha pre - post test for the neurofeedback group were, respectively, 7.32 and 8.97. The mean amplitude of theta pre - post test for the neurofeedback group were, 7.16 and 7.90, respectively.

The finding also suggests that neurofeedback training is effective in reducing symptoms of GAD. These results are based on the changes in the score of the neurofeedback group in the scale of General Anxiety Disorder scale (GAD-7). This procedure can be done in two months, with 15 sessions per week on the average 2 to 3 sessions. Finally it leads to a significant decrease in the symptoms of anxiety in patients with generalized anxiety disorder. As it was explained in the methodology part, the psychiatrist who was double-blinded did the diagnostic interview again after the complication of

the study. The results showed that the treatment group patients were not diagnosed with GAD, but the waiting list group was diagnosed with GAD and their diagnostic symptoms had not been eliminated. But due to ethical issues all the subjects in the waiting list group were treated after the completion of the study.

This finding is consistent with some previous studies. Watson, Woolley – Timmons and Hart (1979) investigated increasing alpha in 32 anxious patients with eyes open by using visual feedback. In this study, the researchers found an increase in alpha brain wave amplitude before reducing anxiety.

Hare and others (1981) treated a group of anxious patients during six alpha training sessions. These patients

Table 1. Mean, Standard Deviation and t-test results in terms of research variables, age variable, educational variables and illness span variables in pretest (pretreatment).

Variables	Neurofeedback		Waiting list group		t
	M	SD	M	SD	
Age	33.67	9.90	27.33	6.80	1.82
Education	11.75	3.04	12.42	2.84	-0.55
Illness span	5.08	4.25	4.25	2.59	0.70
GAD-7	14.67	3.11	13.25	2.37	1.25
GAFs	53.67	3.11	55.50	4.83	-1.10
Alpha Brain Wave Amplitude	7.32	1.40	6.83	1.68	0.77
Theta Brain Wave Amplitude	7.16	1.09	7.21	1.73	-0.80

*P<0.050. ***P<0.01

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Table 2. Mean, Standard Deviation and ANCOVA results in post-test (post treatment).

Variables	Neurofeedback				Waiting list group				F
	Pretest		Posttest		Pretest		Posttest		
	M	SD	M	SD	M	SD	M	SD	
GAD-7	14.67	3.11	3.67	1.55	13.25	2.37	13.33	2.10	442.72*
GAFs	53.67	3.11	75.92	4.16	55.50	4.83	55.42	4.12	148.88*
Alpha Brain Wave Amplitude	7.32	1.40	8.97	1.60	6.83	1.68	6.91	1.56	19.75*
Theta Brain Wave Amplitude	7.16	1.09	7.90	1.32	7.21	1.73	7.29	1.62	6.04*

*$P<0.05$. ***$P<0.01$

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were anxious for 6 years and had not responded to previous psychotherapy and pharmacotherapy treatments. The results showed that alpha brain wave increased in the EEG.

Hammond, (2011) studied the literature relating to the treatment of anxiety disorders through Neurofeedback training. Encouraging preliminary research has been published for the effectiveness of neurofeedback in treating anxiety with 10 controlled studies that have been identified. Moore (2005) reviewed the literature related to the GAD treatment involving neurofeedback training. He mentioned to the increased range of 33 to 88 percent for alpha brain wave amplitude in some studies.

Rice, Blanchard and Purcell randomly assigned 38 volunteers fulfilling criteria DSM-III (APA-1980) and the other seven subjects who were subclinical and were suffering from two clinical symptoms in five groups each with 9 people. The groups where assigned in frontal EMG alpha increase feedback, alpha reduction feedback or waiting list group. The groups received eight training sessions, each lasting 20 minutes.

In order to study the impact of the theta neurofeedback training in GAD treatment, Vanathy, Sharma and Kumar trained 15 patients (alpha increase and theta increase) who had GAD diagnostic criteria after evaluating the baseline. Post treatment evaluating indicated that alpha and theta training caused considerable reduction in personal report indices and in ranked anxiety scale. The current study suggested that alpha and theta training may have appeared in controlling anxiety clinical symptom. Birukova (2005) has found similar results as well.

The current study findings seem to confirm the functional changes of brains in alpha waves amplitude. These changes can be observed following feedback training sessions. It seems that these positive effects and the consistency with the foreign study are the results of common aspect of human beings and also the results of the similar

neurologic conditioning. Although cultural differences have not influenced the study results much, the current study faced with limitations and the future studies can shed more light on the nature of this influence.

This limitation is related to the subjects who were randomly assigned in two waiting list and experimental groups. The inclusion in neurofeedback group has involved some costs and all of the patients have not been able to afford it. Although researchers have attempted to pay part of the costs, but due to the proliferation of sessions, the problem has not still been resolved.

On one hand, this makes the GAD subjects' scores from the beginning to be different, although the conditions in neurofeedback haven't caused a problem; because this group was compared with itself over time, therefore the control and experimental groups should be judged with caution. Another limitation of the present study was respectively the problem of absence of a placebo treatment group (placebo) and absence of the control group (intervention group). This problem is due to two things: First, the limitations of the sample and second other ethical concerns.

To sum up the results of the current study, it should be mentioned that neurofeedback training in GAD patients cause an increase in alpha and theta brain waves amplitude and such training is effective in reducing GAD symptoms while such changes cannot be observed waiting list group. The results also suggest that on one hand, the utilization of neurofeedback training decreased GAD patients' symptoms, while on the other hand it increases occupational, social and psychological functioning level in GAD patients.

The mind has the power to heal itself, but very often it lacks an effective tool to do so. Interventions at different and deeper levels are required to produce further change and to help the growth. Neurofeedback is one such intervention that is just now coming into its own. In addition,

technological advances continue to improve the efficacy of neurotherapy (Demose, 2005).

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