

The Effectiveness of Neurofeedback Training on Anxiety and Craving Reduction in Smokers

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Abstract: This study aimed to evaluate the effectiveness of neurofeedback training on reducing anxiety and craving in smokers. This is an experimental study. For this purpose, 30 smokers (male and female) were selected with convenient sampling method and they were assigned to experimental and control groups randomly. The experimental group received neurofeedback training but control group received no treatment. Measurement tools were Fagerstrom Tolerance Questionnaire (FTQ) for cigarette craving and Depression Anxiety Stress Scale-42 (DASS-42) for evaluating anxiety rate of two groups. Data were analyzed using ANCOVA. After 15 sessions neurofeedback training for experimental group, the rate of anxiety and craving were significantly decreased. In addition, after treatment, both groups showed significant differences in rates of anxiety and craving. The results showed that neurofeedback training caused significant differences in anxiety and craving scores in pre- and post-test. Also, there were significant differences between the post-test scores of experimental and control groups. In conclusion, neurofeedback training can reduce anxiety and craving in smokers.

Key words: Anxiety, cigarette craving, neurofeedback training, depression, cigarette, Fagerstrom Tolerance Questionnaire (FTQ)

INTRODUCTION

In the process of treating the addicts after reaching to the abstinence state, a severe desire is seen for re-experiencing the effects of psychedelic substance (Mokri and Ekhtiari, 2015). Generally craving for drugs is created in facing with symptoms related to the experiences or imaginations of addicted person from conditions related to the consumption pleasure. Craving for drugs has an important role in returning after treating and keeping the situation of consumption and dependency on the drugs. Brody *et al.* (2004) reported that in the brain of smokers in facing with symptoms of consuming the cigarette, the activity of areas related to arousal, compulsory behaviors, sensory integration and periodical memory are increased. These areas include orbitofrontal cortex, prefrontal cortex and pre-insula of area involved in conscious desires. Furthermore, continual nicotine consumption leads to increase the number of nicotinic receptors, a phenomenon which is not predicted for an agonist receptor because generally the conformity of receptor occurs in order to reduce the number or down-regulation (Parrott *et al.*, 2005). Finally, the activity of nicotinic receptors in addition to release the acetylcholine, leads to release a large number

of other neurotransmitters which include dopamine, noradrenaline, glutamate and serotonin (Zevin *et al.*, 1998; Parrott *et al.*, 2005). In terms of neurobehavioral concepts, these complexities made nicotine as one of the most confusing substances among psychedelics (Parrott *et al.*, 2005). Grundey *et al.* (2012) assessed the plasticity of neurons in the brain of smokers in both situations of quitting and compensating the deficit of relative consumption with supplying the nicotine. They reported that lack of neural facilitatory plasticity in the smokers during the period of nicotine cessation was compensated by re-supplying the nicotine. This case confirms the deficit-compensation hypothesis in consuming the nicotine. Fregni *et al.* (2008) by studying on the effect of transcranial Direct Current Stimulation (tDCS) in the area of bilateral DorsoLateral PreFrontal Cortex (DLPFC) of smokers, indicated that craving for cigarette is reduced significantly after the stimulation. Also, Fraser and Rosen (2012), according to a similar research, reported that Anodal tDCS on DLPFC area reduces the craving obtained from the symptoms of cigarette consumption.

Repetition of quitting symptoms between each cigarette causes smokers suffering from increasingly levels of anxiety and distress during the day. Therefore, dependency on the nicotine is a direct mental-biological

reason for stress, this issue explains that why adolescents who started smoking, report double stress and depression in next years (Parrott *et al.*, 2005). Johnson *et al.* (2000) studied several thousands American during both situations of start smoking in the last years of adolescence and early youth (with time interval of 6 years). Attempting to use cigarette in 16 years old caused to appear pervasive anxiety disorder in 22 years old while high anxiety in 16 years old did not lead to increase the rate of consuming cigarette in the future. Kassel and Unrod (2000) believed that unlike the behavioral or sensory aspects of smoking, nicotine is related to the distress and confusion and leads to reduce the anxiety. Moylan *et al.* (2012) reported that although, many researches indicated suffering from anxiety disorders caused by increasing the rate of smoking and dependency to the nicotine, there are also limited and ambivalence articles assessed the probability of this relation in the population with necessary diagnostic criteria. Most evidence support the issue that dependency on cigarette and nicotine increase the risk of suffering from panic disorder and pervasive anxiety disorder. Results of their studies indicated that anxiety disorders cause smokers tendency to consume more cigarette and dependency on nicotine is inefficient for improving this situation.

Scheinost *et al.* (2013) studied the effect of neurofeedback trainings in the area of orbitofrontal cortex on anxiety and relaxation mode by helping of functional Magnetic Resonance Imaging (fMRI). They reported that the neurofeedback trainings with reconstructing and reorganizing the brain networks controlled anxiety and kept these networks changes caused by neurofeedback training effects. Furthermore, Fecteau *et al.* (2014) studied about the effectiveness of transcranial Direct Current Stimulation (tDCS) on regulation the cigarette consumption and the behaviors of making decision in tobacco smokers. These stimulations were accomplished in the area of Dorsolateral Prefrontal Cortex (DLPFC). They reported smokers who had unsuccessful attempt for quitting, mostly had problem in decision-making that is usually formed with inefficient cognitive control and powerful drive for earning reward. The results of their study indicated that using tDCS on DLPFC can be useful in reducing cigarette consumption and it increases the emotions which are sensitive to the reward.

Regarding to these findings, this research studies the effectiveness of neurofeedback training on reduction of anxiety and craving in the smokers. In this study, neurofeedback training was used as a therapeutic method. Because, the clients received no electrical stimulation or conscious message; consequently it was less invasive than methods like tDCS and TMS (Transcranial

Magnetic Stimulation) and it causes least stress for clients. Furthermore, by helping of auxiliary facilities of professional device software, the real electroen cephalography change can be observed both in the form of graphical images and waves amplitudes in the beginning and middle sessions and end of treatment period. The effects obtained from neurofeedback training due to more constant and longer exercises are more permanent than the methods like electric stimulation of brain. In fact, neurofeedback trainings enables client to strengthen the metabolic changes of his brain purposefully and it causes to facilitate the regional Changes in the brain weaves and Blood Flow (rCBF). In this research, it was assumed that neurofeedback training causes anxiety and craving reduction for cigarette in smokers.

MATERIALS AND METHODS

Current research was an experimental method with experimental and control groups with pre- and post-test stages. The experiment group was treated under neurofeedback. Both groups completed questionnaires for assessing cigarette craving and anxiety rate in pre and post-test stages.

Participants: The participants were selected from cigarette smokers (men and women in Isfahan City-Iran) using convenient sampling method in the time span of two months. Participants were selected from clinical clients (30 persons) by the Composition International Diagnostic Interview (CIDI) and they were divided in two experimental and control groups randomly (each group 15 persons).

The criteria for entrance in the study was cigarette smoking for the period of one year and more, lack of brain damage and lack of suffering from anxiety disorders. Participant's age domain was 20 years old and upper. The total sample size included 27 men and 3 women (90% men and 10% women). The most age frequency was related to the ages between 20-30 years old (33.3%) and the least frequency was related to the persons between 51-60 years old (10%). The most time duration for smoking was between 10-20 years (30%) and the least time were between 1-5 years (20%). Most of participants had no quitting record (63.3%) and the persons with quitting record included 36.7% of the sample size. In terms of education level, most of participants educated up to high school diploma degree (14 people) or 46.7% of sample size. The least number included illiterates to educating less than high school (3 people- 10% of sample size). The others educated bachelor degree (9 persons) and higher than bachelor degree were 4 persons. According to

DSM-V, the criteria for exiting from the study program were suffering from mental disorders and/or special physical problems like brain damages or mental retardation and dependency to other psychedelics or even recreational consumption of other psychedelic substances like alcohol and opioids.

Measures

Fagerstrom Tolerance Questionnaire (FTQ): This scale was made by Fagerstrom (1978). This 6-question questionnaire which is scored by Likert scale is in the form of a standard method and confirmed by Worldwide Health Organization (WHO) and the worldwide union of fighting with tuberculosis and lung diseases. The scores of this scale are in the range of 0-10 and higher scores refer to more dependency rate. Scores of 0-3, 4-6 and 7-10 indicate in order low, middle and high dependency level to the nicotine. Fagerstrom questionnaire was standardized by Heydari *et al.* (2009) in Iran. The results indicated that this questionnaire has proper validity and reliability. According to the findings of Poor *et al.* (2013), there is a positive relationship between dependency on drugs and craving. Therefore, participant’s scores in FTQ was the study tool for assessing the rate of dependency on nicotine or craving for smoking at the research.

Depression Anxiety Stress Scale-42 (DASS-42): The score of each participant in the anxiety questions of DASS-42 indicates their anxiety severity. This questionnaire was made by Lovibond and Lovibond (1995) and it’s psychometric properties was calculated by Samany and Jokar (2007) in Iran. The main form of this scale includes 42 questions that for assessing each one of the subscales of depression, anxiety and stress, there are 14 different questions. In this scale, anxiety factor includes symptoms such as physiological arousals, panic and fear. The findings of Samani and Jokar indicated that this scale has proper validity and reliability in Iran.

Procedure: In this research, participants of both experimental and control groups completed fagerstrom and DASS-42 questionnaires as pre-test. Then, experimental group received 15 sessions neurofeedback training (each session was 20 min) with therapeutic protocol of alpha/theta. The purpose of therapeutic protocol was strengthening alpha and suppressing theta in the areas of prefrontal and frontal lobes of both hemispheres. But the control group received no treatment. Then, participants of both groups again answered the FTQ and DASS-42 as post-test. Participants took part in the research voluntarily and they were allowed to discard from the study at any time they wished.

Data analysis: The collected data were analyzed statistically using various descriptive statistics and one way Analysis of Covariance (ANCOVA).

RESULTS AND DISCUSSION

The first hypothesis was about the effect of neurofeedback training on smoker’s craving for cigarette. According to the descriptive findings, Table 1 for the variable of craving or dependency on nicotine in experiment group, the mean scores were 4.33 and 2.47 for pre and post-test, respectively. These changes for control group were less than experimental group in pre-test 4.13 and 4.33 in post-test. In total sample, the mean scores of nicotine dependency were 4.23 in pre-test and 3.40 in post-test.

The mean scores of two groups in pre- and post-test of FTQ (craving for cigarette) were compared using ANCOVA (Table 2). There was a significant difference between experimental and control groups in the post-test scores of dependency on nicotine ($p < 0.01$). Therefore, the scores of dependency on nicotine in post-test of experimental group were different from control group significantly and the effectiveness rate of treatment was 89%. In other words, neurofeedback trainings caused reduction in cigarette craving in smokers significantly.

The second hypothesis was about the effectiveness of neurofeedback training on smoker’s anxiety reduction. It was assumed that neurofeedback training can reduce anxiety levels of smokers. According to descriptive findings, the mean scores of anxiety in experimental group were in pre-test 21.07 and in post-test 15.67. Regarding to control group, mean scores of pre and

Table 1: Mean scores and standard deviations of different variables in pre and post-test in experiment and control groups

Variables	Groups	n	Mean	SD
Anxiety Pre-test	Experimental	15	21.07	8.96
	Control	15	24.33	7.35
	Total	30	22.70	8.22
Anxiety Post-test	Experimental	15	15.67	7.51
	Control	15	24.33	7.35
	Total	30	20.00	8.53
Nicotine dependency Pre-test	Experimental	15	4.33	2.94
	Control	15	4.13	3.00
	Total	30	4.23	2.93
Nicotine dependency Post-test	Experimental	15	2.47	2.36
	Control	15	4.33	2.82
	Total	30	3.40	2.72

Table 2: Comparing experimental and control groups on post-test scores of craving for cigarette using ANCOVA

Source of variations	Sum of squares	df	Mean squares	F-value	p-values	η^2
Group	30.91	1	30.91	41.04	0.01	0.89
Error	20.34	27	0.75		0.01	0.60
Total	562.00	30				

Table 3: Comparing experimental and control groups on post-test scores of anxiety using ANCOVA

Source of variations	Sum of squares	df	Mean squares	F-value	p-values	η^2
Group	247.89	1	247.89	40.16	0.01	0.89
Error	166.66	27	6.17		0.01	0.60
Total	14108.00	30				

post-test had no difference (24.33 in both stages). The mean scores of total sample size in pre and post-test were 22.70 and 20.00, respectively. The mean scores of two groups in pre and post-test of FTQ were compared using ANCOVA (Table 3). The results showed significant difference between two groups in post-test stage ($p < 0.01$). Therefore, the anxiety scores in post-test of experimentation group significantly were different from control group and the effectiveness rate of treatment was 89%. In other words, neurofeedback exercises reduced the anxiety of smokers significantly.

The results of current research indicated that neurofeedback training can reduce the anxiety of smokers significantly. These findings are consistent with study by Arani *et al.* (2010), Naeeniyan *et al.* (2009) and Narimani and Rajabi (2012). The findings of Gonzalez *et al.* (2008) also confirmed that controlling emotional disorders or negative emotions like depression and anxiety is an essential factor for successful of cigarette quitting. Moylan *et al.* (2012) assessed the relationship between smoking dependency and anxiety disorders. Their results indicated that dependency on nicotine increases the risk probability for suffering from panic and pervasive anxiety disorder. In this research, increasing of anxiety level was accompanied with increasing smoking but the findings were distinct for dependency on nicotine.

In addition, results of current research indicated that neurofeedback training causes reduction in smoking craving significantly. The findings of this study were consistent with the results of other studies. Fraser and Rosen (2012) studied transcranial Direct Current Stimulation (tDCS) on the area of prefrontal dorsolateral cortex of both hemispheres and its effect on addiction to cigarette. Aryanpour *et al.* (2007) studied dependency on nicotine according. In terms of selecting therapeutic protocol, this research was consistent with studies like McBride *et al.* (2006), Hommer (1999) and Ekhtiari *et al.* (2008). They studied the brain of addicted people to different kinds of psychedelic substances and smokers who were involved in craving for drugs. Dehghani *et al.* (2009) studied the neurofeedback effectiveness on opioid addict's craving. Narimani and Rajabi (2012) reported that neurofeedback treatments effectiveness on craving beliefs of addicted persons and current research confirmed their findings. The findings of this study are consistent with reports of Hanlon *et al.* (2013) and Li *et al.* (2013) that by

using of fMRI and neurofeedback trainings, indicated the self-regulation possibility of frontal cortex activities in nicotine smokers and reduction of their subsequent craving. In other words, it can be concluded that changes in the alpha and theta waves amplitude in the prefrontal and frontal lobes causes effective changes for quitting addiction. One of these changes is the reduction of craving for psychedelic substances that neurofeedback trainings are applied for reducing it in prefrontal orbitofrontal, dorsolateral and anterior cingulate cortex areas (Hommer, 1999; Demos, 2005).

CONCLUSION

Totally, this research indicated that by using of neurofeedback training, the smoker's anxiety and craving for cigarette can be reduced. This finding as a therapeutic program can be efficient for experts of quitting addiction. From limitations of this research, uncontrolled demographics variables like gender, education level and unsuccessful quitting record of participants with variable of dependency level to nicotine can be referred.

RECOMMENDATION

It is recommended that in the future researches, these variables to be controlled, so that, more accurate results can be achieved in this field.

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