



Neuro-Feedback Training For Overweight Women: Improvement of Food Craving And Mental Health

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ABSTRACT

Major risk factors for diabetes, cardiovascular disorders and cancer (prostate, intestine, breast, etc.) are obesity and being overweight. This study aims to investigate the effect of neurofeedback training to food craving and mental health in overweight women. To this aim, thirty overweight women were divided into two groups; neurofeedback and control groups, using a simple random method. In this experiment, which was accompanied with pre-test and post-test with the control group, women in the experimental group received 10 sessions of neurofeedback. Both experimental and control subjects filled the food craving and general health questionnaire before and after the intervention. Univariate analysis of covariance was used for data analysis. The results showed a significant difference in food craving and mental health between the neurofeedback group and control group. The results showed that neurofeedback training can be considered as one of the complementary therapy intervention, in the field of obesity and overweight.

Key Words: overweight, neurofeedback training, food craving, mental health, women

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Introduction

Obesity and overweight can be considered as an additional weight that may increase the risk of physical diseases and untimely death. The body mass index (BMI), introduced by the World Health Organization and the National Health Institute, is a simple and suitable way to define obesity and overweight. It is the ratio of body weight (in kilograms) to the squared height (in meters). The BMI of 25-29.5 is considered overweight, while the BMI higher than 30 is called obesity (Fock and Kho, 2013).

Obesity and overweight may lead to physical diseases like diabetes and cardiovascular diseases. Moreover, it can damage the quality of life and increase physical and mental disorders

(Kress *et al.*, 2005). Furthermore, obesity and overweight increases the risk of death (Barnes *et al.*, 2007). Various factors, including age, gender, genetic factors, eating habits and physical activity level may affect the emergence and development of obesity and overweight. Food craving is one such factor (Maddah, 2012). Generally, food craving is specified as a severe tendency for eating food which contributes to several major diseases including bulimia, obesity or alcoholism (Weingarten and Elston, 1991). Also food craving is accompanied by future high-calorie food intake (Martin *et al.*, 2008) and weight gain. (Meule *et al.*, 2012; Sitton, 1991). Considering the role of food craving in weight gain, its management a key role in reducing overweight (Albert *et al.*, 2010).

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A complex relationship between mind and body reflects the relationship between mental health and physical health. Weight is an important factor in mental health. Overweight and obese people have lower mental health than people with normal weight (Allison *et al.*, 2009; Robert *et al.*, 2002). Anderson *et al.* (2006) and Goodman and Whitaker (2002) find evidence that mental distress predicts overweight or weight gain. Other researchers find no associations between weight status and mental health (Stic *et al.*, 2005; Tanofsky-Kraff *et al.*, 2006).

Owing to the increasing prevalence of obesity and repetitive failures in weight-loss maintenance, it seems necessary to introduce new therapeutic methods (Match and Simons, 2011). In recent years, new therapy methods have been proposed in the field of obesity and psychological disorders that have attracted the attention of researchers (Teufel *et al.*, 2013). Neurofeedback is one of these new methods (Powell *et al.*, 2007)

Neurofeedback is the biofeedback received via cerebral electrical wave's radiography; it is basically an operant conditioning of cerebral electrical waves. This non-invasive technology helps patients to control and change cerebral electrical waves. The aim of this method is active regulation training of cerebral cortex activities to control cerebral waves. In this method, cerebral electrical waves are recorded and visual, audio or combinatory feedbacks is given to patients. With the help of such feedbacks, patients would volitionally reinforce the waves related to optimal cerebral activities and suppress the waves interrupting such activity (Chirita-Emandi and Puiu, 2014).

Recent investigations have been propounded neurofeedback application in craving in the field of addiction and eating (Hammond, 2011). One study, conducted by Imperatori *et al.* (2017) revealed the effect of neurofeedback training on food craving in healthy people. Fifty healthy people [experimental group (n=25) and control group (n=25)] participated in this investigation and the treatment was performed for 10 sessions. The results showed that neurofeedback intervention reduced food craving. Other study conducted by Meule *et al.* (2012) reported preliminary investigation for the effectiveness of heart rate variability biofeedback in decreasing food craving. Furthermore, Schmidt and Martin (2015) showed the effectiveness of neurofeedback in reducing food craving and overeating periods.

Since the effectiveness of neurofeedback on drug craving in several studies reviewed and whereas the brain regions involved in drug craving and food craving is invariant (Pelchat, 2009), researches on drug craving are shown below.

Dehghani *et al.* (2013) conducted a study to investigate the effect of neurofeedback training on the severity of craving in patients addicted to opioid. Twenty men addicted to opioid [experimental group (n=10) and control group (n=10)], who were under treatment with methadone and buprenorphine, participated in this investigation and the treatment was performed for 30 sessions. The results showed that neurofeedback intervention reduced craving and tendency to use opioid, and increased general health scores in comparison with the control group. Hashemian (2015) showed the positive effect of neurofeedback on reducing the craving for meta-amphetamine.

Some research have been carried out on the effectiveness of neurofeedback on mental health. Research by Rostami and Dehghani (2015) has shown the effect of neurofeedback training in improving psychological health in the research conducted by Bodenhamer and Callaway, (2004); Burkett *et al.*, (2004); Dehghani *et al.*, (2013) on the improvement of drug abusers mental state. In another research, participants who received (alpha-theta training) showed significant improvement in their mood (Raymond *et al.*, 2005). Weon *et al.* (2013) has shown no significant improvement in the general health status and mental health.

Peniston research (1998) also shows that α/θ protocol results in β -endorphin in brain. The mechanism of this effect becomes apparent, when we notice the role of β -endorphin and serotonin in relaxation and stress control and also the role of dopamine in stress. This protocol also resulted in a decrease of 13 point on the millon clinical multiaxial inventory scales (MCMI), including anxiety (Peniston and Kulkosky, 1991).

Based on our search database, including ISI, PubMed and Scopus, there has been scant research on the impact of neurofeedback on food craving and general health. So, this study aimed at answering if neurofeedback treatment leads to an improvement in mental health and food craving for overweight women,

Experimental Overview

Participant

Participants were recruited from two nutrition clinics in Sari. To avoid the participants' awareness of the experimental hypotheses, we did not reveal to them any hypotheses regarding the possible benefits of A/T training on food craving. The participants contributed voluntarily and were free to drop out of the study at any moment. They did not receive payment. The inclusion criteria were: over-weight (BMI = 18.50–29.99 kg/m²); age between 20 and 50 years for both genders. The exclusion criteria were: obesity (BMI ≥ 30 kg/m²), underweight (BMI ≤ 18.49 kg/m²), and a history of psychiatric diseases related to nutritional treatment.

One hundred respondents were assessed for eligibility. Thirty individuals fulfilling the inclusion criteria were enrolled in the present study. All participants were completed the food cravings questionnaire-trait and general Health questionnaire. To evaluate the effectiveness of neurofeedback training on food craving and mental health at the baseline and after intervention, a 39-item form of the food craving questionnaire (FCQ-39) and a general health questionnaire were used. With these checklists two scores were obtained for each participant.

Questionnaires

In the Food Cravings Questionnaires, food cravings were assessed using the trait version of the Food Cravings Questionnaires (Cepeda-Benito *et al.*, 2000).

This 39-item instrument asks participants to indicate on a 6- point scale how frequently they experience food cravings (ranging from never to always). These subscales are (1) intentions and plans to consume food (3 items); (2) anticipation of positive reinforcement that may result from eating (5 items); (3) anticipation of relief from negative states and feelings as a result of eating (3 items); (4) possible lack of control over eating (6 items); (5) thought or preoccupation with food (7 items); (6) craving as a physiological state (4 items); (7) emotions that may be experienced before or during food cravings or eating (4 items); (8) environmental cues that may trigger food cravings (4 items); and (9) guilt that may be experienced as a result of cravings and/or giving into them (3 items). Individuals have to indicate, using a Likert scale ranging from 1 (never or not applicable) to 6 (always), the degree to which each item would be generally true for them. Validity of the FCQ-T is shown with strong associations with

disinhibited eating or eating disorder symptoms in healthy participants and eating disorder patients (Cepeda-Benito *et al.*, 2003; Cepeda- *et al.*, 2000; Moreno *et al.*, 2008). The validity and reliability of the test was calculated by researcher in Mazandaran University in Iran by collecting data from 117 subjects and using the Cronbach α coefficient. The coefficient was 97% which indicates its good reliability.

The General Health Questionnaire (GHQ) is a measure of current mental health and since its development by Goldberg in the 1970s. The GHQ-12 comprises 12 items describing mood states, six of which are positively phrased (PP items, labelled items p1 to p6) and six negatively phrased (NP items, labelled n1 to n6). Each item of the GHQ-12 has four possible response options. Item scores were coded according to the three scoring methods examined: Likert method (all items coded 0-1-2-3), GHQ method (all items coded 0-0-1-1), and C-GHQ method (PP items coded 0-0-1-1; NP items coded 0-1-1-1). Three severity scores were computed as the summed score of all items for each scoring method. Internal validity of test calculated by using Cronbach α coefficient. The coefficient was 0/87. Also reliability of questionnaire in this research was 0/84 (Goldberg and Hiler, 1979).

Procedure

In this study, an experimental method with pre-test, post-test and the control group was used. During baseline, scores for food craving and mental health were obtained. The treatment involved 10 sessions (30-45 minute) of neurofeedback training, three times a week. The neurofeedback training was conducted by Procomp Infiniti Encoder and Biograph infiniti software (v 5.1.3). The alpha-theta protocol was used for the experimental group. The main purpose of alpha-theta training is to increase the frequency of both alpha and theta waves (Scott *et al.*, 2008). Feedback in the alpha-theta training protocol on the Pz area was in an audio format only. In this protocol, the participants closed their eyes and only listened to the sound being played to them. The initial sessions were used to train the patients to decrease the alpha levels that were above 12 mV (peak to peak) while augmenting theta until there was a "crossover." This was defined as the point where the alpha amplitude dropped below the level of theta. Subsequent to achieving the first crossover, both alpha and theta frequencies were augmented and the delta frequency range was also inhibited. This was



intended to discourage sleep transition during low-arousal states. Each alpha-theta session began with the subject sitting in a chair with eyes closed. The active electrode was placed at Pz with a left-ear reference (A1) and right-ear ground (A2). Two distinct tones were employed for alpha and theta reinforcement, with the higher pitched being sound used to index the higher-frequency alpha band. At the start of each session, the therapist spent three to five minutes by reading a script of guided imagery to the experimental subject that dealt with identified essential elements of maintaining abstinence. After the guided imagery, it was made clear to the subject that the objective of the training did not involve explicit rehearsal of the script during neurofeedback.

Subjects reporting previous meditative practices were asked not to use it during training

as meditation has been observed to override alpha-theta reinforcement effects (Braet *et al.*, 2007).

Following the alpha-theta training, the subjects were given the opportunity to process their experience.

Statistical Analysis

The analysis of covariance was done using SPSS for windows version 22. Ancova were conducted to analyze the variables pre and post measurement of control and experimental subjects. To this purpose, the effectiveness of neurofeedback training was considered as an independent variable, to investigate its effect on food craving and mental health as dependent variables.

Results

Table 1. Content of neurofeedback session

Content	Sessions
Acquaintance with neurofeedback device and its relationship with body and computer, learning relaxation techniques	First session
Relaxation exercises and find out the relationship with the sound heard from the computer and learn about situations that may increase food craving	second session
Create a state of deep relaxation and visualization along with sound sea waves and Imaging tempting situations with the sound of the lake by the therapist and then create a state of deep relaxation	third and fourth sessions
Create a state of deep relaxation and visualization along with sound sea waves and Imaging tempting situations with the sound of the lake by the client and then create a state of deep relaxation	Fifth Session
Repeat the cycle of meditation and Imaging by client	sixth to the tenth session

Table 2. Means, standard deviations for mental health and food craving

Variables		Group	Mean	Standard deviation	Number
Mental Health	Pre	Experimental	4/25	1/71	12
		Control	3/73	2/15	15
	Post	Experimental	2	1/27	12
		Control	3/73	1/98	15
Food craving	Pre	Experimental	140/67	18/45	12
		Control	132/93	24/52	15
	Post	Experimental	115/17	30/03	12
		Control	130/20	29/32	15

Table 3. Result of Levene's test for homogeneity of intergroup variance of data.

Variables	Df ₁	Df ₂	F	Sig.
Food craving	2	38	1/57	0/221
General health	2	38	0/523	0/597

Table 4. Multivariate test

	value	Hypothesis df	Error df	F	Sig. level	Eta square	P
Pillai's Trace	0/629	6	68	5/19	0/0001	31/0	0/991
Wilks' Lambda	3750/	6	66	6/96	0/0001	390/	0/999
Hotelling trace	1/65	6	64	8/83	0/0001	0/45	1/00
Roys largest tool	1/65	3	34	69/18	0/0001	62/0	1/00



Discussion and Conclusions

The main aim of present study was to investigate the usefulness of neurofeedback training in reducing food craving and improving mental health in overweight people. As reported for addiction (Burkett *et al.*, 2004; Dehghani-Arani *et al.*, 2013; Fahrion *et al.*, 1992; Peniston and Kulkosky, 1989; Rostami and Dehghani-Arani, 2015; Rahmati *et al.*, 2017; Hafezi Ahmadi *et al.*, 2014), our results showed that ten sessions of neurofeedback training decrease food craving and improves mental health.

As shown in Table 5, neurofeedback training reduced the total scores of food craving in comparison with the control group. These findings are in accordance with the findings obtained by Saxby and Pension (1995), Scott *et al.*, (2005), Hashemian (2015), Rostami and Dehghani-Arani (2015), Dehghani *et al.*, (2008), Imperatori *et al.*

(2017). In this study, neurofeedback training reduced craving in the experimental group. As an explanation for these hypotheses, it can be said that people in neurofeedback group were trained to replace eating behavior by relaxed mood with the aim of conditioning. It has been mentioned (Blum *et al.*, 2012) that a dysfunction in the brain reward system could lead to abnormal cravings. So changes in the reward system, manages craving. Some research studies demonstrated that A/T training may promote changes in the brain system (Dehghani-Arani *et al.*, 2013; Rostami and Dehghani-Arani, 2015; Scott *et al.*, 2005; Javedani *et al.*, 2015). Some studies have shown the role of the hippocampus and memory impairment in eating behaviors (Forlani *et al.*, 1986). Therefore, it may be concluded that neurofeedback has been effective in craving.

Table 5: result of ANCOVA

variables	source	Total square	Df	Mean square	F	sig. level	Eta square
Food craving	Pre-test	19392/32	1	19392/32	72/16	0/0001	0/67
	Group	3259/75	2	1629/87	6/06	0/005	0/25
	Error	9405/35	35	268/72			
Mental health	Pre-test	74/81	1	74/81	89/15	0/0001	0/72
	Group	32/07	1	16/03	19/11	0/0001	0/52
	Error	29/36	35	0/839			

Also neurofeedback training reduced the total scores of general health in comparison with the control group. These findings are in accordance with the findings obtained by Saxby and Pension (1995), Scott *et al.* (2005), and Dehghani *et al.*, (2013). As an explanation of these hypotheses, it can be said that people in the neurofeedback group were trained to decrease stress with increased alpha frequency. Because of A/ T training, the increase in alpha power may reflect neural mechanisms underlying successful coping with stressful situations. Consistently, it has been observed that the deep relaxation associated with NF enhances well-being, the ability to better tolerate stress, and emotional and self-awareness (Boynton, 2001; Gruzelier, 2014) during anxiety situation (Dehghani-Arani *et al.*, 2013; Peniston and Kulkosky, 1989; Scott *et al.*, 2005).

McPeak *et al.*, (1991) believed that in the alpha-theta protocol, volitional and self-motivated replacing of the stress mood with the relaxed mood, leads to the replacement of destructive behaviors with the relaxed mood. Moreover, neurofeedback can improve and regulate brain function by improving its neurochemical function and removing the neurochemical cause of craving.

Neurofeedback uses the operant conditioning as a self-regulating mechanism, and aims to modify the brain's subnormal function, thereby improving psychological disorders.

This research, just like all other studies has some limitations relating to the terms and conditions of scientific research. These limitations can be considered so that they can be eliminated in future studies. We mention the most important once below:

First, Owing to the technology used in the neurofeedback method and its newness, the effects of patient motivation and hope for the new treatment could be effective. These were not controlled in this study. Second, we did not compare A/T training with a sham procedure to prevent the placebo effect. Third, we did not assess the long-term follow-up process, to investigate the continuity and effectiveness of the treatment intervention. Therefore, long-term follow-up is recommended for future studies.

Conclusion

In conclusion, the results of our study are in accordance with other studies in Iran as well as in other countries. Therefore, based on the present study and previous studies in the field of



addiction, neurofeedback affects food craving and mental health, as a self-regulating mechanism. Moreover, neuro-feedback does not have side-effects and can be applied as a complementary treatment for curing overweight and obesity. Owing to the positive effect of neurofeedback training in food craving and mental health, we suggest that the number of treatment sessions be increased for better results.

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