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The Effectiveness of Transcranial Direct Current Stimulation (tDCS) On Food Craving

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A B S T R A C T

Food cravings are defined as a desire without resistance to consumption. Food cravings may predict recurrence or weight gain in obese patients, including those undergoing obesity surgeries to lose weight. The aim of this study was to investigate the effect of direct electrical stimulation from the skull on reducing food cravings. Using the available sampling method and taking into account the conditions for entering the sample, a sample of 20 people were selected and randomly divided into experimental and control groups. Direct electrical stimulation device from the skull, visual analog scale to record the amount of craving, food trait questionnaire - short form were used as tools in this study. Data analysis was performed using multivariate analysis of covariance and univariate analysis of variance. The findings of this study showed that stimulation of a direct electrical session from the skull reduces the amount of food cravings. Due to the effectiveness of this method in reducing food cravings, it is recommended to use this method to reduce cravings in obese people.

Keywords: Direct Electrical Stimulation Of The Skull, Food Cravings, Obesity, Food.

INTRODUCTION

Craving is defined as a desire without resistance to consumption(Wang et al., 2020; Wang, Volkow, Thanos, & Fowler, 2004). Food cravings can be attributed to experiencing disturbing thoughts, tendencies, and often disturbing urges about certain foods (Duarte, Pinto-Gouveia, Ferreira, & Silva, 2016; Hill, 2007; Weingarten & Elston, 1990).

Food and drug cravings contribute to neuropsychological functions(Wang et al., 2004). Craving alone may predict recurrence in addicted patients, some suggest that food cravings may cause recurrence or weight gain in obese patients, including those undergoing obesity surgery to lose weight(Budak & Thomas, 2009; Heinz, Beck, Grüsser, Grace, & Wrase, 2009; Schneekloth et al., 2012).

Also, people who experience food cravings more intensely and more frequently are more likely to be overweight or have eating disorders(Gendall, Joyce, Sullivan, & Bulik, 1998).

Direct cranial electrical stimulation (tDCS) is a neurotherapy technique that directs a weak, direct current into the cortical region and facilitates or inhibits spontaneous neural

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activity(Brunoni et al., 2012; Elsner, Kugler, & Mehrholz, 2018; Gowan & Hordacre, 2020). Direct electrical stimulation of the brain (tDCS) has been extensively tested over the past decade and acts as a non-invasive, inexpensive, and safe alternative to altering cortical excitability by altering the resting potential of cortical neurons. This weak and direct current stimulates the underlying neurons by connecting two electrodes with different poles, usually an anode and a cathode at different points on the surface of the skull. Cathode stimulation reduces brain excitability and anode stimulation leads to increased brain excitability(Zhao et al., 2017). Over the past two decades, a large number of studies with this method have shown positive clinical results.

METHODOLOGY

In the present study, in order to accurately measure and control the research variable, a quasi-experimental design with pre-test and post-test with the control group was used. Also, individuals were assigned to intervention and control groups randomly.

The study population was all male students of Semnan University who had a prominent craving for food (scoring at least one deviation above the average). The sampling process has been done in the period of September 2019 to November 2019 in Semnan University. The sample of this study included 20 students with food cravings. These individuals were selected by available sampling method and randomly assigned to a test group of 10 people and a control group of 10 people. Ten in the experimental group received transcranial electrical stimulation and ten in the control group received sham stimulation.

Research tools include:

1- Direct cranial electrical stimulation device (tDCS)

2- Short form of food craving (FCQ-T-r) questionnaire

3- Visual Analog Scale (VAS)

4- Film to create food cravings

5- Word root completion test

6- Trans cranial electrical stimulation protocol

In the latter instrument, direct electrical stimulation of the skull was used in a 20-minute session with a current of 2 mA. Anode electrode on the posterior lateral part of the prefrontal cortex (DLPFC) of the right brain (F4 region in system 10-20) and cathode electrode on the posterior lateral part of the frontal cortex (DLPFC) on the left side of the brain (F3 region in system 10-20) Was placed. The electrodes were impregnated with sterile 0.9% sodium chloride solution.

RESULTS

The number of participants in this study was 20, 10 of whom were in the experimental group and 10 of them were in the control group. The mean age of the sample was 23.350 years and the standard deviation was 3.116. Six participants were studying for a master's degree and 14 were studying for a bachelor's degree. The results of descriptive findings of craving in three stages in two groups (including mean and standard deviation) are presented in Table 1. According to Table 1, the results of the M. box test show that the observed matrix of dependent

variables is equal between different groups.

Table 1. M box test to test the covariance matrix parity hypothesis

M Box	F	DF1	DF2	P
1,715	0.503	3	58320.000	0.68

Levin test was also used to examine the presumption of equality between variances. Table 2 shows the Levin test to examine the presumption of equality of variances of craving.

Table 2. Levin test to examine the presumption of equality of variances of food cravings

	F	DF 1	DF 2	P
Craving for food 2	0.59	1	18	0.810
Craving for food 3	0.416	1	18	0.527

Table 3. Multivariate test to compare the two groups with pre-test control

Effect		amount	F	Squared ratio	Statistical power	P
group	Wilks Lambda	0.434	10.439	0.566	0.968	0.001

The results of Table 3 indicate that there is a significant difference (p = 0.001) between the groups at the alpha level of 0.05 due to the intervention performed with pre-test control.

Table 4. Inter-subject effects test to compare the two groups in two stages with pre-test control of craving

Source	Variable	Sum Square	DF	Mean Square	F	P	Squared ratio	Test power
group	Craving consumption 2	20.72	1	20.72	0.229	0.638	0.013	0.074
	Craving consumption 3	2145.01	1	/2145.01	16.40	0.001	0.491	0.968

The results of Table 4 show that by controlling the effect of pre-test and comparing the two groups in two stages, at the alpha level of 0.05, there is a significant difference (p = 0.001) between the groups in food cravings at the end of the intervention. However, in order to determine the differences between the two groups in food cravings, a pairwise comparison of the experimental and control groups was performed, the results of which can be seen in the following table.

Table 5. Pair comparison of two groups in food craving based on adjusted means (adjustment based on craving 1)

stage	group		Mean difference	SE	F	P
Craving consumption 2	experiment	Control	2.346-	4.90	0.229	0.638
Craving consumption 3	experiment	Control	23.86-	5.89	16.40	0.001

The results of pairwise comparison of food cravings based on the adjusted means in the experimental and control groups show that the subjects in the experimental group have a lower mean than the control group.

CONCLUSION

The results show that direct electrical stimulation from the skull to the lateral dorsal forehead cortex is effective in reducing food cravings. The results of this study with the studies of Besharat, Rostami, Karimi, and Farahani (2015), Fecteau et al. (2014), Fregni et al. (2008). The lateral dorsal forehead is effective in reducing food cravings, it is aligned and aligned. In a study by Besharat et al. (2015), the additive effect of combining methods of modulating attentional bias and direct electrical stimulation from the skull on reducing food cravings in 48

obese people was investigated. The results showed that the tDCS method alone, and its combination with ABMT significantly reduced the subjects' scores in the post-test. Recent empirical studies have shown that tDCS on the lateral dorsal forehead cortex can regulate the decision-making process, reduce substance use and cravings for various addictions(Fecteau et al., 2014). Fregni et al. (2008), have suggested that both tDCS and rTMS have been used to reduce smoking and other types of cravings, and that both methods produce similar arousal modulations in the cranial cortex, albeit with different mechanisms of action. In another study conducted by Fregni et al. (2008), on 23 subjects, they showed that direct trans cranial electrical stimulation of the DLPFC region alters the food intake of healthy subjects and the amount of food craving in the inclusion protocol. The anode decreases on the right DLPFC and the cathode decreases on the left DLPFC. Explaining why direct electrical stimulation from the skull reduces food cravings can be explained by the fact that studies have shown that the anterior cingulate, almond, insula, and lateral dorsal and dorsal forehead cortices They are consistent with cravings, and in fact one of the most important areas involved in symptom-dependent prediction and drug or food and drug use planning is the DLPFC. Extra cranial electrical stimulation helps reduce cravings. Most of the evidence suggests that the mechanisms of food cravings and drug addiction are common. Drug cravings and addictions are similarly affected by endogenous opioids, serotonin and dopamine in the brain. By applying a slight direct current to the head, it changes the serotonin and dopamine release rates, causing an immediate change in the brain's electrical frequencies and waves. Positive stimulation depolarizes local neurons; this means that by changing their voltage by 5 to 10 microvolts, the neurons move these areas from the resting potential at 65 microvolts to 55 microvolts, so the neurons have less input through their dendrites to start. They need activity. The negative electrode also slightly hyperpolarizes the neurons, so the neurons need more inputs to start working. On the other hand, Schestatsky, Morales-Quezada, and Fregni (2013), consider the local decrease in alpha waves and the increase in beta waves after DLPFC anodic stimulation as effective methods of transcranial direct electrical stimulation.

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