Home-based tDCS to Enhance Cognitive Control in Patients with Obesity Before Bariatric Surgery: A Preliminary Study

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Introduction

Obesity is a major risk factor for cardiovascular, neurological, and oncological diseases. Although bariatric surgery is the most effective treatment for severe obesity, up to 40% of patients fail to modify maladaptive eating behaviors, often due to impaired cognitive impulse control.

We investigated whether transcranial direct current stimulation (tDCS) of the left dorsolateral prefrontal cortex (DLPFC), a key region involved in regulating food-cue reactivity and appetite, can enhance cognitive control and improve the regulation of food-related impulses in patients preparing for bariatric surgery. Specifically, our aim was to assess food-related inhibitory control, weight loss, and brain plasticity changes induced by a 4-week home-based tDCS intervention.

Methods

Randomized, placebo-controlled, parallel groups, double-blind trial

Sex M/F : 1/9
Age (years): 35,6 ± 9,7
Weight (kg): 130, 9 ± 17,2

Home-based anodal tDCS (Figure 1):
2 mA, 20 minutes, 20 sessions
Active/Sham: 5/5

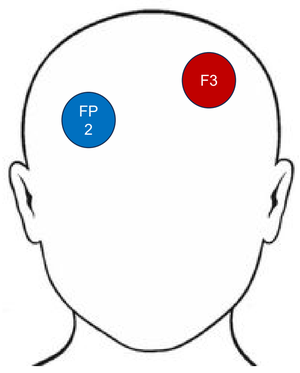

Figure 1. Electrode placement montage, Anode - left DLPFC (F3), Cathode – right supraorbital (FP2), size of sponge electrodes 5x5 cm.

Study protocol (Figure 2): Ten subjects with severe obesity, eligible for bariatric surgery and characterized by reduced control over eating behavior, were enrolled in our prospective experimental pilot study. The first session involved EEG recording during a computerized cognitive inhibition task – the food-related Go/No-Go task (Figure 3). A 4-week home-based stimulation program followed this initial session and was conducted 1,5 months prior to the scheduled bariatric surgery. Patients were randomized into two groups: active tDCS or sham. Immediately after the tDCS intervention, a second visit was scheduled, which included follow-up assessment of weight loss and EEG recordings.

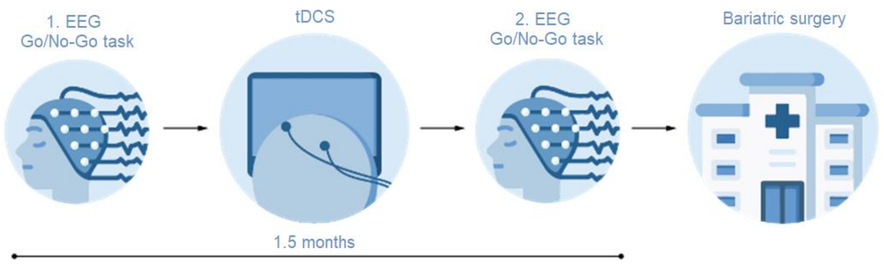

Figure 2. Study protocol

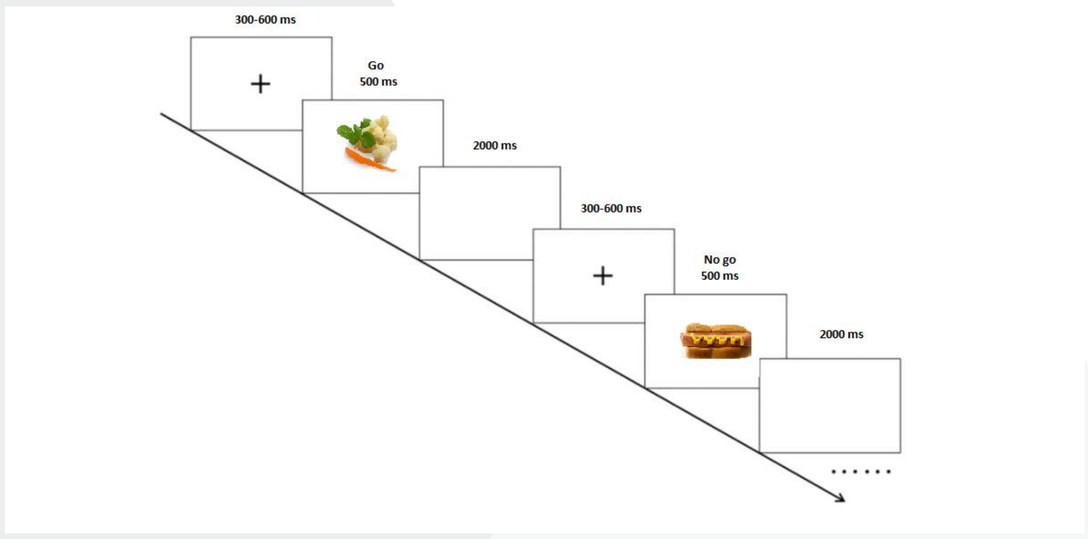

Figure 3. Food-modified Go/No-Go task with EEG recording. Subjects are presented with images of high- and low-calorie food on a screen and are instructed to quickly press a button when the item is low-calorie, and to withhold their response when the item is high-calorie.

Results

Behaviorally, all participants showed slight improvements in No-Go accuracy and slight declines in Go accuracy after the intervention. In addition, the active stimulation group demonstrated faster reaction times relative to the sham group. Notably, participants receiving active tDCS showed a greater reduction in weight compared to the sham group, although with a small effect size (Table 1).

Table 1. Mean change of behavioral measures post stimulation

	Active	Sham	Cohen's d (active - sham)
Accuracy Go (%)	-2,57	-2,71	0,03
Accuracy No-Go (%)	1,66	2	-0,07
False Alarms	-1	-1,2	0,07
Misses	3,6	3,8	-0,03
Reaction time Go (s)	-0,0112	0,0246	-0,83
Weight (kg)	-5	-3,5	-0,31

Qualitative analysis of time–frequency EEG data in the No-Go condition revealed a pattern of theta power (4-8 Hz) increase (synchronization) within inhibitory control network, particularly the anterior cingulate cortex (ACC). This effect was more pronounced in subjects receiving active tDCS compared to sham (Figure 4).

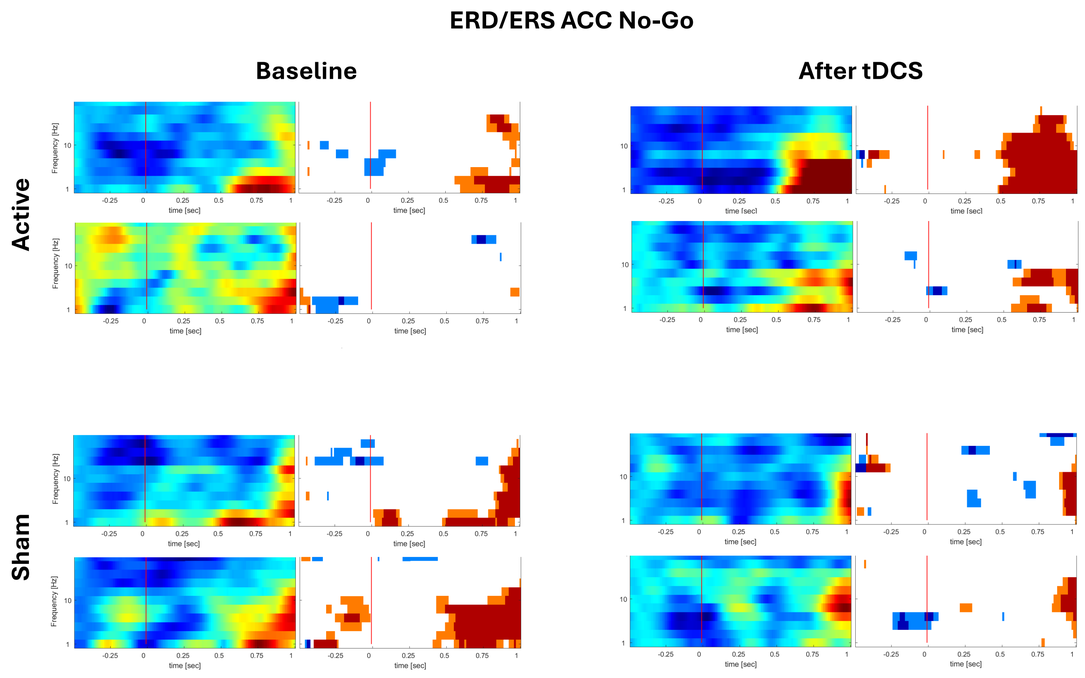

Figure 4. Brain responses in the left anterior cingulate cortex (ACC) of single subjects to No-Go high-calorie food stimuli. Significant event-related desynchronization (ERD) and synchronization (ERS) are shown in the 0–20 Hz range during the interval from 0.5 s before to 1 s after stimulus onset, expressed by time–frequency analysis. Red indicates a power increase (ERS; dark red $p < 0.01$, light red $p < 0.05$), while blue indicates a power decrease (ERD; dark blue $p < 0.01$, light blue $p < 0.05$).

Discussion

Home-based anodal tDCS over the left DLPFC appears feasible and well-tolerated in patients preparing for bariatric surgery. Behavioral trends suggest a potential enhancement of cognitive control, particularly in response to emotionally salient food cues. EEG findings support these behavioral observations, with active tDCS associated with increased frontal-midline theta within the inhibitory control network, consistent with enhanced engagement of top-down control mechanisms.

Although behavioral and neural changes were subtle, the consistent direction of effects in the active stimulation group highlights the potential of tDCS as an adjunctive intervention before bariatric surgery. Further investigation with larger samples is ongoing to evaluate efficacy and individual variability in treatment response.

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