Appeal biases for sweet and fatty foods are robust following a single session of transcranial direct current stimulation (tDCS) in a healthy population.

Jordan D. Beaumont[1]*, Danielle Davis[1], Michelle Dalton[1], Mark Russell[1], and Martin J. Barwood[1]

[1]*School of Social and Health Sciences, Leeds Trinity University, Horsforth, UK*

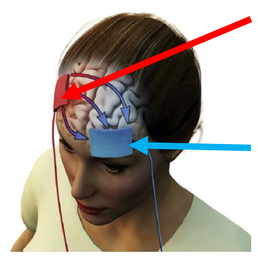
* j.beaumont@leedstrinity.ac.uk @JordanDBeaumont

1 Introduction

Hypo-activation of the dorsolateral prefrontal cortex (DLPFC) is associated with increased reward response to high-calorie foods[1]. tDCS over the DLPFC has been shown to reduce food cravings and consumption, attenuating this reward response[2]. Eating behaviour traits, such as binge-eating, are associated with abnormal activity in the prefrontal cortex (PFC)[3]. These traits may be relevant to tDCS outcomes, yet they have not been assessed following tDCS in a healthy population.

What is tDCS?[4]

A form of non-invasive brain stimulation where a weak electrical current is passed between electrodes (anode and cathode) placed on the scalp.



Anode (anodal "excitatory" tDCS)
Increases activity by inhibiting the activity of gamma-aminobutyric acid (GABA), increasing the likelihood of spontaneous cell firing.

Cathode (cathodal "inhibitory" tDCS)
Decreases activity by inhibiting the activity of glutamate, decreasing the likelihood of spontaneous cell firing.

Accordingly, the present study develops our understanding of the role tDCS plays in appetite control, assessing the effects of stimulation on food reward and craving in healthy-weight participants. We hypothesise that anodal tDCS of the right DLPFC will reduce in-the-moment food craving and the preference for sweet and high-fat foods.

2 Method

Double-blind, sham-controlled, within-participant design.
N = 21 (11 female, 24±7 years, 22.8±2.3 kg·m^{-2})

Eating behaviour traits were measured at baseline using the Food Craving Questionnaire-Trait (FCQ-T-r)[5], Control of Eating Questionnaire (CoEQ)[6], and Three Factor Eating Questionnaire (TFEQ-r18)[7].

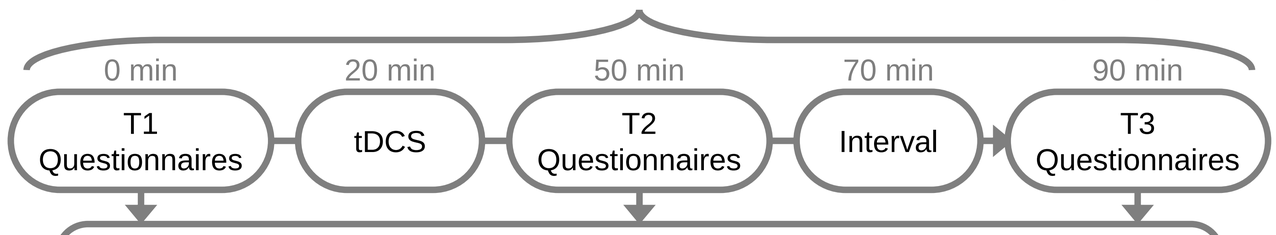
tDCS Parameters: Anodal "excitatory" tDCS was delivered at 2 milliampere (mA) for 20 minutes (ACTIVE) or 36 seconds (SHAM*). The anode was placed over the right DLPFC, and the cathode was placed over the occipital lobe.

*Blinding protocol that has limited neuromodulatory effect, but elicits similar sensations compared with ACTIVE tDCS[12]

Data Analysis: Test-retest reliability of baseline data were determined using Pearson's correlations. Data were compared using analysis of variance (ANOVA) to an alpha level of 0.05.

Session Timeline

2x tDCS sessions scheduled between 09:00 and 15:00, following a 4-hour fast (randomised and counterbalanced, 48-hour minimum washout period).



Questionnaires:

1. Appetite visual analogue scales[8]; 100mm scales measuring hunger, fullness, prospective consumption and the desire to eat.
2. Leeds Food Preference Questionnaire (LFPQ)[9]; computer-based task measuring implicit liking and wanting, and explicit wanting for foods.
3. Food Craving Questionnaire-State[10]; 15-item questionnaire measuring momentary food craving over a 5-point Likert scale.

3 Results

Test-retest analysis indicated moderate-to-good reliability of baseline measures highlighting good correlation (r=0.536-0.955, p<0.02), except for the desire to eat which was poorly related (r=0.382).

Food Craving and Appetite
tDCS had no significant effect on food craving (p=0.896), or ratings of hunger (p=0.515), fullness (p=0.734), prospective consumption (p=0.415) or desire to eat (p=0.141).

Implicit Wanting Appeal Bias
tDCS did not significantly change taste (p=0.704) or fat appeal biases (p=0.502) (**Figure 1**)**.** There were no differences in explicit liking or wanting measures of the LFPQ.

Eating Behaviour Traits
Participants displayed a healthy eating behaviour trait profile (**Table 1**).

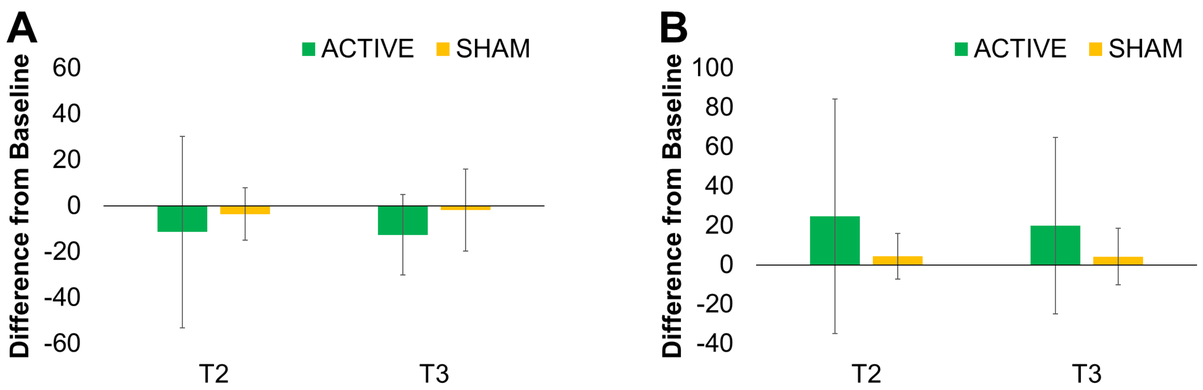


Figure 1: Absolute difference from baseline scores for implicit wanting.
(A) Taste and (B) fat implicit wanting appeal bias. Scores are calculated using a frequency-weighted algorithm, and typically range from -100 to 100. A score >0 highlights a bias towards sweet/high-fat foods, and a score <0 highlights a bias towards savoury/low-fat foods.

Table 1: Participants' eating behaviour trait profile.

FCQ-T-r[5]		35±9
CoEQ[6]	Craving Control	67±18
	Craving for Sweet Foods	29±18
	Craving for Savoury Foods	51±23
TFEQ-r18[7]	Cognitive Restraint	40±20
	Uncontrolled Eating	33±14
	Emotional Eating	22±22

Mean ± SD scores. Possible scores range from 15-90 for the FCQ-T-r, and 0-100 for the CoEQ and TFEQ-r18.

4 Conclusion

Healthy participants with no apparent eating behaviour trait susceptibilities to overconsume did not respond to stimulation, suggesting increasing DLPFC activity using tDCS does not change food reward response in healthy controls. However, unhealthy groups remain a plausible target for tDCS intervention.

Future Direction: Examine the effects of tDCS on appeal bias in individuals with "problematic" eating behaviour traits (e.g. high trait craving or binge-eating) who are overweight/obese or at risk of weight gain.

[1] Alonso-Alonso & Pascual-Leone (2007) *Front Hum Neurosci* **7**, 512; [2] Hall & Lowe (2018) *Nutr Neurosci*, 1-4; [3] Boeka & Lokken (2011) *Eat Weight Disord* **16**, e121-126; [4] Filmer et al. (2014) *Trends Neurosci* **37**, 742-753 ; [5] Meule, Hermann & Kübler (2014) *Front Psychol* **5**, 190; [6] Dalton, Finlayson & Blundell (2015) *Eur J Clin Nutr* **69**, 1313-1317; [7] de Lauzon et al. (2004) *J Nutr* **134**, 2372-2380; [8] Dalton, Blundell & Finlayson (2013) *Obesity Facts* **6**, 348-359; [9] Dalton & Finlayson (2014) *Physiol Behav* **136**, 128-134; [10] Capeda-Benito et al. (2000) *Behav Ther* **31**, 151-173; [11] Steptoe, Pollard & Wardle (1995) *Appetite* **25**, 267-284; [12] Brunoni et al. (2011) *Int J Neuropsychop* **14**, 1133-1145

Leeds Trinity University **School of Social and Health Sciences**
Leeds Trinity University, Horsforth, UK

UK Congress on Obesity
September 2019, University of Leeds