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# The effects of transcranial direct current stimulation (tDCS) on food craving, food reward, and subjective appetite in those with binge-type eating behaviour.

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## 1. Introduction

Transcranial direct current stimulation (tDCS) involves the application of a weak electrical current to the brain via electrodes placed on the scalp (Figure 1) <sup>1</sup>.

This results in the acute and reversible change of activity in a specific region of the brain, which temporarily modifies behaviour, learning and task performance <sup>2</sup>.



Figure 1: tDCS equipment

Recent research has shown promising effects for the use of tDCS to modulate measures of eating behaviour (e.g., food cravings, desire to eat, food consumption) <sup>3,4</sup>.

Our work has indicated a potential eating behaviour trait-dependent effect of tDCS, where individuals displaying behaviours associated with overconsumption (e.g., binge eating behaviour) appear responsive to the modulatory effects of tDCS <sup>5,6</sup>.

This study aimed to extend our prior work by identifying the effects of tDCS on eating-related measures in those displaying binge-type behaviours.

## 2. Method

**Study design:** Within-participant, double-blind, randomised and counterbalanced, crossover study.

**Baseline measures:** Anthropometrics, Binge Eating Scale (BES), Three Factor Eating Questionnaire (TFEQ), Food Craving Questionnaire-Trait-reduced (FCQ-T-r), Control of Eating Questionnaire (CoEQ).

**Participants:** 17 females (23 ± 7 years, 25.4 ± 3.8 kg · cm<sup>-2</sup>, waist-to-hip ratio 1.3 ± 0.1) with mild-to-moderate binge eating behaviour.

**Statistical analyses:** Data were analysed using paired-samples t-tests or analysis of variance (ANOVA), as appropriate for the comparison, to alpha level 0.05. Strength of evidence was determined using Bayes factors.

**Test visits:** Following a 4-hour fast, participants completed two test visits – each session was identical, with the exception of tDCS protocol (Figure 2).

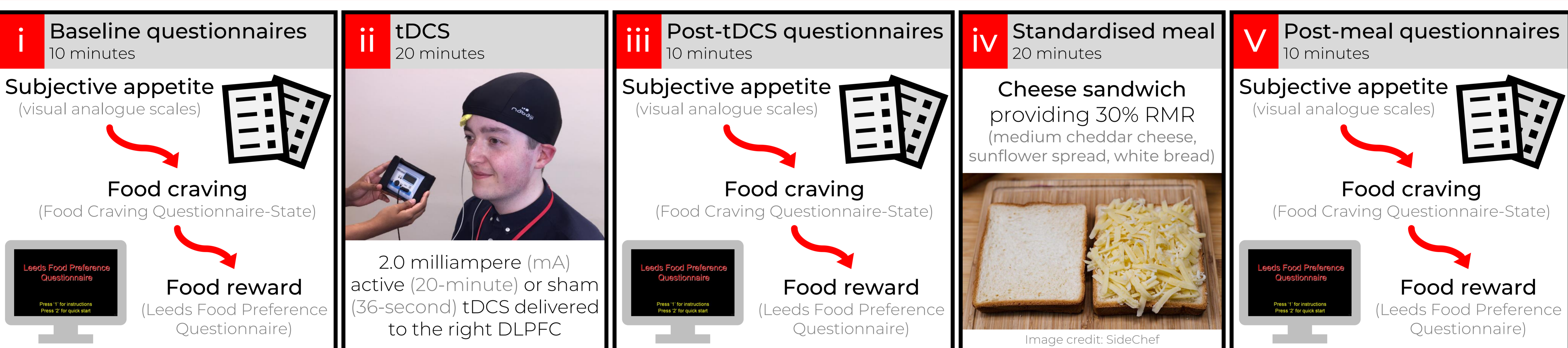


Figure 2: Test visit timeline. Sessions were scheduled between 11:30 and 14:00, with an inter-session interval of 7 ± 1 days. RMR, resting metabolic rate.

## 3. Results

Participants displayed eating behaviour traits that suggest susceptibility to overconsumption (Table 1).

There were no differences when comparing pre- and post-tDCS scores across measures:

- **Appetite scales** –  $p = 0.127$  to  $0.441$ ,  $BF_{10} = 0.040$  to  $0.680$
- **Food craving** –  $p = 0.918$ ,  $BF_{10} = 0.040$  (Figure 3)
- **Food reward** –  $p = 0.082$  to  $0.982$ ,  $BF_{10} = 0.027$  to  $2.391$

No significant differences were found when post-meal data were added into the analyses.

Table 1: Eating behaviour trait scores (mean ± SD)

BES score	21 ± 4 AU
FCQ-T-r	57 ± 10 AU
TFEQ cognitive restraint	10 ± 4 AU
TFEQ disinhibition	11 ± 3 AU
TFEQ hunger	8 ± 3 AU
CoEQ craving control	48 ± 20 mm
CoEQ craving for sweet foods	49 ± 25 mm
CoEQ craving for savoury foods	58 ± 21 mm

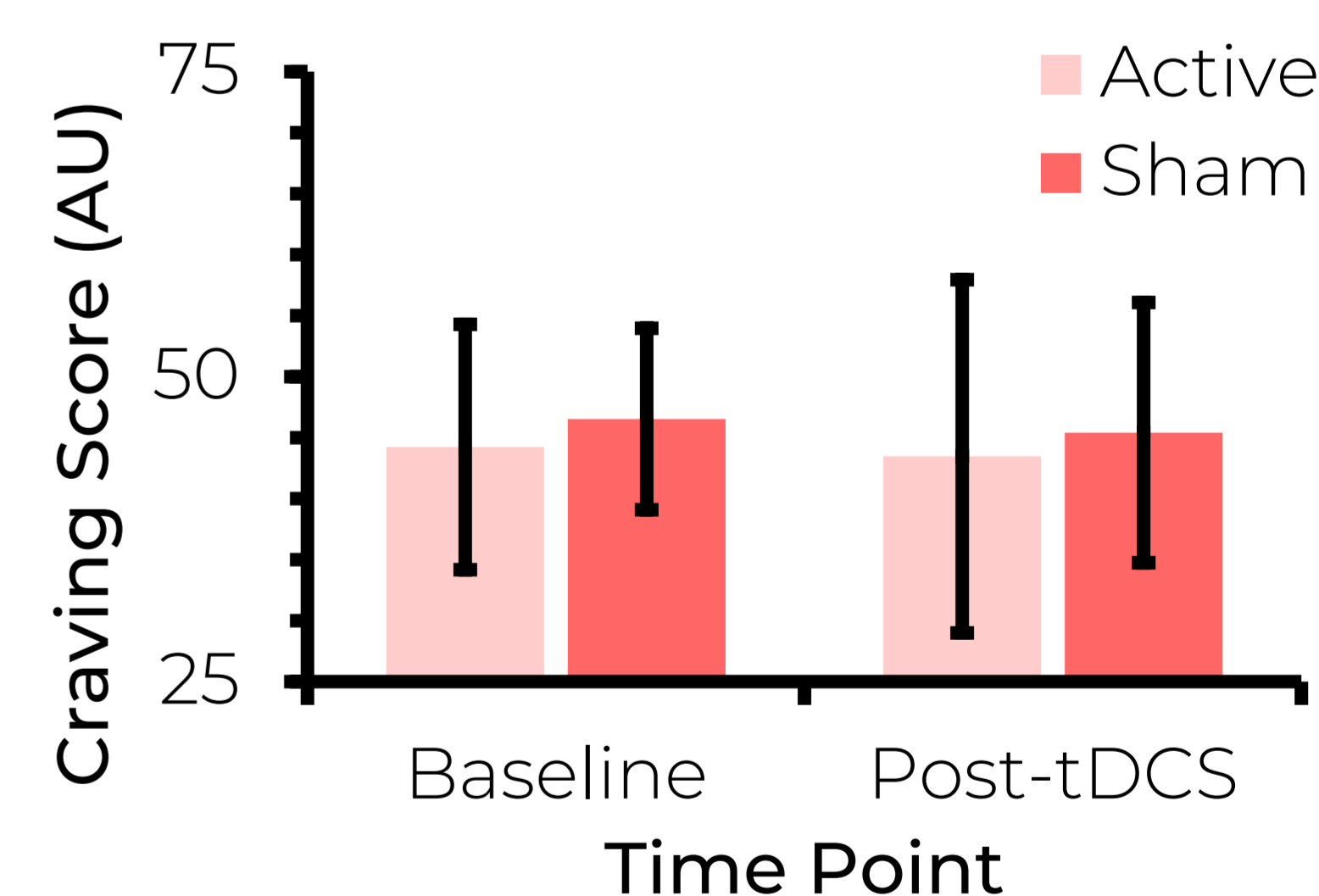


Figure 3: Food craving scores

## 4. Discussion

This data does not support the eating behaviour trait-dependent effect of tDCS, and results align with our prior work in “healthy” populations that do not display eating behaviour traits associated with overconsumption and weight gain.

This may suggest that the eating behaviour traits displayed by the participants recruited to the present study did not reach the threshold required to be responsive to the modulatory effects of tDCS. Participants displayed mild-to-moderate binge eating behaviour, with prior work suggesting clinically-relevant binge eating (i.e., binge eating disorder diagnosis) results in the modulation of eating behaviour through tDCS.

### Conclusion and Future Direction:

The present study may indicate that sub-clinical populations are not responsive to tDCS, and future work should look to directly compare the effects in clinical and sub-clinical populations displaying eating behaviour traits suggesting susceptibility to overconsumption and weight gain.

<sup>1</sup>Thair et al. (2017) *Front Neurosci* 11, 641; <sup>2</sup>Filmer et al. (2014) *Trends Neurosci* 37, 742-753; <sup>3</sup>Hall and Lowe (2018) *Appetite* 124, 78-88; <sup>4</sup>Mostafavi et al. (2018) *Nutr Neurosci* 1, 55-67; <sup>5</sup>Beaumont et al. (2022) *Obes Rev* e13364; <sup>6</sup>Beaumont et al. (2021) *Appetite* 157, 105004