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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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) [1].

This results in an acute and reversible change of activity in a specific region of the brain, temporarily modifying behaviour, learning and task performance [2].

Recent work has shown promising effects of tDCS to modulate eating-related measures (e.g., food cravings, desire to eat, food consumption) [3, 4].

Our prior work highlighted a potential eating behaviour trait-dependent effect of tDCS, where individuals displaying behaviours associated with overconsumption (e.g., binge eating) appear responsive to the modulatory effects of tDCS [5, 6].

Figure 1: tDCS equipment

Aim: Identify the effects of tDCS on eating-related measures in those displaying mild-to-moderate binge eating behaviour.

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^{-2}, 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, 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 visit was identical, with the exception of tDCS protocol (Figure 2).

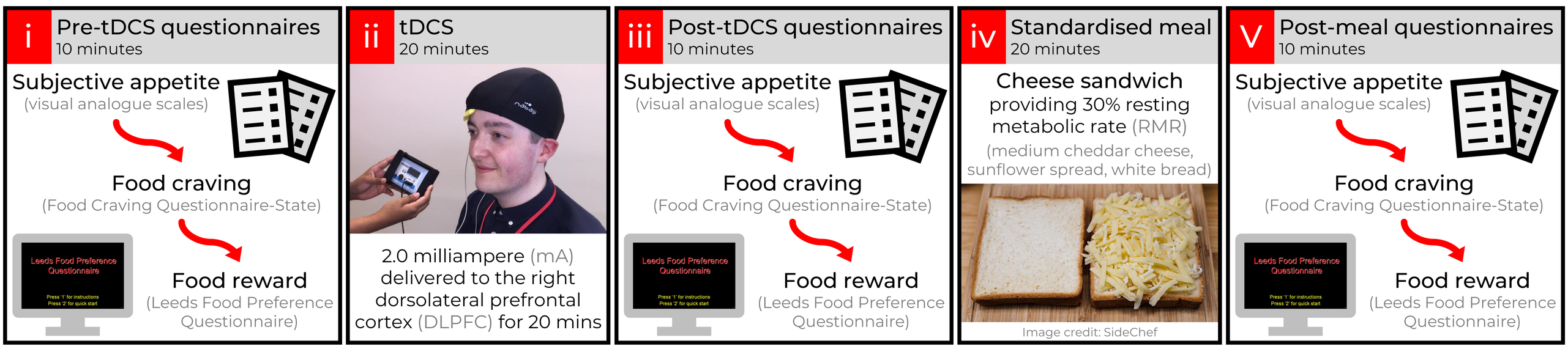

Figure 2: Test visit timeline. Sessions were scheduled between 11:30 and 14:00, with an inter-session interval of 7 ± 1 days.

3. Results

Table 1: Eating behaviour trait scores

BES	21 ± 4 AU
FCQ-T-r	57 ± 10 AU
Cognitive restraint †	10 ± 4 AU
Disinhibition †	11 ± 3 AU
Hunger †	8 ± 3 AU
Craving control ‡	48 ± 20 mm
Craving for sweet foods ‡	49 ± 25 mm
Craving for savoury foods ‡	58 ± 21 mm

Mean ± SD; † TFEQ, ‡ CoEQ

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

Pre- versus post-tDCS scores:
No significant effects of tDCS were found across measures of subjective appetite ($p = 0.127$ to 0.441, $BF_{10} = 0.040$ to 0.680), food craving ($p = 0.918$, $BF_{10} = 0.040$) (Figure 3) and food reward ($p = 0.082$ to 0.982, $BF_{10} = 0.027$ to 2.391).

Post-meal scores:
Scores changed as expected following consumption (e.g., reduced hunger, increased fullness), but there were no differences between active and sham tDCS ($p = 0.071$ to 0.984).

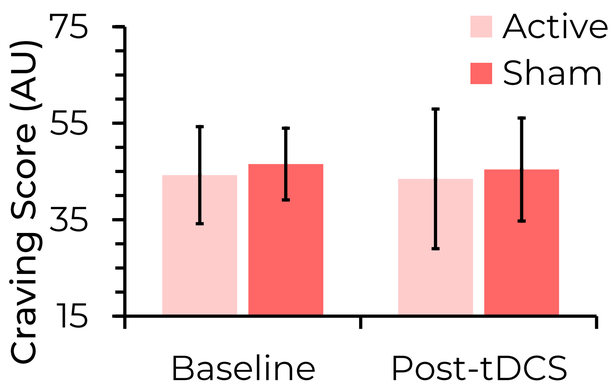

Figure 3: Food craving scores

4. Discussion

The present data does not support the eating behaviour trait-dependent effect of tDCS, and results align with our prior work in "healthy" populations (i.e., those who do not display eating behaviour traits associated with overconsumption and weight gain).

This may suggest that the eating behaviour traits displayed by these participants did not reach the threshold required to be responsive to the modulatory effects of tDCS, with other studies showing significant modulation of eating behaviour through tDCS in those with clinically-relevant binge eating (i.e., binge eating disorder).

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.

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