Is there a role for transcranial direct current stimulation (tDCS) in appetite control?

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What is tDCS?

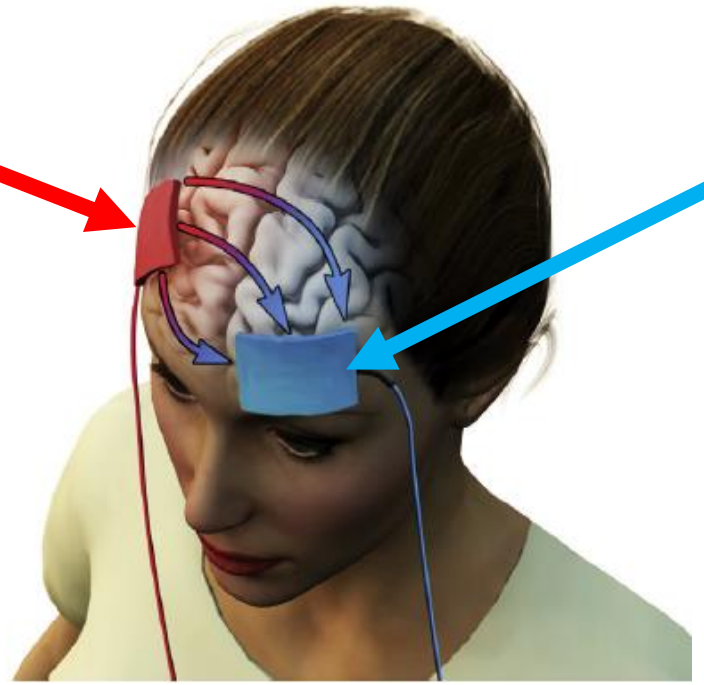
A non-invasive method of brain stimulation where a weak electrical current is passed between electrodes placed on the scalp

Anode

Current is emitted

Increased activity
(inhibition of gamma-aminobutyric acid [GABA])

Anodal “excitatory” tDCS



Cathode

Current is returned

Decreased activity
(inhibition of glutamate)

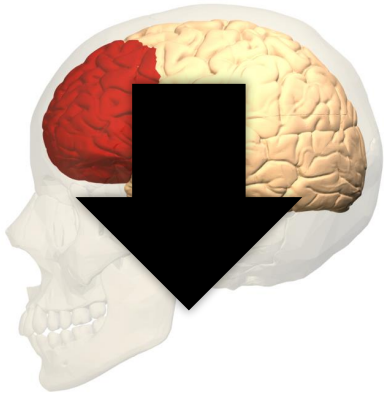
Cathodal “inhibitory” tDCS

(Filmer et al., 2014; DOI:10.1016/j.tins.2014.08.003)

What is Appetite?

A desire or liking for food

Food intake, selection, motivation and preference



Prefrontal Cortex (PFC)

Executive Functions

Cognitive processes that stop impulsive actions

↓

Inhibitory Control

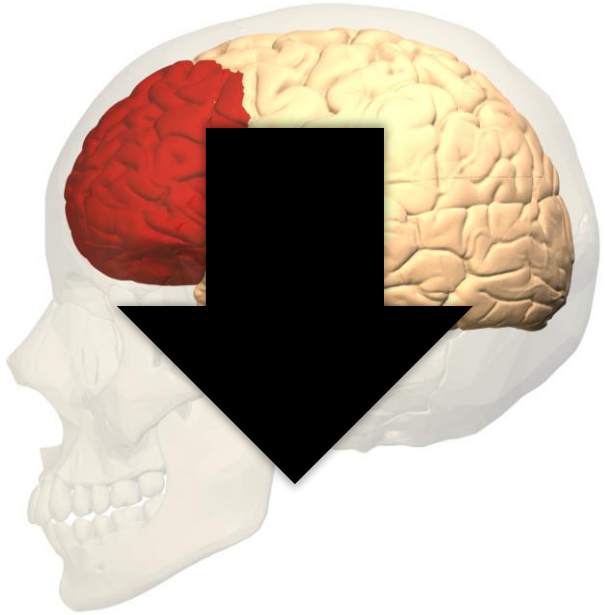
Prevents the influence of external stimuli

↓

Goal-Directed Behaviour

(Blundell et al., 2010; DOI:10.1111/j.1467-789X.2010.00714.x / Joseph et al., 2011; DOI:10.1111/j.1467-789X.2011.00893.x / Alonso-Alonso & Pascual-Leone, 2007; DOI:10.1001/jama.297.16.1819)

tDCS and Appetite



Reduced PFC activity

+

Anodal “excitatory” tDCS

= ?

tDCS and Appetite

Food Craving

Calorie Consumption

Stimulation Parameters

Participants

(Mostafavi et al. 2018; DOI:10.1080/1028415X.2018.1470371 /
Hall & Lowe, 2018; DOI:10.1080/1028415X.2018.1513678)

The effects of prefrontal tDCS on food reward and craving in healthy weight participants

Study Design

Double-blind, sham-controlled, within-participants design

21 participants (11 female, 24±7 years, 22.8±2.3 $kg \cdot m^{-2}$)

Novelty of the Study

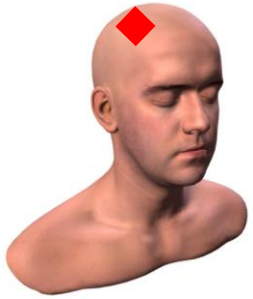
Implicit and explicit components of food reward

Appeal bias for sweet and high-fat foods following tDCS

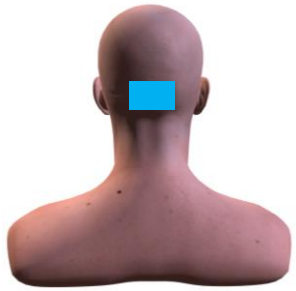
Healthy weight participants – capture variation in measures

Measure eating behaviour traits of participants

tDCS Parameters



Anode over right dorsolateral PFC / Cathode over occipital lobe



Anodal tDCS at 2 milliamp for 20 minutes

2x sessions: “ACTIVE” and “SHAM” stimulation

(randomised and counterbalanced; 48-hour washout period)

Participants were unable to identify the ACTIVE tDCS session above the level of chance (38% correctly identified the ACTIVE session)

Session Timeline

T1
Questionnaires
(0 min)

tDCS
(20 min)

T2
Questionnaires
(45 min)

Interval
(65 min)

T3
Questionnaires
(75 min)

Subjective Appetite Sensations

100mm visual analogue scales

Measure of hunger, fullness, prospective consumption and desire to eat

Food Reward

Leeds Food Preference Questionnaire

Computer-based task that uses images depicting high-fat, low-fat, savoury and sweet foods

In-the-Moment Craving

Food Craving Questionnaire-State

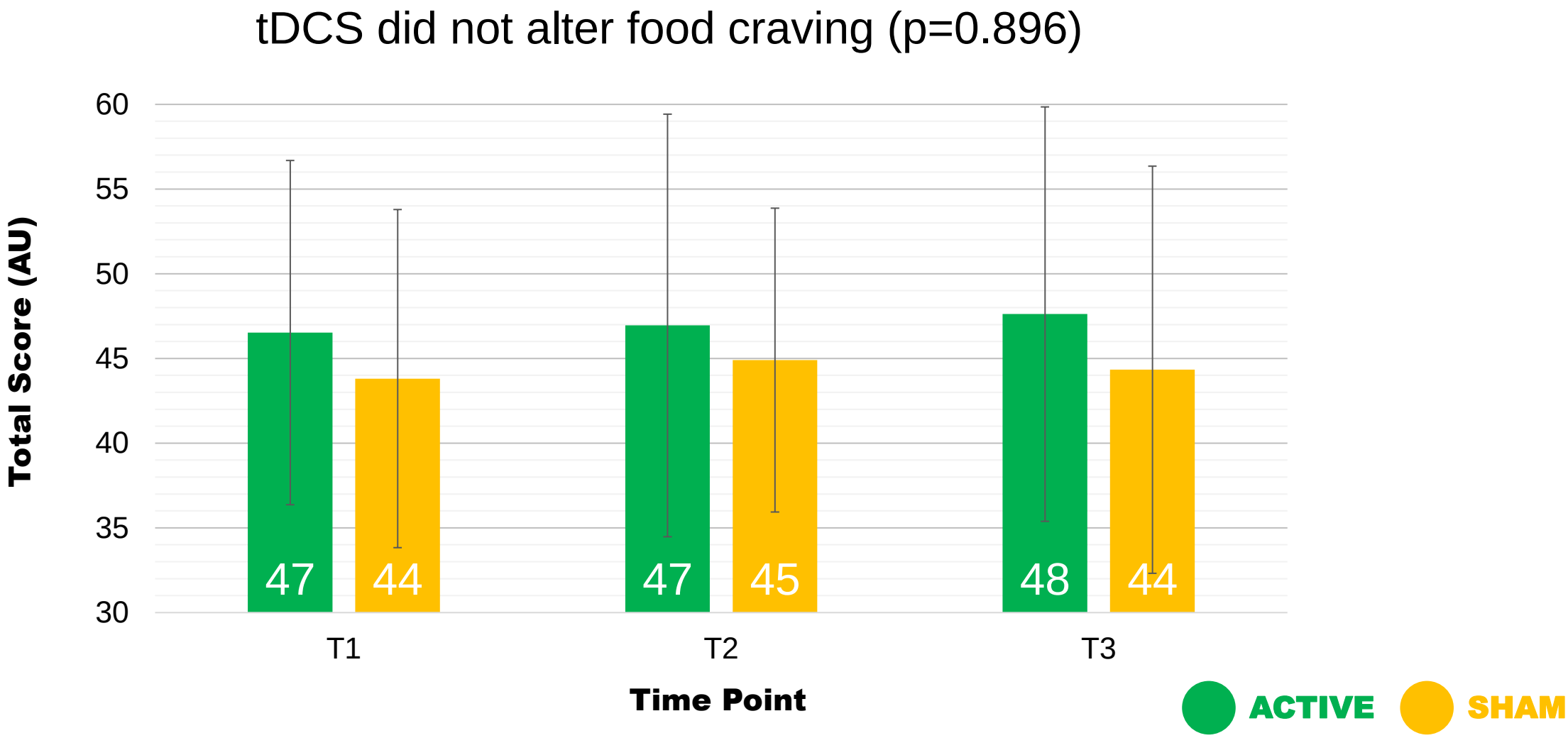
15-item questionnaire

Food Choice Motives

Food Choice Questionnaire

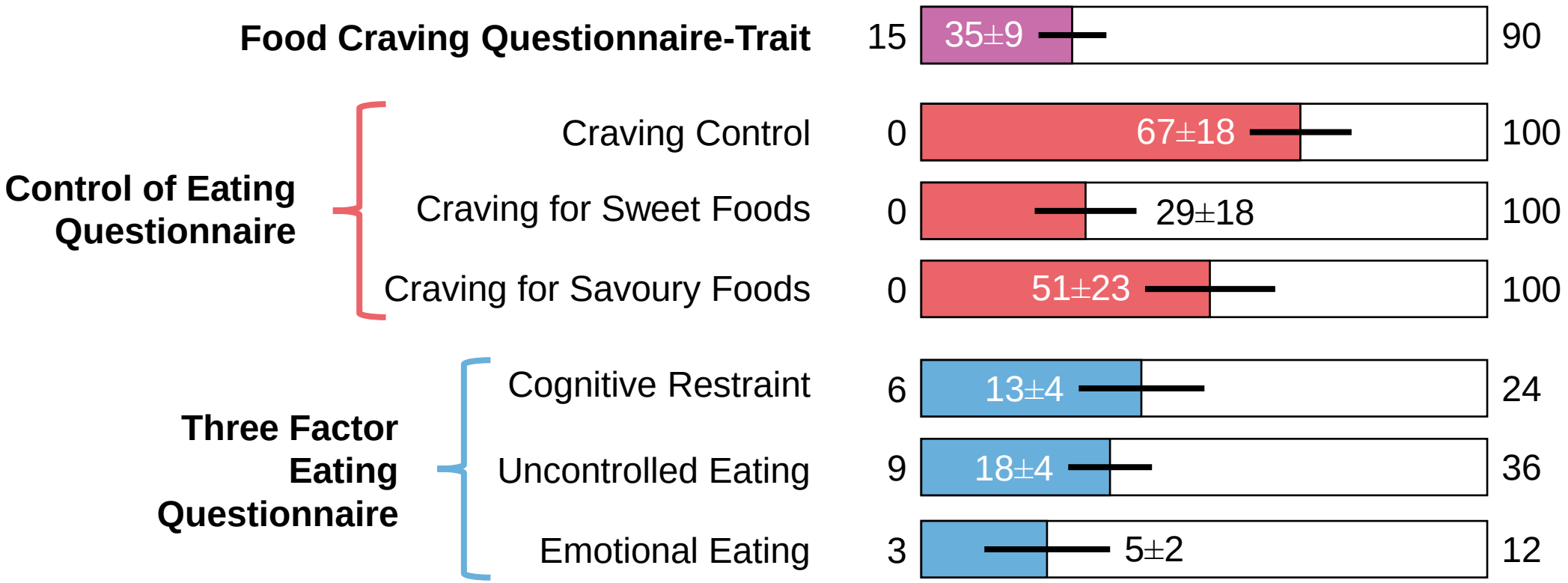
36-item questionnaire

In-the-Moment Craving



Results

ACTIVE tDCS did not significantly alter any measure, when compared to pre-tDCS scores or SHAM stimulation (p>0.05)



Conclusion

Increasing DLPFC activity using tDCS did not change food reward or craving response in healthy weight controls with “healthy” eating behaviours

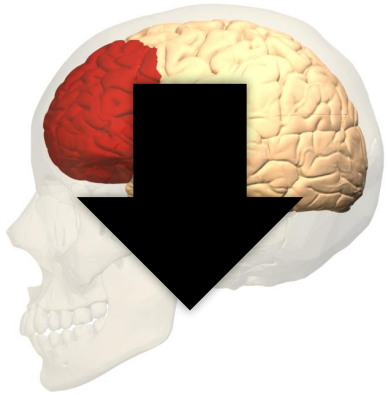
Conclusion

Not all individuals have the same response to the rewarding components of food, or consume these highly rewarding foods

Eating behaviour traits may be important for tDCS outcomes

(Finlayson & Dalton, 2012; DOI:10.1007/s13679-011-0007-2)

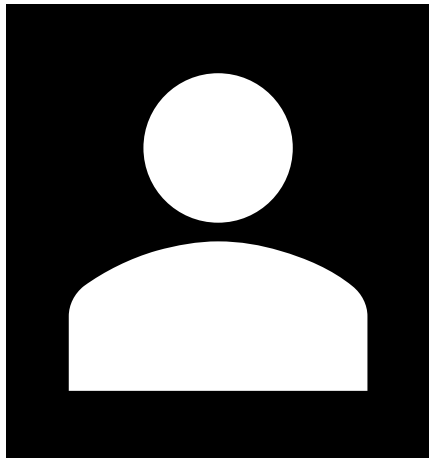
Next Steps



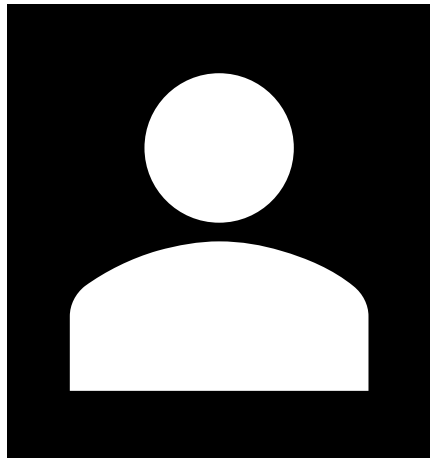
Identify the response of individuals with “problematic” eating behaviour traits, who are overweight/obese or at risk of weight gain

Screen participants using questionnaires
(e.g. Three Factor Eating Questionnaire)

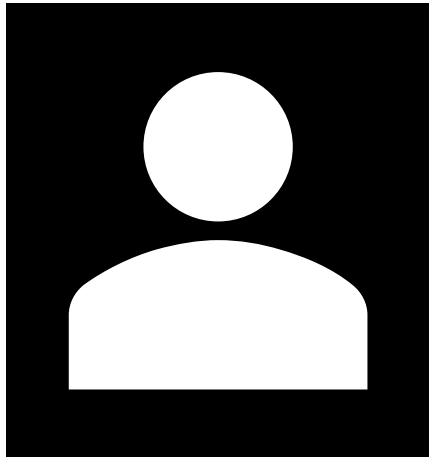
Acknowledgements



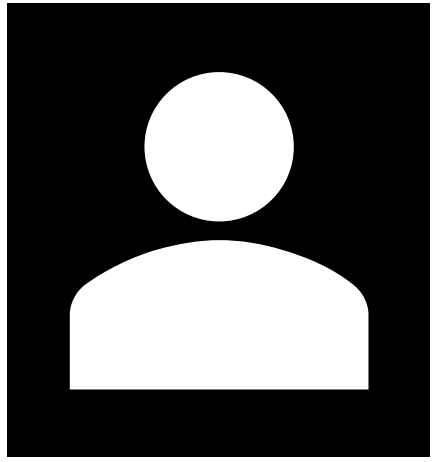
Dr. Martin Barwood



Dr. Danielle Davis



Dr. Michelle Dalton



Prof. Mark Russell

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