Leeds Trinity University

PGR Conference / 23 June 2021

The impact of variation in transcranial direct current stimulation (tDCS) parameters and participant characteristics on eating-related outcomes

Jordan D. Beaumont

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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

Electrodes
(housed in saline-soaked sponges)

Acute and reversible changes in activity of a specific region of the brain

Programming device
(sets customised parameters)

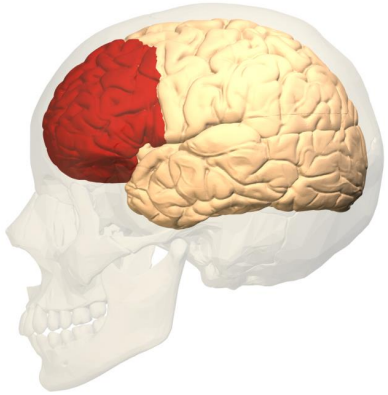
Battery-powered stimulation device
(2x 1.5V AA batteries)

Temporarily modifies behaviour, learning and task performance

Filmer et al. (2014)

Controlling Eating Behaviours

Prefrontal activity



Executive functions

Cognitive processes that allow goal-directed behaviour

Dietary self-regulation

Weight maintenance / Achieving health goals

Figure adapted from Lowe et al. (2019)

Controlling Eating Behaviours

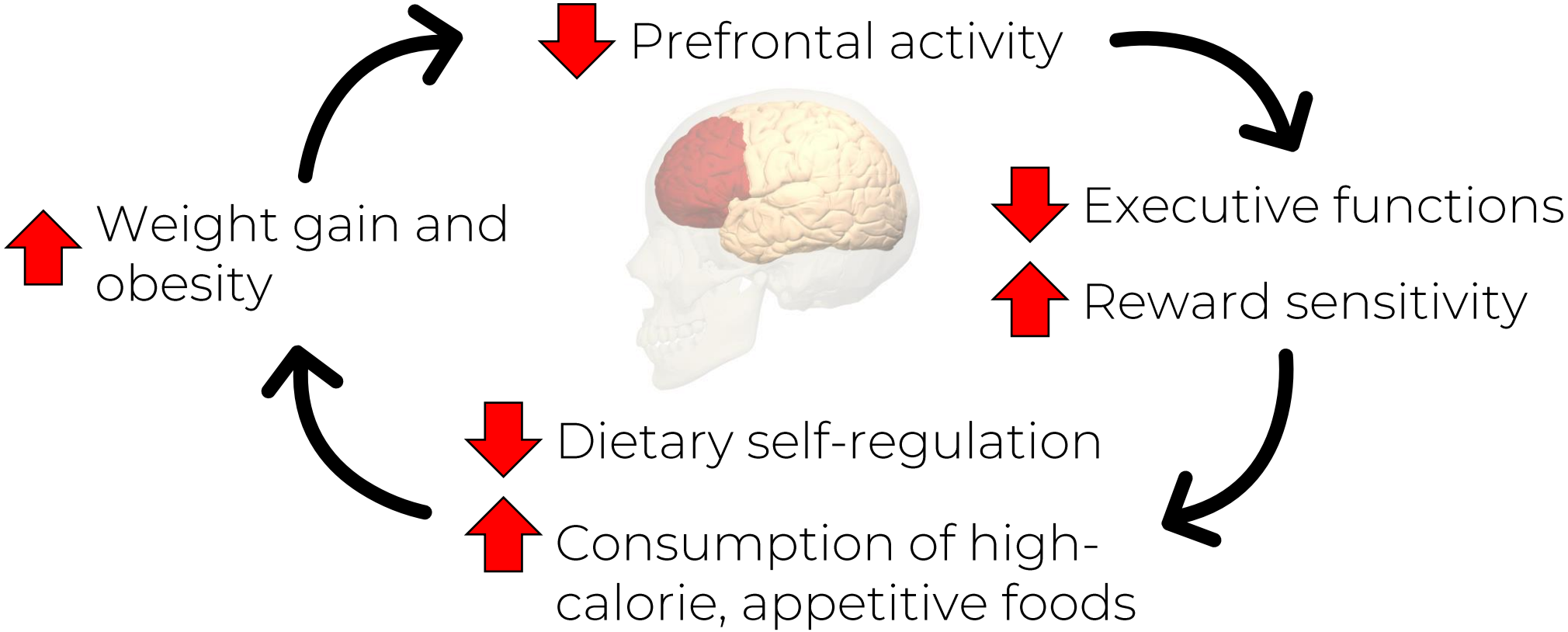
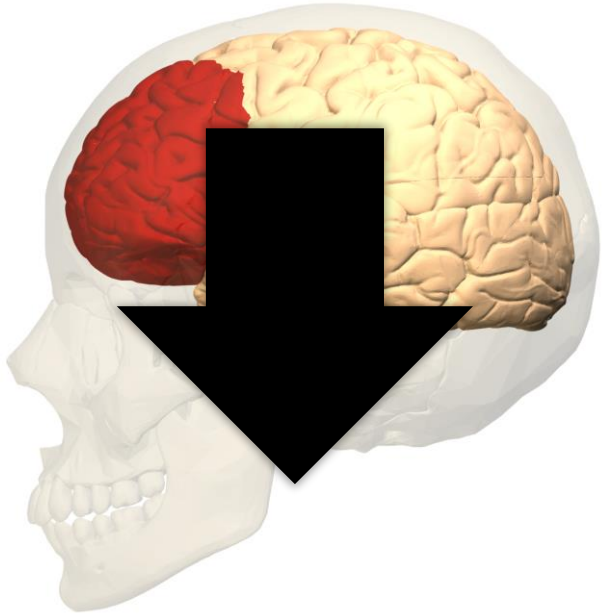


Figure adapted from Lowe et al. (2019)

tDCS and the Control of Eating Behaviour



Reduced prefrontal activity

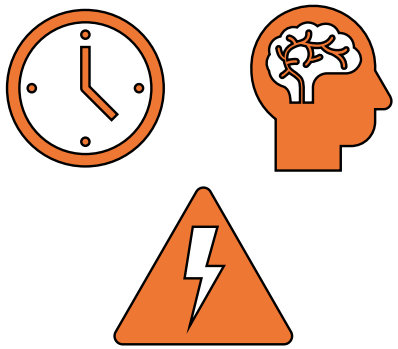
+

tDCS (to increase activity)

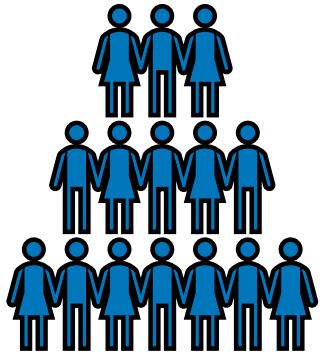
=?

This is a popular area of research, but…

Study design



Stimulation parameters



Participant characteristics

These vary greatly between studies, providing equivocal effects…

…it’s very difficult to identify a consistent effect of tDCS!

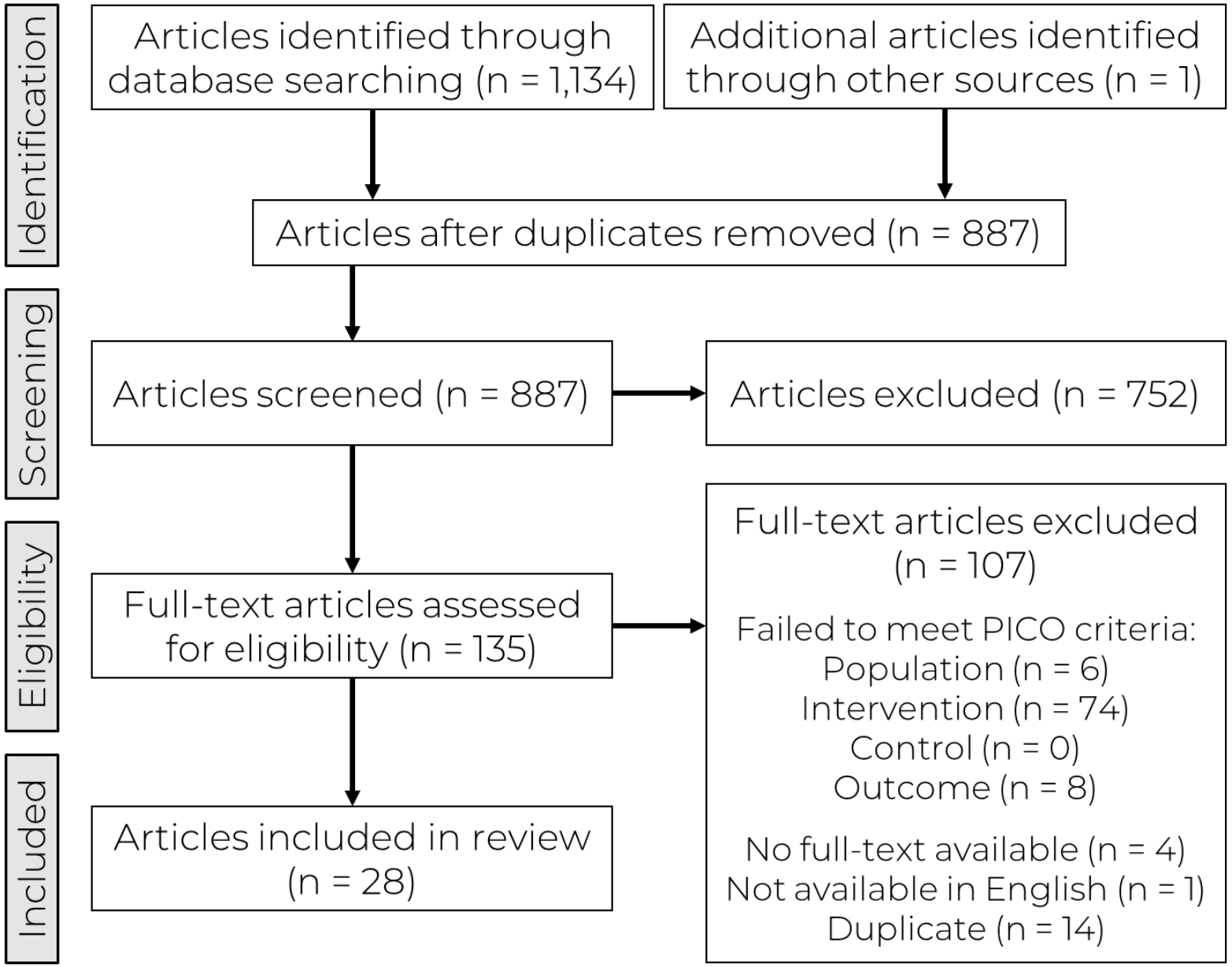
Method

Literature search performed using MEDLINE, PsycINFO, Scopus and Science Direct databases in March 2019 and repeated in July 2020

Inclusion criteria:

- Adult human participants
- Sham-controlled tDCS
- Eating-related outcome (food craving, consumption, reward or subjective appetite)

Literature Search

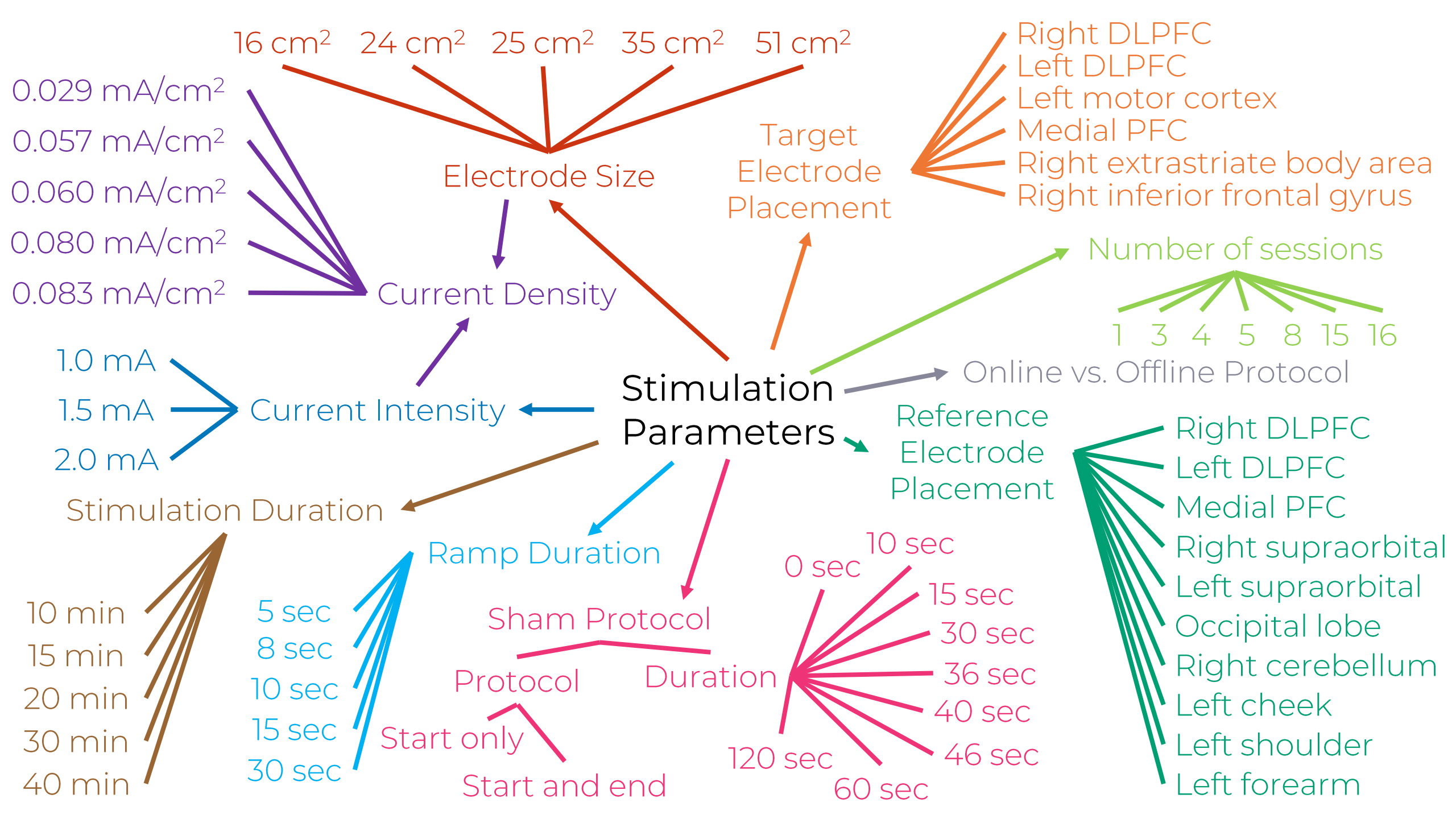


Literature Review #1
(under peer review with Psychosomatic Medicine)

Impact of Stimulation Parameters

Jordan D. Beaumont [a], David Starr [a], Natalie C. Smith [a], Danielle Davis [a], Michelle Dalton [a], Alexander Nowicky [b], Mark Russell [a] and Martin J. Barwood [a]

[a] School of Social and Health Sciences, Leeds Trinity University, Leeds, LS18 5HD, UK
[b] Centre for Cognitive Neuroscience, Department of Clinical Sciences, College of Health and Life Sciences, Brunel University London, Uxbridge, UB8 3PH, UK

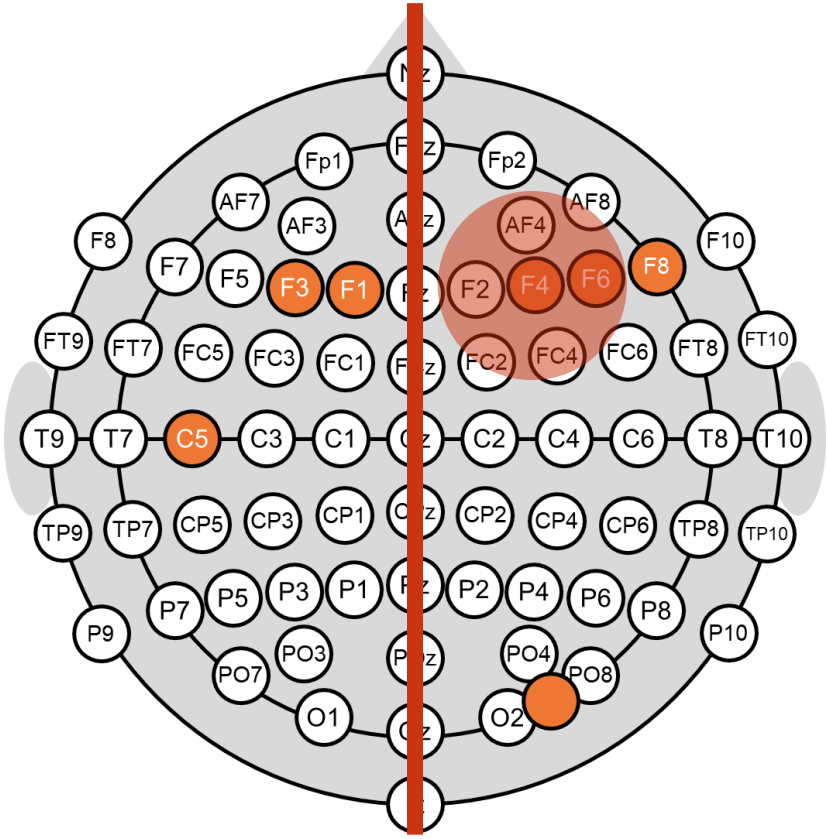

Stimulation Parameters
Electrode Size
16 cm²
24 cm²
25 cm²
35 cm²
51 cm²
Current Density
0.029 mA/cm²
0.057 mA/cm²
0.060 mA/cm²
0.080 mA/cm²
0.083 mA/cm²
Current Intensity
1.0 mA
1.5 mA
2.0 mA
Stimulation Duration
10 min
15 min
20 min
30 min
40 min
Ramp Duration
5 sec
8 sec
10 sec
15 sec
30 sec
Sham Protocol
Protocol
Start only
Start and end
Duration
0 sec
10 sec
15 sec
30 sec
36 sec
40 sec
46 sec
60 sec
120 sec
Target Electrode Placement
Right DLPFC
Left DLPFC
Left motor cortex
Medial PFC
Right extrastriate body area
Right inferior frontal gyrus
Number of sessions
1
3
4
5
8
15
16
Online vs. Offline Protocol
Reference Electrode Placement
Right DLPFC
Left DLPFC
Medial PFC
Right supraorbital
Left supraorbital
Occipital lobe
Right cerebellum
Left cheek
Left shoulder
Left forearm

Identified those parameters that produced the most consistent effects on eating-related outcomes

7 recommendations of the review

Recommendations of the Review

1. Target tDCS over the right dorsolateral prefrontal cortex (DLPFC)



Recommendations of the Review

1. Target tDCS over the right dorsolateral prefrontal cortex (DLPFC)
2. Use current densities between 0.057 and 0.080 mA/cm^2
3. Use current intensities of 1.5 to 2.0 milliampere (mA)
4. Use smaller ($\leq 35\ cm^2$) electrodes over the target area, and larger ($\geq 35\ cm^2$) over the reference site

Current intensity (mA) ÷ Electrode size (cm^2) = Current density (mA/cm^2)

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5. Use stimulation duration of 20 minutes
6. Inter-session intervals of >48 hours (single-session) or ≤24 hour (multi-session)

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7. Use offline protocols, or unrelated media

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Literature Review #2
(manuscript in preparation)

Impact of Participant Characteristics

Jordan D. Beaumont [a], Natalie C. Smith [a], David Starr [a], Danielle Davis [a], Michelle Dalton [a], Alexander Nowicky [b], Mark Russell [a] and Martin J. Barwood [a]

[a] School of Social and Health Sciences, Leeds Trinity University, Leeds, LS18 5HD, UK
[b] Centre for Cognitive Neuroscience, Department of Clinical Sciences, College of Health and Life Sciences, Brunel University London, Uxbridge, UB8 3PH, UK

Participant Characteristics

996 participants recruited across studies, including:

"Healthy" individuals (n = 593)

Trait groups (n = 406)

Susceptibility to overconsumption and weight gain

(Irrespective of weight status!)

Meta-Analysis

Mean, standard deviation and sample size were extracted from studies to calculate estimate of effect (effect size) and perform a random effects analysis

- Effect size (Hedges' *g*), interpreted as trivial (*g* < 0.20), small (*g* = 0.20), moderate (*g* = 0.50), large (*g* > 0.80) (Deeks et al., 2021)

- Focussed on single-session tDCS

- Subgroup analysis: "healthy" versus trait groups

Results

Group	Food Craving	Explicit Wanting	Implicit Wanting	Food Consumption
Overall effect	-0.08 (-0.28, 0.12)	-0.01* (-0.18, 0.16)	-0.06 (-0.37, 0.25)	-0.04* (-0.27, 0.19)
"Healthy" individuals	-0.06 (-0.29, 0.17)	0.09* (-0.18, 0.16)	0.00 (-0.32, 0.32)	0.05* (-0.13, 0.23)
Trait groups	-0.16 (0.57, 0.26)	-0.22 (-0.56, 0.12)	-0.18 (-0.81, 0.45)	-0.14 (-0.69, 0.40)
Frequent food cravings	-0.43 (-1.11, 0.25)	-0.45 (-1.02, 0.11)	-0.54 (-1.23, 0.15)	-0.33 (-1.03, 0.37)
Binge-type behaviour	-	-0.19 (-0.57, 0.19)	-	-0.23 (-0.74, 0.28)

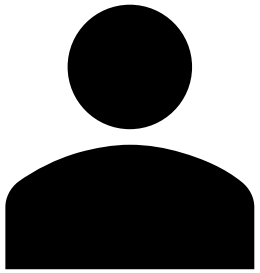
Effect size (95% confidence intervals), * Without expectation effect

Summary

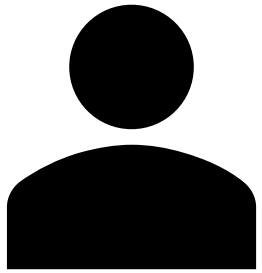
Variation in both stimulation parameters and participant characteristics can lead to variation in the effects of tDCS, so…

- Studies should recruit those displaying eating behaviour traits suggesting a susceptibility to overconsumption
- Choose specific traits appropriate for the behavioural outcome of interest
- Stimulation parameters should be within the ‘effective range’ (i.e. those identified as effective for altering eating behaviour)

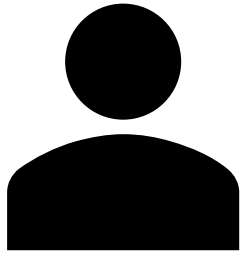
Acknowledgements



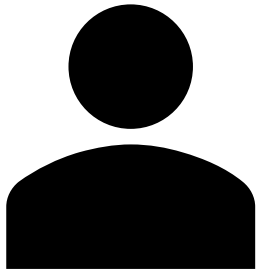
Dr. Martin Barwood



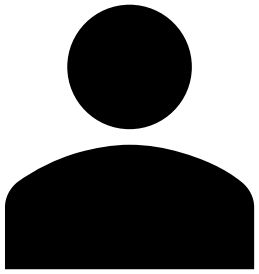
Dr. Danielle Davis



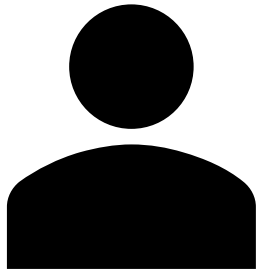
Dr. Michelle Dalton



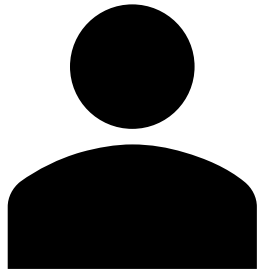
Prof. Mark Russell



Natalie Smith



David Starr



Dr. Alexander Nowicky
Brunel University London

tDCS at LTU

Poster Presentation: 'Understanding the perceptions of transcranial electrical stimulation (tES) techniques.'

Ethics code: SSHS/2021/01
Study end date: 21 May 2021

Leeds Trinity University

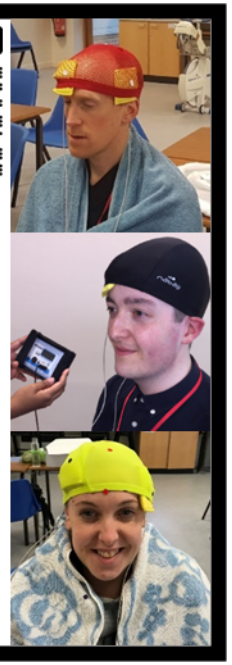
We're looking for participants to share their views on non-invasive brain stimulation (NIBS)

NIBS techniques can alter brain activity, and of interest to researchers and clinicians as they may improve measures of behaviour. We're looking for people over the age of 18 to share their views on these techniques in a short (20 minute) survey.

On completion of the survey, you can enter a free prize draw to win one of three £50 vouchers!

You can find more information and complete the survey at: bit.ly/tesperception

Please contact Natalie Smith to find out more (n.smith@leedstrinity.ac.uk)



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Thank you.

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