Frontal Cortical Asymmetry Predicts Cardiovascular Effort to Facilitate Approach Motivations and Reward Sensitivity

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Overview

Self-Control

Engaging in an act of self-control has been shown to make subsequent attempts more vulnerable to failure, which may result in impulsive behaviour (i.e., ego-depletion). Despite decades of research, replications and meta-analyses report mixed effects.

Competing Theories

- The Resource Model (Baumeister et al., 1994) = Self-control is a physical resource (e.g., glucose) which can be depleted
- The Process Model (Inzlicht & Schmeichel, 2012) = Attention and motivation shifts away from inhibition and towards rewarding cues

Approach Motivation

- Shifts in motivation towards rewarding stimuli and decreased inhibition is characteristic of approach motivation
- Approach motivated states are linked to positive affective states and moods (Mendes, 2016)
- Greater activity of the left prefrontal cortex (PFC) linked to increased approach motivation (Harmon-Jones & Gable, 2018)

Cardiovascular Effort

- Pre-ejection period (PEP) is an index of effort, decreasing the time between onset of heartbeat and ventricular ejection
- The strength and valence of mood (e.g., approach motivation) may impact engagement with tasks (Gendolla, 2000)
- Failures of replication attempts and mixed effects in self-control literature may be due to low effort (e.g., increased PEP)

Hypotheses

H1: Ego-depletion tasks will promote greater impulsivity and sensitivity to rewarding stimuli compared to control tasks

H2: Ego-depletion tasks will increase approach motivation (i.e., left PFC activity), supporting the process model of self-control

H3: Ego-depletion tasks will be more effective in participants with higher baseline approach motivation (i.e., a positive mood) due to increased engagement indexed by cardiovascular effort

Method

PFC Activity

- EEG data recorded via Neuroelectrics Enobio 8 amplifier
- Alpha power measured during baseline and manipulation
- PFC activity computed by subtracting log-transformed left from right power (F4 – F3), with positive values = left PFC activity

Pre-ejection Period

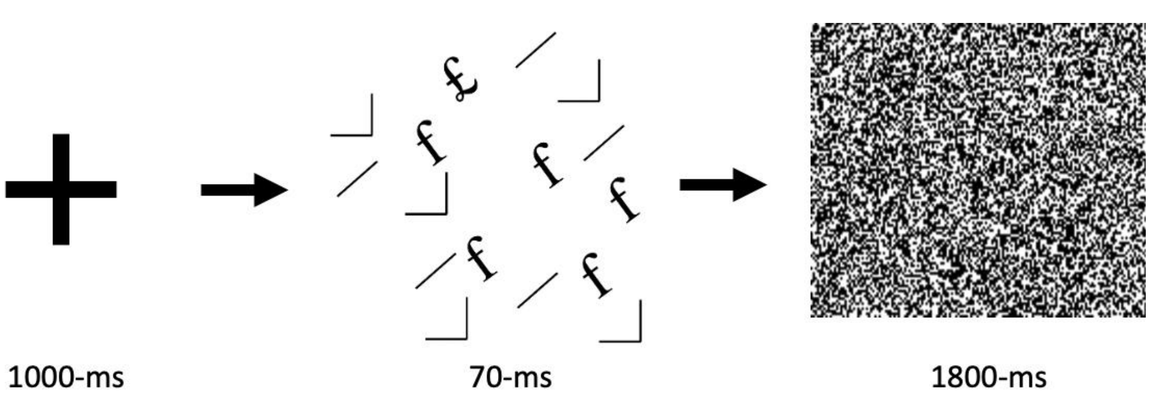
- ECG and ICG recorded via Biopac MP160 amplifier
- AcqKnowledge 5.0 estimated PEP during manipulation

Ego-depletion Task

- Participants completed a restricted writing task (i.e., no use of letters “A” or “N”) versus free writing task (Schmeichel, 2007)

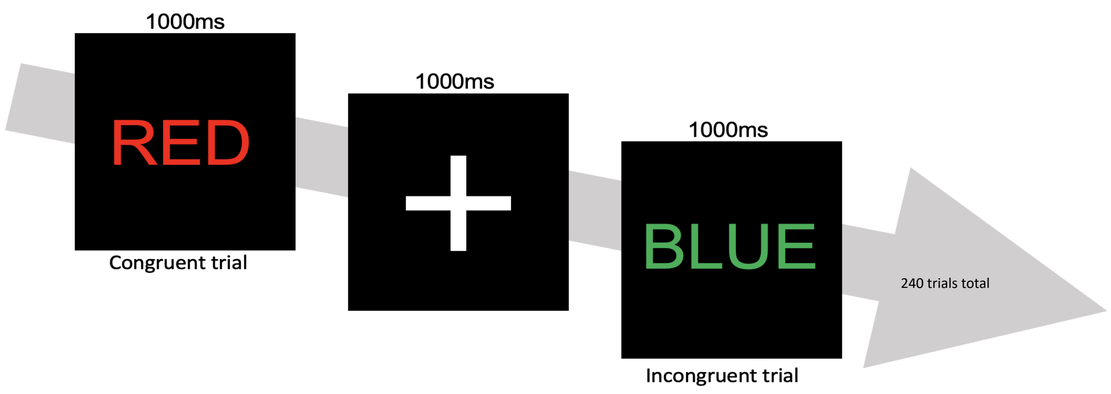
Reward Perception Task

- Participants identified rewarding stimuli (i.e., £ symbol) in array of distractors (adapted via Schmeichel et al., 2010)



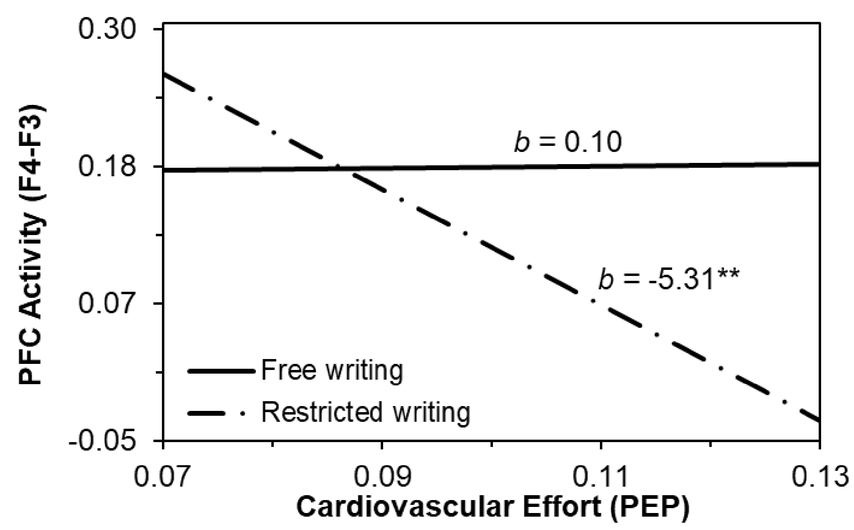
Stroop task

- Impulsivity was assessed via 4-colour Stroop Task (adapted from Hirsch & Inzlicht, 2010; Petzel & Casad, 2023)

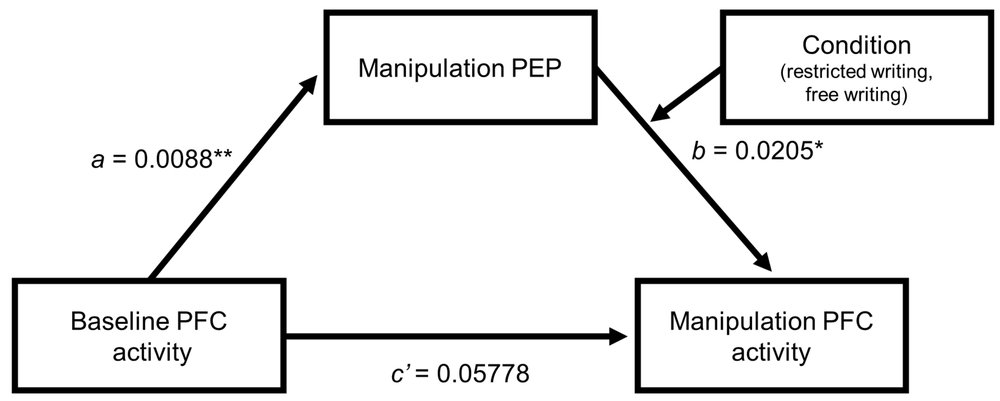


Results (N = 39)

- Condition had no effect on reward perception or Stroop performance (all *p*s > .129), contrary to H1
- Restrictive writing tasks led to greater approach motivation than control tasks (t = 2.06, p = .047), supporting H2
- Higher baseline approach motivation increased cardiovascular effort during tasks (i.e., decreased PEP; t = -2.77, p = .009)
- Condition moderated the relation between PEP and approach motives during the manipulation (t = -2.43, p = .021)



- PEP mediated the relation between baseline and manipulation approach motivations among those assigned restricted writing tasks (95% CI [.0096, .5856]), but not the free writing tasks
- When considering this indirect effect, baseline approach did not predict approach motives during manipulation (p = .578)



Discussion

- Those with baseline approach motivated states (i.e., positive mood) engaged more effortfully with manipulations, indexed by cardiovascular effort (i.e., decreased PEP)
- Consistent with process model, greater cardiovascular effort increased approach motivations as expected during states of ego-depletion, regardless of baseline approach motivations
- Ego-depletion tasks (i.e., restrictive writing) failed to promote enhanced reward perception or impulsive decision making