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Neural Changes Associated with Rewards and Punishment Following Ego Depletion or Boredom

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INTRODUCTION

- Our mental and physical ability, as well as our willpower, are exhaustible. There is an ever-increasing desire to find ways to perform at optimal levels. Recent research suggests that willpower—the capacity to exert self-control—is a limited resource that is depleted after exertion (Job, Dweck & Walton, 2010).
- Ego depletion specifically refers to the idea that self-control or willpower draws upon a limited pool of mental resources that can be used up (i.e., depleted) after cognitive exertion.
- In our study, we explored the link between feelings of depletion and the feedback related negativity (FRN). The FRN is a negative deflection in an electroencephalogram (EEG) that occurs when humans receive positive and negative feedback. The deflection is more negative for negative or unexpected feedback than for positive or rewarding feedback.

AIM

- Our purpose is to find if ego-depletion can be decreased or reversed by positive events (rewards). We aimed to measure the effects of ego depletion on how people respond to reward, through the use of electroencephalogram (EEG) and FRN.

HYPOTHESIS

- Participants in the “depletion” condition will show increased FRN amplitude on reward trials compared to participants in the control condition. Participants in the “depleted” condition will show decreased FRN amplitude on non-reward trials compared to participants in the control condition. Participants in the “depleted” condition will show greater FRN amplitude for food rewards rather than monetary rewards; no differences were expected in the control condition.

METHOD

EXPERIMENTAL TASK

- Participants were randomly assigned using a random number generator to either “Depletion”, “Boredom” or a “Control” condition.
- In the boredom and depletion conditions, the task involved 4 blocks of 5 minutes during which the participant was presented with strings of 4 digits. In the depletion condition, participants were asked to add 3 to each digit and type their response (Kahneman, 2011); in the boredom condition, they were asked to simply observe the numbers as they come up. In the control conditions participants immediately began the doors task described below.
- Participants were then administered the door lottery task. Participants would choose between two doors, one door giving positive feedback, and the other giving negative.

ANALYSIS

- Participants wore a 128-electrode sensor EEG net in order to measure the FRN. We measured the FRN deflection in the EEG in response to stimuli.
- We proposed that people who were depleted would exhibit greater sensitivity to rewards, as indexed by stronger FRN amplitudes following (reward) feedback.

PARTICIPANTS

- 164 total participants.
- 58 (30 female) in depletion group, 50 (27 female) in the boredom group, and 56 (25 female) in the control group.
- Mean age of the depletion group was 21.0 (+/- 2.0 years), 20.5 (+/- 2.1 years) for the boredom group, and 21.0 (+/- 2.3) for the control group.
- All participants were healthy and free from neurological disease.

RESULTS

- Results of the 3x3 ANOVA indicate a significant main effect of condition, F(2,322) = 4.73, p = 0.009, and a significant main effect of group, F(2,161) = 3.69, p = 0.027.
- The Group by Condition interaction was not significant, F(4,322) = 0.41, p = 0.81. Post-hoc analysis indicated the boredom group showed a significantly more negative FRN than the depletion group (p = 0.03) and trend-level different from the neutral group (p = 0.09). Neutral and depletion were not significantly different (p = 0.89).
- The money condition was significantly more negative than the neutral condition (p = 0.003), and trended different than the candy condition (p = 0.09). The candy and neutral conditions did not differ (p = 0.19).

CONCLUSION

- Overall our results showed that there were no interactions between group and condition. There were, however, main effects of group and condition.
- We hypothesized that the “depletion” condition would show the greatest negative FRN amplitude in response to reward, but discovered that the “boredom” group reacted the strongest to the rewards with the greatest negative feedback.
- Consistent with predictions, the money task had the largest FRN amplitude. This is possibly due to the need for reward after being in a “depleted” or “boredom” condition for an extended period of time, with those in the “boredom” condition seemingly being in more of a need for reward.
- Money may lead to larger FRN amplitude because of the demographics need for money over candy. Future studies should examine the effectiveness of the depletion task and compare with sensitivity to reward.

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