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Effects of motivation and depletion on the ability to resist the temptation to avoid physical activity

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Abstract

Understanding the psychological processes that underpin the limited self-control resource could have important consequences for health behaviour change interventions. The present study employs a 2x2 (Autonomous / Controlling x Depleted / Not Depleted) experimental design to investigate whether an initial act of self-control influences participants' ability to employ counteractive control strategies that help to resist temptation and stick to a focal physical activity goal, as well as their feelings of subjective vitality. Experimental instructions manipulated the environments to generate autonomy supportive and controlling conditions. After completing either a depleting or not depleting Stroop task, undergraduate students' (N = 77) counteractive evaluations towards a temptation (to complete a sedentary trial with no information) and a focal goal (to complete a physically active trial that provided valuable information) were measured. Despite the successful manipulation of the experimental conditions, results indicated no significant effect of the motivational support condition or depletion condition on the value participants placed on a temptation or focal goal. A significant interaction between depletion condition, autonomous motivation and controlled motivation was observed for subjective vitality. Participants high in autonomous motivations and low in controlling motivations maintained levels of subjective vitality whether depleted or not. We discuss the importance of future experimental work into the effects of temptations on self-control resources in the physical activity domain.

Introduction

Health behaviour change frequently requires self-control efforts along with proactive and determined action on behalf of the individual, particularly when the target behaviour may not be perceived by all individuals as inherently enjoyable (e.g., physical activity for purposes of 'exercise'). A consequence of changing health behaviours, such as increasing Physical Activity (PA), is the existence of a persistent temptation (i.e., remaining sedentary) not compatible with the long term goal. When attempts are made to support health behaviour change, it is important to reduce and minimise the strength of such temptations. Therefore, successful PA interventions are reliant upon understanding the processes that increase PA compared to fostering sedentary activities. For example, walking through the front door after a long day at work, many individuals know that it would be beneficial for them to participate in 30 minutes of PA but are often faced by the temptation to collapse in a comfortable arm chair in front of the television. What determines whether these individuals stick to their focal goal or give in to such a temptation? Previous research highlights that self-regulation techniques are one of the most effective methods of supporting PA behaviour change (Michie, Abraham, Whittington, McAteer, & Gupta, 2009). Effective self-regulation occurs when one achieves a goal by effectively monitoring and managing one's thoughts, feelings and behaviours (Baumeister & Vohs, 2004). Therefore, understanding the processes and techniques that support participants' attempts to self-regulate their behaviour could provide valuable information for future PA interventions. The present study is designed to examine the impact of ego depletion on one's ability to adhere to a PA related focal goal and reduce the temptation of a sedentary alternative by bolstering the value that one places on that goal. This study also examines whether the motivation towards a cognitive depleting task

influences the relationships between depletion and temptation, and between depletion and reported psychological well-being.

Ego Depletion

Self-control efforts are important to help one adhere to health-related behaviours such as dieting, quitting smoking and participating in regular PA. Failure to implement self-control when exposed to temptations (e.g., cookies, cigarettes, and sedentary behaviours) can be counteractive to achieving health-related goals. Previous research supports the proposition that acts of cognitive self-control weaken one's future self-control attempts. This has been called ego depletion (Baumeister, Bratslavsky, Muraven, & Tice, 1998).

Baumeister et al. (1998) proposed that self-control is a limited resource that is used for all acts of volition, such as controlled processing, active choice, initiating behaviour and overriding responses. Muraven, Tice, and Baumeister (1998) tested the hypothesis that people have a limited self-regulatory capacity in four experimental studies that employed a two-task paradigm. The two-task paradigm tests the fatiguing quality of the self-control by employing an initial cognitive or physical task that does or does not deplete the self-control, followed by a second task that requires self-control. Results from all four experiments revealed that, compared to participants whose self-regulatory strength had not been drained in a preceding self-regulatory task, participants who were ego depleted were less persistent at subsequent unsolvable tasks, worse at controlling their emotions and demonstrated a decline in physical stamina. Muraven et al., concluded that these studies supported the proposition that after people participate in an act of self-control, they are subsequently less capable of regulating themselves because their cognitive resources become depleted. Research studies have now corroborated the hypothesis that performance on a subsequent self-regulatory task becomes impaired after ego depletion (Muraven & Baumeister, 2000; Vohs, Baumeister, & Ciarocco,

2005; Wallace & Baumeister, 2002). In a recent meta-analytic review of 83 studies that made 183 independent tests of the ego depletion effect, a medium to large effect size was found for the impact of ego depletion on a wide range of self-control dependent outcomes (e.g., performance on cognitive tasks, controlling emotions, persistence at unsolvable tasks and problem solving; Hagger, Wood, Stiff & Chatzisarantis, 2010).

Although the effects of ego depletion have been studied across a wide variety of tasks, only a very limited amount of research has been conducted in health behaviour settings and in particular the domain of PA/exercise. Muraven and colleagues (1998) have revealed that acts of self-control depleted participants' ability to perform a subsequent physical task. Specifically, participants who had to suppress emotions while watching a movie performed poorer on a follow-up hand grip task compared to participants who could express freely their emotions during the movie. In a recent study, Martin Ginis and Bray (2010) examined the effects of ego depletion, via the stroop task, on aerobic exercise and found that depletion led to declines in a subsequent exercise work output during a 10-minute bicycle trial. In addition, participants who were ego depleted planned to participate in less exercise in the future than those who were not ego depleted.

Although previous research appears to underline the impact acts of self-control have on subsequent performance, no evidence exists as to whether ego depletion impairs the ability to resist temptations. Baumeister et al., (1998) utilised temptations as a preceding method of inducing ego depletion but no research has examined whether giving in to temptations increases as an outcome of ego depletion.

Counteractive Self-control Theory

Counteractive self-control theory (CSCT; Trope and Fishbach, 2000) proposes that individuals have two options when confronted by a threat to a personally meaningful long-

term goal. Firstly, they can give in to temptations because the short-term costs of sticking to the goal are perceived to be too high. For example, the thought of participating in a tiring exercise session after a long day at work could be considered 'too much'. The second option individuals have, when faced with temptations, is to elicit self-control that supports their efforts to stick to their long-term goal. CSCT identifies two types of self-control strategies that can be employed to counteract or resist temptations: choice alternatives and counteractive evaluations. *Choice alternatives* place contingent based penalties or rewards on behaviours to support acts that are in line with a long-term goal (e.g., rewarding attendance to an exercise class with a trip to the cinema). *Counteractive evaluations* bolster the perceived value that is placed upon the long-term goal (for example, individuals may say to themselves "despite the effort required, it is really important that I go to this exercise class because I want to lose weight"). Myrseth, Fishbach, and Trope (2009) demonstrated that undergraduate students devalued a temptation (leisure time activities) when pursuing an educational goal. Fishbach, Zhang, and Trope (2010) showed that dieters devalued fattening food and enhanced the value of healthy eating when presented with images of fattening foods. Therefore, participants appear to bolster the value of important goals and decrease the value of short-term benefits posed by temptations. What remains unclear, however, is the impact of ego depletion on individuals' capacity to implement these strategies and resist short-term temptations (Fishbach & Trope, 2008).

The Role of Motivation

Previous research has indicated that an individual's motivation for participating in a cognitively depleting task can reduce the effects of ego depletion. Muraven, Gagne, and Rosman (2008) created two conditions that supported two different qualities of motivation (autonomous and controlled), as proposed by Self-determination Theory (SDT; Deci & Ryan,

2000). Autonomous motivations are initiated by the self, are personally meaningful and valued. In contrast, controlled motivations are conducted to avoid feelings of guilt, gain ego enhancements or are externally driven. Social contextual environments can be manipulated to support these two qualities of motivation (Deci, Egharri, Patrick, & Leone, 1994). For example, an autonomy supportive environment elicits and acknowledges perspectives, offers choices, provides relevant information and minimises pressure and control. In contrast, controlling environments highlight normative comparisons, use controlling language and exert pressure. When exerting self-control, supporting autonomous motivation as well as one's personal autonomous motivation resulted in less depletion of self-control that manifested through better performance on a subsequent self-control task (Muraven, Gagne, & Rosman, 2008; Muraven, 2008). Results demonstrated that when participants refrained from eating cookies for more controlled reasons, performance on a handgrip task was worse than those with more autonomous reasons. The author further showed that more autonomous forms of motivation negatively predicted depletion. Therefore, an individual's reason for exerting self-control can moderate the impact of depletion on subsequent acts of self-control. However, it is not clear whether autonomous motivation has the same moderating role when examining the impact of ego depletion on employing counteractive control strategies.

Feelings of Vitality

In addition to the potential moderating effect of motivation, SDT (Deci & Ryan, 2000) proposes that when reasons for participating in an activity are more autonomous, rather than controlled, psychological well-being will be observed (Ryan & Deci, 2000a). In the SDT literature, a key indicator of well-being is subjective vitality (Edmunds, Ntoumanis, & Duda, 2008; Ryan & Deci, 2000b). Ryan and Deci (2008) state that vitality 'represents energy that one can harness or regulate for purposive actions' (p. 703). Further, when one feels vital, he

or she can cope better with stress and challenge (Ryan & Frederick, 1997). Muraven and colleagues (2008) showed that failing to support autonomous motivation can lead to lower feelings of vitality particularly after exerting self-control. Such propositions may have important implications for the effects of ego depletion on participants' feelings of subjective vitality. Specifically, participants high in autonomous motivation should experience feelings of subjective vitality regardless of the challenges or depleting effects of an activity.

Study Hypotheses

To summarise, the main purpose of the present study is to combine two distinct literatures (i.e., ego depletion and counteractive self-control theory) and investigate the effect that ego depletion has on the ability to resist short-term temptations (primary outcome). For counteractive control strategies, it is hypothesised that acts of self-control will impair an individual's ability to resist temptations by reducing his/her ability to employ counteractive control strategies (i.e., bolstering the value of a long term goal and reducing the value of short term benefits of a temptation; H_1). In response to Hagger et al.'s (2009) call for more research that integrates the self-control model with existing health-related models of behaviour change, this study also examines the role of motivation on the ability to employ counteractive control strategies. Based on existent literature, the second hypothesis for the primary outcome proposes that autonomy supportive conditions (H_2) and autonomous motivation (H_3) will moderate the effect of ego depletion on one's ability to employ counteractive self-control strategies

In addition, for behavioural choice, it is hypothesised that more participants who are ego-depleted will choose the temptation due to inability to employ self-control, compared to those who are not ego-depleted, who will employ self-control and make a choice in-line with their valued goal (H_4).

Finally, for subjective vitality (i.e., secondary outcome) it is hypothesised that autonomy support (H_5) and personal autonomous motivation (H_6) will help maintain feelings of psychological health (i.e., feelings of subjective vitality), regardless of whether one is ego depleted or not. Specifically, participants high in autonomous motivation should experience feelings of subjective vitality regardless of the challenges or depleting effects of an activity.

Method

Participants

Participants (n = 77) were undergraduate students who required course credit for participation in research that contributed to their degree (M age = 19.78 SD = 1.69; Male = 35 Female = 42).

Procedure

Ethical consent for the study was obtained from a British University's Ethical Advisory Board. Participants signed up for a study that was advertised to investigate the beneficial effects of PA on cognitive performance. This advertisement was necessary to divert participants' attention from the actual study purpose that was to investigate the effect of ego depletion on individuals' ability to resist temptations, not the effect of PA on cognitive functioning. This faux description was implemented in order to prevent participant bias. The experimental protocol occurred during a single session in a sport and exercise psychology lab and lasted approximately 30-45 minutes. Each participant was randomly assigned to one of four conditions: autonomous depleted (n = 20), autonomous not depleted (n = 18), controlled depleted (n = 19) and controlled not depleted (n = 20). Trial instructions informed participants that they will be required to complete either a physically active trial or a resting trial and that they will choose which they would prefer to complete. However, no participant

actually completed the resting or physically active trial. Participants were informed that they did not need to indicate their choice now but would be asked to specify which session at the end of a questionnaire. The physical task was described as reliable and effective at providing information about individual optimal levels for cognitive functioning and generated presumably valuable information about how to improve cognitive functioning that the resting trial would not provide. The purpose of this description was to emphasise the value of participating in the physically active trial. Before and after the cognitive task, participants were asked to rate the value of the physically active trial, the resting trial and the usefulness of the knowledge about their optimal levels of PA for good cognitive functioning.

Participants completed a cognitive task that required self-control to induce ego depletion and generated two depletion conditions (Depleted and Not Depleted). Written instructions and manipulations of the environment created two different motivational support conditions (Autonomy supportive and Controlling). As an objective marker of ego depletion (Gailliot et al., 2007), three blood samples were taken with a single-use blood sampling lancet and blood glucose levels were measured (mg/dL) using an Accu-Check Aviva blood glucose monitor (i.e., one before and one after the depletion task, and a third one at the end of the study). At the end of the study the participants were informed that they will not complete the remainder of the session on that day. The purpose of the present study was to investigate the impact of ego depletion on the ability to resist temptations and employ counteractive control strategies, not the impact of PA per se. Therefore, participants were only required to believe that they were going to complete either the resting or physically active trial. Participants were informed that the experimenter would be in contact to re-schedule and de-brief the participant. At the end of the data collection, all participants were fully debriefed.

Manipulations

Cognitive task.

Previous research has shown that a modified version of the Stroop task is an effective method of depleting the self-control reserve (Martin Ginis & Bray, 2010; Muraven, Rosman, & Gagne, 2007; Vohs et al., 2005). The computer generated task requires participants to press a key that represents the ink colour of each word in two lists of 70 words as quickly and accurately as possible (Wallace & Baumeister, 2002). In line with previous research, the colours used in the present study were red, blue, green, and purple.

Depleted condition.

In the depletion condition, participants were asked to name the colour of ink that words of different colours were written (e.g., the word "blue" written in red ink). In addition, participants were instructed to ignore this rule when the ink colour was blue and read the written word. Therefore, participants had to implement self-control in terms of two different behaviours.

Not depleted condition.

Participants in the not depleted condition viewed words and colour print that matched (e.g., the word "red" written in red print). Therefore, there was no requirement to override the dominant response and the participants could state the colour of the print without an interfering stimulus (i.e., a different colour written word).

Motivational support.

Pre-cognitive task, two motivation conditions were manipulated through instruction slides and the environment afforded by the experimenter.

Autonomy supportive condition.

Replicating previous research and in line with Williams and colleagues' (2006) definition of autonomy support, the task instructions highlighted the benefits and emphasised the personal challenge of completing the task and acknowledged the participants' positive and negative feelings towards the experiment. In addition, the experimenter remained in a non-obstructive position out of view of the participant. Participants were informed that they could start when they were ready. The instructions stated "Please state as quickly and accurately as you can, the colour of the ink that the words are printed; if you make an error please try and correct it". For the depletion condition the following instructions were added; "unless the ink colour is blue, in which case please ignore the colour of the ink and simply read the text". These autonomy supportive characteristics are similar to an environment that is task involving (i.e., makes the participant feel more connected and valued; Ames, 1992).

Controlling condition.

Participants randomly assigned to the controlling condition received instructions that used controlling language (e.g., "you must"), highlighted normative comparisons (i.e., "success will be a good indication of your cognitive functioning compared to that of other participants") and placed pressure on the participants to not make mistakes. In addition, the experimenter stood next to the participant with a stopwatch to time how long the participant took to complete the task. The experimenter decided when to start the task by stating "Three, Two, One, Go!". Participants were instructed "You need to read as fast and accurately as you possibly can the colour of the ink that the words are printed, and you must ensure that no errors are left uncorrected. Most participants only make one or two errors". For the depletion condition, the following instructions were added, "unless the ink colour is blue, if the colour font is blue you must read the written text". These controlling characteristic are similar to an

environment that is ego-involving (i.e., social comparisons and pressure to not make mistakes; Ames, 1992).

Measures

Pre-task questionnaire.

Prior to commencing the Stroop task, participants completed a questionnaire pack that contained the following measures:

Brief mood introspection scale.

In line with previous research, mood was measured to examine whether it mediated the effects of ego depletion (Muraven et al., 2008). The brief mood introspection scale (Mayer & Gaschke, 1988) was used as it has been frequently employed in previous ego depletion research (Muraven et al., 2008; Moller, Deci, & Ryan, 2006). Participants rated 16 adjectives that represented two independent factors (pleasant versus unpleasant affect, and high versus low arousal) on a scale ranging from 1 (*Definitely do not feel*) to 4 (*Definitely feel*). Previous ego depletion studies have failed to report levels of internal consistency. Mayer and Gaschke (1988) reported alphas of .63 and .86 for the two factors, respectively.

Counteractive-self control strategies.

Self-control efforts were measured through counteractive control evaluations. The perceived value that participants placed on the two trials (physically active and resting trial) and the usefulness of the knowledge about their optimal levels of physical activity for good cognitive functioning was assessed. On 7-point scales ranging from 1 (*Not at all*) to 7 (*Very much*), participants rated 6 items measuring the usefulness and importance of participating in each trial (e.g., "How useful will the results of the physical activity test be to you?"), the importance of the study, the importance of participating in scientific research and the extent to which the study was interesting, as an assessment of a counteractive self-control strategy

(Trope & Fishbach, 2000). Similar to Trope and Fishbach (2000), these ratings were designed to assess the bolstering of the subjective value of the two trials and demonstrated adequate levels of internal consistency (α = .73 for the physically active trial and α = .68 for the resting trial).

Post-task questionnaire.

After completing the Stroop task, participants completed all measures from the pre-task questionnaire as well as the following measures:

Manipulation checks.

Cognitive depletion.

Participants completed two brief manipulation checks to assess their perceptions of ego depletion. For the first item, participants responded to the item "How much effort was required to comply with the cognitive task instructions?" on a on a scale anchored by 1 (*No effort was required*) and 7 (*Maximum effort was required*). Similarly the question "How tiring did you find complying with the cognitive task instructions?" was rated using a 7-point scale anchored by 1 (*Not very tiring*) and 7 (*Very tiring*).

Motivational support.

Six items developed for this study measured the participants' perceptions of the situational motivational climate. Three items measured perceptions of autonomy support (e.g., "My feelings about the cognitive task were considered") and three items measured controlling aspects of the environment (e.g., "I felt pressured to compete the task within a certain time"). All items were rated on a 7-point scale anchored by 1 (*Strongly disagree*) and 7 (*Strongly agree*).

Situational motivation scale.

Motivation for engaging in the cognitive task was measured using the 16-item situational motivation scale (SIMS; Guay, Vallerand & Blanchard, 2000). Participants responded to the SIMS in terms of their reasons why they engaged in the cognitive task (i.e., the Stroop task). The SIMS measures three different regulations (i.e., Intrinsic, Identified, External), as well as amotivation. Intrinsic motivation stems from an inherent interest or enjoyment for an activity, whilst identified motivation occurs when one values the benefits associated with participating in a behaviour. These two motivations represent more autonomous forms of motivation. External motivation, the most controlling motivation, occurs when one participates in an activity to obtain a separable outcome (e.g., rewards) or as an outcome of external pressure. Finally, amotivation represents a lack of intention or desire to conduct the behaviour in question. All sub-scales demonstrated adequate internal consistency (α = .74 - .88). Each sub-scale was measured with four items and rated on a scale anchored by 1 (*Corresponds not at all*) and 7 (*Corresponds exactly*).

Subjective vitality.

The subjective vitality scale (SVS; Ryan & Frederick, 1997; Bostic, Rubio, & Hood, 2000) was employed as an indicator of psychological well-being. Participants responded to six items by indicating the degree to which each statement applied to them right now, using a scale anchored by 1 (*Not at all true*) to 7 (*Very true*), and an example item is "I feel alive and full of vitality". The SVS demonstrated a good level of internal consistency (α = .85).

Behavioural intentions.

Finally, a behavioural intention for the subsequent trial was measured with a dichotomous choice item. Participants were asked to indicate which task they would prefer to participate in today by circling either the Physically Active Trial or Resting Trial. Participants were then

asked to indicate their preference for the session on a 6-point rating scale ranging from -3 ("I much preferred to complete the Physically Active trial today") to +3 ("I much preferred to complete the Resting Trial today") thus reflecting their behaviour intentions and resistance to temptation.

Results

Manipulation Checks

Ego depletion.

Consistent with previous research using the Stroop task as a method of depletion, participants in the Depleted condition perceived the task to be more tiring and requiring more effort to comply with the instructions (M = 4.33 SD = 1.07) compared to the Not depleted condition (M = 3.14 SD = 1.25) $F(1,73) = 22.56$, $p < .001$. Alternative methods of confirming participants' level of ego depletion was their reaction times (i.e., mean time it took participants to respond to each item) and blood glucose levels. Results revealed that the reaction time of participants in the Depleted condition (M = 1.70 SD = .92) was significantly longer than those in the Not depleted condition (M = 1.10 SD = .78) $F(1,74) = 10.03$, $p < .01$. However, for blood glucose levels, a repeated measures ANOVA revealed no significant interaction between Time x Depletion $F(2,73) = .995$, $p > .05$, Time x Motivation $F(2,73) = .208$, $p > .05$ or Time x Motivation x Depletion $F(2,73) = .266$, $p > .05$.

Motivational support.

A One-way MANOVA revealed a significant effect of Motivational support condition $F(2,74) = 20.86$, $p < .001$. Participants in the Autonomy supportive condition scored significantly higher on the autonomy supportive items (M = 5.54 SD = .91) compared to participants in the Controlling condition (M = 4.22 SD = 1.07) $F(1,75) = 34.00$, $p < .001$. In contrast, participants in the Controlling condition scored significantly higher on the

controlling items (M = 3.44 SD = 1.01) than those in the Autonomy supportive condition (M = 2.27 SD = .92) F (1,75) = 27.94, p <.001.

Counteractive Control Strategies

Experimental conditions.

A multivariate ANOVA was conducted with Depletion conditions and Motivational support conditions as the independent variables and the counteractive control strategies towards the resting trial (*Value of Rest*) and the physically active trial (*Value of Physical Activity*) as the two dependent variables to test our first two hypotheses (H_1 and H_2; see Table 1). With regard to the value of the resting trial, results from the MANOVA indicated no significant effect of Motivational support $F(1,73) = 1.76$, $p > .05$, partial $\eta^2 = .02$, or Depletion $F(1,73) = .64$, $p > .05$, partial $\eta^2 = .02$. Further, no significant interaction was observed between Motivation support and Depletion $F(1,73) = .27$, $p > .05$, partial $\eta^2 = .01$. Similarly, with respect to the value placed on the physically active trial, results revealed no significant main effects of Motivational support $F(1,73) = 1.72$, $p > .05$, partial $\eta^2 = .02$, or Depletion $F(1,73) = .17$, $p > .05$, partial $\eta^2 = .00$, nor a significant interaction $F(1,73) = .48$, $p > .05$, partial $\eta^2 = .01$. In line with previous research mood, was tested as a covariate; however, its effects were not significant and it was subsequently removed.

Personal Motivation

To test our third hypothesis (H_3) that autonomous motivation would moderate the effect of ego depletion on task engagement, the same analyses were conducted using the participants' scores from the SIMS. Scores from the SIMS were used to generate autonomous (intrinsic and identified) and controlled (extrinsic and amotivation) motivation composite scores which were then split at the median (4.00 for autonomous motivation and 3.25 for controlled motivation) to produce four groups (high and low Autonomous and high and low Controlled).

A 2x2x2 (Autonomous high and low x Controlled high and low x Depleted and Not depleted) MANOVA was conducted with the value scores for the two trials as the dependent variables. With regards to the value of the resting trial, results showed no significant effect of Depletion $F(1,69) = 1.88$, $p > .05$, partial $\eta^2 = .03$, and Controlled motivation $F(1,69) = .06$, $p > .05$, partial $\eta^2 = .00$. However, a significant effect of Autonomous motivation $F(1,69) = 12.08$, $p = .001$, partial $\eta^2 = .15$, was revealed. A significant interaction between Depletion and Autonomous motivation $F(1,69) = 6.39$, $p = .014$, partial $\eta^2 = .19$, also emerged (see Figure 1). No significant interaction was observed between Depletion and Controlled motivation $F(1,69) = 1.59$, $p > .05$, partial $\eta^2 = .02$, nor between Depletion, Autonomous motivation and Controlled motivation $F(1,69) = 1.42$, $p > .05$, partial $\eta^2 = .02$.

For counteractive control strategies towards the physical activity trial a significant main effect for Autonomous motivation was observed $F(1,69) = 14.82$, $p < .001$, partial $\eta^2 = .18$. This finding indicates that participants high in autonomous motivation valued the physically active trial significantly more than participants low in autonomous motivation. No significant effect was observed for Depletion $F(1,69) = .003$, $p > .05$, partial $\eta^2 = .00$, Controlled motivation $F(1,69) = 3.36$, $p > .05$, partial $\eta^2 = .07$, Depletion x Autonomous $F(1,69) = 1.48$, $p > .05$, partial $\eta^2 = .02$, Depletion x Controlled $F(1,69) = .81$, $p > .05$, partial $\eta^2 = .01$, or Depletion x Autonomous x Controlled $F(1,69) = .95$, $p > .05$, partial $\eta^2 = .01$.

Behavioural Choice

Twenty-three participants selected the physically active trial whereas fifty-four selected the resting trial. Two Chi-square (χ^2) tests were conducted to test our fourth hypothesis (H_4) and revealed that the percentage of participants that selected the physically active trial did not differ by Motivational support condition $\chi^2 = (1, n = 77)\ 2.79\ p > .05$, or by Depletion

condition χ^2 = (1, *n* = 77) .68 *p*>.05. Two separate Chi-square tests were conducted due to less than 5 participants selecting the physically active trial in the autonomous depleted condition (Field, 2005). Two further Chi-square tests with personal motivation scores revealed similar results. Specifically, the percentages of participants that selected the physically active trial did not differ by Autonomous motivation χ^2= (1, *n* = 77) 2.79 *p*>.05 or by Controlled motivation χ^2= (1, *n* = 77) .68 *p*>.05.

Feelings of Vitality

Experimental condition.

Contrary to the fifth hypothesis (H_5) that supporting autonomous motivation would help sustain perceptions of vitality across depletion conditions, a factorial ANOVA revealed no significant effect of Depletion *F*(1,73) = 2.05, *p* >.05, partial η^2 = .03, and Motivational support *F*(1,73) = 1.56, *p* >.05, partial η^2 = .03, nor between Depletion and Motivational support *F*(1,73) = 3.53, *p* .06, partial η^2 = .05, on feelings of subjective vitality.

Motivational scores.

To examine the moderating role of personal motivation on feelings of subjective vitality (H_6) analyses were conducted using participants' SIMS scores. A factorial ANOVA revealed no significant effect of Depletion *F* (1,73) = 2.36, *p* >.05, partial η^2 = .03, and Controlled motivation *F*(1,73) = .15, *p* <.05, partial η^2 = .00, but a significant difference in vitality scores between high and low Autonomous participants *F*(1,73)= 9.09, *p* =.004, partial η^2 = .12. No significant interactions were observed betwe en Depletion and Autonomous motivation *F*(1,73)= 2.22, *p* >.05, η^2 = .03, and between Depletion and Controlled motivation *F*(1,73) = .31, *p* <.05, partial η^2 = .00. However, a significant three way interaction was observed between Depletion, Autonomous motivation and Controlled motivation *F*(1,73) =

4.33, p =.041, partial η^2 = .06, indicating that participants high in Controlled motivation demonstrated similar levels of subjective vitality regardless of their autonomous motivation and across depletion conditions. In contrast, participants low in controlled motivation revealed different levels of vitality when high and low in autonomous motivation across depletion condition. Specifically, and supporting the final hypothesis, participants high in autonomous motivation demonstrated higher and consistent levels of subjective vitality across depletion conditions when low in controlling motivation where as participants low in autonomous motivation and low in controlling motivation had less vitality when depleted (see Figure 2).

Discussion

Understanding the processes responsible for adhering to long-term health behaviour goals, such as increasing physical activity, and resisting temptations that draw one away from these goals (i.e., engagement in sedentary activities) could be important for the development of effective interventions. The present study represents a novel experimental study that examined whether ego depletion and motivation influenced participants' ability to employ counteractive control strategies and adhere to a focal PA goal rather than give in to temptation. This study, and future experimental research, could provide valuable practical guidance for how interventions can support behaviour change along with techniques that support the development of health behaviour habits (i.e., health behaviours that are customary ways of behaving; Ouellette & Wood, 1998).

Experimental Manipulations

Results from the manipulation checks indicated that the study successfully manipulated ego depletion and motivational support. Participants in the depleted condition perceived the Stroop task to be more tiring, required more effort and had longer reaction times compared to

those in the not depleted condition. It is noteworthy however, that the objective measure of ego depletion, blood glucose levels, did not reveal any significant differences between conditions. However, Clarkson, Hirt, Jia, and Alexander (2010) highlighted that individual perceptions are sufficient to evoke ego depletion. The successful implementation of the Stroop task as a means of inducing ego depletion corroborates previous research employing the same task (Martin Ginis & Bray, 2010; Muraven et al., 2007). Manipulation checks further confirmed that the pre-task instructions successfully manipulated participants' motivation for completing the cognitive task. Participants in the autonomy support condition scored significantly higher on the autonomy supportive items and significantly lower on the controlling items compared to participants in the controlling condition.

Counteractive Control Strategies

Counteractive self-control theory (Trope & Fishbach, 2000) hypothesises that one possible way of adhering to a focal goal is to increase the value placed on that goal and decrease the value of temptations. As a measure of counteractive control strategies, participants in the present study were requested to answer questions that indicated the perceived value that they placed on both a physically active trial and a resting trial. The design manipulated the physically active trial to represent a focal goal and the resting trial to represent a temptation and examined the previously untested hypothesis that acts of self-control may diminish the capability of participants to employ counteractive control strategies. However, results did not support this hypothesis (H_1). No significant effect of cognitive depletion on the value that participants placed on the resting trial or the physically active trial was observed. Similar unexpected results were found for the motivational support condition (H_2). No significant differences were observed in perceived value of the physically active trial or the resting trial between the autonomy support and controlling condition. This non-significant effect of

motivational support is not surprising given the non-significant effect of cognitive depletion. According to previous research (Muraven et al., 2008), motivational support moderates the impact of ego depletion caused by an initial act of self-control on a second subsequent self-control act. However, in this study motivational support during the first ego depleting act could not reduce the impact of depletion on a subsequent act of self control because no such effect existed.

We also examined the role of motivation in this study by analysing participants' personal motivation scores. Previous research (Moller et al., 2006) has highlighted that the reasons why one conducts an activity influences the strength of ego depletion. The present results showed that how participants, high and low in autonomous motivation valued the resting trial was contrary to the hypothesis ($H_{3)}$ when depleted and not depleted. Specifically, participants high in autonomous motivation who were depleted placed more value on the resting trial (temptation) than when not depleted. In contrast, participants low in autonomous motivation valued the resting trial similarly whether cognitively depleted or not.

With regards to the value that participants placed on the physically active trial, only a significant effect of autonomous motivation was observed. Participants high in autonomous motivation placed greater value on the physically active trial in both the depleted and not depleted condition compared to those low in autonomous motivation. These results suggest that even though there was no significant effect of cognitive depletion, when participants were highly autonomous they were more likely to value a trial that carries pre-identified benefits (i.e., knowledge of their optimal levels of physical activity for cognitive functioning). However, caution must be expressed because the same participants also placed a high value on the resting trial that carried no pre-identified benefits and represented a temptation away from the focal goal.

Potential explanations for why the present results do not support the hypotheses may be found in the propositions of Counteractive Control Theory (CCT; Trope & Fishbach, 2000). Specifically, CCT proposes that short-term costs or temptations will not elicit counteractive control when they do not threaten a valued goal. It is plausible that some of the participants did not place any true value on the pre-prescribed goal. When no value is placed on the long-term goal, Trope and Fishbach (2005) found that participants would choose according to simple economic considerations. Mean scores for the value participants placed on the valued goal suggests that a medium value was placed on the physically active trial, a similar level to that of the resting trial. In an attempt to manipulate personally valued goals, previous studies on counteractive control have used dieters and exercisers leaving gyms, individuals who presumably value physical activity and healthy eating. (Fishbach, Zhang, & Trope, 2010; Myrseth, Fishbach, & Trope, 2009). Therefore, future studies should attempt to implement a goal that is already personally valued by the research participants. Using already meaningful goals would help clarify whether the non-significant findings were due to an undervalued goal or because an initial act of self-control does not impact one's ability to employ counteractive control strategies.

Trope and Fishbach (2005) highlight that the balance between the long-term goal and the strength of the temptations is also a critical factor for counteractive control strategies to be employed. Therefore it is possible that the present study failed to achieve an appropriate balance between these factors and may have been the cause of the non-significant findings regarding the use of counteractive control strategies (Trope & Fishbach, 2005). Participants from this study were undergraduate students from a Sport and Exercise Science bachelor's degree course. Participants may have had already completed significant levels of physical activity on the day they visited the lab making the short-term temptation of the resting trial

very strong. Alternatively, because participants planned to be physically active in the near future, they could have given in to temptation without identifying a conflict in the balance between the temptation and the goal. Fishbach and Converse (2010) highlight that self-control failure, or self-regulation failure (Baumeister & Vohs, 2004), is frequently caused by the failure to identify that a conflict between an important goal and a temptation exists. Therefore, the scenario generated for this study may have failed to have achieved a sufficient level of perceived long-term cost from the temptation (resting trial) for the participants to identify a conflict. If conflict identification, or lack of, is a cause for the present results this may provide an important insight into a potential barrier to participating in physical activity or exercise in the general public. If one has a perception that deciding not to be physically active is of little threat to important longer term goals, such as reducing cholesterol or increasing cardiovascular fitness, it is less likely that one will identify a potential self-control conflict. The challenge for future laboratory studies in this area is to establish an appropriate level of temptation that necessitates conflict identification and the use of counteractive self-control strategies.

If remaining sedentary carries a low perception of cost towards important long-term goals, this could have important practical implications for future health initiatives. For example, physical activity interventions may need to support, and link, the relationship between the consequences of sedentary lifestyles and the attainment of personally meaningful long-term goals. This would initiate awareness that a conflict existed and increase the likelihood of counteractive self-control strategies being employed. Such potential implications highlight the importance of employing experimental methods in the development of effective health interventions.

Behavioural Choice

As a second measure of their ability to resist temptation, participants indicated whether they would prefer to complete a 'physically active trial' or a 'resting trial' following the Stroop task. Results revealed that the percentage of participants that selected the trials did not differ by depletion condition or motivational support condition. In fact, a large percentage of participants (70%) selected the resting trial to complete the desired analyses. These findings provide further support to the suspicion that the balance between the strength of the temptation and the strength of the long-term goal was not optimal. Future research designs would benefit from developing an experimental protocol that would facilitate a greater balance in the strength between the two behavioural choices.

Feelings of Vitality

Results revealed that reported subjective vitality did not differ between the two depletion conditions or the two autonomy supportive conditions. However, a close to statistically significant interaction between motivation and depletion conditions was observed that was contrary to what was expected. Specifically, perceptions of vitality were similar in the depleted condition regardless of whether participants were assigned to the controlling or autonomous condition.

Personal motivation.

In order to explore the relationships between motivation, self-control and feelings of vitality further, participant's motivation scores (median split) were used as independent variables instead of the two autonomy supportive conditions. Multivariate analyses indicated that participants scoring high in autonomous forms of motivation had higher perceptions of subjective vitality regardless of depleting condition. A significant three way interaction between depletion, autonomous motivation and controlling motivation was also observed.

This finding indicates that perceptions of subjective vitality for those high and low in autonomous motivation across the depleted and non-depleted conditions differed depending on the level of controlling motivation. Participants who possessed low controlled motivation and high autonomous motivation demonstrated a similar level of vitality regardless of depletion condition. Participants low in controlled motivation and low in autonomous motivation demonstrated lower levels of subjective vitality when ego-depleted. In contrast, participants high in controlled motivation demonstrated similar levels of subjective vitality regardless of whether they were high or low in autonomous motivation whether depleted or not depleted. These results provide partial support for SDT and previous research by indicating that being high in autonomous motivation and low in controlled motivations for conducting a behaviour is associated with maintained vitality (Ryan & Deci, 2008). For example, Nix and colleagues (1999) demonstrated in a variety of studies that undergraduate students who engaged in activities for autonomous reasons exhibited enhanced or maintained feelings of subjective vitality relative to students with more controlled reasons. Kasser and Ryan (1999) showed that when older participants possessed more autonomous regulations towards their daily activities they demonstrated higher levels of subjective vitality.

The conflicting results for subjective vitality observed between the motivational support conditions and the personal motivation scores suggest that there may have been an aspect of the manipulation that did not fully support autonomous motivation. A potential confounding factor may have been that the majority of participants were first and second year undergraduates participating in research to accrue credit towards their degree. It is possible that the external reward for participating may have created some external regulations for participating in the study not measured by the manipulation checks.

Limitations and Future Directions

The present study represents a novel experimental design that attempted to understand the processes responsible for how one adheres to a focal goal and resist temptation in the face of cognitive depletion. Results stemming from experimental research, such as that employed in the present study, adds further understanding of the barriers to and solutions for participating in regularly PA as well as feelings of mental well-being. Specifically, the present research highlights that when participants are high in autonomous motivation and low in controlling motivations for conducting a cognitively depleting task, they maintain perceptions of vitality. Therefore, employers, teachers and coaches that attempt to create autonomy supportive environments could help support their employee's mental well-being.

Edmunds (2005) highlighted that a major limitation of the exercise focussed literature is the lack of studies that examine the theoretical tenets of SDT using experimental designs. In addition, it is important that research in the exercise and public health domain continue to test and examine the role of complementary and alternative theories through experimental research designs to assess whether they add further understanding to the processes responsible for behaviour change and associated mental health outcomes. However, despite the innovative nature of this research, limitations must be acknowledged.

When interpreting results from experimental studies caution must be expressed for the degree to which their findings can extrapolate to real world settings. It is clear that any conclusions drawn from our study would require further examination in more ecologically valid studies. Further, the limitation of dichotomising motivation at the median must be acknowledged (e.g., similarity of those individuals close to the median split, a reduction in effect size and an increased chance of finding spurious effects; Field, 2005). However, there is clear theoretical reasoning for splitting individuals into those with high and low in autonomous motivation, and those with high and low in controlled motivation (MacCallum,

Zhang, Preacher, & Rucker, 2002). SDT suggests that quality of motivation varies on a continuum and that the quantity of autonomous and controlled motivation can also vary. Therefore, a median split facilitates the dichotomization based on quantity as well as the quality of motivation.

The design of this study meant that even before a participant had received information about the up-coming cognitive self-control task, each participant may have already made the decision to complete the resting trial. That is, previous research indicates that counteractive evaluations only take place before a decision is made. For example, Myrseth et al., (2009) showed that gym participants only bolstered the value of a healthly bar compared to a chocolate bar *before* deciding which to eat. Once the decision had been made, participants rated the two bars equally. Therefore, although the present design did not require participants to make a choice between the two trials until they rated the utility of the physically active and resting trials, participants knew that this decision was approaching and may have had already consciously made their decision. Future research designs could examine whether knowledge of an approaching choice between giving in to temptation or sticking to a focal goal reduces the ability to employ counteractive evaluations. Therefore, such designs should not indicate to the participant that they will have to make a choice until after the depletion task. Further, in determining the effects of ego depletion on counteractive self-control this study only examined one counteractive control strategy. Counteractive self-control theory (Trope & Fishbach, 2000) also proposes that one can employ choice alternatives as a method of resisting temptations. Therefore, future research designs could incorporate choice alternatives as a measure of counteractive control. For example, participants could be requested to assign a proportion of their research credit to a temptation and valued goal. The proportion of credit assigned could indicate efforts to support adherence to the focal goal or give in to temptation.

Summary

To conclude, this study successfully manipulated ego depletion and supported autonomous motivation towards an ego depleting task. However, these experimental conditions did not have any significant influence on the ability to enhance the value of an imposed goal or to actually choose that goal over a tempting alternative. Despite these non-significant results, this study provided partial support for SDT's (Deci & Ryan, 2000) proposition that high personal autonomous motivation combined with low controlling motivation is associated with vitality in the face of both depleting and not depleting tasks. Future research should continue to develop study designs that explore the role of ego depletion on people's ability to employ counteractive control strategies. Knowledge of the processes that underpin the capacity to adhere to a long-term goal and resist temptations could have important implications for developing more effective health interventions.

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Table 1

Mean (Standard Deviations) Counteractive Control Scores Towards the Resting Trial and Physically Active Trial

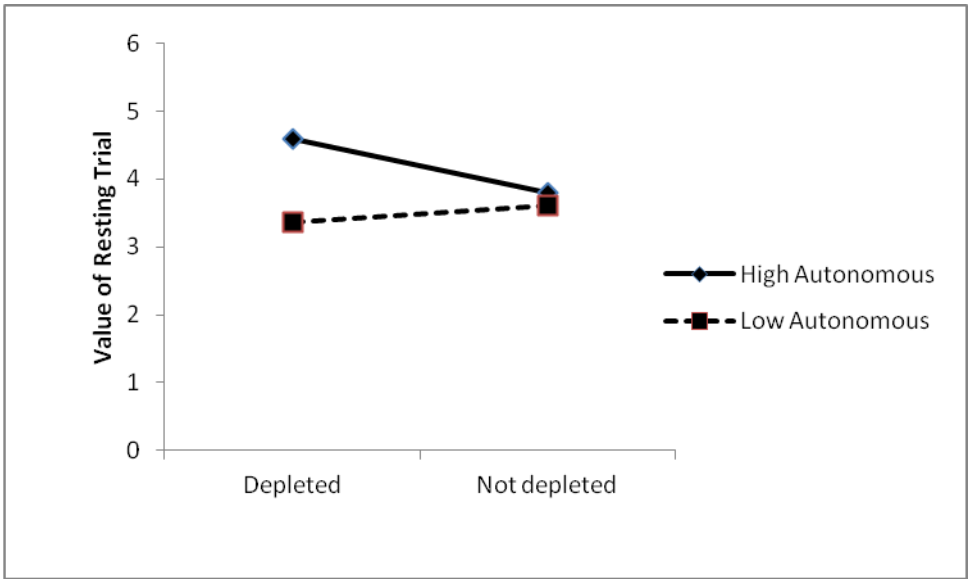
	Depleted				Non-depleted			
	Autonomous		Controlled		Autonomous		Controlled	
	M	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*
Value of Resting Trial	4.32	(1.10)	3.72	(1.29)	3.81	(.87)	3.68	(.99)
Value of PA Trial	4.40	(1.1)	4.07	(1.17)	4.35	(.88)	4.22	(1.39)

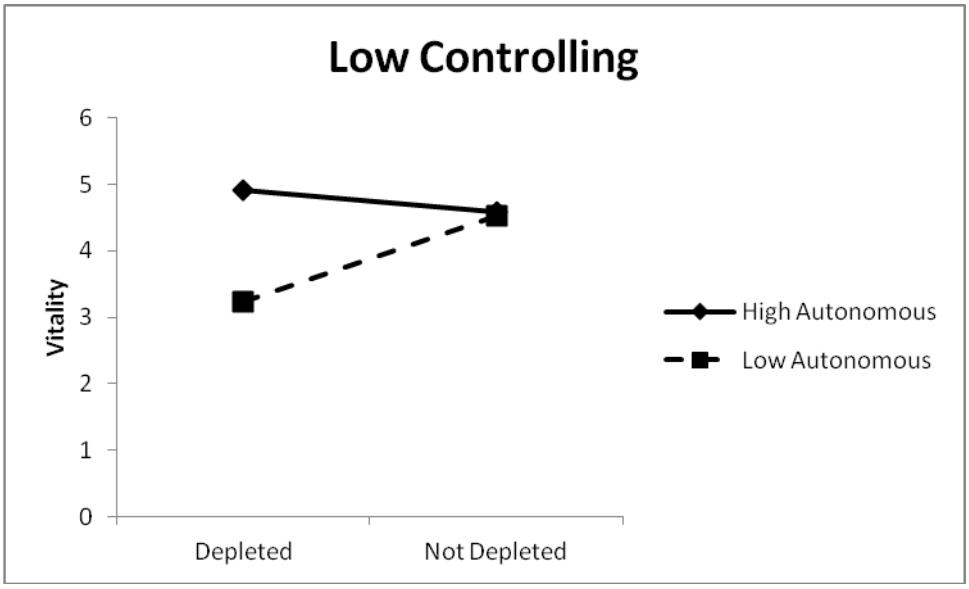
Figure Captions

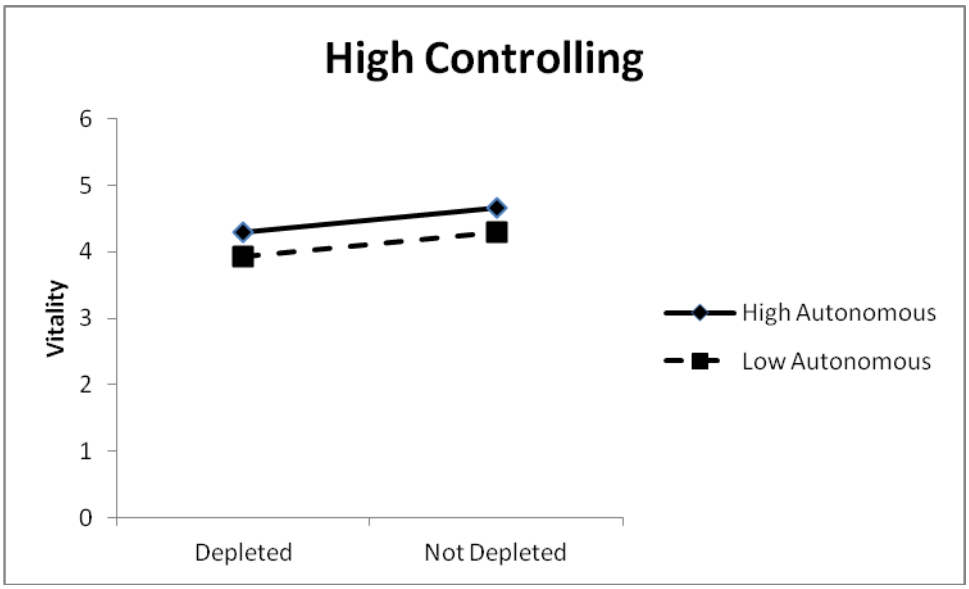
Figure 1. The value participants high and low in autonomous motivation (SIMS) placed on the resting trial when depleted and when not depleted.

Figure 2a. Three-way interaction for subjective vitality scores for participants low in controlled motivation, autonomous motivation and depletion conditions.

Figure 2b. Three-way interaction for subjective vitality scores for participants high in controlled motivation, autonomous motivation and depletion conditions.


Value of Resting Trial
6
5
4
3
2
1
0
Depleted
Not depleted
High Autonomous
Low Autonomous


Low Controlling
Vitality
6
5
4
3
2
1
0
Depleted
Not Depleted
High Autonomous
Low Autonomous


High Controlling
Vitality
6
5
4
3
2
1
0
Depleted
Not Depleted
High Autonomous
Low Autonomous