Exploring the Link Between Ego Depletion and Exercise Intentions

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Abstract

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People are constantly subject to external demands that can lead to impairments in self-control. One theory that accounts for such impairments is ego depletion, which can be responsible for people choosing to succumb to unhealthy habits rather than engaging in health-related behaviors. In study 1, I investigated the effect of ego depletion on exercise intentions among participants who do not exercise. I also tested whether showing participants an exercise advertisement framed in terms of the desirable outcomes to be attained by exercising would attenuate the effect of ego depletion on exercise intentions. No support was found for these predictions. In study 2, I used a revised measure of exercise intentions, and I examined participants who do exercise. I also investigated whether exercise self-efficacy would mediate the effect of ego depletion on exercise intentions and whether exercise habit strength would moderate these relationships. Support was found for the interaction of ego depletion and exercise habit strength on exercise self-efficacy.

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Introduction

Imagine you are on your way home after a long day at work. Today was an especially hard day because you were faced with additional strenuous tasks that you were not expecting. In turn, you might be feeling depleted. While sitting on the bus, you look up, and you see a health-related advertisement that shows the benefits of exercise. You do not normally exercise, but is it possible that simply seeing this advertisement might increase your intention to start exercising? Would it matter whether the advertisement focused on the undesirable outcomes that can be prevented by exercising (e.g., heart disease) versus the desirable outcomes that can be gained by exercising (e.g., physically fit)?

The first goal of this research is to examine the link between ego depletion and exercise intentions. Building from past research that has shown that ego depletion reduces the duration and frequency of exercise (Oaten & Cheng 2005), I predict that this effect will hold for exercise intentions. In addition, a second goal of this research is to counteract the proposed impact of ego depletion on exercise intentions. While the basic effect of ego depletion is that the exertion of self-control subsequently leads to a self-control impairment, the process model of ego depletion proposes that exerting self-control leads to a shift in motivation and attention towards obtaining rewards (Inzlicht & Schmeichel 2012). Indeed, past research has identified motivation as a moderator of ego depletion (Muraven & Slessareva, 2003; Walsh 2014). For example, leading participants to focus on rewards of a given behavior has successfully counteracted the effect of ego depletion on subsequent self-control efforts (Boucher & Kofos 2012; Muraven & Slessareva 2003). In line with the process model of ego depletion, I test whether showing depleted participants an exercise advertisement framed in terms of the desirable outcomes (rewards) to be gained by exercising can counteract the effect of ego depletion on exercise intentions.

Now imagine a scenario similar to the one described earlier. That is, you are on your way home after a long day at work (i.e., you are feeling depleted), but in this scenario, imagine that you do exercise weekly, and you are planning on exercising this evening. You are about to doze off on the bus when you receive a message from a friend asking you to meet for a drink tonight. This unexpected invite is acting as a barrier to your intended exercise plans. Of course, you could make a conscious decision to go exercise, but given what you have endured at work, you are having trouble declining the offer to meet your friend for a drink, the seemingly more relaxing option. Are you having trouble declining this offer because your depleted state has made you more focused towards immediately rewarding behavior (e.g., going for a drink with a friend)? Or is it that being depleted has made you unable to cope with the prospect additional strenuous activity (e.g., exercise), especially in the face of a barrier to your exercise plans? Additionally, would being a habitual exerciser make you more likely to choose to exercise rather seeing your friend?

A third goal of this research is to examine the mediating role of exercise self-efficacy on the relationship between ego depletion and exercise intentions. Specifically, I predict that a depleted state leads to a decrease in exercise self-efficacy, which is the confidence in one's own abilities to perform exercise behaviors, especially in the face of barriers (Ducharme & Brawley 1995; Sniehotta, Scholz, & Schwarzer 2005). Being that self-efficacy influences motivation (Bandura & Cervone 1986; Schunk 1995), such a finding might help to explain the process model's proposed impact of depletion on motivation. Lastly, the final goal of this thesis is to look at how exercise habit strength moderates the effect of ego depletion on exercise intentions and exercise self-efficacy. Since past research has shown that those who with stronger habits (i.e., behaviors that are automatic and frequent; Verplanken & Orbell 2003) are less likely to fall

victim to self-control threats to those habitual behaviors (Neal, Wood, & Drolet 2013), in this instance, I predict that those who are habitual exercisers are less likely to have their exercise intentions and exercise self-efficacy impacted by ego depletion.

The remainder of this thesis is organized as follows. First, I discuss ego depletion and its potential impact on exercise intentions. Second, I discuss how framing the positive outcomes to be gained by exercising (vs. the undesirable outcomes to be avoided by exercising) in an exercise advertisement might help to counteract the effect of ego depletion on exercise intentions. Third, I review the literature on ego depletion and self-efficacy, and then I propose exercise self-efficacy as a mediating variable on the relationship between ego depletion and exercise intentions. Lastly, I explain the potential moderating role of exercise habit strength on two relationships, namely ego depletion and exercise intentions, and ego depletion and exercise self-efficacy. These predictions will be tested across two studies. This thesis will then conclude with a discussion of the findings and the implications of this research.

Theoretical Background

Ego Depletion

The original resource model of ego depletion posits that self-control is a finite resource and that exerting self-control on one task reduces the capacity to exert self-control on a following task (Baumeister, Bratslavsky, Muraven, & Tice 1998). However, the resource model of depletion has been subject to much scrutiny, and while some have questioned its merit (Carter & McCullough 2014; Lurquin & Miyake 2017; Friese, Loschelder, Gieseler, Frankenbach, & Inzlicht 2019; Job, Dweck, & Walton 2010), others have proposed alternative explanations to account for its effect (Tice, Bratslavsky, & Baumeister 2001; Hagger, Wood, Stiff, & Chatzisarantis 2010a; Inzlicht & Schmeichel 2012). More recently, Inzlicht and Schmeichel

(2012) put forth the process model of depletion, which states that exerting self-control leads to shifts in attention and motivation away from deliberate control and towards rewards. An important similarity between the resource model and the process model is that according to both models, the exertion of self-control at time 1 leads to self-control impairment at time 2.

A considerable amount of research has examined the effect that depletion has on attitudes and behaviors. Such areas of research include persuasion (Burkley 2008; Wheeler, Briñol, & Herman 2007; Itzchakov, Uziel, & Wood 2018), task performance and task persistence (Baumeister et al. 1998), risk perceptions (Lisjak & Lee 2014), message processing (Agrawal & Wen Wan 2009), brand attitudes (Gillespie, Joireman, & Muehling 2012), prosocial behavior (Achtziger, Alós-Ferrer, & Wagner 2015), and personal health (see Hagger, Wood, Stiff, & Chatzisarantis 2009). Within the domain of health-related (and lack thereof) behaviors, one commonality among depletion research is that impaired self-control often leads to outcomes that are impulsive and sometimes maladaptive. For example, Muraven, Collins, and Nienhaus (2002) found that participants who were depleted consumed larger quantities of beer in an ostensibly unrelated taste test. Additionally, Muraven, Collins, Shiffman, and Paty (2005) demonstrated similar findings in a more naturalistic setting. Specifically, participants who reported to exert more self-control in their daily lives were more likely to increase their daily alcohol consumption. Similar outcomes have been uncovered in contexts related to food consumption. Walsh (2014) found that participants who were depleted ate larger quantities of chocolate chip cookies while filling out demographic information at the end of an experiment. In research conducted by Inzlicht and Kang (2010), participants who were depleted by coping with stereotype threat subsequently ate larger quantities of ice cream.

More closely related to my thesis is the research that has examined the effects of depletion on physical activity. Early depletion research conducted by Muraven, Tice, and Baumeister (1998) showed that depleted participants were less likely to persist at a hand-grip task, which requires physical effort. In another set of studies, athletes who were depleted after working on a cognitively demanding task performed fewer sit-ups than athletes who were not depleted (Dorris, Power, & Kenefick 2012). These findings are in line with evidence showing that depletion generally lowers the level of effort exerted on difficult tasks (Hagger et al. 2010a).

It is important to note that the physical behaviors measured in past depletion studies were often tasks assigned to the participants by the researchers. In a real-world setting, a person who has impaired self-control due to depletion might decide to not attempt the difficult task. If this is the case, performance on a task has less meaning, since the task was to never be attempted in the first place. To illustrate, if a depleted individual faces certain barriers towards regulating impulses (see Inzlicht & Schmeichel 2012), this individual might decide to not exercise, especially if more tempting options are available. An example of how depletion might negatively affect people's willingness to engage in a behavior was demonstrated by Oaten and Cheng (2005). In their research, the authors found that students who were dealing with exam stress had impaired self-control, and that this impairment led not only to a decrease in the duration of exercise, but also to a decrease in the frequency of exercise. The authors concluded that the participants in this study exhibited a decrease in exercise frequency and duration due to being depleted. The study of intentions in relation to depletion is then important. After all, intentions are "indications of how hard people are willing to try" (Ajzen 1991, p.181), and intentions often precede behaviors (Sniehotta et al. 2005). Building from previous research that has demonstrated the negative effect of depletion on exercise behaviors, I predict,

H1: Depletion will reduce exercise intentions, such that in comparison to nondepleted participants, participants who are depleted will display lower exercise intentions.

Ego Depletion and Message Framing

Having discussed ego depletion and how it can impact exercise intentions, we will now look at a potential moderator of this effect: message framing. As previously mentioned, Inzlicht and Schmeichel (2012) proposed the process model of depletion as an alternative to the original resource model, which dictates that self-control is a finite resource that depletes temporarily upon exertion. According to the process model, those who are depleted after an initial act of self-control become unable to exert self-control on a following task due to shifts in attention and motivation towards satisfying immediate desires. An interesting aspect about the process model is that it seems to better explain how previous research has been able to find ways to counteract the depletion effect (Inzlicht & Schmeichel 2012; Walsh 2014).

Research performed by Walsh (2014) demonstrated that priming participants with a goal prior to depleting them diminished the effect of depletion. Specifically, depleted participants who were primed with a goal were more motivated than nondepleted participants to exert self-control on a goal-related task. Early research by Muraven and Slessareva (2003) also found that motivation moderates the effect of depletion on self-control. In their research, the authors demonstrated that monetary incentives (study 3) and induced beliefs about the positive outcomes of a behavior (studies 1 & 2) counteracted the effect of depletion on subsequent self-control efforts. These findings provide evidence that depletion leads to a shift in attention and motivation towards obtaining rewards. Thus, if those who are depleted are less likely to intend to engage in physical activity, shifting the focus towards the positive outcomes gained from exercising might counteract the effect of depletion on exercise intentions. Consequently, the benefits of exercise

are often detailed in certain health-related communications, and one important area of study pertaining to health-related communications is message framing (Gallagher & Updegraff 2012).

There is a wide body of literature on message framing and its effects on consumer behavior. A message framed in terms of gains focuses on the benefits of engaging in a specific behavior, whereas a message framed in terms of losses focuses on the consequences of not engaging in a certain behavior (Block & Keller 1995). Another component of message framing is the kernel state. The kernel state of a message refers to the specific outcomes to be gained or avoided by engaging in a behavior, and both gain-framed and loss-framed messages can portray desirable or undesirable outcomes (de Bruijn, Out, & Rhodes 2014). To illustrate, a gain framed message might state, "If you floss regularly, you reduce your chances of developing gum disease." In this case, "gum disease" is an undesirable outcome or kernel state. Alternatively, a similar message might state, "If you floss regularly, you increase your chances of having healthy gums." The kernel state of this message is "healthy gums," a desirable outcome.

If depletion leads to reduced exercise intentions, showing depleted participants an exercise advertisement framed in terms of the desirable outcomes to be gained by exercising (vs. the undesirable outcomes to be avoided by exercising) might lead these participants to focus on the rewards of exercise. Such findings would support the process model of depletion, which proposes that depletion leads to shifts in attention and motivation towards satisfying rewards. It should be noted that past meta-analyses have suggested that the persuasiveness of message framing does not depend on whether the outcomes in a communication are portrayed as undesirable or desirable (see O'Keefe & Jensen 2006, 2007, 2008). More recent research conducted by de Bruijn et al. (2014) showed that participants who were randomly exposed to one of two kernel state conditions (undesirable vs. desirable) of an exercise communication did not

differ in their level of exercise intentions. In consequence, it seems unlikely that kernel state will have an effect on exercise intentions among those who are not depleted. Therefore, I predict,

> **H2a**: Kernel state will moderate the effect of depletion on exercise intentions, such that showing depleted participants an exercise advertisement that portrays the desirable outcomes to be attained by exercising (vs. the undesirable outcomes to be avoided by exercising) will counteract the effect of depletion on exercise intentions.
>
> **H2b**: There will be no effect of kernel state on exercise intentions among nondepleted participants.

Ego Depletion and Self-Efficacy

In a broader sense, self-efficacy can be referred to as the belief in one's capabilities to perform behaviors in order to achieve a desired outcome (Bandura 1977, 1997, 2006; Schwarzer 1992). It is a primary determining factor of many health-related behaviors, and those who are higher in self-efficacy for certain behaviors are less likely to relapse their previous unhealthy habits (Schwarzer 2008). However, it should be noted that self-efficacy is more practically related to specific behavioral outcomes (Bandura 2006). For instance, someone could be high in self-efficacy for healthy eating, but that does not mean that this person will also be high in self-efficacy for exercise, or any other behavior.

Self-efficacy beliefs have been shown to be an important predictor of smoking cessation (DiClimente 1981), pain control (Bandura, O'Leary, Taylor, Gauthier, & Gossard 1987), and academic achievement (Komarraju & Nadler 2013). More importantly, numerous studies have demonstrated that exercise self-efficacy is a strong predictor exercise intentions and behaviors (Ducharme & Brawley 1995; Dzewaltowski, Noble, & Shaw 1990; Scholz, Sniehotta, & Schwarzer 2005; Sniehotta et al. 2005). An important aspect of such studies is that they tend to

look at exercise self-efficacy in terms of people's beliefs in their abilities to overcome obstacles to their exercise routines (Ducharme & Brawley 1995). For example, a measure of exercise self-efficacy might ask respondents to rate their confidence in adhering to an exercise routine when faced with certain barriers (e.g., "When I am feeling tired," "When I am feeling depressed," "When there are other interesting things to do"; Bandura 2006).

Findings from past research suggest that impaired self-control reduces self-efficacy for certain behaviors. Although self-control was not assessed, Focht, Knapp, Gavin, Raedeke, and Hickner (2007) showed that acute bouts of exercise led to a decrease in self-efficacy to continue exercising. Additionally, Bandura and Cervone (1986) found that reduced self-efficacy after physical exertion led to decreased motivation to continue working on the same task. An important note about these studies is that they measured self-efficacy as a function of working on the upcoming task, and not necessarily as a function of barriers to the task. However, both physical and mental exertion can act as barriers to exercise (Toscos, Consolvo, McDonald 2012). It is then plausible that those who are depleted after a strenuous task are not willing to exert effort on a subsequent task because they feel that they are unable to face barriers to achieving a desired outcome. Nevertheless, research in these areas has produced mixed results.

In research conducted by Gailliot and Baumeister (2007), depleted participants did not demonstrate significant differences in self-efficacy in comparison to nondepleted participants. A limitation of this research is that the authors measured self-efficacy using one item to assess perceived performance on the depleting task, and self-efficacy, although sometimes influenced by past behaviors (Orsega-Smith, Payne, Mowen, Ho, & Godbey 2007), is a measure of future behaviors (Bandura 1997, 2006; Chow, Hui, & Lau 2015). Comparatively, research by Chow et al. (2015) found evidence that depletion decreases self-efficacy for certain behaviors. Across

three studies, the authors demonstrated that participants who exerted self-control at time 1 displayed reduced self-efficacy for healthy eating (study 1) and for performance on various mental tasks (studies 2 & 3). Hence, the current research aims to replicate these findings in a different domain: exercise. Furthermore, since self-efficacy helps to predict exercise intentions (Scholz et al. 2005; Sniehotta et al. 2005), another important aim of the current research is to examine whether exercise self-efficacy mediates the relationship between depletion and exercise intentions. Thus, this research predicts,

H3a: Ego depletion will reduce exercise self-efficacy, such that in comparison to non depleted participants, depleted participants will display lower exercise self-efficacy.

H3b: Exercise self-efficacy will mediate the relationship between depletion and exercise intentions.

Ego Depletion, Self-Efficacy, and Habits

Habits can be defined as behaviors that have become automatic and frequent (Verplanken & Orbell 2003). People form habits through the repetition of a behavior, sometimes in an attempt to achieve a goal (Wood & Neal 2007). An equally important feature of habits is that they are often prompted by situational cues (Verplanken & Melkevik 2008). For instance, in research conducted by Neal, Wood, Wu, and Kurlander (2011), habitual popcorn eaters assigned to either a stale or fresh popcorn condition ate equal amounts of popcorn in a movie theater but not in a conference room, regardless of hunger. Although such food habits might be seen as unhealthy, habits can often be beneficial for personal health. That is, someone might develop a beneficial habit of going for a run every morning before getting ready for work. In contrast, someone might develop a detrimental habit in the form of eating an unhealthy snack every afternoon at work.

There have been several studies that have examined the link between habits and self-control. Research by Galla and Duckworth (2015) demonstrated that those with good self-control tend to practice better habits that lead to more beneficial life outcomes. In addition, the results from this study as well as others demonstrated that those with good self-control do not necessarily work harder in order to resist temptation, but rather, through self-control, they have developed good habits to rely on (Adriaanse, Kroese, Gillebaart, & De Ridder 2014; Gillebaart & Adriaanse 2017). Accordingly, habits persist even when self-control is impaired due to depletion (Orbell & Verplanken 2015). This is because performing habitual behaviors is a somewhat default response that requires little motivation and self-control (Neal et al. 2013). For example, in research performed by Neal and Wood (2006), participants who were depleted continued to engage in both beneficial (going to the gym) and detrimental (going to Krispy Kreme in the afternoon) habits (Neal, Wood, & Quinn 2006). Neal et al. (2013) extended these findings by showing that habit performance for both good and bad habits increased when self-control was impaired. If depletion does lower exercise intentions, the exercise intentions of habitual exercisers should then be unaffected by depletion. In addition, given exercise self-efficacy helps to predict exercise intentions (Scholz et al. 2005; Sniehotta et al. 2005), the exercise self-efficacy of habitual exercisers should also be resistant to the effects of depletion. Formally,

> **H4a:** Exercise habit strength will moderate the effect of depletion on exercise intentions, such that participants with stronger exercise habits will not have their exercise intentions affected by depletion.

H4b: Exercise habit strength will moderate the effect of depletion on exercise self-efficacy, such that participants with stronger exercise habits will not have their exercise self-efficacy affected by depletion.

Overview of Studies

In study 1, I tested hypothesis 1, which states that depletion will decrease exercise intentions. I also tested hypothesis 2a, which states that showing depleted participants an exercise advertisement portraying the desirable outcomes to be attained by exercising (kernel state) will counteract the effect proposed in hypothesis 1, and hypothesis 2b, which states that kernel state will have no effect on exercise intentions among nondepleted participants. Study 1 demonstrated no effect of depletion on exercise intentions (hypothesis 1) and no interaction of depletion and kernel state (hypothesis 2a). It should be noted that in study 1, I recruited participants who reported to not exercise, as the results of a pretest suggested that the kernel state manipulation would be most effective among these participants.

For study 2, I recruited participants who reported to exercise, and I looked at whether depletion would lower exercise intentions among these participants (hypothesis 1). I also tested hypothesis 3a, which states that depletion will lower exercise self-efficacy, and hypothesis 3b, which predicts that exercise self-efficacy will mediate the relationship between depletion and exercise intentions. There was no main effect of depletion on exercise intentions (hypothesis 1) and on exercise self-efficacy (hypothesis 3a). In this study, I also tested hypothesis 4a, which states that exercise habit strength will moderate the effect of depletion on exercise intentions, and hypothesis 4b, which states that exercise habit strength will moderate the effect of depletion on exercise self-efficacy. Unexpectedly, the results showed that among those with stronger exercise habits, depletion reduced exercise self-efficacy. The reverse effect was observed for participants

with weaker exercise habits. The implications of these findings are discussed in the General Discussion portion of this thesis.

Pretest 1

The goal of this pretest was to explore whether the two exercise communications created for study 1 successfully depicted either the positive outcomes that can be attained by exercising or the negative outcomes can be avoided by exercising (kernel state: undesirable vs. desirable). In this pretest, I also measured exercise importance and exercise frequency as a means to explore whether there would be differences in perceptions of outcomes at different levels of these measures. If such differences were to exist, this criterion could then be used for selecting participants for study 1. It should be noted that the measure of exercise frequency used in this pretest is different from the measure of exercise habit strength used in study 2.

Method

Design and participants. A two-factor (kernel state: undesirable vs. desirable) pretest was conducted to examine whether the exercise advertisement manipulation to be used for study 1 successfully portrayed either the desirable outcomes to be gained by exercising or the undesirable outcomes to be avoided by exercising. Seventy participants (28.6% female; M_{age} = 37.50, SD = 13.32) recruited through the Amazon Mechanical Turk platform were randomly assigned to each condition, and each participant was provided a nominal monetary compensation ($1.00 US).

Procedure. Participants were told that they would be participating in a study about consumer perceptions of exercise information. In the first part of the pretest, participants were asked questions pertaining to exercise goal importance (May & Irmak 2014): “How important is it for you to exercise?” and “How important is it for you to engage in physical activity?” (1 = not

at all to 7 = very). They were also asked to self-report their weekly exercise frequency: "On average, how many hours per week do you exercise?" (exercise frequency: I generally don't exercise vs. 30 minutes – 1 hour vs. 1 – 2 hours vs. 2 – 3 hours vs. more than 3 hours). The question intended to measure self-reported exercise frequency was borrowed from MTurk's inclusion / exclusion criteria.

In the second part of the pretest, participants were told that they would first be viewing a digital advertisement containing exercise information, and that they would then be asked questions pertaining to the digital advertisement. After viewing the advertisement containing either undesirable or desirable outcomes **(**Appendix A**)**, participants were presented a set of three statements that served as attention checks: "According to the advertisement, playing poker counts as exercise," "The exercise guidelines presented in the advertisement are for children under the age of 12," and "According to the advertisement, walking counts as exercise" (true or false). After providing their answers to the attention check statements, participants were then asked to rate the tone of the advertisement (-3 = very negative to +3 = very positive), the convincingness of the advertisement (-3 = very unconvincing to +3 = very convincing), and the outcomes portrayed in the advertisement: "In the advertisement you just read, we listed a number of "outcomes" that adults who exercise are likely to experience. Did these "outcomes" focus on the bad things that can be prevented by exercising or on the good things that can be gained by exercising?" (-3 = bad things to +3 = good things; Berry & Carson 2010; de Bruijn et al. 2014). The questions on tone and convincingness served as filler questions that were inserted in order to disguise the purpose of the study

Finally, participants answered a set of questions regarding demographics (e.g., age, gender), English language abilities (reading, writing, speaking), issues while completing the

study (technical, distraction), and permission for data use. Participants were also invited to write what they thought the purpose of the study was.

Results and Discussion

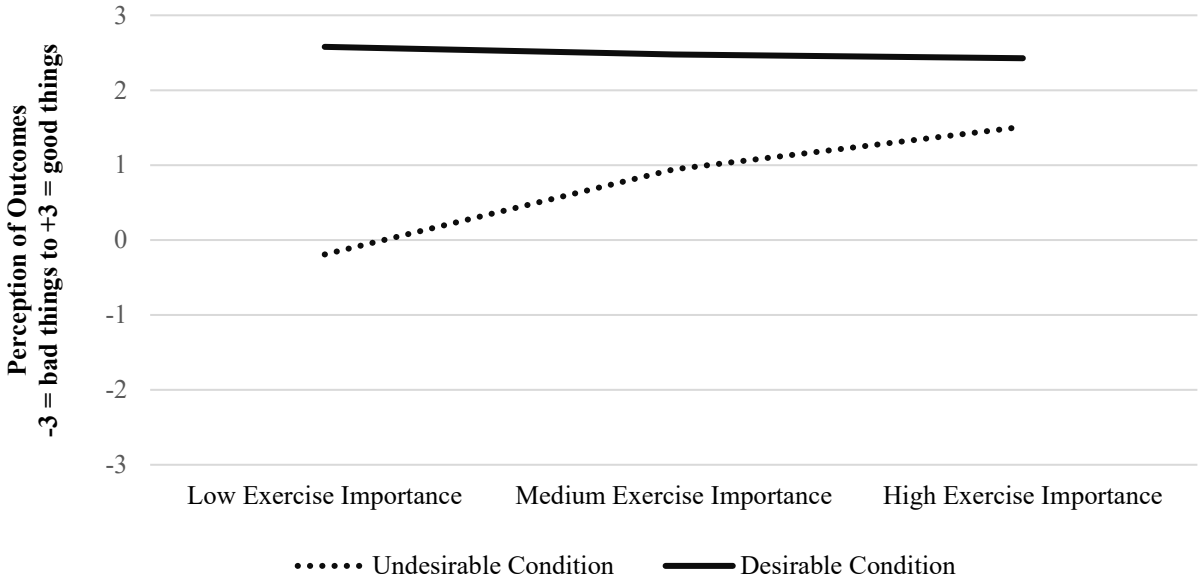
Exclusion criteria. Participants were removed from the analysis based on a number of exclusion criteria. First, two participants did not provide permission to use their responses, so these participants were excluded. Next, eight participants who failed the attention checks (more than one out of three questions wrong) were excluded. Accordingly, the responses from 60 participants were included in the analysis (31.7% female; M_{age} = 37.99, *SD* = 13.54).

Kernel state manipulation. The results of a t-test demonstrated that participants in the undesirable kernel state condition (*M* = .62, *SD* = 1.82) perceived the outcomes listed in the advertisement as less desirable than did participants in the desirable kernel state condition (*M* = 2.52, *SD* = .89; $t(40) = 5.07$, $p < .001$). Since Levene's test indicated unequal variances (F = 14.81, $p < .001$), the degrees of freedom were adjusted from 58 to 40. Although there was a significant difference in the perception of outcomes between participants in each condition, participants in the undesirable condition rated the outcomes as desirable (*M* = .62, *SD* = 1.81, on a scale of -3 to +3). Furthermore, a one sample t-test demonstrated that this value (*M* = .62, *SD* = 1.81) was not significantly different from the midpoint, which is 0 ($t(28) = 1.84$, $p = .08$). Thus, additional analyses were conducted.

First, a moderation analysis using PROCESS Model 1 (Hayes 2017) was conducted to analyze the interaction effect of kernel state and exercise importance (two items; $r(58) = .88$, $p < .001$) on perception of outcomes. The results of the moderation analysis revealed a main effect of kernel state ($\beta = -.51$, $t(58) = -5.27$, $p < .001$), a main effect of exercise importance ($\beta = -.24$, $t(58) = 2.51$, $p = .01$), and a significant interaction of kernel state (coded as 0 = undesirable and

1= desirable) and exercise importance (β = .27, t(56)= 2.87, p = .006). The interaction effect was most pronounced at the lowest level of exercise importance. See figure 1.

Figure 1: Exercise Importance × Kernel State Interaction on Perception of Outcomes

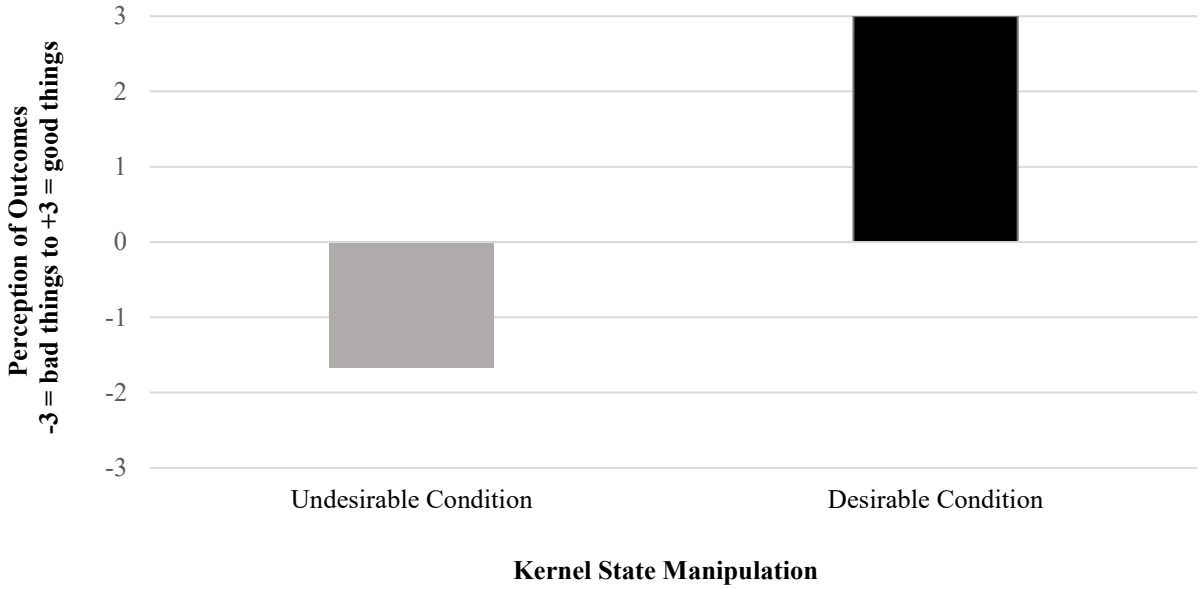


Note: values for graphical representation were set by PROCESS Model 1 (Hayes 2017) at the following levels of the unstandardized scale: low exercise importance = 4.00, medium exercise importance = 6.00, and high exercise importance = 7.00.

Since exercise importance and exercise frequency were found to be significantly and positively correlated (r(58) = .69, p < .001), a 2 (kernel state: undesirable vs. desirable) × 5 (weekly exercise frequency: I generally don't exercise vs. 30 minutes – 1 hour vs. 1 – 2 hours vs. 2 – 3 hours vs. more than 3 hours) ANOVA was conducted. The results revealed a main effect of kernel state (F(1, 50) = 25.50, p < .001), no main effect of frequency (F(4, 50) = 1.90, p = .14), and no interaction of kernel state and frequency (F(4, 50) = 2.24, p = .08). However, a test of simple main effects using the Bonferroni correction revealed that participants who do not exercise were the only ones to perceive undesirable outcomes as truly undesirable ($M_{Undesirable}$ = -1.67, SD = 1.53; $M_{Desirable}$ = 3.00, SD = .00; F(1, 50) = 18.23, p < .001; n = 6). The results of these additional analyses suggested that the kernel state manipulation would be most effective

among participants who do not exercise. Specifically, it was expected that the moderating role of kernel state on the relationship between depletion and exercise intentions would be most effective among participants who don't exercise. See figure 2.

Figure 2: Effect of Kernel State on Perception of Outcomes Among Participants who do not Exercise



Study 1

Study 1 had two main objectives. The first objective was to test hypothesis 1, which states that participants who are depleted will display a lower intention to exercise. The second objective was to test hypothesis 2a, which states that an exercise communication that displays desirable outcomes will counteract the effect of depletion on exercise intentions, and hypothesis 2b, which states that there will be no effect of kernel state among nondepleted participants. Based on the results of the first pretest suggesting that people who do not exercise are more susceptible to the framing of undesirable outcomes in an exercise advertisement, participants who do not exercise were recruited to participate in this study.

Method

Design and participants. One hundred and sixty participants (55 % female; M_{age} = 38.00, *SD* = 11.87) who reported that they do not exercise were recruited through the Amazon Mechanical Turk platform. These participants were selected based on an inclusion criterion listed on Mturk ("I generally don't exercise"). Participants were randomly assigned to a 2 (depletion: nondepletion vs. depletion) × 2 (kernel state: undesirable vs. desirable) experimental design, and each participant was compensated ($2.00 US).

Procedure. Participants were told that they would be completing three tasks as part of this study. In the first task, participants were asked to solve a series of anagrams (word puzzles) ostensibly meant to assess creative skills. This anagram task is a commonly used depletion manipulation (Walsh 2014). Participants in the nondepletion condition were given hints with each word puzzle (e.g., C D E E I T X (hint: an emotion): _____), whereas participants in the depletion condition were not given any hints (e.g., C D E E I T X _____). The purpose of not providing hints for the anagrams in the depletion condition is to force participants to exert self-control to complete the task. Participants were given a minimum of two minutes and a maximum of four minutes to complete the anagrams. The page automatically advanced once the four minutes had elapsed.

After the depletion manipulation, participants were asked a series of manipulation check questions, each anchored on a seven-point Likert scale (1 = not at all to 7 = very), to assess how effortful, difficult, and tiring they found the task (Itzchakov et al. 2018). In addition, participants were asked a set of five questions related to both positive (pleasant, pleased) and negative (depressed, unhappy, in a bad mood) mood. Each mood item was displayed to participants on a seven-point Likert scale (1 = definitely do not feel to 7 = definitely feel; Walsh 2014). The

purpose of assessing mood was to rule out the effect of mood on the dependent variable as an alternative explanation to self-control impairment (Baumeister et al. 1998).

In the second task, participants were told that they would be viewing an advertisement that contains exercise information, and that they would subsequently be asked questions regarding this advertisement. First, participants saw an ad containing either the desirable (e.g., physically fit, healthy heart) to be gained by exercising, or the undesirable (e.g., physically unfit, heart disease) outcomes to be avoided by exercising (Appendix A). This ad manipulation was the same one examined in the first pretest, and this task was designed to manipulate the perception of rewards to test the process model of ego depletion. Participants were then presented with the same attention check statements and filler questions used in the first pretest.

In the third task, participants were told that they would be asked a series of questions related to general health and eco-friendliness. The items measuring exercise intentions, the dependent variable for this study, were inserted among a set of filler questions about doctor's visits and eco-friendly behavior, in an attempt to disguise the purpose of the study. The three-item exercise intention measure was adapted from a scale used by White, Macdonell, & Dahl (2011). The items stated, "How likely are you to start exercising within the next seven days?", "How inclined are you to start exercising within the next seven days?", and "How willing are you to start exercising within the next seven days?" Participants provided each answer on a seven-point Likert scale (1= not at all to 7 = very). Once the study was over, participants answered a final set of questions (e.g., demographics) identical to those used in the first pretest.

Results

Exclusion criteria. A preliminary look at the data revealed that 22 participants had successfully completed the anagram task in the depletion condition. Since it is quite unusual for

such a high number of participants in the depletion condition to fully complete the anagram task, further analyses were conducted on the depletion manipulation check questions. Specifically, participants were separated into three groups: nondepletion, depletion, and failed depletion (those who fully completed the anagram task). A one-way ANOVA on the depletion manipulation check using the three aforementioned groups revealed a significant main effect of the three-group manipulation ($F(2, 157) = 98.36$, $p < .001$). A post hoc analysis using Tukey's HSD revealed significant differences between the groups at each level ($M_{Nondepletion} = 1.96$, $SD = .93$; $M_{Depletion} = 4.75$, $SD = 1.36$; $M_{Faileddepletion} = 2.77$, $SD = 1.34$). These results indicated that the depletion manipulation was unsuccessful among participants in the depletion condition who successfully completed the anagram task. The reason for this outcome is unclear, however, it is possible that repeated exposure to anagram tasks through studies on Mturk has led certain participants to seek out the aid of anagram solvers, which can easily be found online.

The remaining participants were excluded using the same criteria from the first pretest. Firstly, one participant was excluded for not granting permission to use the provided responses. Additionally, two participants were excluded for failing the attention checks (e.g., more than one out of three questions wrong). In sum, a total of 25 participants were excluded from the analysis, resulting in a total of 135 participants (52.7% female; $M_{age} = 38.39$, $SD = 12.11$).

Depletion manipulation check. A t-test on the depletion manipulation check (three items, $\alpha = .88$) revealed that participants in the depletion condition reported feeling more depleted ($M = 4.74$, $SD = 1.36$) than participants in the nondepletion condition ($M = 1.95$, $SD = .93$; $t(90) = -14.16$, $p < .001$). Since Levene's test indicated unequal variances, degrees of freedom were adjusted from 133 to 90. Based on the results from the t-test, the manipulation was deemed successful.

Effect of depletion on mood. Unexpectedly, a t-test on the measures of mood revealed that participants in the depletion condition were significantly different from participants in the nondepletion condition on ratings of both negative mood ($M_{Nondepletion}$ = 3.01, SD = 1.25; $M_{Depletion}$ = 3.71, SD = 1.38; $t(133) = -3.09$, $p = .002$) and positive mood ($M_{Nondepletion}$ = 4.89, SD = 1.33; $M_{Depletion}$ = 4.07, SD = 1.39; $t(133) = 3.46$, $p = .001$).

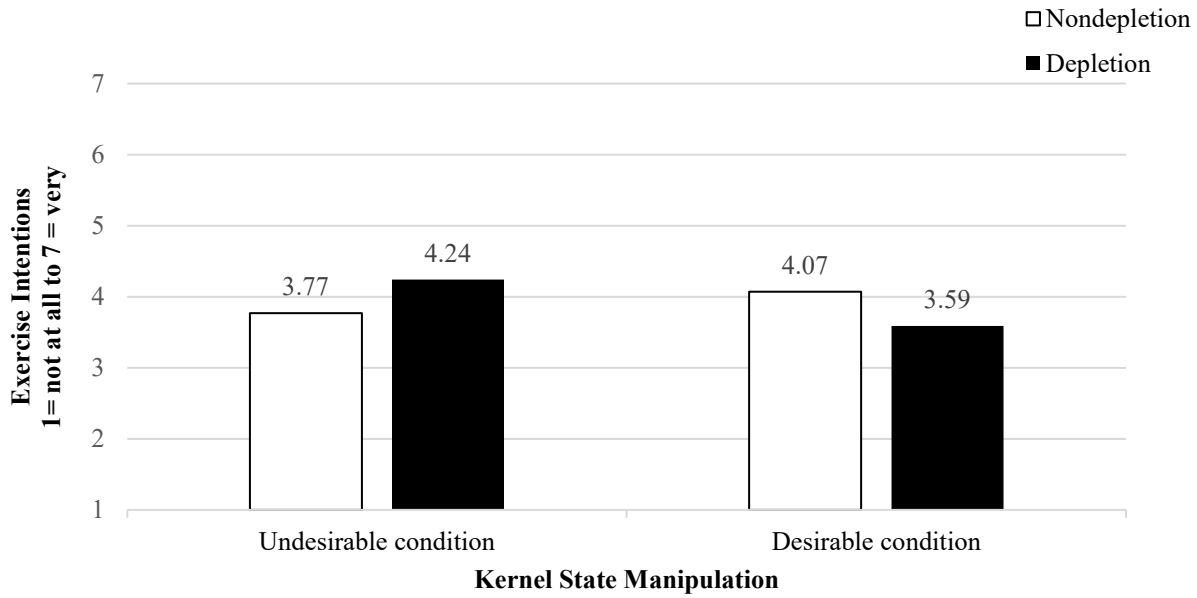
Given that depletion was found to have a significant effect on measures of positive mood (two items, $r(133) = .65$, $p < .001$) and negative mood (three items, $\alpha = .92$), additional tests were conducted to examine whether these variables should be included as covariates in the main analysis. First, a simple linear regression revealed that positive mood had a significant effect on exercise intentions ($b = .34$, $t(133) = 3.03$, $p = .003$), and that positive mood also explained a significant proportion of variance in exercise intentions ($R^2 = .065$, $F(1, 133) = 9.19$, $p = .003$). In order to test the homogeneity of variance assumption, a depletion × kernel state ANOVA was conducted on positive mood. The results revealed no interaction effect ($F(1, 131) = .025$, $p = .88$), confirming that positive mood was homogeneous across all groups. A second ANOVA on the dependent variable, exercise intentions, yielded a non-significant interaction of depletion, kernel state, and positive mood ($F(5, 93) = 5.31$, $p = .14$), meaning that the assumption of homogeneity of regression was confirmed. These results indicated that positive mood should be included as a covariate in the main analysis.

Following the analyses performed on positive mood, a series of tests was conducted to examine whether negative mood should be included as a covariate in the main analysis. The results of a second simple linear regression revealed that negative mood had a significant effect on exercise intentions ($b = -.37$, $t(133) = -3.12$, $p = .002$), and that negative mood also explained a significant proportion of variance in exercise intentions ($R^2 = .068$, $F(1, 133) = 9.76$, $p = .002$).

Furthermore, the results of a depletion × kernel state ANOVA on negative mood revealed no interaction effect ($F(1, 131) = .002$, $p = .97$), confirming the assumption of homogeneity of variance. A second ANOVA on exercise intentions yielded a non-significant interaction of depletion, kernel state, and negative mood ($F(6, 85) = 2.19$, $p = .051$). The latter result confirms the homogeneity of regression assumption. Thus, negative mood should also be included as a covariate in the main analysis.

Effect of depletion and kernel state on exercise intentions. A 2 (depletion: nondepletion vs. depletion) × 2 (kernel state: undesirable vs. desirable) ANCOVA was conducted on exercise intentions (three items, $\alpha = .96$). The results of this analysis revealed no main effect of depletion ($M_{Nondepletion} = 3.92$, $SE = .21$; $M_{Depletion} = 3.91$, $SE = .26$; $F(1, 129) = .001$, $p = .98$), no main effect of framing ($M_{Undesirable} = 4.00$, $SE = .23$; $M_{Nondepletion} = 3.83$, $SE = .23$; $F(1, 129) = .28$, $p = .60$), and no interaction of depletion and framing ($F(1, 129) = 2.16$, $p = .14$) after controlling for positive and negative mood. Additionally, participants in the nondepletion condition did not demonstrate significant differences in exercise intentions based on the kernel state manipulation ($M_{Difference} = .30$, $SE = .42$; $F(1, 129) = .53$, $p = .47$). However, since there was no effect of kernel state among depleted participants, the latter findings do not provide support for hypothesis 2b, as the kernel state manipulation could have been flawed. See figure 3 for a visual depiction of the findings.

Figure 3: Depletion × Kernel State Interaction on Exercise Intentions



Note: estimated marginal means are adjusted for covariates at the following values: positive mood = 4.55 and negative mood = 3.30.

Discussion

The results of study 1 could not support hypothesis 1, which states that depletion will reduce exercise intentions, and hypothesis 2a, which states that there will be an interaction of depletion and kernel state on exercise intentions. It should be noted that since there were potential issues with the depletion manipulation, the data might be deemed unreliable. Moreover, it is possible that the intention scale used was not a valid measure of intentions for this study. Participants who had never exercised before were asked if they would start exercising within the next seven days, and even in a state of depletion, agreeing to exercise at some point in the near future might not be perceived as requiring self-control resources. These issues were corrected in study 2.

Pretest 2

A depletion manipulation that was deemed more appropriate for online use was adapted from research performed by Muraven, Pogarsky, & Shmueli (2006). In such a task, participants in the nondepletion condition are asked to retype a passage into a text box. In the depletion condition, participants are asked to retype the same passage, however, they are instructed not to retype any spaces or *e*'s that they see in the text. There is a natural inclination to retype a passage as it is seen, and inhibiting this inclination requires self-control resources (Muraven, Shmueli, & Burkley 2006; Rieger 2004). Since previous research has provided limited details for the successful employment of such a depletion procedure, a pretest was conducted to determine whether the depletion manipulation created for use in study 2 would be successful.

Method

Design and participants. Seventy participants (44.3% female; M_{age} = 38.73, SD = 11.76) recruited through the Amazon Mechanical Turk platform were randomly assigned to a two-factor (depletion: nondepletion vs. depletion) experimental design. Participants were provided a nominal monetary compensation ($.90 US).

Procedure. Participants were told that they would be completing one task to assess typing ability. Participants in both conditions were shown a 266-word word passage adapted from a business textbook. In the nondepletion condition, participants were instructed to retype the passage as fast they can. In the depletion condition, participants were instructed to retype the passage as fast as they can, but to omit all spaces and letter *e*'s as they retyped the passage. An image of the text was displayed to participants so that the text could not be copied and pasted into the text box. Further, in order to ensure that mood was not affected by the depletion manipulation, participants were told to type as fast as they can but to not be concerned with

being able to finish the task. The time limit to complete the task was two minutes, however, participants in both conditions were required to stay on the task page to work on the task for the total two minutes. The page advanced automatically once the time had elapsed.

After the depletion manipulation, participants were asked how effortful, difficult, and tiring they found the task (1= not at all 7 = very; Itzchakov et al. 2018). Additionally, participants were asked two questions to assess positive mood (pleasant, pleased) and three questions to assess negative mood (depressed, unhappy, in a bad mood). Each mood item was displayed to participants on a seven-point Likert scale (1 = definitely do not feel to 7 = definitely feel; Walsh 2014).

Finally, participants answered a final set of questions (e.g., demographics) almost identical to the ones used in pretest 1 and study 1. However, the question requesting permission for data use was modified to ask participants whether their data should be used. Participants were also given the opportunity to provide additional comments to the researcher.

Results and Discussion

Exclusion criteria. Responses were removed from the analysis based on two exclusion criteria. First, the responses of any participants who indicated that their data should not be used were further examined for any inconsistencies. An example of such inconsistencies was whether a participant had chosen the same numerical answer across the board for each question (e.g., all 1's or all 7's), or whether a participant had scored at a similar level on measures of positive and negative mood (e.g., consistently above or below 4 on both negative and positive mood; 1 = definitely do not feel to 7 = definitely feel). Four participants who indicated that their data should not be used and who scored high on both measures of positive and negative mood were removed from the analysis. Second, participants who did not properly follow instructions for the typing

task were removed. Examples of not following instructions were whether participants failed to attempt the task, whether participants purposely wrote words not from the passage or made unrelated comments in the text box, or whether participants in the depletion condition attempted to type out the passage without omitting spaces and *e*'s. Nine participants who did not follow instructions for the typing task were excluded from the analysis. Accordingly, the responses from 57 participants were used (42.1% female; M_{age} = 38.20, *SD* = 11.44).

Depletion manipulation check. The results of a t-test demonstrated that participants in the depletion condition (*M* = 5.13, *SD* = 1.00) reported feeling more depleted (three items, α = .76) than participants in the nondepletion condition (*M* = 3.66, *SD* = 1.35; *t*(55) = -4.72, *p* < .001).

Effect of depletion on mood. A t-test revealed that there was no effect of depletion on measures of negative mood ($M_{Nondepletion}$ = 3.27, *SD* =1.52; $M_{Depletion}$ = 3.31, *SD* = 1.40; *t*(55) = -.083, *p* = .93; three items, α = .93) and positive mood ($M_{Nondepletion}$ = 4.64, *SD* = 1.47; $M_{Depletion}$ = 4.65, *SD* = 1.49; *t*(55) = -.02, *p* = .98; two items, *r*(55)= .66, *p* < .001). Based on the results of the manipulation questions and mood measures, the pretest was deemed successful.

Study 2

The purpose of study 2 was to examine the mediating role of exercise self-efficacy on the relationship between depletion and exercise intentions (hypotheses 1, 3a, and 3b), and the moderating role of exercise habit strength on these relationships (hypotheses 4a and 4b). In this study, only participants who reported to exercise were recruited. There were three main reasons for this sample criteria: i) the measure of habit strength (hypotheses 4a and 4b) used in this study requires participants who engage in the specified behavior, ii) exercise self-efficacy (hypotheses 3a and 3b) is measured by showing participants barriers to exercise and asking them how certain

they are that they could overcome these barriers to follow through with their exercise routine; participants who reported not to exercise might not be as sensitive to these barriers, and iii) including participants who exercise allowed for a revised measure of exercise intentions (hypothesis 1) using a scenario approach.

Method

Design and participants. One hundred and sixty participants (41.9% female; M_{age} = 38.11, *SD* = 12.13) who self-reported to exercise at least 30-minutes to 1 hour per week were recruited through the Amazon Mechanical Turk platform. Similarly to in study 1, participants were selected based on an exclusion criterion listed on MTurk ("I generally don't exercise"). Participants were randomly assigned to one condition in a two-factor (depletion: nondepletion vs. depletion) experimental design, and each participant was compensated ($2.00 US).

Procedure. Participants were told that they would be taking part in two studies. In the first study, participants were asked to complete a typing task ostensibly intended to assess typing ability. The task used in this study was identical to the one used in pretest 2. In the nondepletion condition, participants were asked to retype a passage as fast as they can. The passage was adapted from a business textbook and contained 266 words. In the depletion condition, participants were asked to retype the same passage as fast as they can, but they were also instructed to retype the passage without using the space bar or the letter *e*. Participants in both conditions were instructed to work on the task for two minutes, and the page automatically advanced once the time was up.

Once participants completed the typing task, they were asked to indicate how effortful, difficult, and tiring they found the task (Itzchakov et al. 2018). Additionally, participants were asked questions pertaining to positive mood (pleasant, pleased) and negative mood (depressed,

unhappy, in a bad mood; Walsh 2014). All manipulation check and mood questions were identical to the ones used in study 1 and pretest 2. Once participants completed the task and corresponding questions, they were thanked for their participation and instructed to move onto the second study.

In what was presented as the second study, participants were told that they would be completing three tasks. In the first task, participants were told that they would be randomly assigned to an activity related to personal well-being, and that they would be asked questions pertaining to that activity. In reality, all participants were shown an exercise self-efficacy scale created by Bandura (2006) and adapted for use in this study (Appendix B). This scale is originally an 18-item scale that displays one situation for each item and asks participants to rate how certain they are (0 = cannot do at all to 100 = highly can do) that they could continue to perform their exercise routine when faced with this situation. For study 2, one item, "When there are other interesting things to do," was removed since it was too similar to the dependent variable. Additionally, the scale was altered to a more simple response format that showed participants items anchored from 0 to 10 rather than from 0 to 100 (Everett, Salamonson, & Davidson, 2009).

In the second task, participants were told that they would be randomly assigned to two scenarios, and that they would be asked one question for each scenario. All participants saw the same two scenarios in the same order. In the first scenario meant to measure exercise intentions, participants were asked to imagine that they had to choose between following through with their exercise plans or seeing a friend and relaxing in the sun (Appendix C). After reading the scenario, participants were shown a seven-point Likert item that asked, "How likely are you to visit your friend instead of exercising?" (1 = not at all likely to 7 = very likely). Previous

depletion research has successfully conducted similar measures of choice whereby a more tempting option is paired against an option that would typically require more self-control (Salmon, Fennis, de Ridder, Adriaanse, & de Vet 2014). Participants then saw a filler scenario that presented descriptions of two charities, and they were then asked which charity they would be most likely to donate $1.00 to as part of a hypothetical purchase (Appendix C).

In the third and final task, participants were again told that they would be randomly assigned to one activity, and that they would be asked questions about how often they engage in that activity. However, all participants saw the self-report habit index (SRHI; Verplanken & Orbell 2003) adapted for exercise habits. The SRHI is a 12-item scale that aims to measure different components of habitual behaviors. In the original scale, a behavior (e.g., exercise) is listed within the statement "_____ is something," and then participants are presented 12 items pertaining to that behavior (e.g., "I do frequently," "I do without thinking," "I do automatically"; Appendix D). All items in this measure are intended to be anchored on a seven-point Likert scale (1 = strongly disagree to 7 = strongly agree; Verplanken & Orbell 2003). At the end of the study, participants answered a final set questions (e.g., demographics) identical to the ones used in pretest 2.

Results

Exclusion criteria. Participants were excluded based on the same exclusion criteria from pretest 2. First, the responses of any participants who indicated that their data should not be used were further examined for any inconsistencies, but no inconsistencies were found. In addition, any participants who did not adequately follow instructions for the typing task were removed. Ten participants who did not attempt the typing task or who typed words not from the passage

into the text box were excluded from the analysis. In total, 150 participants (44 % female; M_{age} = 38.41, SD = 12.36) were included in the analysis.

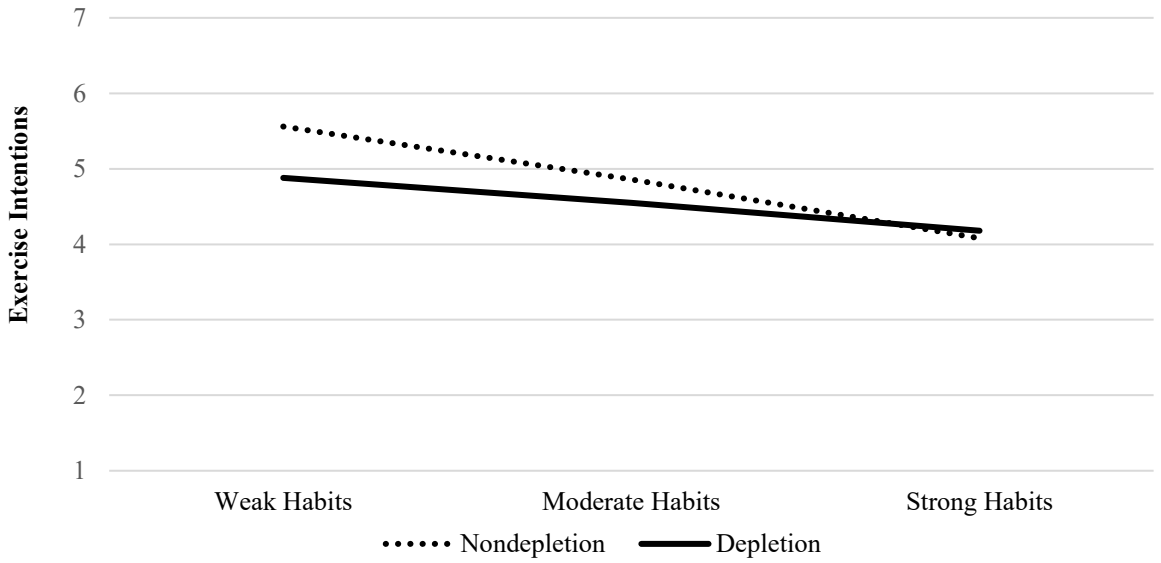
Depletion manipulation check. A t-test on the manipulation check questions (three items, α = .82) revealed that participants in the depletion condition reported feeling more depleted than participants in the nondepletion condition ($M_{Nondepletion}$ = 3.77, SD = 1.50; $M_{Depletion}$ = 4.80, SD = 1.56; $t(148) = -4.11$, $p < .001$). These results indicated that the depletion manipulation was a success.

Effect of depletion on mood. A t-test on the measure of negative mood (three items, α = .93) yielded no significant difference between nondepleted and depleted participants ($M_{Nondepletion}$ = 2.90, SD = 1.40; $M_{Depletion}$ = 3.30, SD = 1.49; $t(148) = -1.69$, $p = .09$). Unexpectedly, a t-test on the measures of positive mood (two items, $r(148) = .76$, $p < .001$) revealed a significant difference between nondepleted and depleted participants ($M_{Nondepletion}$ = 4.83, SD = 1.45; $M_{Depletion}$ = 4.20, SD = 1.70; $t(148) = 2.43$, $p = .02$). However, a regression analysis demonstrated that positive mood did not explain a significant proportion of variance in exercise intentions (R^2 = .00, $F(1, 148) = .002$, $p = .96$), and that positive mood did not have a significant effect on exercise intentions ($b = -.005$, $t(148) = -.05$, $p = .96$). No additional analyses regarding measures of mood were performed.

Main effect of depletion. A t-test analyzing the effect of depletion on exercise intentions and on exercise self-efficacy was conducted. For the measure of self-efficacy, the 17 items in the exercise self-efficacy scale were average to create one item (α = .95). The results of the t-test revealed no main effect of depletion on exercise intentions ($M_{Nondepletion}$ = 4.88, SD =1.82; $M_{Depletion}$ = 4.52, SD = 1.90; $t(148) = 1.19$, $p = .48$) and no main effect of depletion on exercise self-efficacy ($M_{Nondepletion}$ = 5.86, SD = 2.26; $M_{Depletion}$ = 6.05, SD = 1.89; $t(148) = -.55$, $p = .58$).

Effects of depletion and exercise habit strength on exercise intentions. For the measure of exercise habit strength, the twelve items in the SRHI were averaged to create one item (α = .94). In order to examine the interaction effect of depletion and exercise habit strength, a PROCESS Model 1 (Hayes 2017) was conducted on exercise intentions. The results revealed no main effect of depletion (β = -.08, t(148)= -1.03, p = .30), a main effect of exercise habit strength (β = -.26, t(148)= -3.31, p = .001), and no interaction of depletion and exercise habit strength (β = .09, t(146)= 1.16, p = .25). See figure 4.

Figure 4: Depletion × Exercise Habit Strength Interaction on Exercise Intentions

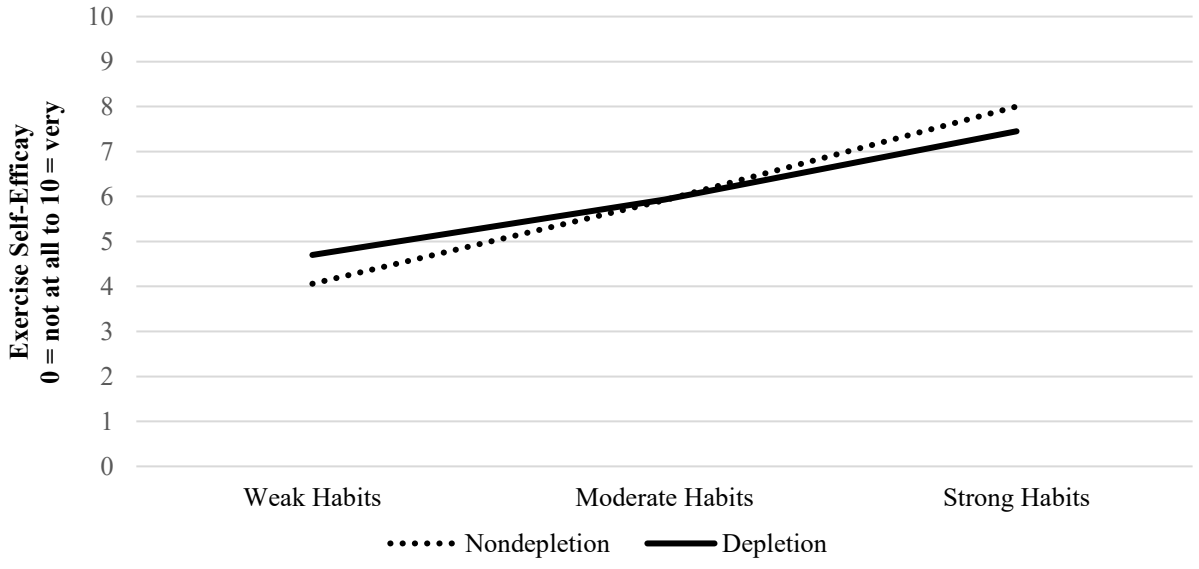


Note: exercise intentions were measured by asking participants, "How like are you to visit your friend instead of exercising?" (1 = not at all likely to 7 = very likely).
Values for graphical representation were set by PROCESS Model 1 (Hayes 2017) at the following levels of the unstandardized scale: weak habits = 2.44, moderate habits = 4.17, and strong habits = 6.08.

Effects of depletion and exercise habit strength on exercise self-efficacy. A second moderation analysis using PROCESS Model 1 (Hayes 2017) was conducted on exercise self-efficacy, and the results revealed no main effect of depletion (β = .001, t(148)= .01, p = .99), a main effect of exercise habit strength (β = .73, t(148)= 13.25, p < .001), and a significant

interaction of depletion and exercise habit strength (β = -.11, t(146) = -2.04, p = .04). These results indicated a crossover interaction, such that depleted participants displayed reduced exercise self-efficacy in comparison to nondepleted participants, but this was only the case for those with stronger exercise habits. For those with weaker exercise habits, depleted participants were found to be higher in exercise self-efficacy than nondepleted participants. These findings are contradictory to what was expected from this study. It was hypothesized that depleted participants with weaker exercise habits would display reduced exercised self-efficacy in comparison to nondepleted participants, and that participants with stronger exercise habits would have their exercise self-efficacy unaffected by depletion. See figure 5 for a visual depiction of the findings. An important note is that the Johnson-Neyman technique showed that these differences were not significant at the .05 level (see Appendix E).

Figure 5: Depletion × Exercise Habit Strength Interaction on Exercise Self-Efficacy

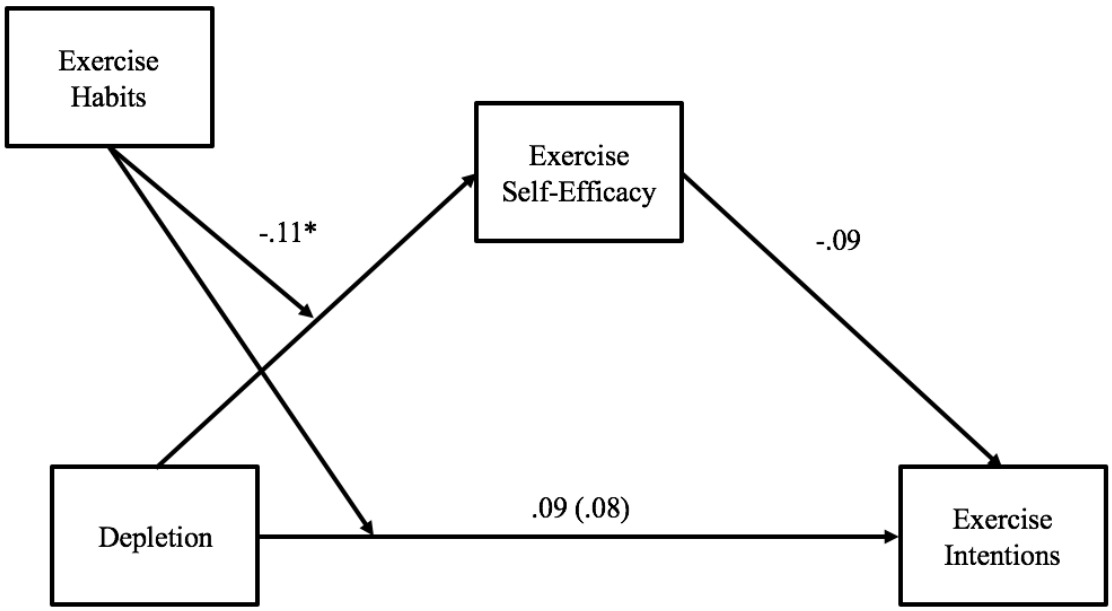


Note: values for graphical representation were set by PROCESS Model 1 (Hayes 2017) at the following levels of the unstandardized scale: weak habits = 2.44, moderate habits = 4.17, and strong habits = 6.08.

Effect of self-efficacy on exercise intentions. The results of a simple linear regression yielded a significant effect of exercise self-efficacy on exercise intentions (β = -.254, t(148) = -3.20, p = .002). These results also showed that exercise self-efficacy explained a significant proportion of variance in exercise intentions (R^2 = .065, F(1, 148) = 10.21, p = .002). That is, participants higher in exercise self-efficacy reported that they would be more likely to exercise rather than seeing a friend. These findings support past research showing that exercise self-efficacy predicts exercise intentions (Scholz et al. 2005; Sniehotta et al. 2005).

Testing for moderated mediation. In order to get a full picture of the main predictions of this study, a moderated mediation using PROCESS Model 8 (Hayes 2017) with 5,000 bootstrapped samples was conducted. This analysis used depletion as the independent variable, exercise habit strength as the moderator variable, exercise self-efficacy as the mediator variable, and exercise intentions as the dependent variable. As expected, the results yielded a significant interaction of depletion and exercise habit strength on exercise self-efficacy (β = -.11, t(146)= -2.04, p = .04), but no main effect of depletion on exercise self-efficacy (β = .001, t(148)= .01, p = .99), and no main effect of depletion on exercise intentions (β = -.08, t(148)= -1.03, p = .30). In addition, this model did not identify exercise self-efficacy as a significant predictor of exercise intentions (β = -.09, t(148)= -76, p = .45). It should also be noted that the total effect of the interaction term (depletion × exercise habit strength) decreased (β = .08, t(145)= 1.02, p = .31; 95% CI [-.02, .05]) when the mediator, exercise self-efficacy, was added to the model. See figure 6 for a visual depiction.

Figure 6: Moderated Mediation Analysis



Note: values represent standardized regression coefficients. The value inside the parentheses represents the standardized regression coefficient when the proposed mediator is included in the model.
*p = 04. All other p's > .3.

Discussion

The results of study 2 were not able to provide support for hypothesis 1, which states that depletion will negatively affect exercise intentions, and hypothesis 4a, which states that participants with stronger exercise habits will not have their exercise intentions affected by depletion. Furthermore, the findings from this study could also not support hypothesis 3a, which states that depletion will reduce exercise self-efficacy, and hypothesis 3b, which states that exercise self-efficacy will mediate the effect of depletion on exercise intentions. However, partial support was provided for hypothesis 4b, which states that exercise habit strength will moderate the effect of depletion on exercise self-efficacy. While it was hypothesized that participants with stronger exercise habits would not have their exercise self-efficacy affected by depletion, a

counterintuitive effect was demonstrated. Specifically, depleted participants who reported stronger exercise habits were found to be lower in exercise self-efficacy than nondepleted participants. In contrast, depleted participants who reported weaker exercise habits were found to be higher in exercise self-efficacy than nondepleted participants.

General Discussion

Summary of Results

The first aim of this thesis was to test whether depletion leads to reduced exercise intentions. Researchers have suggested that impaired self-control lowers exercise intentions (Hagger, Wood, Stiff, & Chatzisarantis 2010b), and there has been direct that evidence depletion leads to a decrease in the frequency of exercise (Oaten & Cheng 2005). However, findings from the two studies conducted as part of this thesis could not support the prediction that depletion leads to reduced exercise intentions. This was true for participants who reported to not exercise (study 1) and for those who reported to exercise (study 2). These results are contradictory to what would be expected of depleted participants. If situational demands (exam stress) interpreted as impairing self-control lead to a decrease in exercise behaviors (Oaten & Cheng 2005), then it seems that depletion induced in an experimental design should negatively impact exercise intentions. One possibility is that the measures of exercise intentions used in both studies did not adequately capture the self-control resources required to participate in exercise.

Additionally, in study 1, there was no interaction of depletion and kernel state (outcomes: undesirable vs. desirable). Specifically, I predicted that showing depleted participants an exercise advertisement that portrays the desirable outcomes to be gained by exercising (vs. the undesirable outcomes to be avoided by exercising) would lead these participants to focus on the rewards of exercise. This focus was predicted to counteract the effect of depletion on exercise

intentions. However, it is important to note that this was a novel attempt at using a component of message framing to support the process model of depletion. The proposed method could not be supported, but the reasons for this lack of support are not necessarily to do with the method itself. Potential reasons for this are discussed in the Limitations and Future Research section of this thesis.

The second purpose of this thesis was to demonstrate that depletion lowers exercise self-efficacy and that exercise self-efficacy mediates the relationship between depletion and exercise intentions. I also predicted that exercise habit strength would moderate these relationships, but only partial support was provided for these predictions. Specifically, the results from study 2 indicated that the effect of depletion on exercise self-efficacy is dependent on the level of exercise habit strength. When exercise was reported to be less habitual, depleted participants were higher in exercise self-efficacy, but when exercise was reported to be less habitual, depleted participants were lower in exercise self-efficacy.

Theoretical and Managerial Contributions

Although the research in this thesis offered only partial support for certain key predictions, significant theoretical contributions are noted. As previously mentioned, past researchers have suggested that depletion lowers intentions and behaviors related to physical activity (Hagger et al. 2010b). In addition, Oaten and Cheng (2005) demonstrated that students who were depleted by dealing with exam stress engaged in lessened amounts of physical activity, both in duration and frequency. The authors also offered several alternative explanations for their findings, one of them being perceived lack of time to engage in physical activity during a stressful examination period. While it seems intuitive that impairments in self-control negatively impact exercise intentions and behaviors, the two studies conducted as part of this thesis could

not support a link between depletion and exercise intentions. It is important to note that these studies had several limitations that are discussed in the Limitations and Future Research section of this thesis.

Moreover, in study 1, a novel attempt was made at using message framing to counteract the effect of depletion on exercise intentions. First, such findings would have contributed to the process model of depletion by showing that those who are depleted at time 1 focus on the rewards of a potential time 2 behavior. Second, the predicted findings would have had significant managerial contributions by providing an avenue for future research to explore the framing of outcomes in a health advertisement and how this impacts people who have impaired self-control.

Lastly, the findings from study 2 contribute to research on the link between depletion and self-efficacy. Although Chow et al. (2015) demonstrated that depletion reduces self-efficacy for certain behaviors, I was not able to fully replicate these findings for exercise self-efficacy. It might then be the case that depletion does reduce self-efficacy, but only for certain behaviors, such as self-efficacy for healthy eating and self-efficacy for math problems (Chow et al. 2015). An important contribution from study 2 was the novel attempt at examining the moderating role of exercise habit strength on the relationship between depletion and self-efficacy. This attempt led to a counterintuitive interaction between depletion and exercise habit strength on exercise self-efficacy. That is, depleted participants who had stronger exerciser habits demonstrated reduced exercise self-efficacy. The opposite effect was demonstrated among depleted participants with weaker exercise habits.

Limitations and Future Research

The research performed in this thesis is not without limitations. First, there was a potential issue with the depletion manipulation used in study 1. A seemingly large number of

participants were able to complete the depleting anagram task, and this was deemed unusual. One explanation is that repeated exposure to anagram tasks has led online participants to seek out the help of anagram solvers, which can easily be found online. Although none of the predicted effects were found even after excluding participants who successfully completed each anagram, the potential issue of participants finding shortcuts to depletion tasks raises a question as to which depletion manipulations are appropriate for online use.

In addition, the initial purpose of this research was not necessarily to examine participants who don't exercise (study 1), however, the results of a pretest suggested that the kernel state manipulation would be most effective among these participants. That being said, it might be the case that depletion does not affect exercise intentions among those who never intended to exercise. Past research has shown that intenders and nonintenders differ significantly on measures of self-efficacy (Lippke, Ziegelmann, & Schwarzer 2005) and outcome expectancies (Ginis et al. 2013). According to the health action process approach (HAPA; see Schwarzer 2008), these variables are significant contributors to the motivation for certain health-related behaviors, including exercise (Schwarzer et al. 2007; Schwarzer & Renner 2000; Scholz, Keller, & Perren 2009). If the motivation for exercise is lacking in nonintenders, then it is possible that depleted nonintenders do not demonstrate impaired self-control for exercise, since these people would not have exercised in the first place. For example, one study by Vanden Auweele, Rzewnicki, and Van Mele (1996) found that a significant proportion of middle-aged men do not intend to exercise and for no specific reason. Future research should then look at whether depletion is a worthwhile avenue for studying exercise intentions among nonintenders.

Another important limitation of this research is that the intention scale used in study 1 asked participants, "How (inclined, likely, willing) are you to start exercising within the next

seven days?" Among participants who do not exercise, agreeing to exercise in seven days might not be perceived as requiring self-control. In research performed by Agrawal & Wen Wan (2009), participants who were primed with a higher level of construal were more likely to exert self-control on a task following depletion. It is then possible that a time frame of seven days operates at a higher level of temporal construal for exercise behaviors, especially for those who do not exercise. This potential limitation was addressed using a scenario approach in study 2, however, no effect of depletion on exercise intentions was demonstrated. Another possibility is that the intention measures used for both studies did not adequately capture the self-control resources required to exercise. If this is the case, future depletion research might choose a measure of exercise intentions that better captures the effortful nature of exercise.

Lastly, while past research has successfully counteracted the effect of depletion, the order in which the counteracting procedure was presented to participants has varied. That is, in the research performed by Muraven and Slessareva (2003) participants were provided with potentially motivating incentives after being exposed to the depletion manipulation. However, Walsh (2014) successfully counteracted the effect of depletion by priming participants with a goal prior to depleting them. It is then possible that the kernel state manipulation employed in the study 1 would have been more successful if it was shown to participants prior to exposing them to the depletion manipulation. However, the manipulation employed in the current research could have also been flawed. For example, the amount of writing and symbols used within this manipulation (see Appendix A) could have caused participants to not adequately focus on the portion of the advertisement that focused on outcomes (kernel state: undesirable vs. desirable).

Conclusion

The research conducted as part of this thesis extends the literature on the link between depletion and exercise intentions. Although past research has shown that depletion might have caused participants to exercise less frequently (Oaten & Cheng 2005), no effect of depletion on exercise intentions was demonstrated among participants who do not exercise (study 1) and participants who do exercise (study 2). Further, study 1 showed no interaction effect of depletion and kernel state on exercise intentions. In study 2, there was no interaction of depletion and exercise habit strength on exercise intentions, and exercise self-efficacy did not mediate the relationship between depletion and exercise intentions. However, an important relationship identified in study 2 is the interaction between depletion and exercise habit strength on exercise self-efficacy. While it was expected that depletion would directly lower exercise self-efficacy in participants with weaker exercise habit strength, a completely opposite relationship was demonstrated. That is, depletion led to increased exercise self-efficacy among participants with weaker exercise habits, and the reverse was true for participants with stronger exercise habits. The reasons for these results are unclear, and additional research is needed to better examine these relationships.

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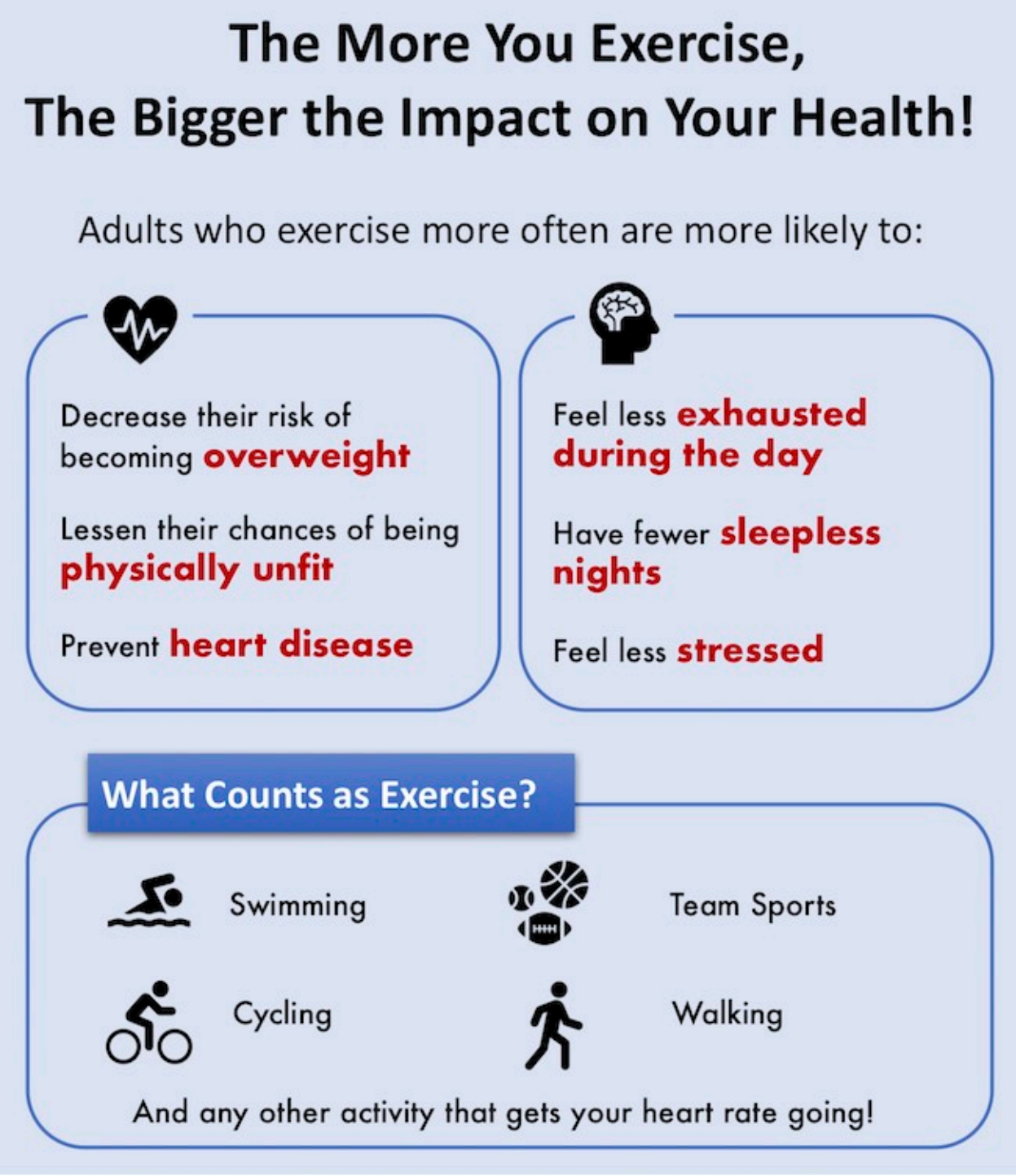
Appendices

Appendix A: Kernel State Manipulation (Study 1)

Undesirable condition



Desirable condition

Appendix B: Exercise Self-Efficacy Scale (Study 2)

How confident are you that you could continue to carry out your exercise routine regularly when faced with the following situations?

1. When I am feeling tired
2. When I am feeling under pressure from work
3. During bad weather
4. After recovering from an injury that caused me to stop exercising
5. During or after experiencing personal problems
6. When I am feeling depressed
7. When I am feeling anxious
8. After recovering from an illness that caused me to stop exercising
9. When I feel physical discomfort when I exercise
10. After a vacation
11. When I have too much work to do at home
12. When visitors are present
13. If I don't reach my exercise goals
14. Without support from my family or friends
15. During a vacation
16. When I have other time commitments
17. After experiencing family problems

**All items anchored from 0 = not at all confident to 10 = very confident*

(Bandura 2006; Everett et al. 2009)

Appendix C: Scenarios (Study 2)

Exercise intentions scenario (dependent variable)

Imagine that it's a bright and sunny afternoon. You've done what you had to do for the day, and you are about to get ready to go get in some exercise when your phone vibrates. You grab it and take a look, and you see that your friend left you a message: "Hey. Beautiful day outside. If you aren't busy, why don't you come over? We can enjoy this great weather on my patio. You in?"

This is quite the tempting offer: you always have a fun time with your friend, and you really want to go! But, you also know that if you go, you won't get back in time to exercise today (and you really should exercise today).

How likely are you to meet your friend instead of exercising?

**Anchored from 1= not at all likely to 7 = very likely*

Charitable behavior scenario (filler scenario)

Imagine that you've been asked to donate $1.00 to one of two charitable organizations as part of a purchase you just made.

The first charity, **Greener World**, is focused on sustainability. Their aim is to work with various companies in order to make companies' operations more environmentally friendly in order to reduce the impact of travel and manufacturing on the environment.

The second charity, **All for Education**, helps to support education for disadvantaged children. They run drives to raise supplies and to contribute to schools to help improve infrastructure.

Which charity would you prefer to donate $1.00 to?

1) Greener World
2) All for Education
3) I would choose not to donate

Appendix D: Self-Report Habit Index for Exercise (Study 2)

Exercise (physical activity) is something:

1. I do frequently
2. I do automatically
3. I do without having to consciously remember
4. that makes me feel weird if I do not do it
5. I do without thinking
6. that would require effort not to do it
7. that belongs to my (daily, weekly, monthly) routine
8. I start doing before I realize I'm doing it
9. I would find hard not to do
10. I have no need to think about doing
11. that's typically 'me'
12. I have been doing for a long time

**All items anchored from 1 = strongly disagree to 7 = strongly agree*

(Verplanken & Orbell 2003)

Appendix E: Depletion × Habit Strength on Exercise Self-Efficacy (Study 2)

```
Run MATRIX procedure:

*************** PROCESS Procedure for SPSS Version 3.2 *****************

          Written by Andrew F. Hayes, Ph.D.       www.afhayes.com
    Documentation available in Hayes (2018). www.guilford.com/p/hayes3

**************************************************************************
Model  : 1
    Y  : ZSEMean
    X  : ZConditi
    W  : ZHMean

Sample
Size:  150

**************************************************************************
OUTCOME VARIABLE:
 ZSEMean

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .7488      .5607      .4483    62.1200     3.0000   146.0000      .0000

Model
             coeff         se          t          p       LLCI       ULCI
constant      .0070      .0548      .1270      .8991     -.1013      .1152
ZConditi      .0006      .0550      .0106      .9915     -.1080      .1092
ZHMean        .7308      .0552    13.2475      .0000      .6217      .8398
Int_1        -.1130      .0555    -2.0374      .0434     -.2227     -.0034

Product terms key:
 Int_1    :        ZConditi x        ZHMean

Test(s) of highest order unconditional interaction(s):
       R2-chng          F        df1        df2          p
X*W      .0125     4.1509     1.0000   146.0000      .0434
----------
    Focal predict: ZConditi (X)
          Mod var: ZHMean   (W)

Conditional effects of the focal predictor at values of the moderator(s):

     ZHMean     Effect         se          t          p       LLCI       ULCI
    -1.0903      .1238      .0821     1.5085      .1336     -.0384      .2860
     -.0267      .0036      .0550      .0656      .9478     -.1051      .1123
     1.1561     -.1301      .0841    -1.5468      .1241     -.2963      .0361
```

**All values standardized*

There are no statistical significance transition points within the observed range of the moderator found using the Johnson-Neyman method.

Conditional effect of focal predictor at values of the moderator:

ZHMean	Effect	se	t	p	LLCI	ULCI
-1.9811	.2245	.1233	1.8207	.0707	-.0192	.4682
-1.7959	.2036	.1142	1.7825	.0767	-.0221	.4293
-1.6108	.1826	.1053	1.7343	.0850	-.0255	.3908
-1.4256	.1617	.0967	1.6723	.0966	-.0294	.3528
-1.2405	.1408	.0884	1.5919	.1136	-.0340	.3156
-1.0553	.1199	.0806	1.4863	.1394	-.0395	.2793
-.8702	.0989	.0735	1.3467	.1802	-.0463	.2441
-.6850	.0780	.0671	1.1628	.2468	-.0546	.2106
-.4999	.0571	.0618	.9241	.3570	-.0650	.1792
-.3148	.0362	.0578	.6255	.5326	-.0781	.1504
-.1296	.0152	.0555	.2745	.7841	-.0944	.1249
.0555	-.0057	.0550	-.1035	.9177	-.1144	.1030
.2407	-.0266	.0564	-.4716	.6379	-.1382	.0849
.4258	-.0475	.0596	-.7973	.4266	-.1654	.0703
.6110	-.0685	.0643	-1.0645	.2888	-.1956	.0586
.7961	-.0894	.0702	-1.2733	.2049	-.2282	.0494
.9813	-.1103	.0770	-1.4324	.1542	-.2625	.0419
1.1664	-.1313	.0845	-1.5526	.1227	-.2983	.0358
1.3516	-.1522	.0926	-1.6437	.1024	-.3351	.0308
1.5367	-.1731	.1010	-1.7134	.0888	-.3728	.0266
1.7219	-.1940	.1098	-1.7673	.0793	-.4110	.0230

********** ANALYSIS NOTES AND ERRORS **********

Level of confidence for all confidence intervals in output:
  95.0000

W values in conditional tables are the 16th, 50th, and 84th percentiles.

NOTE: Variables names longer than eight characters can produce incorrect output.
      Shorter variable names are recommended.

------ END MATRIX -----

**All values standardized*

Appendix F: Moderated Mediation Analysis (Study 2)

```
Run MATRIX procedure:

*************** PROCESS Procedure for SPSS Version 3.2 *****************

          Written by Andrew F. Hayes, Ph.D.       www.afhayes.com
    Documentation available in Hayes (2018). www.guilford.com/p/hayes3

**************************************************************************
Model  : 8
    Y  : ZDV
    X  : ZDepleti
    M  : ZSEMean
    W  : ZHMean

Sample
Size:  150

**************************************************************************
OUTCOME VARIABLE:
 ZSEMean

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .7488      .5607      .4483    62.1200     3.0000   146.0000      .0000

Model
              coeff         se          t          p       LLCI       ULCI
constant      .0070      .0548      .1270      .8991     -.1013      .1152
ZDepleti      .0006      .0550      .0106      .9915     -.1080      .1092
ZHMean        .7308      .0552    13.2475      .0000      .6217      .8398
Int_1        -.1130      .0555    -2.0374      .0434     -.2227     -.0034

Product terms key:
 Int_1    :        ZDepleti x        ZHMean

Test(s) of highest order unconditional interaction(s):
       R2-chng          F        df1        df2          p
X*W      .0125     4.1509     1.0000   146.0000      .0434
----------
    Focal predict: ZDepleti (X)
          Mod var: ZHMean   (W)

Conditional effects of the focal predictor at values of the moderator(s):

     ZHMean     Effect         se          t          p       LLCI       ULCI
    -1.0903      .1238      .0821     1.5085      .1336     -.0384      .2860
     -.0267      .0036      .0550      .0656      .9478     -.1051      .1123
     1.1561     -.1301      .0841    -1.5468      .1241     -.2963      .0361

**************************************************************************
OUTCOME VARIABLE:
 ZDV

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .3074      .0945      .9305     3.7832     4.0000   145.0000      .0059
```

**All values standardized*

```
Model
              coeff         se          t          p       LLCI       ULCI
constant     -.0051      .0789     -.0643      .9488     -.1611      .1509
ZDepleti     -.0816      .0792    -1.0302      .3046     -.2381      .0749
ZSEMean      -.0902      .1192     -.7566      .4505     -.3259      .1454
ZHMean       -.1969      .1179    -1.6693      .0972     -.4299      .0362
Int_1         .0825      .0810     1.0175      .3106     -.0777      .2427

Product terms key:
 Int_1    :        ZDepleti x        ZHMean

Test(s) of highest order unconditional interaction(s):
       R2-chng          F        df1        df2          p
X*W      .0065     1.0352     1.0000   145.0000      .3106

****************** DIRECT AND INDIRECT EFFECTS OF X ON Y *****************

Conditional direct effect(s) of X on Y:
     ZHMean     Effect         se          t          p       LLCI       ULCI
    -1.0903     -.1715      .1192    -1.4390      .1523     -.4070      .0640
     -.0267     -.0838      .0792    -1.0574      .2921     -.2404      .0728
     1.1561      .0138      .1222      .1127      .9104     -.2277      .2552

Conditional indirect effects of X on Y:

INDIRECT EFFECT:
 ZDepleti    ->    ZSEMean     ->    ZDV

     ZHMean     Effect     BootSE   BootLLCI   BootULCI
    -1.0903     -.0112      .0197     -.0586      .0215
     -.0267     -.0003      .0083     -.0200      .0159
     1.1561      .0117      .0207     -.0258      .0592

      Index of moderated mediation:
             Index     BootSE   BootLLCI   BootULCI
ZHMean      .0102      .0164     -.0197      .0481
---

********************** ANALYSIS NOTES AND ERRORS ************************

Level of confidence for all confidence intervals in output:
  95.0000

Number of bootstrap samples for percentile bootstrap confidence intervals:
  5000

W values in conditional tables are the 16th, 50th, and 84th percentiles.

NOTE: Variables names longer than eight characters can produce incorrect output.
      Shorter variable names are recommended.
```

**All values standardized*