1 Self-Control

The most cited theory of self-control is that which Baumeister and his colleagues have proposed in their articles. But this theory also has been heavily criticized. Explain the pros and cons of the theory and make the case for a better theory. This can be a theory in the literature or a theory you devise yourself. Explain exhaustively how the better theory can explain the findings that Baumeister's theory explains; but also explains the findings that are a problem for Baumeister's theory.

1.1 Introduction

A person's ability to exert self-control has proven beneficial in nearly every aspect of civilized life. For instance, children that successfully demonstrate impulse control on a delay of gratification task have shown greater achievement as adults (Mischel, Shoda, & Peake, 1988). Higher levels of self-control as adults have shown an array of other positive outcomes such as higher self-esteem, better relationships, good interpersonal skills, subjective well-being, less binge eating and alcohol abuse, and greater success achieving weight loss goals (Crescioni et al, 2011; Tangney, Baumesiter, & Boone, 2004; Williams & Ricciardelli, 1999, Woods & Heretick, 1983). Understanding what has been referred to as the "Master Virtue," in that most virtues considered positive are based upon this trait (Baumeister & Exline, 1999; Hood, Hill, & Spilka, 2009), can be beneficial for leading society into a more harmonious existence.

Self-control has been operationalized a number of different ways. For instance, an individual's capacity for foregoing immediate gratification in order to secure long term benefits is a definition that incorporates the unique human capacity to plan well in advance of present circumstances (Metcalfe & Mischel, 1999). Alternately, self-control has been defined as one's ability to alter his or her dominant response tendency (Baumeister & Heatherton, 1996). This definition casts a wider net on what it means to regulate a thought or behavior. For instance, when considering emotion regulation, self-control is the ability to keep from expressing an experienced emotion. In attention regulation, self-control is the ability to keep focus on a target despite experiencing distracting stimuli elsewhere. In behavioral regulation, self-control is the ability to refrain from acting a particular way due to internal or external demands. Each of the preceding examples are instances in which a person experiences, and subsequently suppresses, an instinctual drive in favor of a more appropriate action.

As important as self-control has shown to be in our daily lives, it begs the understanding of the underlying processes responsible for our tendency to succeed, or to fail, at exerting self-control. For example, perhaps a structured model of self-control would assist in developing programs to rehabilitate violent criminals for return to society; alter diet regimes to stem the tide of an obesity epidemic in the United States; and train children to grow with improved self-restraint. In order to address these

questions, a number of researchers have taken to task the questions of self-control (Carver & Scheier, 1982; Metcalfe & Mischel, 1999; Muraven, Tice, & Baumeister, 1998; Strack & Deutsch, 2004). The question of what controls humans' ability to exert self-control has been an often debated and sometimes contentious one. For its part, this paper will review the state of two proposed models of self-control in preparation of proposing a new one. Muraven, Tice, & Baumeister (1998) developed a theory of self-control dependent on a lone process which draws from reserve stores in order to function appropriately. In response, Inzlicht and Schmeichel proposed a model that explains self-control as a shift in attention and motivation away from effort and towards relief.

1.2 Resource Depletion Model

Whereas Inzlicht and Schmeichel's process model of self-control asserts two interacting systems are responsible for behavior, the resource depletion model predicts one process relying on a reserve of regulatory resources with which to expend (Baumeister & Heatheron, 1996). Historically, this process is likened to Freud's (1923, 1930) concepts of Id, Ego, and Super-ego which has been further refined as methods and technology allowed for more accurate measures and estimates of the process Freud described.

As mentioned above, the resource depletion model occurs though one process outlined by Carver and Scheier (1982). The process begins with the acquisition of standards. This process generally begins at birth, is cultivated in childhood, and refined as an adult. The manner by which humans learn what is and is not deemed appropriate behavior occurs in various ways including, but not limited to, operant condition, modeling, and vicarious learning. These standards, what Freud would consider the super-ego, are the rules which constrain one's behavior in order to maintain civility.

The next step, self-monitoring, requires that the individual be able to identify where their desired behavior falls within what is considered socially appropriate. Individual differences in dispositional self-monitoring play an important role in the execution of self-control in that people who are generally low in self-monitoring are less likely to be aware of their dominant behavioral tendencies, making it unlikely that they would be able to compare it to a prescribed norm. Only when a person has identified both a clear standard and identified where their desired behavior falls in relation to that standard, can they begin to alter the self in a manner consistent with the standard (or at least to a level in which the consequences for not entirely meeting said standard are determined acceptable by the individual). The resource depletion model considers the act of altering the self as an effortful, cognitively taxing action (Muraven, Tice, & Baumeister, 1998; Vohs & Baumeister, 2004) of which an individual is only capable of exerting in finite amounts.

Resource depletion, also referred to as ego depletion in order to help describe the process in Freudian terminology, is based on the observation that an individual's ability to override their dominant response tendency is determined by a finite resource that, when depleted, is unable to be called upon on subsequent

tasks that might have otherwise benefited from its use (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Muraven, Tice, & Baumeister, 1998). This has been shown to occur for all acts of self-control, including decision making (Baumeister, Sparks, Stillman & Vohs 2008), intellectual performance (Schmeichel, Vohs, & Baumeister, 2003), affect regulation (Schmeichel, Volokhov, & Demaree, 2008), behavioral control (Muraven, Baumeister, & Tice, 1999) and attentional control (Schmeichel, 2007). This model initially used the operation of a muscle as an analogy to describe the manner in which a person only had a limited amount of regulatory "strength" that he or she could use in order to override their dominant response tendency (Baumeister et al., 1998). Like a muscle, when this resource had become depleted, a sufficient refractory period is necessary in order to fully reinstate a person's regulatory capacity.

Importantly, ego depletion posits that self-control is domain general. That is, expenditure in one area of self-control (i.e. reading a difficult technical manual out loud for 10 minutes) diminishes one's ability to exert self-control on a seemingly unrelated task (i.e. keeping a hand submerged in an ice bath). Domain generality is necessary to the theory as it would be far less interesting, or impactful, had the findings demonstrated domain specificity such that daily dieting only affected one's propensity for eating junk food at night. Producing evidence for a centralized resource of self-control which is responsible for all acts of volition provides a theory applicable to peoples' whole lives instead of piecemeal domains.

To further this "muscle" model of self-control, Muraven, Baumeister, & Tice (1999) showed that regular exertions of small amounts of self-control rendered participants less susceptible to depletion than a control group after two weeks. The suggestion the authors make is that regularly overriding various dominant practices (e.g., brushing teeth with a non-dominant hand, sitting with proper posture, refraining from cursing) is very much like a muscle that has regularly been worked out. An important distinction must be made here in that, unlike a muscle, regulatory strength has not been shown to improve through exercise. Instead, participants showed more resilience to depletion tasks on subsequent self-control measures.

Initially, the model made no claim as to the underlying psychological mechanism responsible for reduced self-regulatory capacity after initial exertion. This changed with a series of papers out of the Baumeister and Tice lab (Gailliot & Baumeister, 2007; Gailliot et al, 2007; Masicampo & Baumeister 2008) which proposed evidence that glucose metabolization in the brain was responsible for reduced regulatory capacity. Briefly explained, much as a bicep requires glucose to operate, so too does the brain. Since overriding a dominant behavioral or cognitive response tendency is effortful, much like a bicep curl, the brain, likewise, metabolizes glucose. This was demonstrated both by measuring "consumption" of glucose in a pre-post blood test which showed lower glucose levels for those having exerted self-control and by "replenishing" self-control where participants who received glucose (compared to a placebo) between trials performed better than the placebo group on the second control task.

1.2.1 Emerging evidence against a resource model of self-control

In the past few years, a number of studies (predominately Etherton et al., 2018; Lurquin et al., 2016, Osborne et al., 2016) have virtually decimated the notion of a resource model of self-control. Despite a wealth of confirmatory findings in the literature (see Hagger et al., 2010), and a moderate to large effect size among them (Cohen's $d = .62$), many published replications have failed.

Hagger et al. (2010) meta analysis has proven to be a vital inflection point in the story of ego depletion. As noted, this paper found support for the effect among the 198 published experiments analyzed with an effect size greater than most reported in social psychology (Richard, Bond & Stokes-Zoota, 2003). Importantly, the method employed by Hagger et al. did not account for the possibility of publication bias. Briefly put, publication bias is the phenomena whereby only significant or novel findings are published in journals inherently *overestimating* the actual support for a theory.

In light of larger replication issues in the social sciences, Carter and McCullough (2014) conducted a reanalysis of the 83 studies included in Hagger et al.'s meta-analysis. In this reanalysis, Carter and McCullough discovered evidence of small study effects, including publication bias. This reanalysis returned mean effect sizes ranging from g = -0.10 to d = 0.50.

A further meta-analysis by Carter, Kofler, Foster and McCullough (2015) using methods to correct for publication bias (Duval & Tweedie, 2000; Stanley & Doucouliagos, 2014), *and* including unpublished data solicited from researcher's file drawers, led to bias-corrected mean effects size estimates ranging from g = -0.27 to g = 0.24. Carter et al. concluded that they "find very little evidence that the ego depletion effect is a real phenomenon" (p. 796).

In addition to these reanalyses, several critical tests of ego depletion have since been conducted. These experiments were largely preregistered, reducing at least the possibility that potential null findings be relegated to the proverbial file drawer.

A large-scale, registered replication report (RRR), conducted by Hagger et al. (2016), was unable to find support for ego depletion. Across 23 labs, and using electronic and largely automated procedures to reduce possible experiment variability, participants completed the oft-used depletion manipulation of crossing out the letter 'e' in a block of text (or did not cross out in the control group, per Baumeister et al., 1998). The agreed upon dependant task was the Multi-Source Interference Task (MSIT; Bush, Shin, Holmes, Rosen, & Vogt, 2003), similar in principle to the forward and backward digit-span tasks used by Brandon Schmeichel (2007; Schmeichel, Volokhov, & Demaree, 2008). Overall, the experiment across the 23 labs revealed a null effect.

Osborne et al. (2016) was unable to replicate Masicampo et al. (2008). Masicampo's paper helped establish glucose as the resource on which control purportedly relied. Lurquin et al. (2016) was unable to replicate ego depletion in the same manner it was initially established (Baumeister et al., 1998) using attention control as the depletion task and operation span recall (Turner & Engel, 1998) as the dependant

task. Each of these were preregistered studies.

Most recently, and perhaps most damning, Etherton et al. (2018) conducted 12 small studies traversing depletion procedures and dependent control task spheres. In three groups of four independent studies, participant either 1) crossed out letter (or didn't) and then solved anagrams, 2) Stroop task on hand grip persistence, or 3) wrote a story without (or with) using the letters *a* or *n*. Of these 12 studies, only one returned a significant (p <0.05) instance of a control group performing better than a depletion group.

Description	Study	*n*	Means		*p*	ES
			Control	Depletion		
Crossing out letters on Anagrams solved	1A	69	7.14	6.56	.194	0.27
	1B	70	7.03	6.46	.216	0.26
	1C	70	5.80	6.06	.597	-0.15
	1D	69	6.82	6.14	.169	0.34
Stroop Task on Hand Grip Persistence	2A	70	52.46	49.64	.800	0.06
	2B	70	46.84	60.74	.169	-0.33
	2C	70	62.64	65.67	.806	-0.06
	2D	70	47.89	44.02	.689	0.01
Lexical Override Writing on Math Problems Solved	3A	70	92.57	76.43	.034	0.52
	3B	70	88.74	81.00	.339	0.23
	3C	66	76.65	85.29	.289	-0.29
	3D	70	77.94	74.37	.654	0.11

Figure 1: Etherton et al., 2018

The meteoric rise, and similar fall, of the resource model of self-control should provide the social sciences with a great deal to consider. The model was simple, elegant, accessible, and testable. The model even provided publishing opportunities for many, academics. But this proved to be a weakness rather than a strength. The model, as well as the perverse incentives (not limited to publishing as a requirement for promotion and tenure) drove the entire field to commit bad science, to simply solve puzzles within a paradigm without regularly questioning the paradigm itself.

It is important, for the purposes of this exam to address an assumption made in the wording of the question I am seeking to answer regarding ego depletion. The question provided by the committee implores me to "Explain exhaustively how the better theory can explain the findings that Baumeister's theory explains." However, it has become clear that one particular theory cannot better explain Baumeister's findings. Rather, it appears as though Baumeister's effects were illusory to begin with. In light of this, the rest of my response will be dedicated to presenting an alternate theory that might better explain how self-control operates, but not necessarily one that better explains unreplicable findings.

1.3 Process Model

Inzlicht and Schmeichel (2012) have offered an alternative explanation for the mechanisms behind what on the surface appears to be a strict resource model of self-control. Instead of a single pool of resources from which a person can access when it is necessary to exert an act of cognitive or behavioral control, it is more likely that shifts in both motivation and attention are responsible for decreased performances on Task 2 of the sequential task paradigm. The following will outline some of Inzlicht and Schmeichel's arguments and propose studies to determine which model fits the observable process of one's exerting self-control.

1.3.1 Shifts in Motivation

Motivation is vital for one to exert self-control in any situation. Simply stated, if one is not motivated to alter his or her behaviors in favor of ones with a more desirable outcome, then there would be no self-control enacted. For example, high stakes gambling involves large risk which carries the potential of great losses, but also great gains. A person's motivation to avoid losing their life's savings may be sufficient to motivate them to abstain from such uncertainty. Betting someone a nickel on who will walk through the door next, however, involves little potential risk. Therefore, the latter situation would likely not reach the motivational threshold for which one would engage self-control in order to refrain from gambling.

To be more specific, Inzlicht and Schmeichel (2012) note that changing a participant's motivations can alter his performance on a subsequent task. For instance, Muraven and Slessareva (2003) demonstrated that offering participants incentives to perform on Task 2 attenuated the performance drop in depleted participants. That is to say, the central pool of resources accessed by participants somehow instantly regenerates and makes available those same resources. According to the resource depletion model of self-control, these resources should be gone.

An alternative conceptualization of self-control may help demonstrate how shifts in motivation can affect performance on Task 2. The common representation of self-control is a forceful interruption of one behavior in favor of an ultimately more desirable one. If, however, we consider self-control as a competition between opposing forces, then it is easier to consider motivational strengths (Heatherton & Wagner, 2011). For instance, an outcome behavior is entirely reliant on whether an impulse force (typically the lesser adaptive of forces) is stronger or weaker than a control force. If someone on a diet is considering whether to take a second helping at dinner, they likely will if his or her impulse forces outweigh his control forces.

Inzlicht and Schmeichel (2012) note that the resource depletion model focuses solely on one side of this equation: the control force. It is entirely plausible, however, that failure of control has less to do with the amount of control one has, but the amount of control relative to impulse one has at any given

moment. Logically, as control forces can wax and wane, so too can impulse forces, leading to a potential situation where regulatory failures are in fact increases in impulse rather than decreases in control forces.

Motivation is difficult to control in the lab, however. Typically, individuals participating in psychological research, particularly research in academic settings, are undergraduate students fulfilling research requirements for a class in which they are enrolled. This presents an obvious motivation problem in that students are motivated to earn credit, which they do by simply showing up. Even those with an intrinsic interest in participating may feel that exerting themselves on the first of two tasks in the sequential task procedure is effort enough to merit the credit they came to receive. It could be that participants "self-license" themselves to exert less effort on Task 2 after having fully exerted themselves on Task 1 (Kivetz & Simonson, 2002; De Witt Huberts, Evers, & De Ridder, 2011). As such, motivating students to fully and willingly participate in every step requires careful consideration when evaluating data that appear to reflect a central depleted resource.

Sustaining participant motivation across tasks 1 and 2 in the sequential task paradigm is vital to combating any motivational shifts, whether it is a shift in impulse over control forces, shift toward self-licensed relief, or any other mechanistic shift away from exerting control. Study 2 in the present research seeks to prevent shifts away from participant control by introducing a potential monetary incentive to perform as well as possible on Task 2. Distinct from Muraven and Slessareva (2003), the motivational component will be introduced prior to Task 1, at a time when a sudden, 'magical,' reinstatement of self-control resources could not explain increased self-control performance after a depletion task.

1.3.2 Shifts in Attention

As mentioned previously, attention (monitoring) is a vital component of exerting self-control regardless of whether the underlying mechanism is resource dependent. After all, if people are unable, or unwilling, to monitor how their behavior compares to an established standard, then even if they were sufficiently motivated to motor their behavior into place, they would lack requisite information regarding their current behavior and how that behavior compared to the standard.

In addition to potential shifts in motivation from control forces outweighing impulse forces to impulse forces outweighing control forces, attentional forces likely play a role in the likelihood of any particular behavioral outcome occurring. Consider what may be of importance to an undergraduate student participating in the sequential self-control task procedure. After having participated in one difficult task (of which his or her motivation to perform is perhaps already questionable), a shift from control forces to impulse forces is likely accompanied with a shift in attention from the task of control to the rewards available to them by their participation. This is to say that once participants feel that they have fulfilled what they consider a sufficient amount of effort on their part for participating in the experiment, they are then only focused on the credit they will receive instead of the control they might otherwise be exerting.

In fact, Wan and Sternthal (2008) found that introducing performance feedback to depleted participants appeared to buffer against the effects of ego depletion on Task 2. That is, when participants were able to monitor how their behavior compared to an established standard, the effects of ego depletion at Task 1 were eliminated. This finding is therefore inconsistent with a resource model in that participants are not being reinstated with self-control resources, rather, in general, participants who are able to monitor their behavior perform better than those who are not.

Attention to task is, however, not something that is applied uniformly among participants. In Wan and Sternthal's (2008) experiments, participants either were or were not presented with a clock for them to monitor their performance. In this scenario, participants' ability to fail to monitor is restricted, but what happens when participants are allowed to freely attend (or not) to their performance on Task 2?

Inzlicht and Gutsell (2007) found evidence that an initial exertion of self-control dampens a participant's monitoring component in future tasks. In this paper, Inzlicht and Gutsell investigated the role of error-related negativity (ERN). ERN is an evoked brain potential from the anterior cingulate cortex (ACC), an area of the prefrontal cortex considered to be responsible for monitoring activity (Dehaene, Posner, & Tucker, 1994; Heatherton & Wagner, 2011; Kerns, Cohen, MacDonald, Stenger, & Carter, 2004). The ERN occurs when people make errors while completing a reaction task. That is, when a person commits an error, the ERN is what tells him or her that an error has been made.

Inzlicht and Gutsell (2007) measured participants' ERN while completing a Stroop task after having already completed a depletion or control task. They found that participants who had completed the depletion task at Time 1 showed depressed ERN amplitudes in addition to poorer overall Stroop performance compared to those who did not complete the depletion task at Time 1. The authors proposed that the depressed ERNs in depletion-condition participants signified a reduced capacity to monitor their behavior thus leading to poorer performance on Task 2. This provides a plausible alternative explanation to a centralized resource-model by demonstrating that "depleted" participants simply are not attending to their performance on Task 2 after having just completed a difficult task to the degree "non-depleted" participants are.

1.4 Process Model Testing

In attempting to establish one model, or even just a better model of self-control, the process model needs to be evaluated in a manner which renders it distinct from ego depletion. Fortunately, the process model and the resource depletion model can be pitted against one another where they differ with respect to the role of effort, attention, and motivation. This was the focus of unpublished research conducted over the course of 2018.

This unpublished study was designed to pit Baumeister's resource model of self-control against the Inzlicht and Schmeichel's process model of self-control. In any scientific venture, it is best to conduct

experiments which can falsify one and corroborate the other. That the resource depletion model has a varying amount of research supporting it, and one experiment would simply not suffice in establishing a prominent model, this study aimed to support the process model of self-control by effectively locking the cogs of motivation and attention into place. Without the ability to shift motivation and attention away from responsibility and towards relief, participants should demonstrate either a depletion pattern, a process pattern, or a pattern that matches neither.

In this experiment, participants were brought into a laboratory and sat in front of a computer running an experiment program built in Qualtrics survey software. Participants in the depletion control condition spent ten minutes writing without any restrictions, while the depletion condition participants wrote for ten minutes without using the letters a and n. The participant was then told that the next portion of the experiment involved a hand grip task, but not before they were read instructions about how they could win a $50 Visa gift card. Having already been randomly assigned to a high motivation condition (they would win the gift card if they lasted the longest) or a low motivation condition (one winner would be randomly selected). Participants then completed the dependent task (hand grip sustain above 70% maximum strength) in one of the two attention conditions, the high attention manipulation (1, goal and performance visible) or the low attention manipulation (0, goal and performance not visible).

Results from this experiment did not support this process model. First, performance was no worse for participants whose motivations were allowed to shift than for those whose motivations were (ostensibly) locked into place by making salient the impact their performance had on their reward. Second, while participants who were able to observe their goal and performance performed better than those who did not, this attention discrepancy did not better account for results of depletion because there was no evidence of depletion initially. This does not rule out the role of attention in self-regulatory behavior, rather, this finding does not permit the conclusion that the process model falsifies and replaces the resource model of self-control.

However, this single study suffered from a number of flaws, not least of all its lack of potential for converging evidence to support the process model. At the time it was conducted, practical limitations necessarily reduced the ability to look at multiple spheres of control. This particular test of the process model would benefit from an Etherton et al. (2018) experimental framework whereby numerous types of regulatory cognitions and behaviors were tested. In order to determine any possible evidence left for ego depletion, these tasks will be performed both with an ego depletion task for half and without for half. After being assigned to either a depletion (vs. control) condition, participants will also be assigned to one of two attention conditions, and finally to one of two motivation conditions. Lastly, in order to uncover evidence of the domain generality of the process model, three different types of dependant measures will be used.

The resulting experimental design is extensive (See Figure 4). First, participants will be assigned to

one of six depletion conditions (3 depletion tasks by 2 factors within). Next, participants will be assigned to either a high or low-motivations condition. Next, they will be assigned to a high or no task-attention condition. Finally, participants will complete one of three dependant tasks.

Depletion Manipulations		Motivation Manipulations	Attention Manipulation	Dependant Measure
Crossing Out Letters	Cross out "e"	High Motivation	Task Performance Available	Anagram Solving
	Cross out "e" with added rules			
Stroop Task	Read word aloud			Hand Grip Persistence
	Identify ink color with added rules			
Lexical Override	Freewrite	Low Motivation	Task Performance Absent	Math Problems Solved
	No "*a*" or "*n*"			

Figure 2: Experimental Design

1.4.1 Depletion Manipulations

Crossing Out Letters The crossing out letters task will be similar to that used by Etherton et al. (2018) which itself was developed from previous studies (Baumeister et al., 1998). The task involves providing participants in both conditions a ten-page block of text (so that the participant will not run out of letters to cross out). Participants in the control condition will be instructed to cross out every single "e" they encounter. Participants in the experimental, and considerably more difficult, condition are provide the following instructions: *"cross off the letter "e" every time it appears with the following exceptions: 1. Do not cross out the "e" if it is adjacent to another vowel (e.g., friend); 2. Do not cross out the "e" if it is one letter away from another vowel (e.g., vowel); 3. Do not cross out the "e" if the word has 6 letters (e.g., "there"); 4.Do not cross out the "e" if it is the third to last letter (e.g., customers); 5.Do not cross out the "e" if there are double letters in the word (e.g., "hello")".*

Stroop Task Participants will complete a Stroop-like color-naming task in which they are given a set of five pages on which color names are listed. For those in the control condition, the color names were printed in black letters, and participants will be instructed to simply name the color word as written.

Those in the depletion condition will be given modified Stroop instructions similar to those described by Wallace & Baumeister (2002). Standard Stroop task instructions are to name the color of ink in which a word is printed, an effortful task which purportedly requires self-control when the written word and the ink of that word are discordant (e.g., 'Yellow' written in green). To increase the difficulty (and thereby ostensibly increase the amount of regulation necessary) the Stroop instructions will be modified to name the color of the ink in which words were written, textitexcept that for words printed in the ink color red, when they are to name the word that is printed in red.

Lexical Override Participants assigned to the lexical override depletion task will spend 10 minutes writing a story about a summer experience. The topic of the story is irrelevant as the objective of this task is to experimentally manipulate the effort required for participants to complete their story. Participants

in the experimental condition will be instructed to create stories without using words containing the letters *a* or *n*. Participants in the control condition will be given no restrictions for constructing their stories. If it is the case that self-control is reliant on a central resource for execution, participants in the lexical override condition will demonstrate poorer performance on the dependent task regardless of which motivational and attentional conditions they are assigned.

1.4.2 Motivational Manipulations

The first step in locking the cogs of the process model requires that participants have sufficient motivation to complete a second difficult task. Inzlicht and Schmeichel (2012; Inzlicht, Schmeichel, & Macrae, 2014) propose that after the completion of an initial effortful task, the motivation of participants will shift away from completing the tasks asked of them and toward the relief of no longer engaging in these tasks. In order to properly motivate participants, it is necessary to convince them they will receive a textitvaluable reward based on either their dependant task performance (high motivation) or by chance (low motivation). In the unpublished study referenced above, motivation was manipulated in much the same way. However, it was possible that the motivation (a $50 gift card) was insufficiently motivating. Also, participants had multiple motivations; some who participated in the experiments were more motivated by course or extra credit they were to receive rather than the possibility of winning $50.

High Motivation For this set of studies, the potential monetary reward will be raised to $250. The high motivation manipulation involves providing to the participant the impression that a $250 gift card will be awarded to the best performer on the dependant task (anagram solving, hand grip persistence, math problems solved, depending). It is imperative that participants believe that they have an equal opportunity to win the gift card. As such, they will be told that the dependant task they will perform has been standardized so that no previously developed skill will provide anyone a (dis)advantage. For example, a participant who faces a math task, but believes they are poor in math and therefore have no chance of winning will not be sufficiently motivated to perform well on the dependant task.

Low Motivation In the low motivation condition, participants will again be informed that they have an opportunity to win a $250 gift card. However, in this condition, participants will be told that one person will be randomly selected from all of those participating to be the winner. In this case, low-motivation participants will not experience any additional motivation (apart from their intrinsic motivation, which should be randomly distributed across motivation conditions) to perform well. As with high-motivation participants, this group will be told the dependant tasks have been standardized so that previous skill will not help or hinder their performance.

1.4.3 Attentional Manipulations

Whereas the process model of self-control predicts that after an exertion of considerable effort, participants will shift their attention away from obligation and towards relief and reward, the depletion model makes no such predictions. Rather, the depletion model posits that focus on monitoring behavior, and the extent to which it does or does not meet a particular standard, can influence how well people will perform on an effortful task. In order to provide support for the process model, keeping participants' attention from shifting is necessary. In order to do this, participants will be assigned to one of two attention conditions.

High Attention The objective for the high-attention conditions (adapted for each dependant measure) is to have participants focus on the task-at-hand rather than allow for their attention to shift towards relief from the task, towards the possible reward of the task, or in any other sense away from what they are doing. For the anagram solving task, high-attention participants will see a counter which will indicate to them how many anagrams (out of 200, more than they could conceivably complete in five minutes) they have successfully completed. For the hand grip task, high-attention participants will be able to monitor their performance, both as it relates to their individualized pressure threshold, but also to the amount of time they are persisting. For the math problems solved, similar to the anagram task, participants will be displayed the number of math problems they have answered correctly out of 200.

Low Attention According to Inzlicht and Schmeichel (2012), the process model predicts that self-regulatory failure occurs when a person's mind is permitted to shift towards relief and reward instead of their regulatory goal. For low-attention participants, indicators that would otherwise permit for self-monitoring (as in the high-attention condition) will be removed. For the anagram and math problem solving tasks, this means participants will be provided neither how many anagrams or math problems they have solved, respectively. For hand grip participants, the low-attention condition will require them to complete the hand grip task with no real-time performance monitoring capacity.

1.4.4 Dependant Measures

In order to provide support for the process model, converging evidence must demonstrate consistent decreases in performance over many different self-control tasks. As such, this project seeks to provide evidence by using three dependent measure of control: anagram solving, handgrip persistence, and math problems solved. For each dependent variable, a higher measurement is interpreted as a greater level of self-control than a lower measurement.

Anagram Solving The anagram-solving task will be similar to previously used tasks (Baumeister et al., 1998; Gailliot et al., 2007; Park, Glaser, & Knowles, 2008) will administered following the depletion

task and explanation of the particular motivation condition assigned. This task has been used in a number of self-regulation studies, requiring self-regulatory engagement by creating and then overriding various letter combinations until a solution is reached (e.g., Gailliot et al., 2007). Participants will be presented an electronically prepared card stack with one anagram presented at a time. When an anagram is successfully completed, an indication of this will be presented and that anagram card will be removed from the electronic stack. If the anagram is incorrect, the participant will be alerted and the anagram card will be randomly inserted back into the electronic stack. Participants will be asked to complete as many anagrams as they can within five minutes. The number of correctly completed anagrams will recorded for each participant as the measure of self-control (Etherton et. al 2018).

Handgrip Persistence One's ability to forego the relief of releasing a hand dynamometer by continuing with the task has often been used as a dependent measure of self-control. For this experiment, after participants have completed the first depletion task and have been given their randomly assigned motivational and attentional instructions, the participants assigned to the hand grip dependent measurement task will be prompted to gain the experimenter's attention.

Once the participant has gained the attention of the experimenter, the experimenter will bring the participant to a computer running the Venier software which records pressure placed on the hand dynamometer in real time. The participant will then be asked to squeeze the dynamometer as hard as he or she can one time to establish a maximum grip strength, measured in Newtons. This maximum grip strength will be multiplied by 0.7 in order to construct a minimum threshold goal equal to 70% of his or her maximum grip strength. The participant will be instructed to maintain a constant grip strength at or above this 70% threshold for as long as he or she can. Calculating this threshold is vital to eliminate individual differences with respect to participants' own handgrip strength. Otherwise, without controlling for dispositional handgrip strength, it is possible to conclude that the best predictor of self-control is one's hand strength and not the factors predicted by either the resource model or the process model. An Excel tool (Marson & Pyle, 2018) was built to quickly calculate participants' 70% threshholds, generate a threshold line, and ultimately enter and save their persistence times.

Participants will be asked to hold the handgrip above their personally calculated threshold for as long as possible. The experimenter will begin timing the moment the strength meter rises above this threshold, and will end timing as soon as the meter falls below the threshold. This time will be used as the control metric for this task. After this task, participants will be debrief and dismissed.

Math Problem Solving For the mathematics-solving dependant measure, participants will be presented 200 single-digit math problems in a similar fashion to the anagrams - electronically, one at a time, in random order, for a period of five minutes. Solving mathematical problems has been used as an outcome measure in several previous depletion studies (Johns et al., 2008; Tyler & Burns, 2008; Vohs,

Baumeister, & Ciarocco, 2005; Wright et al., 2007; Mead, Baumeister, Gino, Schweitzer, & Ariely, 2009). The number of problems accurately solved in 5 minutes will serve as the dependent measure.

1.5 Future Directions

As reviewed, the ability to exert self-control is beneficial in many ways. From the individual level by abstaining from unhealthy food and behaviors, to the cultural level by recycling or conserving water, the ability to override one's dominant response tendency typically results in betters outcomes. Understanding the underlying psychological process(es) can allow researchers and practitioners alike to develop programs in order to help boost the self-control ability of those that might seek or need assistance with their impulse control. This experiment seeks to begin to fill the void in self-regulatory research left by the collapse of ego depletion. Ultimately, the state of self-control research has progressed to a state of immature science (Kuhn, 1962/1970) as it emerges from crisis. This project will certainly not settle the state of self-regulatory work, but, along with numerous other studies, has the potential to help direct the future of the science of self-control.

1.6 References

Baumeister, R.F., Bratslavsky, E., Muraven, M., & Tice, D.M. (1998). Ego depletion: Is the active self a limited resource? Journal of Personality and Social Psychology, 74(5), 1252-1265.

Baumeister, R. F., & Exline, J. J. (1999). Virtue, personality and social relations: Self-control as the moral muscle. Journal of Personality, 67, 1165-1194.

Baumeister, R.F., & Heatherton, T. F. (1996). Self-regulatory failure: An overview. Psychological Inquiry, 7, 1-15.

Baumeister, R.F., Sparks, E.A., Stillman, T.F., Vohs, K.D. (2008). Free will in consumer behavior: Self-control, ego depletion, and choice. Journal of Consumer Psychology, 18(1), 4-13.

Bush, G., Shin, L. M., Holmes, J., Rosen, B. R., & Vogt, B. A. (2003). The Multi-Source Interference Task: validation study with fMRI in individual subjects. Molecular Psychiatry, 8, 60-70.

Carter, E. C., Kofler, L. M., Forster, D. E., & McCullough, M. E. (2015). A series of meta-analytic tests of the depletion effect: Self-control does not seem to rely on a limited resource. Journal of Experimental Psychology: General, 144, 796-815.

Carter, E. C., & McCullough, M. E. (2014). Publication bias and the limited strength model of self-control: Has the evidence for ego depletion been overestimated? Frontiers in Psychology, 5, Article 823.

Carver, C. S., Scheier, M. F. (1982). Control theory: A useful conceptual framework for personality-social, clinical, and health psychology. Psychological Bulletin, 92, 111-135.

Crescioni, A. W., Ehrlinger, J., Alquist, J. L., Conlon, K. E., Baumeister, R. F., Schatsschneider, C., Dutton, G. R. (2011). High trait self-control predicts positive health behaviors and success in weight loss. Journal of Health Psychology, 16, 750-759.

Dehaene, S., Posner, M., & Tucker, D. (1994). Localization of a neural system for error detection and compensation. Psychological Science, 5, 303-305.

De Witt Huberts, J. C., Evers, C., & De Ridder, D. (2011). License to sin: Self-licensing as a mechanism underlying hedonic consumption. European Journal of Social Psychology, 42(4), 490-496.

Duval, S., & Tweedie, R. (2000). Trim and fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. Biometrics, 56, 455-463.

Etherton, J.L., Osborne, R., Stephenson, K., Grace, M., Jones, C., De Nadai, A. (2018). Bayesian analysis of multimethod ego-depletion studies favours the null hypothesis. British Journal of Social Psychology, 57(2), 367-385.

Freud, S. (1923/2010). The Ego and the Id. United States: Pacific Publishing Studio.

Freud, S. (1930/2005). Civilization and Its Discontents. New York, NY: W.W. Norton & Company.

Gailliot, M. T., Baumeister, R.F. (2007) The Physiology of Willpower: Linking Blood Glucose to Self-Control. Personality and Social Psychology Review, 11, 303-327

Gailliot, M. T., Baumeister, R. F., DeWall, C. N., Maner, J. K., Plant, E. A., Tice, D. M., et al. (2007). Self-control relies on glucose as a limited energy source: Willpower is more than a metaphor. Journal of Personality and Social Psychology, 92, 325-336.

Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. (2010). Ego depletion and the strength model of self-control: A meta-analysis. Psychological Bulletin, 136, 495–525. https://doi.org/10.1037/a0019486

Heatherton, T.F., Wagner, D.D. (2011). Cognitive neuroscience of self-regulation failure. Trends in Cognitive Sciences 15(3), 132-139.

Hood, R.W., Hill, P.C., Spilka, B. (2009). The Psychology of Religion: An Empirical Approach. New York, NY: Guilford.

Inzlicht, M., Gutsell, J.N. (2007). Running on empty: neural signals for self-control failure. Psychological Science 18(11), 933-937.

Inzlicht, M., Schmeichel, B.J. (2012). What is ego depletion? Toward a mechanistic revision of the resource model of self-control. Perspectives on Psychological Science 7, 450.

Inzlicht, M., Schmeichel, B. J., & Macrae, C. N. (2014). Why self-control seems (but may not be) limited. Trends in Cognitive Sciences, 18(3), 127–133

Johns, M., Inzlicht, M., & Schmader, T. (2008). Stereotype threat and executive resource depletion: Examining the influence of emotion regulation. Journal of Experimental Psychology: General, 137, 691–705.

Kearns, J.G., Cohen, J.D., MacDonald, A.W., Cho, R.Y., Stenger, V.A., & Carter, C.S. (2004). Anterior cruciate conflict monitoring and adjustments in control. Science 303(5660) 1023-1026.

Kivetz, R., & Simonson, I. (2002). Earning the right to indulge: Effort as a determinant of customer preferences toward frequency program rewards. Journal of Marketing Research, 39, 155-170.

Kuhn, T. (1962/1970). The Structures of Scientific Revolution. Chicago, Il: The University of Chicago Press.

Lurquin, J.H., Michaelson, L.E., Barker, J.E., Gustavson, D.E., von Bastian, C.C., Carruth, A.M. (2016). No evidence of the ego-depletion effect across task characteristics and individual differences: a preregistered study. PLoS ONE, 11.

Marson, S., Pyle, M.B. (2018). Marson-Pyle Hand Pressure Calculator and Logger. Unpublished Instrument. Retrieved from `https://drive.google.com/open?id=19HSJ_DwfWJDJkk_b3F0tp_kvURAr9dT6`

Masicampo, E. J., & Baumeister, R. F. (2008). Toward a physiology of dual-process reasoning and judgment: Lemonade, willpower, and expensive rule-based analysis. Psychological Science, 19(3), 255–260. doi:10.1111/j.1467-9280.2008.02077.x

Mead, N. L., Baumeister, R. F., Gino, F., Schweitzer, M. E., & Ariely, D. (2009). Too tired to tell the truth: Self-control resource depletion and dishonesty. Journal of Experimental Social Psychology, 45, 594–597.

Metcalfe, J. & Mischel, W. (1999). A hot/cool-system analysis of delay of gratification: Dynamics of willpower. Psychological Review, 106, 3-19.

Mischel, W., Shoda, Y., & Peake, P.K. (1988). The nature of adolescent competencies predicted by preschool delay of gratification. Journal of Personality and Social Psychology, 54, 687-696.

Muraven, M., Baumeister, R.F., & Tice, D.M. (1999). Longitudinal improvement of self-regulation through practice: Building self-control strength through repeated exercise. Journal of Social Psychology, 139(4), 446-457.

Muraven, M., Slessareva, E. (2003). Mechanisms of self-control failure: Motivation and limited resources. Personality and Social Psychology Bulletin, 29(7), 894-906.

Muraven, M., Tice, D.M., & Baumeister, R.F. (1998). Self-control as limited resource: Regulatory depletion patterns. Journal of Personality and Social Psychology, 74(3), 774-789.

Osborne, C., Vuu, G., & Henninger, F. (2016, August 19). Replication of EJ Masicampo, RF Baumeister (2008, PS 19(3)). Retrieved from osf.io/3h29d

Park, S. H., Glaser, J., & Knowles, E. D. (2008). Implicit motivation to control prejudice moderates the effect of cognitive depletion on unintended discrimination. Social Cognition, 26, 401–419. https://doi.org/10.1521/soco.2008.26.4.401

Richard, F. D., Bond, C. F., & Stokes-Zoota, J. J. (2003). One hundred years of social psychology quantitatively described. Review of General Psychology, 7, 331-363.

Schmeichel, B. J. (2007). Attention Control, Memory Updating, and Emotion Regulation Temporarily Reduce the Capacity for Executive Control. Journal of Experimental Psychology: General. 136, 241-255.

Schmeichel, B. J., Vohs, K. D., Baumiester, R. F. (2003). Intellectual Performance and Ego Depletion: Role of the Self in Logical Reasoning and Other Information Processing. Journal of Personality and Social Psychology. 85, 33-46.

Schmeichel, B.J., Volokhov, R.N., Demaree, H.A. (2008). Working memory capacity and the self-regulation of emotional expression and experience. Journal of Personality and Social Psychology 95(6) 1526-1540.

Stanley, T. D., & Doucouliagos, H. (2014). Metaregression approximations to reduce publication selection bias. Research Synthesis Methods, 5, 60-78.

Strack, F. & Deutsch, R. (2004). Reflective and impulsive determinants of social behaviors. Personality and Social Psychology Review, 8(3), 220-247.

Tangney, J.P., Baumeister, R.F., & Boone, A.L. (2004). High Self-Control Predicts Good Adjustment, Less Pathology, Better Grades, and Interpersonal Success. Journal of Personality, 72, 271-324.

Turner M.L., & Engle R.W. (1998) Is working memory capacity task dependent? Journal of Memory and Language, 28(2):127–54.

Tyler, J. M., & Burns, K. C. (2008). After depletion: The replenishment of the self's regulatory resources. Self and Identity, 7, 305–321.

Vohs, K. D., & Baumeister, R. F. (2004). Understanding Self-Regulation. In R. F. Baumeister & K. D. Vohs (Eds.), The Handbook of Self-Regulation (pp. 1-9). New York, NY: The Guilford Press.

Vohs, K. D., Baumeister, R. F., & Ciarocco, N. J. (2005). Self-regulation and self-presentation: Regulatory resource depletion impairs impression management and effortful self-presentation depletes regulatory resources. Journal of Personality and Social Psychology, 88, 632–657.

Wallace, H. M., & Baumeister, R. F. (2002). The effects of success versus failure feedback on further self-control. Self and Identity, 1, 35–41.

Wan, E.W., & Sternthal, B. (2008). Regulating the effects of depletion through monitoring. Personality and Social Psychological Bulletin, 34, 32-46.

Williams, R.J. & Ricciardelli, L.A. (1999). Restrained drinking and cognitive control among adolescents. Adolescence, 34(135), 557-565.

Woods, W.P. & Heretick, D.M. (1983). Self-schemata in anorexia and obesity. Imagination, Cognition, and Personality, 3(1), 31-48.

Wright, R. A., Junious, T. R., Neal, C., Avello, A., Graham, C., Herrmann, L., . . . Walton, N. (2007). Mental fatigue influence on effort-related cardiovascular response: difficulty effects and extension across cognitive performance domains. Motivation and Emotion, 31, 219–231.