School of Psychology and Speech Pathology

Examining Role of Self-Control Exertion in the Strength Model of Self-Control Using Modified Versions of the Sequential Task Paradigm

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2014). The proposed research study received human research ethics approval from the Curtin University Human Research Ethics Committee, Approval Number **RDHS-44-16**

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Abstract

One of the main models of self-control used today is the strength model of self-control proposed by Baumeister (1998). The model proposes that acts of self-control consume some form of self-control resource and repeated use will leave a person depleted of this resource and unable maintain the same level of self-control, a state known as ego-depletion. In the last three years, the strength model has become embroiled in controversy as a meta-analysis by Carter and McCullough (2014) found that the effect of ego-depletion was indistinguishable from zero. In response to this challenge to the strength model's validity, this project aims to examine the methodology of how the strength model is conventional tested and investigate how ego-depletion may be reliably evoked. Composed of three studies, the first study is a meta-analysis on the relationship between the perceived effort exerted by participants in sequential task paradigm experiments and ego-depletion. The second and third studies are laboratory experiments which attempt to enhance the motivation of participants by employing monetary incentives, or extending duration of, the initial self-control task in sequential task paradigm experiments, to increase self-control exertion and evoke ego-depletion. In addition, an attempt to more accurately assess self-control exertion through task parameters rather than traditional self-report measures were utilized. Results from the three studies found that the conventional approach of using perceived effort was an ineffective way of measuring self-control exertion. However, it is inconclusive whether the use of task parameters to measure depletion is sufficiently reliable. In addition, neither monetary incentives nor task duration effectively evoked the ego-depletion effect. Results illuminated critical methodological shortcomings in the ways that strength model have been tested in the past and suggests that future research should examine some key concepts and experimental protocols of strength model research.

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CHAPTER 1

Introduction

1.01 Introduction

Civilization has been built on the premise that humans are able to overcome our primitive impulses and take goal-directed actions to secure long-term beneficial, adaptive outcomes. The ability to exert a degree of self-control to overcome unwanted habits, or the need for immediate gratification, has led to the flourishing of cultural, scientific and moral development for the humanity. Modern researchers such as Baumeister (2002) and Muraven et al. (2005) define self-control as a person's capacity to alter, modify, change, or override impulses, desires, and habitual responses. Day-to-day application of self-control could be seen in many facets of human behaviour including overcoming the impulse to binge drink, eating healthy food, not smoking cigarettes, refusing to consume recreational narcotics, refraining from overspending, or resisting the impulse to procrastinate (Steel, 2007; Tice & Bratslavsky, 2000).

A popular model employed to understand self-control in recent times is the "strength" model conceived by Baumeister and colleagues (1998). This model holds the position that volitional and effortful acts of self-control require the consumption of a finite resource. As this resource is limited, expending it through self-control acts will lead to its depletion and temporarily decreasing performance in further acts of self-control. This state of weakened self-control capacity is termed *ego-depletion*. Since the first published articles on ego-depletion two decades ago (Baumeister et al., 1998; Muraven et al., 1998), this position has been the predominant position by which the concept of self-control has been applied in various areas of psychology and sport sciences. The application of the strength model in areas such as health behaviours (Hagger, 2010), consumer psychology (Baumeister et al., 2008)

and clinical interventions (Christiansen, Cole & Field, 2012), among others, yielded a surge of studies.

A search over academic databases yields more than four hundred publications on the topic. However, more recent reviews of such studies have raised serious doubts about the model's credibility (Carter & McCullough, 2014; Carter, Kofler, Forster & McCullough, 2015). Questions that have been raised include the small study effect and publication bias, challenging the contemporary acceptance of the strength model.

While questions regarding the research and statistical evidence of the strength model have been raised, a fundamental issue has yet been satisfactorily addressed. That is, whether the way by which we test the strength model, as traditionally employed, is sufficient to test the model itself. The sequential-task experimental paradigm (further details in section 2.04) was first developed in Baumeister's (1998) research as a means to test and evoke an observable ego-depletion effect. While it nonetheless produced a rich collection of literature, the question that must be raised is whether this experimental paradigm was sufficient and adequate to provide support for the strength model. Indeed all evidence, be it experimental or statistical, will lose its credibility resulting in both the supporters and critics of model having no basis upon which to their conclusions if the experimental paradigm is not considered fit-for-purpose. In addition, any moderating variable of the ego-depletion effect that has been proposed would also be rendered invalid as the ego-depletion effect that their moderating effect was limited to begin with.

The current project was undertaken to address this issue. Three studies have been conducted including a meta-analysis which reviews the relationship between people's perceived effort and self-control performance reduction, and two experimental studies examining the effects of monetary incentives and task duration. By reviewing and further

developing the standard sequential-task experimental paradigm used to test ego-depletion hypotheses, the primary goal was to establish an experimental protocol that could reliably test and observe the depletion effect.

CHAPTER 2

Literature Review

2.01 Nature of Self-Control

In order to enact behaviours geared at long-term goals, a degree of self-control that overcomes our need to react to immediate impulses (Ainslie, 1975; Fujita & Han, 2009) and to delay gratification (Metcalfe & Mischel, 1999; Mischel, Shoda, & Rodrieguez, 1989) is necessary. Without it, humans will lack the capacity for the disciplined, focused effort required for ulterior goals (Loewenstein, 1996). However, the human capacity for self-control is finite. On a day-to-day basis, examples of self-control lapses can be found on multiple occasions. What leads to failures of self-regulation may vary from person to person, but these instances could have a spectrum of consequences, from the trivial to the disastrous. Previous research support this position and illustrate that self-control capacity deficits have an impact on numerous domains of behaviour including alcoholism (Muraven et al., 2005), smoking (Russell, 1971), sexual impulses (Gailliot & Baumeister, 2007), and academic achievements (Tangney, Baumeister, & Boone, 2004), among others.

The fundamental nature of self-control acts could be understood as the effortful commitment of executive function to overcome conditioned, or spontaneous, reactions. The core tenet of any self-control acts is that it must be directed to override, suspend, interrupt and/or alter a person's own natural responses (Carver & Scheier, 1998). It is important to recognise that self-control, being an exertion to overcome habits, requires a conscious awareness of the act itself (Wegner & Zanakos, 1994). While most day-to-day actions are taken without awareness or thought, self-control exertion occurs when these actions are brought into the realm of awareness in order to be counteracted. In the case of where people

were instructed to suppress a certain thought, the act of suppression would only occur if they actively searched for a distracter when the assigned suppressed thought arises in their conscious mind. Perhaps the most important aspect of this operation is that any attempts to overcome one's impulses or conditioned habits will unavoidably produce resistance. It is through the volitional exertion of resistances to habitual forces and momentary impulses that an act of self-control is distinguished from other forms of behaviours. It is the position of Schmeichel, Vohs and Baumeister (2003) that in order to classify something as a self-control act, it must involve the executive control to initiate counter-habitual behaviours. It is due to this intentional act that self-control processes require a degree of effort to be committed into the process. According to Bargh (1994), acts which do not require effort or executive control should not be considered as self-control, but belong to a general category known as automatic behaviours.

2.02 Limited Capacity of Self-Control

Much of the research that had been devoted to the field of self-control had either employed a cognitive-based approach, or a capacity-based approach. A cognitive-based approach essentially considered self-control as an operation, or dynamic process, of attitudes, intentions, expectations, beliefs, and/or judgments (Ajzen, 1985; Bagozzi, 1992; Koestner, Bernieri, & Zuckerman, 1992; Sansone & Smith, 2000). Capacity-based models on the other hand were based on the idea that self-control ability is limited by a finite resource (Baumeister & Heatherton, 1996; Fishbach, Friedman, & Kruglanski, 2003; Metcalfe & Mischel, 1999; Mischel et al., 1989). It was based on this understanding that Baumeister developed the strength model of self-control (Baumeister, Bratslavsky, Muraven, & Tice, 1998). The strength model categorizes self-control acts not dissimilar to actions undertaken by a physical muscle (Muraven & Baumeister, 2000). The level of strength the muscle is

capable of producing, and the duration by which this strength could last is actually finite. Self-control, much like a muscle, requires power to exert force for prolonged periods of time. If a muscle must maintain such exertion, it would eventually lead to fatigue and losing its ability to continue to uphold the strain. Similarly, prolonged and intensive self-control exertion will lead to the exhaustion of self-control and thereby impairing self-control.

Not unlike a muscle, the fundamental assumption of the strength model is that self-control acts (e.g., controlling impulses, overriding habitual responses, making choices) require the expenditure of some manner of self-control energy or resource, known as ego-energy (Baumeister et al., 1998). Current research had thus far been unsuccessful to identify the nature and source of this ego-energy. However it is generally believed that it draws upon a finite resource and when the resource has been partially or wholly depleted, it would result in the diminishing of the person's capacity to further regulate their actions and behaviours. Consequently, performance of subsequent acts of self-control acts will be significantly reduced. This temporary impediment of one's ability to exert effortful executive function to overcome immediate impulses and habitual forces was termed "ego-depletion" (Muraven & Baumeister, 2000; Bauer & Baumeister, 2011).

It should be noted that self-control actions are not restricted to one sphere of behavioural control. Baumeister, Vohs and Tice (2007) categorized spheres of self-control into seven main domains including attentional control, emotional control, impulses/affective control, thought control, cognitive processing, choice/volition as well as social processing. Effectively, all acts of self-control draw upon a single, domain-general, internal pool of self-control resource. This implies that efforts exerted in one domain of self-control could lead to the state of ego-depletion shared by all others.

2.03 Ego-Energy in the Form of Glucose

One key issue that has eluded researchers is what exactly is “ego-energy?” While a number of studies have been conducted, experiments have never observed the energy directly. Rather, it is merely inferred inductively by the decrease in self-control performance. Although inductive reasoning is common in the field of psychology, it nonetheless falls short of the goal of actually demonstrating the nature of ego-energy. Since the conception of ego-energy, there has been a concerted effort to identify its physiological basis. One attempt is that of Gailliot and colleagues (2007) which postulated that the level of ego-energy is determined by the level of glucose that was accessible to their brain. As glucose was responsible for supplying energy for both body and the brain, it is understandable to draw intuitive connection between the two. By interpreting self-control resource as a biological medium of energy (sugar), this position had the benefit upholding to the law of conservation of energy as the total amount of energy within an independent system can never increase. In nine studies, they discovered three important biological effects. Firstly, compared to performance in self-control acts that required little exertion, undertaking highly demanding self-control acts alleviated the level of blood glucose consumption. Secondly, the decrease in glucose in an individual was significantly correlated with the reduction of self-control performances. Last, this decrease was then attenuated through the ingestion of glucose supplements which resulted in a substantial improvement in self-control functions. Gailliot and Baumeister’s research yielded the first evidence which suggested a biological basis for the strength model and glucose was the vital component which its absence corresponded to the ego-depletion phenomenon. Initially, a series of independent studies managed to replicate those findings (DeWall, Baumeister, Stillman, & Gailliot, 2007; Gailliot, Peruche, Plant, & Baumeister, 2009; Masicampo & Baumeister, 2008; Wang & Dvorak, 2010).

In spite of initial success and support, the position that glucose availability as a biological basis for ego-energy, was soon challenged by other researchers. Among the arguments that were proposed, one submitted that the biological mechanism of glucose's effect on self-control did not make logical sense due to the demand for glucose from the brain is relatively limited (Kurzban, 2010). A self-control task enacted within a laboratory setting should not impart any noticeable difference to the overall supply for glucose. Evidence from studies such as those of Kurzban (2010) and Beedie and Lane (2012) demonstrated that even after behaviours that demanded self-control exertion, supply of glucose to the brain remained comparatively stable and could not account for the ego-depletion effect. More importantly, further studies have been met with mixed outcomes with a number of them failing to find any significant results. For example, after self-control exertion, Molden et al. (2012) did not observe any significant reduction to blood glucose levels. It is worth noting that this study differed from those done previously as it employed a much more precise means of evaluating blood glucose level suggesting that previous results may have been in fact a construct of inaccurate measurements.

Even if there was no drop in glucose level when self-control was exerted, it nonetheless seemed empirically proven that consuming glucose helped the increase in performance in self-control behaviours. For example, studies that examined specifically this question found that aggression inhibition was both improved after ingesting glucose (Dvorak & Simons, 2009). Similarly, a study by Gailliot et al's (2009) found that those who took the glucose supplements were less likely to stereotype an individual. In addition, if someone was predisposed with high levels of prejudice, not taking glucose supplements was related to an increased chance of using derogatory statements. Yet this position too has been called into question. Evidence such as those of Sanders, Shirk, Burgin, and Martin (2012) as well as Hagger and Chatzisarantis (2013) have found that in order for cognitive control to be

increased, all one needed to do was to gargle glucose solutions rather than actually ingesting it. These results suggest that rather than actual carbohydrate metabolization, as long as there was glucose in the mouth, the brain would somehow compensate for any decrease in self-control level. It was their argument that the effect was due to carbohydrate-sensitive receptor cells within the oral cavity conveying signals to the brain's region involved in motivation and need for cognitive control, two areas likely to be involved in successful self-control (Hagger & Chatzisarantis, 2013). However, this argument was also challenged as Lange and Eggert (2014) proposed that the chances of consuming glucose supplements having any meaningful effect on self-control was statistically unlikely and attaining that the results found in Gailliot et al's (2009) report were less than 1% based on the incredibility index of Schimmack (2012). As such, the position that the biological basis for ego-energy is glucose remains uncertain.

2.04 Testing the Strength Model

One of the most important developments in conjunction to the conceptualization of the strength model was the means to test it. Along with the model itself, Baumeister and his colleagues also developed the Sequential-Task Experimental Paradigm (Baumeister et al., 1998; Finkel et al., 2006; Muraven, Tice, & Baumeister, 1998). As it stands, this experimental protocol, and variations of it, is the standard experiment methodology by which the majority of depletion-related studies employ.

Perhaps the greatest strength of this experimental model is its simplicity. A typical sequential-task experiment requires from the participants to perform two tasks in a sequence. While those assigned to the experimental group will receive two tasks both requiring self-control exertion, only task 2 will have this requirement for those assigned to the control group. In theory, the strength model dictates that people in the experimental group would have spent their ego-energy on task 1 and thereby evoking ego-depletion. This leaves their

ego-energy reserves drained resulting in a performance penalty when engaging in task 2. For those in the control group on the other hand, as their task 1 did not require self-control (or at least very little), their performance in task 2 would be approached with a 'full tank' and thus should be able to give optimal performance (Baumeister et al., 2007).

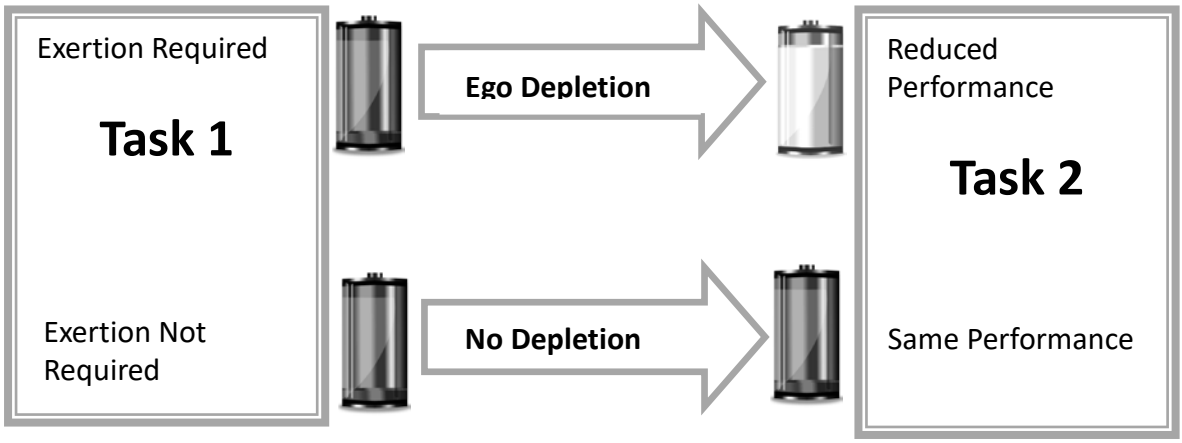

Figure 1. Sequential-Task experiment illustration

At its inception, two studies were conducted based on this new method of testing the limited capacity paradigm of self-control. Both Baumeister et al. (1998) and Muraven et al., (1998) employed the sequential-task experiment and obtained comparable findings. Within the study helmed by Baumeister, subjects were instructed to consume radishes while at the same time not to eat delicious cookies that were placed before them. A second group on the other hand, were given different instructions and were not required to eat the radish but were allowed to enjoy the cookies. A third group, serving as control, skipped this process entirely and was not shown any foods. They were then administered a geometric puzzle which was impossible to solve. The level of their self-control capacity was deduced by comparing how long they persisted in this task. The result was a significant difference between the first and second group with the second group spending almost twice the time and making significantly more attempts solving the puzzle before giving up. No difference was found between those

who enjoyed the cookies and the control group who skipped task 1. Baumeister reasoned that the suppression of the desire to eat the alluring chocolate while at the same time resisting the aversion of the radish posed a substantial enough challenge to one's self-control that their ego-energy was spent in this task. Having experienced ego-depletion, the experimental participants demonstrated impaired performance when engaging the puzzle task.

It is arguable that the reason why Baumeister's experiment succeeded may have been due to participants resenting the experiment for denying them the cookies and therefore, consciously or not, did not choose to perform as well as the other group (Sims, 2013). The study conducted by Muraven et al. (1998) addressed this issue by removing the variable of 'treats' from the experiment. They requested that participants suppress their emotional expression while watching an arousing video while the control group was assigned no such requirements. It was predicted that ego-energy would be spent in task 1 through the act of suppressing their emotional responses will undermine performance on task 2. In addition, this experiment did not involve the experimenter denying anything tangible from the participant and therefore the matter of resentment to the experimenter should not arise (Sims, 2013). Task 2 involved maintaining squeezing tension on a handgrip exerciser for as long as possible. The researcher's position was that ego-energy was required to overcome the physical strain and muscular fatigue that builds up with time and those who are in a depleted state from suppressing their emotions beforehand would perform significantly worse. The results confirmed this hypothesis.

Similar effects have been replicated across multiple studies and between many difference domains of self-control (Martijn et al., 2007; Tyler & Burns, 2008; Wright, Martin, & Bland, 2003). The evidence yielded from this stream of research seems to support the strength model as predicted by Baumeister et al. (1998).

2.04.1 Initial Support for the Strength Model

Since the conception of the strength model, there had been a steady build-up of empirical support for the effects of ego-depletion (Baumeister, Gailliot, DeWall, & Oaten, 2006; Muraven & Baumeister, 2000). Many of these studies were designed with the premise of the common 'reservoir' of ego-energy so exertion in one field of self-control affected the ability of another. Evidence from studies such as Baumeister et al. (2008) found that being made to choose between options (an act of cognition) could negatively impact one's ability to resist physical pain. Within their study, participants were required to make a series of choices between different products presented to them. The control group however, only needed to write down their thoughts, feelings and opinions of various advertisements. Task 2 required both groups to submerge their arm into a tank of water at near-freezing temperature. Level of self-control was measured by how long they were able to keep their arm submerged before the agony overwhelmed them. Data showed that those who were forced to choose between products withdrew their arm in less than half the time compared to the control group. Other studies have shown similar results in which the act of choosing could reduce one's ability to persevere under repeated failure (Baumeister et al., 1998; Muraven & Baumeister, 2000)

Extending research to issues that is more grounded in real-world problems, the strength model have found to be robust in health-related behavioural changes such as sexuality (Gailliot & Baumeister, 2007) and alcoholism (Muraven et al., 2005). Beyond the area of health behaviour, social psychologists have also found the strength model to be useful in predicting impulse buying behaviour (Vohs & Faber, 2007), academic performances (Tangney et al., 2004) and even various forms of criminal activities (Gottfredson & Hirschi, 1990).

2.04.2 Meta-Analyses of Ego-Depletion Literature and Their Implication

After decades of research investigating the strength model, Hagger, Wood, Stiff, and Chatzisarantis (2010a) attempted to establish an overall synthesis of this research by conducting a meta-analysis on 198 studies. Using the method developed by Hunter and Schmidt (1990), the conclusion of this endeavour was that the evidence in support for the ego-depletion effect yielded a medium-size overall effect (d = 0.62 [95% CI: 0.57, 0.67]). In spite of their conclusion, and almost two hundred studies that largely supported the strength model, the validity of the strength model and even the existence of ego-depletion has nonetheless been called into question by subsequent studies.

The first of these criticisms came from Carter and McCullough (2014) which raised two important issues. It was their opinion that the strong effect size found in Hagger et al. (2010a) was actually inflated due to the small-study effect. This meant that studies with relatively small samples would produce disproportionally larger effect size estimates. Consequently, this effect would reflect publication biases, the tendency of journal editors to only publish studies that yields a significant finding (Englert, Bertrams, Furley & Oudejans 2015). Without these null-finding articles being included into the meta-analysis, it was inevitable that the effect size of ego-depletion would become inflated as a consequence. From the position of Carter and McCullough, the depletion effect may very likely be non-existent as a result of this process. It should be noted that the problem of publication bias is not unique to ego-depletion literature, or even psychology in general. However, it is in the field of psychology that the problem seems to be more prevalent (Bakker, van Dijk, & Wicherts, 2012; Ferguson & Brannick, 2012). Utilizing a three stage method of analysis of Hagger's findings, including (1) binomial test outlined by Ioannidis and Trikalinos (2007); (2) trim and fill method (Duval & Tweedie, 2000a, 2000b); as well as (3) extended Egger's regression test

(Egger, Smith, Schneider, & Minder, 1997; Moreno et al., 2009; Stanley, 2005), Carter and McCullough (2014) demonstrated a clear effect of publication bias. Carter, Kofler, Forster, and McCullough (2015) then followed up with another meta-analysis which employed a different statistical method as well as included a number of studies that were not published at the time. It was their conclusion that given a review that was untainted by publication bias or small sample effects, the effect size of ego-depletion was not distinguishable from zero.

In response, Hagger & Chatzisarantis (2014) argued that the lack of effect in Carter et al. (2015) may be due to methodological issues or true heterogeneity in the effect. Similarly, Gervais (2015) specifically called the methodology adopted by Carter et al. (2015) into question stating that is it neither particularly accurate, precise, nor reliably able to differentiate effects from non-effects. Cunningham and Baumeister (2016) proposed that Carter and McCullough's review may have suffered from a number of limitations including underrepresenting published studies, inclusion of methodologically questionable experiments, accepting unsubstantiated null conclusion, among others. Indeed, they argued that articles remaining unpublished may not have been due to the null findings themselves, but rather the quality of the research experiment. Cunningham and Baumeister proposed that the use of published articles, as opposed to unpublished ones, had the benefit of peer-reviewed quality of the study which increased its credibility to be included into the meta-analysis. By including unpublished articles, Carter and McCullough inevitably raised the possibility of contaminating the data pool by including research studies of varied quality. In addition Carter et al.'s (2015) broadest possible analysis actually supported the ego-depletion effect (Hedge's g=0.43) rather than rejecting it.

In order to address the finding of Carter and McCullough (2014), a 24-lab pre-registered replication study of the ego-depletion effect was conducted using a standardized

sequential-task experiment protocol (Hagger & Chatzisarantis, 2016). The meta-analysis of the data yielded from this effort revealed an averaged, bias-corrected effect size across all studies of $d = 0.02$, with confidence intervals that included zero (CI [-0.09, 0.13]). In light of this conclusion, a retrospective view of the ego-depletion literature may now reveal a new, more critical, interpretation of the findings of the last two decades. As noted previously, the actual effects of ego depletion in previous studies have yielded conflicting results. For example Job, Walton, Bernecker, and Dweck (2013) found that ego-depletion not only failed to present itself after task 1, but in fact an increase in self-control proficiency was observed.

Three possible explanations could be derived from this literature. The first is the position of Carter and McCullough (2014) in which ego-depletion as a phenomenon does not exist, but rather it is merely a statistical artefact resulting from biased dissemination of findings. Although this position has the benefit of providing cause for closure to a highly controversial field, it fails to address the scores of research that has been conducted on this topic that did yield a significant finding supporting the strength model. Even if the premises of strength model may be in question, observations of the ego-depletion effect and similar effect size as cognitive fatigue should not be dismissed entirely. This leads to the second possibility, namely that while the ego-depletion effect exists, the reason for its occurrence is not due to some form of self-control energy but rather some other mechanism which has until now, still yet to be identified. There has been a number of attempts to explain the depletion effect using alternative models which will be discussed in the next section (e.g. Schmeichel Harmon-Jones & Harmon-Jones, 2010). However, while this position allows for the observed phenomenon to be explained, it runs into the same problem as the strength model in that they are merely a different model to interpret the same observations. For whatever mechanism by which the reduction of self-control could be rationalized, it nonetheless could just as easily be interpreted as an outcome of the depletion of ego-energy. The last possible explanation to

such conflicting findings is while the strength model is valid and sound, the way in which experiments have been conducted had inherent methodological problem. It is due to these problems that the identification and observation of ego-depletion could not be observed reliably (Chatzisarantis & Hagger, 2015). Therefore, the issue is not so much a problem with the strength model but rather the methodology that has been traditionally been utilized to test for it. This is also the main focus of the current project.

2.04.3 Motivation and Replication

The lack of effect from Carter's meta-analysis illustrated a serious challenge to the strength model. That is, there are as much evidence that refute the ego-depletion effect as there are supporting it. Studies that challenged the ego-depletion effect often utilized variables which moderated the effect. Over the years, multiple incentives on motivation have been identified that could counteract the effects of ego-depletion if applied after task 1 in a sequential-task experiment. For example, providing cash incentives (Muraven & Slessareva, 2003), triggering a positive mood change such as humour (Tice, Baumeister, Shmueli, & Muraven, 2007), reminding participants of their core values (Schmeichel & Vohs, 2009), using if–then contingencies (Webb & Sheeran, 2003), or even religious activities such as meditating (Friese, Messner, & Schaffner, 2012) and praying (Friese & Wänke, 2014) could all potentially counteract the decrease in self-control performance when tackling task 2. The implication of these studies is that self-control is more a matter of motivation rather than capacity. Although one can make the argument that an increased motivation will only affect those who are 'partially depleted', and that no amount of motivation could compensate for people who are 'fully depleted' (Vohs, Baumeister, & Schmeichel, 2012). Yet on a practical level, it is impossible to completely deplete a person of their self-control resource with just 10-15 minutes' worth of self-control exertion. This implies that in a laboratory setting, it is

doubtful that any experiment design could allow researchers to observe the true effect of ego-depletion. This highlights the question of how results, supporting or otherwise, could be replicated. Given that the full effect of ego-depletion could not be evoked, and at least one variable, motivation, is able to moderate the partially depleted self-control performances, it becomes questionable as to whether researchers are able to reliably replicate findings. Furthermore, without a reliable means to test the ego-depletion effect, the field unable to progress in testing theoretical hypotheses relating to mechanism of the strength model, including moderators (i.e. identifying when the effect exists and does not exist).

2.05 Alternative Explanations for the Ego-Depletion Effect

Before examining the methodological issue that might have marred previous researches of ego-depletion, this section will first explore some of the alternative models that have been proposed to explain the ego-depletion effect without subscribing to the strength model.

2.05.1 Fatigue

A possible rationale of the ego-depletion effect was that it was attributable to mental fatigue. Perhaps inadvertently, the muscle analogy that Baumeister and Heatherton (1996) employed made the two concepts seem similar. Mental fatigue was a subjective experience that people have when their mental resources had been taxed (Cameron, 1973). This was characterized as the temporary reduction to maintain standard performance in self-control tasks (Chaudhuri & Behan, 2004). One of the key reasons why ego-depletion might be expressed as mental fatigue was the fact that their symptoms were almost identical. Symptoms such as diminished heart rate variability (Segerstrom & SolbergNes, 2007), weak

neural errors (Inzlicht & Gutsell, 2007), as well as decrease in blood glucose levels (Gailliot et al., 2007) were all shared between mental fatigue and ego-depletion.

A case could also be made that ego-depletion was actually just a more specific form of mental fatigue. When discussing ego-depletion, two aspects need to be stressed, the common resource pool that is tapped by self-control tasks and employment of the sequential-task experiment design. While experiments involving ego-depletion employed any task that required self-control exertion, a fatigue-oriented experiment on the other hand could employ any form of task that was difficult, frustrating or monotonous (Warm, Parasuraman, & Matthews, 2008). Although persistence in such tasks undeniably required self-control, the key difference was that ego-depletion encompasses multiple spheres of control while mental fatigue focused on just the mind. Additionally, experiments in the mental fatigue literature commonly measured the lowering of performance within a single, extended task over time while ego-depletion experiments required two separate tasks. Although the two phenomena share certain similarities, it is inconclusive whether mental fatigue and ego-depletion are symmetric as there are two conflicting views. On one hand, studies seem to indicate rather than being the same phenomenon, fatigue may instead just mediated the effect between depleted self-control resources and further task performances (Muraven et al., 1998). Yet Baumeister and Voh (2016) argues that fatigue is a symptom of the ego-depletion effect which is not inconsistent with the resource depletion approach.

2.05.2 Motivation & Attention Process

Another prominent alternative of the ego-depletion phenomenon stems from the position that motivation was the primary mechanism for the reduction of self-control performance (Inzlicht & Schmeichel, 2012; Kurzban, Duckworth, Kable, & Myers, 2013; Loftus, Yalcin, Baughman, Vanman, & Hagger, 2015). Schmeichel, Harmon-Jones, and

Harmon-Jones (2010) believe that rather than the depletion of ego-energy, the reduction of self-control performance found in the strength model literature was due to an attention shift. Two such shifts occur during ego-depletion. When an individual had exerted significant self-control, an involuntary reduction of motivation to continue such exertion occurred. This leads to a shift in motivation away from further restraint and vigilance, and towards approach-oriented impulses (Inzlicht & Schmeichel, 2012). Evidence such as Schmeichel et al. (2010) demonstrated that when an individual was in an ego-depleted state, their approach impulses increased in strength. They reasoned that when a person focused their effort on targets of self-control, such as suppressing aggressive impulses, other forms of approach impulses were left free to influence the individual. There was a critical difference between this process model and the strength model as the capacity of self-control was not diminished by exerting self-control, but rather it was the willingness to maintain self-control that has been reduced. The second part of the process model was a shift in attention away from cues signalling the need for self-control such as error monitoring and emotional reactions to errors (Boksem, Meijman, & Lorist, 2006; Inzlicht & Gutsell, 2007), and towards the cues that were related to the need for self-gratification (Schmeichel et al., 2010). This process indicated that rather than an actual inability to control oneself, it was the prioritization of attention towards sensory information had led people to judge that certain situation did not require their self-control. Through this attention shift, people became motivated to approach their short term, "want-to" goals, and avoided their long term, "have-to" goals. In a study by Inzlicht and Gutsell (2007), they found that depletion had the effect of weakening the monitoring of self-control failures. With attention waned, an individual lost sight of their long-term goal and become less observant to instances where self-control was required. By hampering the system that maintained monitoring vigilance, a person's awareness of the difference between desired and current states was impeded. Attention not only shifts away from cues of self-control

requirements, but also towards self-gratification. Inzlicht and Gutsell (2007) propose that the shift of attention left people more sensitive to reward potentials. Evidence for this could be found in Schmeichel et al. (2010) in which after exertion of self-control, individuals became more perceptive towards symptoms associated with reward compared to those who did not exert themselves. Operating together, the process model gave a rationale to the cognitive operation of an individual during ego-depletion without resorting to any form of ill-defined self-control resource.

2.06 Limitations of the Sequential-Task Experiment Design

In spite of the problem raised by Carter and McCullough (2014) and Carter, Kofler, Forster, and McCullough (2015) reviews, Baumeister and Vohs (2016) advised caution against confusing two separate issues: the robustness of the strength model itself, and the effectiveness of lab procedures that tests it. Experimental practices dictates that the coefficient of results alone are not evidence of an effect. Rather, such effect status must be achieved through significant coefficient being in line with theoretical conditions that are supposed to trigger an effect. For the strength model's sequential-task experiment, this is interpreted through the performance between experimental and control group showing no significant difference in the performance of task 2. However, the fundamental mechanism of the sequential-task experiment is that self-control resources is depleted during task 1. This is achieved though making sure the participant exerted self-control during this period. Furthermore, the observed ego-depletion effect, must be concur with the manipulating variable having an effect on task 1 self-control exertion. It is through a designing and administering lab protocols that conforms to this experimental paradigm that the ego-depletion effect is confirmed or refuted. It has been implied by Lee, Chatzisaranstis and Hagger (2016) that the lack of significant findings in previous studies may had been the result

of previous studies not having the appropriate experiment design. Previous ego-depletion studies rarely employ any form of manipulation checks to examine whether their manipulating variable affected task 1 exertion levels. Consequentially, the question of whether the difference of performance in task 2 was indeed due to self-control resources being depleted during task 1 remains open. If it is uncertain as to whether the sequential-task experiments employed by previous studies had the proper test conditions, and thereby successfully reduced of self-control resource, it limits inferences that can be drawn from study findings. Part of the problem is that the sequential-task experimental paradigm does not have a built-in mechanism to ascertain whether, and to what degree, exertion has been made. Without such a mechanism, conclusions regarding ego-depletion could only be drawn by inference. Furthermore, question will remain over validity of the sequential-task experiment as a means to test the strength model.

Given the limited resource approach to self-control, one important variable necessary in a sequential-task experiment is the effort participants exert on task 1. In order for ego-depletion to be reliably induced, sufficient effort must be committed otherwise the task may fail to expend the ego-energy of the participant. As all self-control acts are acts of exertion directed to specifically overcome conditioned habits or natural impulses, ego-energy is consumed at each instance when this happens. It is through multiple successful attempts of this process in which eventually depletes self-control resources. Therefore, the exact level of ego-depletion is a function of the number of instances in which people attempted to overcome their habits or impulses. More specifically, two variables will affect how much on an individual’s resources are spent during the task, the frequency by which self-control is exerted, and the duration of the task that requires such exertions.

Unfortunately, when the sequential-task experiment was originally conceived, direct measures of self-control exertion were not included. Until this point, there have been few attempts to making sure that self-control exertion had taken place as a result of performing task 1, or that continuous exertion over time impacted the how much self-control performance decreased. One exception was the study by Hofmann, Vohs, and Baumeister (2012) in which participants were asked questions regarding the type, and strength, of temptation they experienced within the last 30 minutes of questioning. In addition, information involving the degree of conflict they experienced in terms of this temptation and other personal goals, and whether they attempted to resist said temptation in various times of the day were also collected. This study found that the more instances where participants resisted a desire, and the greater the intensity of the desire was, their ability to continue to resist temptations gradually decreased over time. This study provided noteworthy support to the limited resource model as it confirmed the sum of self-control exertion is correlated to the lowering of self-control capacity. Due to the nature of strength model research however, findings that are relevant to the field of ego-depletion must be established within the parameters of the sequential-task experimental paradigm. As this study was not conducted using this experiment design, the conclusion cannot be generalized as confirmation to the strength model itself. It is however, plausible to apply the principles of this study that is the number of self-control attempts determining the level of depletion to a sequential-task experiment.

2.06.1 Incentives and Motivation Shift

So far however, there has been little research in ascertaining whether participants actually exert themselves during task 1 (Inzlicht & Schmeichel, 2012). One possible confounding variable is if an individual is not motivated enough to enact effortful control over themselves

during task 1, they may not become depleted. Although it is assumed that ego-depletion occurs due to the difference in performance of the second self-control task, the test does not account for the uncertainty that the difference was due to actual reduction of self-control resource or other reasons. If, for example, people were not motivated to exert themselves during task 1, they would not have sufficiently committed themselves to task 1 for ego-depletion to occur. In previous studies, motivation to exert self-control has merely been assumed but never ascertained. If a difference in performance between the control and experimental group is observed, but participants were unmotivated during the test, the result would have been an illusion of the ego-depletion effect due to variables not accounted for in the experiment, and not the actual phenomena.

In order for the relationship between self-control exertion and ego-depletion to be established, the assumption of the connection between motivation and self-control exertion must be made. Given that acts of self-control are proposed to be due to individuals overriding of habitual or impulsive forces, people need to be driven to do so. However, it is possible that for whatever reason, people may not be motivated to exert themselves during task 1. If this is the case, significant variation to task performance will occur, leading to an unreliable observation of the ego-depletion effect. There are many theories regarding how motivation operates. For example, it is the position of Vroom's (1964) expectancy-value model motivation could be understood as a relationship of how much value one places on the outcome of an act (valance), how capable they believe they are at performing it (instrumentality), and the expectation of the level of effort corresponding to degree of performance (expectancy). Therefore, one possible way to increase motivation of an individual of performing a task is to increase the value of the self-control task. This could be achieved by offering people a reward on the condition that they exert themselves in the behaviour. This method is also supported by self-determination theory (SDT; Ryan & Deci,

2000). According to SDT, motivation could be differentiated into two main types, intrinsic motivation and extrinsic motivation. Being intrinsically motivated is to inherently enjoy and/or feel interested in performing a task. Due to the drive to perform the task is generated internally, no external reinforcements is needed. Being extrinsically motivated is to be driven to performance due to external forces. This of course, assumes that the nature of the task is unpleasant and the natural response is to stop or avoid doing it entirely. On an experimental level, the extrinsic motivators, in this case the employment of reward, could be used as a manipulating variable. Although these rewards cannot overcome the undesirable nature of the task itself, it can none the less motivate them to exert more self-control to overcoming the avoidance impulse that the task generates. The two theories share a common mechanism in that motivation are responsive to external manipulation.

A third, noteworthy dimension of motivation in the SDT is amotivation. Distinct from intrinsic or extrinsic motivation, amotivated people lack purposes or goals with regards to action formation and have little intention to engage in an activity. In situations where amotivated people do indeed engage in an activity, this is done so not as a result of their will (Deci & Ryan 1985; Frederick & Ryan 1995). Moreover, amotivation often implies that the individual either lacks self-efficacy concerning the activity, believe that the action will produce desired outcome or having the impression that even high levels of effort will not be sufficient for success. As such, there is very little, if any, motivation to achieve high levels of task performances.

While there had been studies that manipulated motivation using incentives (e.g. Muraven & Slessareva, 2003; Boucher & Kofos, 2012) to counteract ego-depletion, these incentives were applied to task 2 rather than task 1. In some, the rewards were used to compensate, but not incentivize, participants for engaging in task 1 (Inzlicht & Schmeichel,

2012). To our knowledge, no previous study had attempted to manipulate the motivation of a participant on task 1 which supposedly, is when ego-energy is ‘spent’. While outcomes of these studies pointed to incentives having either a moderating or even nullifying effect of ego-depletion, they none the less fail to standardize the level of exertion or motivation before the depletion-evoking task 1. As a result, ego-energy that was spent engaging task 1 cannot be accounted for by the difference in performance in task 2.

CHAPTER 3

Current Project

3.01 Objectives

The primary objective of this study is to establish an experimental method by which ego-depletion could be reliability evoked by manipulating self-control exertion.

3.02 Overview

Lee, Chatzisarantis, and Hagger (2016) put forward a position that the problem with the conflicting findings of the ego-depletion literature, as well as the zero effect size of Carter and McCullough's 2014 meta-analysis, may be the result of a systemic methodological flaw in how the sequential-task experiment had been conventionally utilized. That is, there had never been a way to ascertain whether self-control have been exerted in task 1. The primary goal of this project is to explore how self-control exertion could be accurately measured, evoked, and whether it actually impacts on self-control performances in a sequential-task experiment.

This project will include three studies. In order to examine whether previous studies is methodologically valid in evoking the ego-depletion effect, study 1 is a meta-analysis to examine the correlation between perceived effort exerted on task 1 and self-control performances. Through examining the connection between perceived effort and the ego-depletion effect, this study could examine the validity of the ego-depletion effect found in previous studies in that they were indeed outcomes of depleted self-control resource. If it is the case that perceived effort was not correlated with the ego-depletion effect, then we must acknowledge the means by which ego-depletion was evoked in previous studies was flawed

and the ego-depletion effect that was observed could not be used as supporting evidence for the strength model.

Baumeister and Vohs (2016) argued that accurate testing of any hypothesis of the strength model and the ego-depletion effect will require more than just observation of the effect. The experiments' design must allow researchers the ability to manipulate the independent variable. We propose that the insignificant self-control performance differences in previous research studies is the result of the lack of self-control exertion manipulation applied during task 1. Indeed, no study to date has attempted to manipulate the participant's level of self-control exertion during task 1 within a sequential-task experiment (Inzlicht & Schmeichel, 2012). One possible way to address this was proposed by Lee, Chatzisarantis, and Hagger (2016) through incentivizing participants with monetary reward to exert themselves on task 1. Study 2 employs this approach in which monetary reward is promised to participants if they perform well in task 1 in a sequential-task experiment.

Use of monetary incentives has three potential limitations. The first is that whether the incentive is effective will depend on whether people consider financial rewards to be desirable. Among those who hold little interest in the prospect of monetary compensation, there may be no difference between those who were offered the incentive, and those who were not. Secondly, use of incentives may result in the undermining effect (Deci & Ryan, 1985) which refers to the phenomena where the offer of monetary incentives may cause a person to feel their sense autonomy to be been weakened as they are now under external influence when engaging in the task. As such, they become less interested in exerting themselves. To address this issue, measures the value participants placed on the monetary reward, and control for it statistically. Lastly, it is possible that monetary incentives may trigger an over-justification effect (Festinger & Carlsmith, 1959) in which people become less

motivated to exert themselves on task 2 if a similar reward is not offered as well. This problem however, is unlikely to arise as the over-justification effect applies when tasks are domain-specific and do not generalise to different tasks (Chatzisarantis, Biddle, & Meek, 1997).

As noted previously, self-control exertion is measured as the total number of times the participant successfully overcomes their habit or impulse. As such, even people highly motivated to perform well in task 1 may not be sufficient to evoke ego-depletion if self-control exertion is not enacted over a prolong period of time. The majority of studies that employ the sequential-task experiment only require participants to engage for a period of 5-6 minutes (Hagger et al., 2010a). It is possible that this duration is not sufficient to have drained the participant's ego-energy enough for ego-depletion takes place. Given that Hagger et al. (2010a) meta-analysis found that the duration of task 1 have a significant moderating effect on the ego-depletion effect size, study 3 will perform an identical experiment as study 2, except rather than manipulating exertion through the use of incentives, exertion will be manipulated through extending the duration of task 1.

Extending the duration to increase self-control exertion could potentially cause participants to perform poorly in task 2 not because of spent ego-energy, but rather the increased negative affect and boredom from doing such a long task 1 (see Inzlicht & Schmeichel, 2012). This could potentially yield an effect that is not due to the depletion of self-control resource. This issue could be address by measuring the levels of boredom the participant experienced and statistically controlling for it. In theory, if the decrease in performance in task 2 is the result of self-control exertion and not boredom, exertion should mediate the effects of ego-depletion while boredom should have no such effect. Although the hypothesis of duration task 1 having eliciting ego-depletion is consistent with the phenomena

of mental fatigue (Boksem & Tops, 2008), there is a distinct difference that needs to be pointed out as it pertains to this project. Studies in mental fatigue do not employ the sequential-task experiment. That is, no non-depletion control group to serve as a contrast to the depletion group. Without this comparison, results found in the mental fatigue literature could not be technically classified as an ego-depletion effect.

This project serves to explore possible variables that could be adopted into the sequential-task experimental paradigm to reliably evoke the ego-depletion effect. In doing so, the current project will examine feasibility of self-control exertion being measured using task parameters only. Studies 2 and 3 are laboratory-based sequential-task experiments which measures self-control exertion by employing a computerized self-control task which will enable identification of the precise moments when self-control exertion was required. The total amount of times when the participant successfully overcomes their habit or impulse would serve as the measurement of self-control exertion. Lastly, the research will examine the relationship between perceived effort and self-control exertion by utilizing self-report questionnaires on participant's perceived self-control.

3.03 Hypothesis

Study 1 *Hypothesis 1*: Perceived effort will be positively correlated to the ego-depletion effect.

Study 2 *Hypothesis 2*: The ego-depletion effect will be more likely to be observed among participants who were offered monetary incentives to perform well during task 1 in a sequential task paradigm experiment than those who were not offered the same incentives.

Study 3 *Hypothesis 3*: The ego-depletion effect will be more likely to be observed among participants who engaged in the first self-control task in a sequential task paradigm experiment for an extended period (20 minutes) than those who engaged in task 1 for a shorted period (7 minutes).

CHAPTER 4

Study 1

There has been to date no attempt to systematically examine the role of perceived effort on task 1 on the ego-depletion effect in sequential task paradigm experiments. A re-examining of existing literature would reveal not only the effect size of ego-depletion, but also size of effort was committed into the studies. In doing so, it is expected that the parameters based on studies that measure the level of effort exerted on task 1 could be established.

4.01 Methods and Materials

4.01.1 Literature Search & Inclusion Criteria

A search of literature through electronic databases was conducted for this study including Medline, PsycARTICLES, PsychEXTRAS, ERIC, and PsycINFO, beginning from 1998 (the year of Baumeister et al.'s and Muraven et al.'s initial articles) until the current date (July 2016). Search terms that were used included all variations of "depletion/ego-depletion", "ego energy", "limited resources", "self-control", and "self-regulation". Further articles were sought through examining the reference sections of the retrieved articles. Upon compilation of articles, each paper were reviewed to identify only studies that employed some variation of a sequential-task experiment. In addition, studies must not only have recorded the performance on task 2, but also a measurement of perceived effort that was committed to the initial depleting phase of the study. If data was recorded but not presented in the journal article, authors were contacted to acquire the missing dataset.

4.01.2 Meta-Analytic Strategy

The meta-analysis method was adopted from Hunter and Schmidt (1990) which corrects effect sizes for sampling error. Simulation studies such as Monte Carlo found that the ideal approach is to employ a random effect model as it allows for the generalization of corrected effect sizes to not just studies involved in the meta-analysis, but also the greater population (Field, 2003; Hagger, 2006; Hunter & Schmidt, 2000; Kisamore & Brannick, 2007). Most commonly used effect size measurements includes Cohen's *d*, Hedges' *g* and Glass's Δ. Both Cohen's *d* and Hedges' *g* employs pooled variances while assuming equal population variances in their calculation. Glass's *Δ* (hence known as simply d) on the other hand, makes no such assumption and utilizes the standard deviation of a control group in estimating mean differences between groups. Given the variations of experiments across the studies and the population involved, Glass's *d* was chosen, which is the observed mean difference for the depletion and control conditions divided by the corrected standard deviation of the control group (Glass, 1976).

The analysis for self-control performance will involve five steps. The different measurement of self-control performance results on different implication of their scores. The increase in performance score implies the presence of the ego-depletion effect in some studies (i.e., persistence time) while the depletion effect is observed through the decrease in performance score (i.e., reaction times). Therefore, the first step was to ensure that all effect sizes were coded consistently with a positive effect reflecting greater depletion. The second was calculating the Glass's *d* for the depletion effect and effort for each individual study based on how experimental and control condition affects them. If sample size for each groups were not reported and could not be retrieved, the overall sample size was split equally between experimental and control groups. In the studies where the analysis resulted in a

negative Glass's *d*, it implies that in self-control performance in the ego-depletion group actually improved compared to those in the control group. Afterwards, in the event that variables were represented using more than one measurement (persistence, reaction time, etc), the effect size will be averaged into a single value for the ego-depletion effect and perceived effort to be employed in the meta-analysis so to adhere to Hunter and Schmidt (2004) procedures. Finally, Glass's *d* for each variable will be corrected for sampling error. In addition to the effect size, 95% confidence intervals around the estimated population correlations was also calculated (CI_{95}). The CI_{95} provides the estimate variability in the mean, specifically it gives a precise estimate of the mean and are based on sampling error.

We evaluated the moderating effects of perceived effort by conducting a separate meta-analysis using the same method. After the effect size had been corrected for total sample size, perceived effort was grouped into high, mid and low effort groups depending on whether each effort score were on the top, middle or bottom third compared to the others. These were then employed as a moderating variable to the ego-depletion effect. The meta-analysis was conducted again on each effort group and the moderating effect would be substantiated if the effect sizes for the ego-depletion effect for each of the effort group was significantly different, and that there is a reduction in variance within the subset compared to the overall variance (Hunter & Schmidt, 1990).

4.01.3 Publication Bias Analysis

Following the example set by Carter and McCullough (2014), three statistical techniques were applied examine the small study-effects of the existing literature, including the binomial test (Ioannidis & Trikalinos, 2007; Schimmack, 2012), the trim and fill method (Duval & Tweedie, 2000) as well as Egger's regression test (Egger et al., 1997; Moreno et al., 2009).

This study also employed the “incredibility-index” (IC-index) developed by Schimmack (2012) which was based on Ioannidis and Trikalinos (2007) as a means to evaluate the probability of a collection of studies having insufficient number of statistically non-significant findings, based on unbiased sampling, for the overall dataset to lose credibility. The IC-index is calculated through a binomial test on the significant results of the studies and an estimated average overall statistical power is taken. The higher the IC-index is, within a range of 0 to 1, the less credibility the dataset becomes.

Trim and fill method (Duval & Tweedie, 2000a) is a funnel-plot-based method measures and compensates for publication biases based on the assumption that asymmetry of a funnel-plot is due to unpublished findings. It achieves this by computing statistics which compares the effect size from each study plotted against study precision (commonly the reciprocal of sample size from each study). Asymmetry caused by the presence of outlying effect size values in the estimated ‘funnel’ shape are considered as indicative of small study effect – an inflated effect size due to that study’s sample size. Similarly, the absence of balancing effect size values points to the same conclusion as large studies with null findings are suspiciously missing. That is, journals refusing to publish studies that have sufficient power but had null findings. The outlying plots were then ‘trimmed’ and the missing studies are ‘filled’ by simulating these missing effect size values along with inputting ‘mirror’ values in order to retain symmetry. The aggregate effect size was then recalculated.

Although Egger’s regression test also employs the funnel plot (Egger et al., 1997; Sterne, Egger, Rothstein, & Sutton, 2005), it does not assume that asymmetry is due to publication bias. Rather, it operates by quantifying the relationship between effect size estimates and standard errors. Often described as a weighted least squares (WLS) regression model, Egger’s test calculates the effect size by weighing the inverse of standard error

squared. Within the regression model, the coefficient significance associated of the standard error is interpreted as a test of funnel plot asymmetry. Only it is common practice for the only slope coefficient of the regression to be interpreted, Stanley (2005) proposed to also examine the model's intercept to evaluate the possible under-lying effect size when standard error = 0. The Egger's test therefore, allows for the estimation of both funnel plot asymmetry and a prediction of the overall effect size if there were no publication bias.

4.02 Results

A total of 33 articles with 45 independent effect sizes were identified as eligible based on inclusion criteria. However, data from 11 studies could not be retrieved in the original article and were not available after contacting authors and after analysis, effect size of 1 study (Dvorak & Simons, 2009) proved to be an outlier and was removed. The final number of articles therefore included in the analysis is 21. Results of the meta-analysis for effects of self-control depletion on task performance for each study are presented in Table 1, and results for the effects of self-control depletion on perceived effort are presented in Table 2.

Table 1. *Results of Meta-Analysis of Ego-Depletion Effect*

Author	Date	Study #	N	*d*	SE	95% CI		%Weight
						LL	UL	
Ainsworth et al.	2014	2	72	0.36	0.18	-0.03	0.68	3.64
		3	127	0.33	0.24	-0.11	0.83	3.34
Boucher & Kofos	2012	1	41	-2.20	0.48	-3.04	-1.25	2.12
Bray et al	2008	1	49	0.08	0.29	-0.49	0.64	3.09
Bray, Martin & Woodgate	2011	1	61	0.08	0.26	-0.42	0.59	3.25
Burkley	2008	3	78	0.48	0.23	0.02	0.94	3.37
		4	60	0.14	0.26	-0.37	0.65	3.24
Christiansen, Cole & Field	2012	1	80	-0.04	0.22	-0.48	0.40	3.42
Converse & Deshon	2009	1	75	0.12	0.18	-0.24	0.48	3.63
		2	40	-0.21	0.23	-0.66	0.25	3.38
		3	60	-0.61	0.33	-1.26	0.05	2.84
Fennis, Janssen, & Vohs	2009	1	37	0.88	0.36	0.16	1.59	2.68
Friese, Hofmann & Wanke	2008	2	66	0.30	0.30	-0.29	0.89	3.02
		3	45	0.43	0.25	-0.06	0.93	3.27
Geeraert & Yzerbyt	2007	1	44	0.33	0.31	-0.27	0.93	2.98
Holmqvist	2008	1	62	0.05	0.28	-0.50	0.59	3.14
		2	34	-0.08	0.26	-0.58	0.42	3.26
		3	52	-0.13	0.35	-0.81	0.55	2.77
Job et al	2015	1	68	0.04	0.24	-0.44	0.51	3.32
Muraven, Collins & Nienhaus	2002	1	58	0.30	0.27	-0.23	0.82	3.20
Muraven, Shmueli & Burkley	2006	1	93	0.76	0.22	0.32	1.19	3.43
		2	103	0.80	0.18	0.45	1.14	3.66
		4	152	0.89	0.22	0.47	1.32	3.46
Ostafin, Marlatt & Greenwald	2008	1	85	2.90	0.38	2.15	3.64	2.59
Segerstrom & Nes	2007	1	83	0.21	0.22	-0.22	0.64	3.44
Stillman, et al	2009	2	139	0.03	0.17	-0.30	0.34	3.69
		3	66	0.10	0.25	-0.39	0.58	3.30
Uziel & Baumeister	2012	1	45	0.70	0.32	0.07	1.32	2.92
Wan & Sternthal	2008	1	50	0.53	0.23	0.08	0.98	3.39
		2	81	0.61	0.30	0.02	1.19	3.03
Webb & Sheeran	2003	1	31	-4.51	0.96	-6.39	-2.64	8.72
Wheeler, Brinol & Hermann	2007	1	68	0.41	0.25	-0.08	0.90	3.30

Note. N = Sample size in study. *d* = Glass' delta, sample-size weighted observed difference effect size for depletion effect; *SE* = standard error; 95% CI = 95% confidence intervals; LL = lower limit of 95% confidence interval; UL = upper limit of 95%confidence interval; %Weight = inverse variance of each study's effect estimator.

Table 2. *Results of Meta-Analysis of Ego-Depletion on Perceived Effort*

Author	Date	Study #	N	*d*	SE	95% CI		%Weight	Effort
						LL	UL		
Ainsworth et al.	2014	2	72	-3.97	0.39	-4.74	-3.20	2.88	High
		3	127	-5.64	0.71	-7.02	-4.26	1.96	High
Boucher & Kofos	2012	1	41	0.02	0.31	-0.59	0.63	3.12	High
Bray et al	2008	1	49	0.54	0.30	-0.05	1.12	3.17	High
Bray, Martin & Woodgate	2011	1	61	-0.89	0.28	-1.44	-0.34	3.22	High
Burkley	2008	3	78	-0.50	0.23	-0.96	-0.05	3.34	Low
		4	60	-0.54	0.27	-1.07	-0.02	3.25	Low
Christiansen, Cole & Field	2012	1	80	-1.07	0.26	-1.57	-0.57	3.28	Mid
Converse & Deshon	2009	1	75	-0.59	0.33	-1.24	0.06	3.07	Mid
		2	40	-0.66	0.19	-1.04	-0.29	3.43	High
		3	60	-1.10	0.27	-1.62	-0.58	3.26	Low
Fennis, Janssen, & Vohs	2009	1	37	-1.26	0.40	-2.03	-0.48	2.87	High
Friese, Hofmann & Wanke	2008	2	66	-1.09	0.28	-1.64	-0.54	3.21	Mid
		3	45	-1.47	0.37	-2.19	-0.74	2.95	Mid
Geeraert & Yzerbyt	2007	1	44	-0.47	0.31	-1.07	0.14	3.13	Low
Holmqvist	2008	1	62	-0.13	0.26	-0.63	0.37	3.28	Mid
		2	34	-0.21	0.28	-0.75	0.34	3.22	Mid
		3	52	-0.92	0.38	-1.66	-0.17	2.92	Mid
Job et al	2015	1	68	-2.97	0.44	-3.84	-2.10	2.72	Mid
Muraven, Collins & Nienhaus	2002	1	58	0.12	0.21	-0.29	0.52	3.40	Low
Muraven, Shmueli & Burkley	2006	1	93	0.45	0.17	0.13	0.78	3.49	Low
		2	103	-0.38	0.27	-0.91	0.14	3.25	Mid
		4	152	-0.69	0.21	-1.09	-0.28	3.40	Low
Ostafin, Marlatt & Greenwald	2008	1	85	-0.18	0.22	-0.61	0.25	3.38	Low
Segerstrom & Nes	2007	1	83	-0.45	0.23	-0.89	-0.00	3.36	Low
Stillman, et al	2009	2	139	-0.36	0.25	-0.85	0.13	3.30	Mid
		3	66	-0.40	0.17	-0.74	-0.06	3.48	Mid
Uziel & Baumeister	2012	1	45	-0.71	0.32	-1.34	-0.09	3.11	High
Wan & Sternthal	2008	1	50	-0.41	0.29	-0.98	0.16	3.19	High
		2	81	-0.43	0.23	-0.87	0.21	3.35	High
Webb & Sheeran	2003	1	31	-0.38	0.80	-5.34	-2.21	1.73	Low
Wheeler, Brinol & Hermann	2007	1	68	0.41	0.25	-0.08	0.89	3.30	Low

Note. N = Sample size in study. *d* = Glass' delta, sample-size weighted observed difference effect size for depletion effect; *SE* = standard error; 95% CI = 95% confidence intervals; LL = lower limit of confidence interval; UL = Upper limit of 95% confidence interval; Effort = Amount of effort devoted to task 1*;* %Weight = inverse variance of each study's effect estimator.

The overall meta-analysis results are shown on Table 3. The overall effect size for ego-depletion does not support Carter and McCullough's position that the effect was not distinguishable from zero. Although small, the size of the ego-depletion effect was statistically significant and 95% confidence intervals did not encompass zero, *d* = 0.25, 95% CI [0.05.; 0.45]. There was also a medium effect for perceived effort (*d* = -.79, 95% CI [-1.08.; -.51).

Table 3. *Meta-analytic Results for Overall Effect of Experimental Condition*

	k	*d*	*d* 95% CI		SE	χ^2	τ^2	I^2	I^2 CI_{95}	
Variable			LL	UL					LL	UL
Depletion Effect	32	0.25	0.05	0.45	0.10	152.08**	0.25	79.60	71.80	85.30
Perceived Effort	32	-0.79	-1.08	-0.51	0.15	285.07**	0.57	89.10	85.70	91.70

Note. k = number of primary studies used in the meta-analysis *d* = Glass' delta, sample-size weighted observed difference effect size for depletion effect; 95% CI = 95% confidence intervals; *LL* = lower limit of confidence interval; UL = upper limit of confidence interval; *SE* = standard error of *d*; χ^2 = Pearson cumulative test statistic; τ^2 = between study variance; I^2 = Higgins and Thompson's (2002) I^2 statistic. *** = p < .000

4.02.1 Moderation Analysis

After dividing the studies were divided into high, mid, and low effort studies group based on the effort scores respective to the instrument used, the meta-analysis was conducted again, results are presented in Table 4. Due to the overlapping of 95% CI of the effort subsets of studies, as well as the inclusion of zero within their range, the proposed moderating effect of effort on the ego-depletion effect is rejected.

Table 4. *Moderation Analysis Results*

	k	*d*	95% CI		τ^2
Condition			LL	UL	
High Effort	10	0.15	-0.23	0.52	0.27
Mid Effort	11	0.13	-0.06	0.33	0.05
Low Effort	11	0.45	-0.03	0.93	0.49

Note. k = number of primary studies used in the meta-analysis, *d* = Glass' delta, sample-size weighted observed difference effect size for depletion effect; 95%; 95% CI = 95% confidence intervals; LL = lower limit of confidence interval; UL = upper limit of confidence interval; τ^2 = between study variance

4.02.2 Publication Bias

Based on posthoc power calculations for each experiment, the average power was estimated to be .23 which resulted in an IC index smaller than .001 (for the binomial test, $p < .001$). Therefore, it is unlikely that more non-significant findings exist than are not included in this dataset. Tweedie and Duvall's (data) trim and fill method was employed to investigate possible missing studies in the 'funnel' plot of study effect size against standard error, an

estimate of publication bias, followed by a re-estimation the random-effects meta-analysis that included these imputed studies. The trim and fill method showed that the no studies were missing, and that no studies needed to be imputed to achieve symmetry in the funnel plot (Figure 2, Table 5).

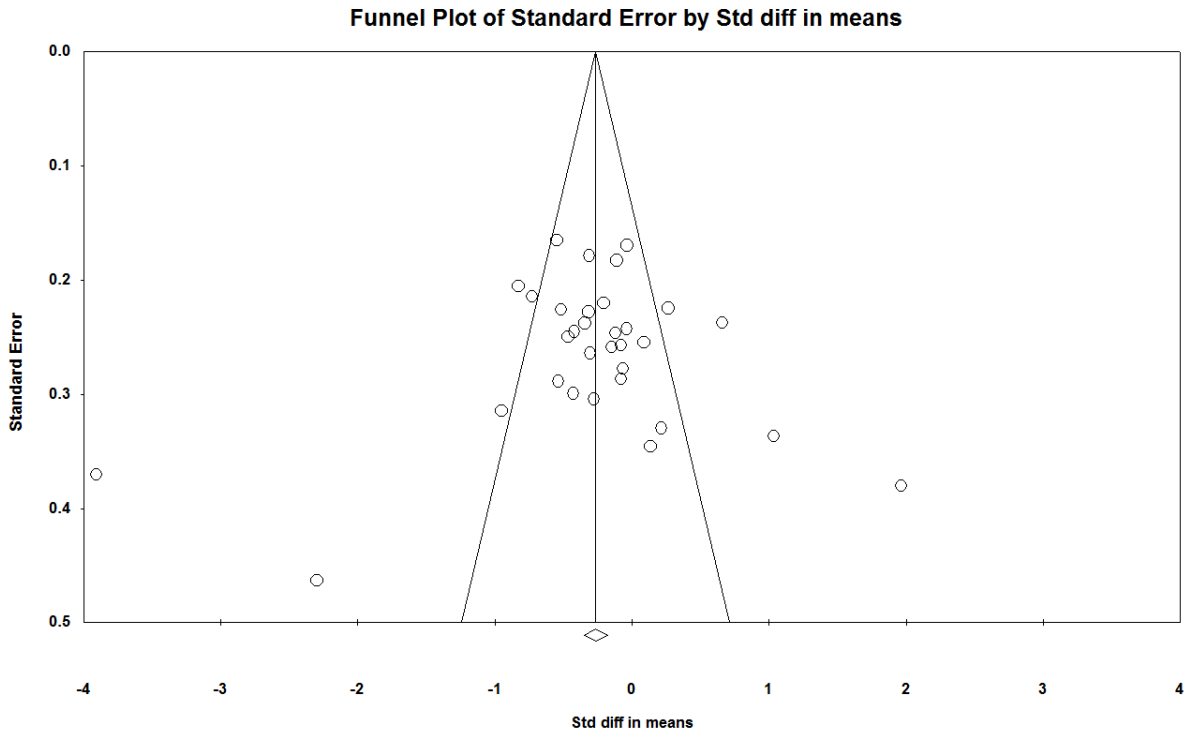

Figure 2 Funnel Plot of Standard Error by Std Diff in Means

Table 5. Results from Trim and Fill Under the Random Effects Model

	Studies Trimmed	Point Estimate	Lower Limit	Upper Limit
Observed Values		-.27	-.35	-.18
Adjusted Values	0	-.40	-.47	-.31

Applying the weighted least squares regression analysis using Egger's (date) analysis, in which the effect size is predicted by study precision, the intercept (B0) was not statistically significant -.86 ($p < .34$; CI_{95} [-5.18, 3.46], t (32) =.41). This indicated that there was no publication bias.

In summary all three tests for publication bias indicated that publication bias was not an issue in the present meta-analysis.

4.03 Discussion

The primary aim of the current analysis was to examine the moderating effect of perceived effort committed on the first task in sequential-task experiments on the ego-depletion effect using meta-analytic methods. The current evidence suggests that experimental condition confers only limited levels of the ego-depletion effect. While not the medium level of effect as found my Hagger et al. (2010a), neither is it indistinguishable from zero as concluded by Carter et al. (2015). Perceived effort did not exert any moderating effect on the ego-depletion effect.

There are three primary of shortcomings that could be identified in this meta-analysis. First, not all eligible studies were included. As noted, 12 articles (over 30%) were dropped from the final analysis due to the fact that the required information could not be retrieved or outlying effect size. Either the data itself was no longer available, or the authors of these studies could not be contacted or did not respond. It is unknown whether such a level of omitted data would have had a significant influence on the final outcome of the current analysis.

Second, it is important to recognise that the use of classification of effort into high, mid and low effort groups in study 1 may have prevented us from detecting moderating effects as this categorisation reduces number of studies.

Third, the lack of perceived effort's moderating effect on and self-control performance difference may say more about the means by which effort is measured rather

than the relation itself. Studies that were included in this meta-analysis employed self-report measures in order to assess the level of effort that participants exerted when completing the tasks. However, this at best means that the 'effort' that is measured is the perceived effort of the participant rather than actual self-control exertion. There are studies that have demonstrated that there is a significant discrepancy between perceived effort and actual self-control exertion (e.g. Doherty, Smith, Hughes & Collins, 2001). It is possible therefore, that the absence of moderating effect was due to the limitation of the measures used. In addition, the current meta-analysis was not able to show conclusively whether the differences in effort between studies were connected to the ego-depletion effect. It is unclear why perceived effort did not moderate the ego-depletion effect. Furthermore, given that effort during the first task is likely to be a critical mechanism that underlies all previous experiments that employs the sequential-task experimental paradigm, this uncertainty opens the possibility that ego-depletion effect in high effort studies were due to other unknown variables rather than effort during the first task. Rather than concluding that exertion has no effect on subsequent self-control performance, it might be more fruitful to investigate how effort could be more accurately measured, or explore other potential factors that may cause depletion other than first task effort.

In conclusion, current findings revealed no moderating effect of perceived effort on self-control performance in a sequential-task experiment. It is therefore important to explore possible means to reliably measure effort with greater precision during the first task in sequential-task experiments. This may contribute to identifying conditions in which participants exert self-control, and thereby develop an experimental paradigm that reliably evokes the depletion effect.

CHAPTER 5

Study 2

Although strength model postulates that expenditure of self-control resource during task 1 would leave an individual unable to maintain their self-control performance during task 2, this is based on the assumption that sufficient effort was committed to task 1. It is possible that the lack of results from previous studies may be because participants did not exert themselves during the experiment. This study aims trigger an ego-depletion effect by offering monetary incentives to manipulate self-control exertion. We believe that those who were offered the incentives and performed well in task 1 will more likely demonstrate a noticeable drop in performance during task 2 compared to those who were not offered the same incentives.

5.01.1 Experiment Design

Study 2 employed a standard sequential-task experiment with manipulations of effort using a monetary incentive and depletion using a standard depletion paradigm. The experiment employed a 2 (depletion: depleting vs. non-depleting task) x 2 (task 1 incentive: incentivized vs. non-incentivized) fully-randomized controlled experimental design. A power analysis was conducted based on Hagger et al's meta-analysis effect size, $d = 0.62$, results indicated that the minimum sample size for this study should be set at 120.

Participants assigned to the experimental groups were informed that they will receive a monetary reward if they exerted themselves in task 1. Monetary reward was set at $15 as it was the approximate amount required to pay for a standard lunch on campus. In the control group on the other hand, no mention of monetary reward was mentioned. For those in those

assigned to the depletion condition, both tasks required self-control exertion while for those assigned to the non-depletion condition, only task 2 required exertion. Established strength model prediction implies that for those in the depletion condition, effort in task 1 would cause the participant to expend their self-control resources resulting in a drop in performance for task 2 relative to the non-rewarded participants. However, those assigned to the non-depletion condition were not expected to experience depletion as task 1 they engaged in did not require the same level of exertion. Thus, their performance in task 2 should not be significantly affected by rewards.

Two cognitive tasks were selected for this study, task 1 was a selective typing task and task 2 was a multi-source interference task (MSIT).

Selective Typing Task – The selective typing task was designed to engage the vigilance level of a person (Muraven, Pogarsky, & Shmueli, 2006). A passage of text is displayed in front of the participant on a computer screen and the participant is required to type it out. For those assigned to the control group, no special rules apply and the participant only need to complete typing the passage as they see it. On the other hand, those assigned to the experimental group will be required to omit all occurrences of the letter “e” or “n”. This necessitates the participant to overcome their well-learned, automatic reaction while typing (Rieger, 2004) which will require substantial self-control effort. Participants are measured based on the level of their accuracy divided by the time taken it takes to complete the task.

Multi-Source Interference Task (MSIT) – The MSIT (Bush, Shin, Holmes, Rosen, & Vogt, 2003) is a time-reaction task that was originally intended to be used as a means for identifying and interrogating the dorsal anterior midcingulate cortex (daMCC) and the cingulo-frontal-parietal cognitive/ attention (CFP) networks. The protocol employed for this

study was written by (Bush & Shin, 2006). Essentially, the MSIT requires the participant to sit in front of a computer and react to a set of three numbers (1, 2, or 3) that was located at the centre of the screen in a row. Two of these numbers were identical (matching distractor) while the third was different. Instructions to the participants were that, using their right index (left), middle (centre) and ring (right) they needed to pinpoint the odd one out by pressing the corresponding key on the keyboard (e.g, 244, the correct answer is '2' on the left). Theoretically, intuitive reaction of the participant will associate the higher number with the finger nearer to the little finger. Through moving the odd one out to locations that does not match their corresponding position, the participant was required to exert self-control to overcome their natural reaction to identify the location of the number and not the value. For example, a participant presented with "311" is required to resist using their ring finger but to apply with their index finger instead. For those assigned to the control group, all numbers' positions were based on their associated value (1 = left, 2 = centre, 3 = right) so no significant self-control was required. Experimental group on the other hand, target number were be presented in random locations at inconsistent intervals. Their response time is recorded. As this study is only interested in the instances where self-control exertion was required, only the accuracy for incongruent items would be taken for further analysis.

5.01.2 Manipulation check

Due to the specific design of the sequential-task experiments employed in this study there are at multiple variables that required statistical checking in order to maintain credibility of the results. First, in addition to the performance difference between control and experimental group, the evocation of ego-depletion needed to be corroborated using a self-report measure of known depletion-related symptoms. This was to make sure that depletion did indeed occur during the performing of task 1. Second, how much effort was exerted by

the participant needed to be ascertained as the primary manipulated variable is the effort that is committed into task 1. Third, motivational levels needed to be accounted for as the whole idea of monetary incentives is the manipulation the motivational level of those engaging in task 1. Finally, the overjustification effect is a phenomenon derived from SDT (Deci, Koestner, & Ryan, 1999).One alternative explanation of the effect of the incentive on motivation is that it provided a focus on the reward for task 1 which provided participants with an expectation of reward for task 2. So it is possible that performance in task 2 may have decreased because participants were not rewarded rather than due to depletion. This is often attributed to a shift in perceived locus of causality from internal (doing the task for personal enjoyment) to external (monetary rewards). In the current studies, all these variables are addressed by designing and administrating a questionnaire to measure them and statistically controlling for their effects in the analysis.

Motivation, Effort and Depletion Questionnaire – A motivation, effort and depletion questionnaire was developed specifically for this project. It consists of 23 items and is divided into two sections. The first, consisting of 9 items measures the level of effort the participant put into task 1 as well as the depletion level they are experiencing (e.g., “Do you feel mentally exhausted after doing the task?”). The second part, consisting of 14 items measures the participant’s domain of motivation when undertaking task 1. Items for scale were combined from various well-validated scales including the intrinsic motivation inventory (Ryan, Koestner, & Deci, 1991; e.g “I did the task because I will receive money for doing so”), and questions employed in related studies (Boucher & Kofos, 2012). The reason why these items were combined into one instrument was due to the overlapping nature of these items and would save time for participants completing them. All questions are available in the appendix.

5.02 Methodology

5.02.1 Participants

Participants (N = 140; male = 26, female = 114) were drawn from Curtin University's research participant pool. The study was advertised on online using the SONA online experimental management system in which students are able sign up provided with a time and date for the experiment. Mean of participants was 22.21 years (*SD* = 6.597).

5.02.2 Procedure

Participants were informed that the study was a typing speed experiment as a cover story to mask the true purpose of the experiment. As they arrived at the laboratory, they were given the consent form and general information of the study. Participants were given basic instructions regarding task 1 told that participation points were already given to them. Participants were then given instructions and a practice trial of task 1 and task 2. Upon completion, those assigned to the experimental group were given $15 to keep and was told that if they demonstrated that they exerted a lot of effort in the main trial of task 1, they could keep this reward. In the case that they failed to demonstrate substantial effort however, they were required to return the money back to the experimenter. This additional information was not provided for those assigned to the control group. After task 1 was completed, those in the experiment group were told that they had demonstrated sufficient effort and were allowed to keep the reward. This information was not given to the control group. The main trial of task 2 was then administrated and after completion, all participants completed the motivation, effort and depletion scale. After the survey, participants were debriefed, thanked, and dismissed. In order to uphold equity, the control group received the same monetary prize after the experiment was completed.

5.03 Results

5.03.1 Manipulation Check

As expected, participants in the incentivized condition had a higher reaction time for MSIT incongruent items (M = 889.66 milliseconds, SD = 185.42) than those in the non-incentivized condition (M = 873.45 milliseconds, SD = 176.07) however this difference did not reach significant level ($F(1,138) = .28$, $p = .60$). Against expectations however, participants assigned to the incentivized condition experienced more instances of self-control failure as measured by the frequency of error responses, when items were incongruent (M = 144.99, SD = 112.25) than those in the non-incentivized condition (M = 138.71, SD = 124.33) but this difference again did not reach significant level ($F(1,138) = .09$, $p = .77$). Regression analysis found that incentive condition did not predict performance on task 1 (β = -.03, $p = .49$; Table 6). The significant effect of depletion condition on performance on task 1 was expected as part of the test instruction for the ego-depletion group to omit 'e's and 'n's (β = -.88, $p < .001$). Most importantly, the interaction effect of the incentive and depletion conditions on performance on task 1 was not statistically significant ($F(4,134) = 103.805$, $p = .00$) with $R^2 = .756$ (Table.6) . This indicates that the depletion manipulation failed to increase participants' self-control exertion.

Table 6. Regression analysis predicting numbers of typed 'e' and 'n' in task 1 in the dual-task paradigm by depletion and motivation (incentive) manipulations.

Model		β	*t*	*p*
1	(Constant)		-.019	.985
	Incentive Condition	-.030	-.696	.488
	Depletion Condition	-.873*	-20.412	.000
	Extrinsic Motivation	.037	.853	.395
2	(Constant)		.013	.990
	Incentive Condition	-.030	-.687	.493

Depletion Condition	-.874	-20.351	.000
Extrinsic Motivation	.038	.870	.386
Incentive Condition x Depletion Condition	.017	.403	.688

* $p < .001$

Finally, a bivariate correlation was conducted between performance on task 1 (numbers of typed 'e's and 'n's) and perceived effort. The correlation between self-control exertion as measured by performance on task 1 and perceived effort was small and not statistically significant (r = -.061, p = .47).

5.03.2 Test of Study Hypothesis

A two-step hierarchical linear regression was conducted. Perceived effort was the dependent variable while the incentive condition (-1 = *control condition*, 1 = *incentivized condition*) and depletion condition (-1 = *non-deplete condition*, 1 = *depletion condition*) were the independent variables. The two variables were entered independently on the first step of the regression. In addition, in order to control for the effect of extrinsically motivated effort and extrinsic motivation were also entered on the first step of the analysis. The two-way interaction between the depletion and incentive were entered in the second step. All continuous variables were standardized and interaction terms were computed from these standardized scores. No significant main or interaction effects for either depletion or incentive was found.

Table.7 Regression analysis predicting perceived effort in task 1 in the dual-task paradigm by depletion and motivation (incentive) manipulations.

Model		β	*t*	*p*
1	(Constant)		-.043	.966
	Incentive Condition	.152	1.829	.070
	Depletion Condition	.114	1.390	.167
	Extrinsic Motivation	.295	3.545	.001
2	(Constant)		-.024	.981
	Incentive Condition	.153	1.826	.070
	Depletion Condition	.113	1.382	.169

Extrinsic Motivation	.296	3.540	.001
Incentive Condition x Depletion Condition	.019	.237	.813

In order to examine the effect of incentive on a measure of depletion based on the task itself, two separate hierarchical linear regression analyses were conducted. Accuracy and reaction time from task 2 were the dependent variables while incentive conditions were used as the independent variables were entered in the first step of the analysis along with extrinsic motivation. A two-way interaction effect of depletion and incentive conditions were entered in the second step of each analysis.

Results revealed that neither the condition had a significant effect on reaction time or accuracy rate of the MSIT task (Table 8). In addition, there was not interaction effect of the incentive and depletion conditions on the reaction time or accuracy rate.

Table.8 Regression analysis predicting task 2 (MSIT) performance

		Reaction Time			Accuracy Rate		
Model		β	t	p	β	t	p
1	(Constant)		56.923	.000		38.801	.000
	Incentive Condition	.054	.619	.537	.025	.279	.780
	Depletion Condition	-.012	-.142	.887	.072	.836	.405
	Extrinsic Motivation	.039	.448	.655	-.005	-.062	.951
2	(Constant)		56.531	.000		38.540	.000
	Incentive Condition	.054	.612	.542	.024	.269	.789
	Depletion Condition	-.012	-.139	.890	.073	.840	.402
	Extrinsic Motivation	.038	.428	.669	-.008	-.094	.925
	Incentive Condition x Depletion Condition	-.029	-.331	.741	-.052	-.600	.549

5.03.3 Posthoc Analysis

To explore the possibility of a participants trading off accuracy for speed, a bivariate correlation between MSIT reaction time and accuracy rate was conducted and the correlation was found to be medium and statistically significant ($r = .44$, $p < .000$).

5.04 Conclusion & Discussion

There was no effect of perceived effort on ego depletion effect, this should be interpreted with caution as the reason for this lack of correlation is unknown. Similarly, given that the effect of monetary incentive on perceived effort was marginal, it is difficult to conclude whether the experimental design of the current study was successful in instigating greater effort among participants.

The current study did not find any effect of monetary incentives on performance on the second self-control task in the sequential-task experiment. The validity of the strength model, however, could not be inferred from the findings. The core assumption of this experiment was that monetary incentives was able to increase exertion on task 1 leading to the expenditure of ego-energy, resulting in the ego-depletion effect that was measurable in performance on task 2. However, the fact that providing monetary incentives did not definitively affect people's perceived effort on task 1 meant that it was not possible to ascertain whether participants actually exerted themselves on the task. It is entirely possible that participants were unmotivated by the incentives leading to an ineffective manipulation. If this is the case, performance of participants would have been unaffected by the monetary reward. Rather, factors not accounted for by this experiment would have been the cause of variations of participants' task performances. Therefore, the lack of effects between monetary

incentives and MSIT performance, be it reaction time or accuracy, does not support nor refute the strength model.

A number possible reasons could have accounted for absence of significant effect. The first is the uncertainty as to whether the selective typing task was sufficient in spending ego-energy of the participants. If the task was insufficient to put participants into an ego-depleted state, no changes in task 2 could be observed. A second possible reason for the results was that monetary rewards were insufficient incentive to motivate participants to increase effort to a point where they become depleted. If the manipulating variable is inadequate in encouraging self-control exertion, participants will against been engaging the MSIT task with a 'full tank', resulting in no performance difference. On the other end of the spectrum is that the current study did not examine the possibility and effect of students who believe that the amount of monetary reward they were offered was so great that they feel they need to 'repay' the experimenter with extra effort that is carried forward to the second task. If this phenomenon was present during the experiment, it would be impossible to measure ego-depletion through observing task 2 performance. The third possibility is that both was true and that neither the manipulating variable, nor the self-control depleting task, operated as intended in this study.

Assuming the strength model is valid, if the manipulation of monetary reward had an effect in inducing greater depletion in the incentivized condition, but the task parameters were ineffective in measuring the greater effort of the participants, the ego-depletion effect should have been observed in difference in performance on task 2 on the between the incentivized and non-incentivised conditions for participants that received the depleting task. Given the lack of ego-depletion effect, however, it is more likely due to monetary reward not having the effect in motivating participants to exert themselves. This is not to say that reward

and motivation are not connected, as relationship is supported by an abundance of research literature. Rather, monetary reward may have been ineffective in manipulating self-control exertion within the current sequential-task experiment.

The question of the use of student sample needs to be raised with regards of the practicality of using monetary reward to incentivize participants. Due to the fact that the study was not advertised as one which had monetary compensation, students arrived at the laboratory primarily motivated by the acquisition of participation points. For people who came during the start of the semester, it is possible that they are already self-motivated and would have performed well on each of the tasks regardless of monetary incentives. Similarly, people coming to the lab during the end of the semester were coming due to the fact that they need to fulfil their obligation to their course and would have been amotivated regardless of rewards. If this is true, then the only people who's motivation might have been affect by the monetary incentives would have been the people who participated during middle of the semester.

CHAPTER 6

Study 3

One interpretation of the findings of the previous study is that the incentive was insufficient in motivating participants to 'expend' greater effort and, therefore, greater self-control resources on task 1 leading to greater depletion. The present study adopted an alternative strategy to amplify self-control exertion by increasing the length of time participants spend exerting self-control. Specifically, the duration of task 1 in the sequential task paradigm was manipulated. We believe that those who were required to undertake task 1 for 20 minutes and performed well, will more likely demonstrate a noticeable drop in performance during task 2 compared to those who only needed to undertake task 1 for 7 minutes.

6.01 Experiment Design

Study 3 employed a standard sequential-task experiment with an additional manipulation in which the duration of task 1 was varied. A 2 (depletion condition: depleting vs. non-depleting task) x 2 (task 1 duration: extended vs. standard) fully randomized controlled experimental design was adopted. The study used identical tasks and design to study 2: task 1 was the selective typing task and task 2 was the multi-source interference task (MSIT).

The depletion manipulation was identical to that adopted in the previous study. Both tasks will required self-control exertion for participants assigned to the depletion condition while only task 2 will entail self-control exertion for participants assigned to the non-depletion condition. Participants assigned to the control group engaged in task 1 (selective typing task) for 7 minutes, consistent with many tasks adopted in previous ego-depletion

studies (Hagger et al., 2010). In contrast, participants assigned to the experimental group engaged in task 1 for 20 minutes. We expected participants assigned to the depletion condition and received the extended duration task 1 to experience elevated levels of depletion compared to participants assigned to the depletion condition receiving the standard duration task 1, and to participants in the non-depletion conditions regardless of task duration. We expected this to be manifested in an interaction between depletion and task 1 duration conditions.

A minor change was made to the Motivation, Effort and Depletion Questionnaire as an additional section based on a modified version of the Leisure Boredom Scale (LBS; Iso-Ahola & Weissinger, 1990) was included. The LBS is a 19-item questionnaire designed to assess an individual's experience of boredom during leisure time. It utilizes a 4-point Likert scale with overall responses ranging from 19 to 76 (See: Appendix J).

6.02 Method

6.02.1 Participants

As in study 2, participants (N = 120; male = 36, female = 84) were drawn from Curtin University's research participant pool and managed using the SONA system. The mean age of participants was 21.70 years (*SD* = 5.149).

6.02.2 Procedure

A cover story suggesting that the study was a typing speed experiment was used to mask the true hypothesis of the experiment. When participants arrived at the laboratory, they were provided with general information and the consent form of which they were required to sign. Students were told that participation was purely voluntary, that they were free to

withdraw at any time without providing any reason, and that there were no penalties for withdrawing. Instruction on the selective typing task was then given and a practice trial run commenced. After task 1 has been successfully completely, the same procedure was undertaken for the MSIT. After the practice trial for task 2 had been completed, the main trial for task 1 began followed immediately by task 2. After the completion the main trial of the tests, participants were asked to complete an online questionnaire comprising the motivation, effort and depletion scales. When they finished the survey, participants were debriefed, thanked and dismissed.

A bivariate correlation to examine the relationship between perceived effort and performance of task 1 (numbers of typed ‘e’s and ‘n’s) was conducted. To analyse the effect of experimental conditions on performance on task 1, a hierarchical linear regression was conducted. The number of times ‘e’s and ‘n’ were typed was the dependent variable, indicating depletion, while the depletion (-1 = *non-deplete condition*, 1 = *depleted condition*) and duration condition (-1 = *control condition*, 1 = *extended condition*) were the independent variables. Depletion and duration condition were entered independently on in the first step stage of the analysis. In order to account for possible performance difference due participants experiencing boredom during the study, levels of boredom were taken through survey at the end and was also entered in the first step of the regression to statistically control for its effect. The two-way interaction effect between the independent variables were entered in the second step.

Analysis of the effect of duration on depletion was conducted using two separate hierarchical linear regression analyses. Performance of on task 2, measured as accuracy and reaction time, were the dependent variables in the analyses while depletion and duration

conditions were the independent variables. Two-way interactions between the depletion and duration conditions were entered in the second step of each regression.

6.03 Results

6.03.1 Manipulation Check

As expected, participants in the extended duration condition had a higher reaction time during the MSIT when items were incongruent (M = 893.803 milliseconds, SD = 180.471) than those in the standard duration condition (M = 870.657 milliseconds, SD = 169.993) although this difference did not reach significant levels ($F(1,106) = .73$, $p = .40$). Contrary to expectations however, participants assigned to the extended duration condition experienced more instances of self-control failure, as measured by the frequency of error responses, when items were incongruent (M = .851, SD = .113) than those in the standard duration condition (M = .811, SD = .173) although this difference again did not reach significant levels ($F(1,106) = 1.46$, $p = .23$). Finally, in order to establish a correlation between self-control exertion and perceived effort, a bivariate correlation was conducted between performance of task 1 (numbers of typed ‘e’s and ‘n’s) and perceived effort was conducted. The bivariate correlation between perceived effort and self-control exertion measured by performance on task 1 was small and not statistically significant ($r = .020$, $p = .83$).

6.03.2 Test of Study Hypotheses

Regression analysis found that task duration did not have statistically significant main effect on performance on task 1 ($F(4,119) = 1.423$, $p = .23$) with $R^2 = .047$ (Table 9). A significant main effect of depletion condition on task 1 performance was expected. Consistent

with the ego-depletion effect however, this was also not statistically significant. Most importantly, task duration and depletion condition failed to achieve a statistically significant interaction effect on task 1 performance.

Table.9 Regression analysis predicting perceived effort of Task 1.

Model		β	t	p
1	(Constant)			
	Task Duration	.020	.189	.850
	Depletion Condition	.130	1.210	.229
	Boredom	-.190	-1.992	.049
2	(Constant)			
	Task Duration	.013	.122	.903
	Depletion Condition	.137	1.262	.209
	Boredom	-.202	-2.085	.039
	Task Duration x Depletion Condition	-.066	-.717	-.475

* $p < .05$

Regression analysis found that neither depletion nor duration condition had a significant main effects on reaction time or accuracy rate of MSIT performance (Table 9). In addition, there was no interaction effect of depletion and duration condition on reaction time or accuracy rate.

Table.10 Regression analysis predicting task 2 (MSIT) performance

		Reaction Time			Accuracy Rate		
Model		β	t	p	β	t	p
1	(Constant)						
	Task Duration	.024	.222	.085	.084	.774	.440
	Depletion Condition	.072	.679	.498	.098	.930	.354
	Boredom	.033	.340	.735	.010	.107	.915
2	(Constant)						
	Task Duration	.021	.187	.852	.090	.824	.411
	Depletion Condition	.076	.711	.478	.091	.863	.930
	Boredom	.040	.405	.686	-.001	-.014	.989
	Task Duration x Depletion Condition	.038	.401	.689	-.062	-.662	.510

As neither the performance from task 1 nor task 2 were correlated with task duration, interactive effect of all three variables (task duration, depletion condition, task 1 performance) needs not be examined.

6.04 Posthoc Analysis

To explore the possibility of a participants trading off accuracy for speed, a bivariate correlation between MSIT reaction time and accuracy rate was conducted and the correlation was found to be medium and statistically significant ($r = .35$, $p < .000$).

6.05 Conclusion & Discussion

The current study is consistent with findings of studies 2 in that perceived effort was not related to levels of self-control measured by task 1 parameters. This lack of relationship should be treated with caution as the perceived effort as measured by the current instrument may have been interpreted as the motivated commitment of effort rather than compelled exertion. Motivated commitment of effort here implies that the acts of self-control were motivated with a stronger emphasis on the initiative on the part of participant. Compelled exertion on the other hand implies that the participant is amotivated and less driven to perform well. Rather than one's own commitment to the task, it is the circumstances of the experiment's requirement that forces the participant to exert their self-control. As extending duration functions to increase the instances when exertion is required, but not motivating participants to commit effort to the task, the instrument may require further refinement in order to meaningful results to be yielded.

Results show no effects of between task 1 duration and performances in either task 1 or task 2. This is not inconsistent with the resource depletion approach duration and performance on tasks 1 and 2 in a sequential task paradigm. Similar to the incentive manipulation in study 2, task duration did not increase participants' exertion level on task 1.

We also found no ego-depletion effects, similar to findings of other studies. Of course, the current experiment alone does not contradict the strength model, but it adds further data to previous null findings and also suggests that task duration may not be a moderator of depletion effects. The result shows that the experiment was not suitable for testing the validity of the model.

Taken in context of the previous points, the lack of effect between duration and task 1 performance raises the question of whether the selective typing task is able to detect or measure self-control exertion. Unlike study 2, the current study employs a more mechanical approach to increasing self-control exertion. By extending the time in which participants are required to engage in the task, more opportunities were given to the subject to expend their self-control resource. In spite of this however, there is no corroborating variable to indicate that self-control exertion occurred. Extending duration neither produced any depletion effect observed in task 2, nor was there any effect with self-report measures of self-control. There could be two possible interpretations of this outcome. The first is that the duration of the task in this experiment, even when extended, was still insufficient to induce the ego-depletion effect. Although we extended the duration of the task significantly, there is no evidence to suggest that 20 minutes of task engagement is sufficient to push a participant to the ego-depletion state. Without a reliable timeframe to act as a duration threshold, the experiment is based on the assumption that a 20 minute task is capable of triggering ego-depletion whereas 7 minutes of the same task could not. If this assumption is incorrect and that an even greater duration is required for participants to reach the ego-depletion state, then the manipulation in this study would have been ineffective. The second is that a selective typing task is itself unable to evoke self-control exertion, regardless of how long the task is undertaken. Although this task has been used to induce depletion in previous experiments (e.g. Englert & Bertrams,

2012), we found no evidence of depletion in the current study. In either case, the experiment as employed by the current study may be require further refinement to test the validity of the strength model.

Although the trade-off effect was addressed in the analysis of the data, one strategy that may have been utilized by the participants but not accounted for in the experiments is pacing. Given the long duration of the first task in the experimental group, it is possible that even without a deliberate increase in accuracy, participants may have, consciously or not, curbed the speed of typing. As such, by employing this pacing strategy the participants may have inadvertently prevented themselves from reaching the ego-depletion state during the course of the typing task. Regardless of the level of motivation or duration of the task, if a pacing strategy is employed, it is highly unlikely that the ego-depletion effect would have occurred. Consequently, the performances in the second task would be unaffected. Future studies should control for this variable such as through creating an environment of urgency so the participant does not feel they have the luxury of pacing themselves.

CHAPTER 7

General Discussion

7.01 Introduction

The strength model's basic premise is acts of self-control require the individual to spend a limited resource, leaving them reducing capacity to continue to perform further self-control acts to the same level as before. The current project aims to address the issue regarding sequential-task experimental paradigm used to test it. Namely, to establish an experimental method that not only satisfies preconditions that give rise to the ego-depletion effect, but reliably triggers the effect as well.

7.02 Triggering Variable of Ego-Depletion

The main objective of this study is to explore possible variables that could manipulate the level of self-control exertion committed to task 1. The project explored two possible ways that might increase exertion including monetary incentives and task duration. Whilst neither manipulation resulted in any significant difference in performance in task 2, the reason for this outcome warrants in depth analysis. The use of monetary incentives might have affected the outcome of study 2, this is because it is uncertain whether the $15 offered was sufficient to strike the balance between being able to incentivize people to put effort into the tasks while not being too much to cause the participants to disbelieve that the offer of reward was genuine. We speculate that the latter may due to the advertisement for the study made no mention of any monetary reward and was only introduced to the experimental group during testing. Under such circumstance, it is natural for participants to be sceptical to whether the offer of a monetary reward was indeed genuine. This suspicion would be more prominent if

the amount offered is so high that participants suspect whether a study of this nature would actually offer such a significant amount of money. Scepticism of the experimenter's motive behind introducing the reward without notice beforehand may have nullified the motivation manipulating effect of the money itself. An additional concern regarding the use of monetary reward is the overcompensation effect. Effectively, for people who perceived the reward to be beyond what they appraised their own effort during task 1 was worth, they would commit extra high levels of exertion as a means to 'give back' to the experimenter for their generosity. This extra exertion would have masked the ego-depletion effect as rather than motivating them to deplete themselves during task 1 and perform worse in task 2, would have caused them to perform at a similar or even at a higher level than the unincentivized group. This is not to say that the limited resource model of self-control is incorrect, but rather that participants would be able to dig deeper into their reserves of self-control resource which they would normally would not access. Therefore, the amount offered by the experimenter must be high enough to motivate participants to exert their self-control, but not so high that participants stop believing that it the offer is genuine, or cause participants to overcompensate in their task 2 performance. While the principle of employing monetary rewards may be sound, based on the numerous studies on the effect of such incentives, it is unknown whether $15 offered here struck that balance or whether it failed to increase the motivation of participants. Future studies hoping to employ the use of monetary rewards should first conduct a pilot study examining what amount of reward is able to strike this balance before moving on to testing its effect on ego-depletion. For example, a single task study could be employed in which different amounts of monetary rewards were offered to different groups. The level of performance of the task, corroborating with a survey as to the degree by which the participant believed that the reward was a genuine offer rather than an experimental deception, could establish what is the most likely amount which could strike this balance.

Another question that needs to be address is whether the experimental design employed in the present study was sufficient to test the strength model. The theoretical conditions that is necessary for the strength model to be tested is that participants exerted themselves during task 1 so that they engage task 2 with a reduced level of self-control resource. The current study is unable to draw a definitive conclusion as to whether self-control expenditure actually increased due to the monetary incentives. In terms of actual exertion measured by task performance during task 1, the prospect of monetary reward saw no noticeable change in speed and number of self-control failures. In that regard, there should be no difference in terms of the self-control resource that was spent during task 1 between the experimental and control group. However, the marginal difference that it made for the perceived effort seem to indicate that even if there was no change in their actual performance, it may have had the effect of motivating participants to putting in more effort. Although it is difficult to infer any conclusive findings from these conflicting results, given that the perceived effort only managed to achieve marginal and not significant effect it is more likely that monetary incentives were unable to truly affect the degree of self-control exertion of the participant. As such, the research design in the current study may not have been sufficient to test the strength model.

Although we used a task duration than that was substantially longer than depletion conditions used in previous ego-depletion studies using the sequential task paradigm (Hagger et al., 2010 found the average duration to be approximately 5 minutes) it is unknown whether this was sufficient to evoke ego-depletion. The hypothesis that the longer the duration of task 1, the higher the chance of depletion is based on the assumption that the relationship between exertion on task 1 and performance in the second is somehow linear: as period of exertion on task 1 increases, performance of task 2 will decrease. Ego-depletion is defined as the loss of

self-control when self-control resources have been depleted, not merely reduced. Although people could become partially depleted, research shows that with additional motivation self-control reserves could be further committed so to compensate the ego-depletion effect. As such, studies that attempt to examine the effects of ego-depletion based on task duration of task 1, should first undertake a pilot study to determine what duration of the task is necessary to cause participants to reach a point of mental exhaustion where no self-control resource remains to be committed, even when motivated. Only after reaching this point of mental exhaustion could the effect of ego-depletion likely manifest in the performance of task 2. Without a systematic exploration of how long a task needs to be before self-control resources has been depleted, it is impossible to determine if task 1 had the desired effect of causing the subject to completely exhaust their self-control reserves.

Given that it is impractical to measure self-control exertion through the amount of failed attempts at self-control as an increased number of self-control failures may merely be the result of participants given more opportunities to fail, the only measurement that could be used to examine the level of effort committed to task 1 is through perceived effort. Perceived effort was unaffected by the changes in experimental conditions, the test of using task duration the experiment design used in the current study would have been unsuitable for testing the strength model's theoretical predictions. Without a clearly observable difference in the effort committed to task 1, one could not induct conclusion regarding any effects, or lack thereof, of task 2.

7.03 Shortcomings and Recommendations

One shortcoming of studies 2 and 3 is the use of the MSIT as a measure of ego-depletion. Ego-depletion, as measured by the difference in performance between the

depletion and non-depletion group, assumes that task being perform is able to detect the different level of self-control capacity. However, the measure of self-control exertion in the MSIT comes in two forms which actually counteracts each other, the accuracy rate and the reactions speed. As indicated by the posthoc analysis of studies 2 and 3, when undertaking tasks such as the MSIT, participants traded off speed for accuracy or vice versa. Specifically, in order to increase their reaction speed, participants may react prematurely before they are certain of the correct answer. Similarly, they may choose to be more cautious about accuracy and take a longer time to react. In doing so, this trade off effect may have affected the outcome of this experiment in ways which obscured the performance difference between the groups.

A careful examination of the definition of 'effort' may be warranted in light of study 3. That is, self-report measures of effort may have been affected by the how perceived effort is portrayed. Although self-control exertion is defined as the attempts to overcome habits or impulses, there may be a difference between motivated exertion and unmotivated exertion. The instrument employed in the current study was worded in a way that asked about how much effort participants believed that they have committed to the task. However, this form of effort may be a qualitatively different form of effort than what was required for study 3. Whilst in study 2, the participants were motivated through monetary incentives, this was not the case in study 3. Without any incentives to do well in the tasks, the effort elicited to undertake the task may have been qualitatively different to that of study 2. While this may not have affected the overall outcome of the ego-depletion measurements, it would have none-the-less affected the self-control report of participants. It may be prudent to explore any possible differences between motivated effort and elicited effort and how either might have affected the level of self-control exertion in a sequential-task experiment.

In both experiments, it is unknown whether intrinsic motivation was a variable that affected the results. It is an assumption on the experimenter's part that the selective typing task was inherently unpleasant to engage in. This however was never established empirically and if participants found this activity to be exciting or pleasurable, task 1 would have been unable to depletion the self-control resource of the participants and subsequently have little effect on task 2 performance.

The question of motivation should also be addressed with regards to the experiments of the project. It should be noted that this study suffers from sampling bias as the test participants of studies 2 and 3 were drawn entirely from the undergraduate student population. It is unknown whether this student population had developed the self-control capacity during their lives to engage in the tasks adequately. If they had not, and if they were amotivated, they might never reached the state of ego-depletion regardless of what tasks they were required to perform, or how long they are endured. Therefore, this sample of undergraduate students may not have been representative of self-control research. Future studies should attempt to test the ego-depletion hypothesis in real life settings and among non-student population.

7.04 Final Words

The current study have drawn from previous studies and targeted key gaps in the field of the strength model and ego-depletion research. Although the current studies did not replicate the depletion effect, there are substantial room of refinements and modifications to enhance its sensitivity and practicality in a sequential-task experiment. Similarly, the lack of results highlights to some of the key problems requiring future investigation including how

manipulating variables may be required pre-trial for fine tuning purposes before being applied to a sequential-task experiment.

The immediate priority of strength model research is to first establish experimental protocols which reliably pushes participants to experience neurologically verifiable point of ego-depletion. We recommend that a research study which systematically manipulates the duration of a self-control task while objectively observing or monitoring physiological measures such as activity in the anterior cingulate, and muscle tension (Wright, Rex Martin, & Bland, 2003), increase in the beta-frequency band (13-25 Hz) power in the right inferior and middle frontal gyri (Tanaka, Ishii & Watanabe 2014), changes in heartrate (Brownsberger et al. 2013), among others. Although these are not determining factors that could ascertain that participants have reached the point of mental fatigue, it nonetheless could serve as corroborating evidence along with self-report measures of effort taken after the experiment. The duration in which we could infer as being an ego-depletion state should be the point in which the self-report measures show maximum effort being given as well as physiological measures reaching peak level output. Once this duration is determined, employ this as the standard task length for a sequential-task experiment so to accurately observe whether there are noticeable differences in task 2 performance. Through replication studies across multiple laboratories, we may be able to develop such a procedure by which this conceptual linchpin of the strength model, the point of neurologically verifiable depletion takes place, could be utilized for testing other related issues such as moderators of the depletion effect. It is only through this level of meticulous experimentation by which we would be able to develop an experimental protocol to tackle the field of ego-depletion. This is position is not unlike that of Lurquin and Miyake (2017) whom suggested three steps to move the field of strength model research forward. These include establishing a common definition

of self-control, developing accurate measurements for self-control, and propose rationale for the ego-depletion that are not based on circular logic.

Finally, the field of ego-depletion while wrought with controversy, provides the opportunity to re-examine research methods, including definitions of key concepts, experimental parameters and statistical implications. These are fertile grounds to cultivate stringent research protocols and rigorous re-conceptualization of relevant ideas.

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*denotes studies included within study 1 meta-analyses

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Appendix A: Study 2 Step-by-Step Procedure

Participants will be recruited to a study and will be informed that it is a study of number recognition and reaction time

The experimenter will prepare the laboratory with the selective typing task ready to begin (with the participant's number recorded according to randomization schedule) and the questionnaires ready for completion. In addition, the multi-source interference task (MSIT; practice and main trial versions) will be accessible on the computer desktop or folder for the experimenter to easily 'launch' it during the course of the experiment.

On arrival to the laboratory, participants will be greeted by the experimenter, and asked to sit at a desk. The experimenter will introduce the study using the following script:

"Thank you very much for coming in. This is a number recognition and time reaction study. As part of the study, you will be asked to perform a series of simple tasks on a computer. The whole study will take between 30 to 60 minutes. You are free to withdraw at any time you want without any penalties and your participation points have already been given to you. Please read the following instruction sheet. You can then ask me questions and, if you agree to participate, please sign the consent form"

Experimenter hands participant information sheet and consent form (see Appendix B and C). After the participant has finished reading, asked any questions and signed the consent form, the experimenter will collect the information sheet and consent form, put them to one side, launch the practice version of the selective typing task on the computer, complete the session and participant number, and introduce task 1 using the following script:

"Now, on the computer screen in front of you are two text boxes. In the top box [indicates to top window on screen] will appear a passage of text, using the keyboard I want you to type the text exactly how it is printed into the computer using the keyboard. You will be able to see what you have typed in the lower box on the computer screen. Please work as quickly and accurately as possible until you are stopped by the computer. You cannot use the delete or backspace so if you make a mistake just carry on. Remember, this will be the practice trial of the typing task so it will be a short passage. Are you ready to begin? **Please begin the practice task".**

Experimenter depresses enter key and the participant engages in the typing task for two minutes. After two minutes, the program will stop with the instruction "Stop! Your experimenter will now give you some instructions". The experimenter will then close down the typing task practice and launch the practice version of the MSIT. The experimenter will introduce the practice task for the MSIT using the following script:

"Now you will practice task 2. On the screen you will be presented with a series of three numbers. When they appears on the screen, you need to use the '1', '2', and '3' keys on the keyboard to indicate the identity of the unique number, that is, the number that is not repeated. For example, if the set of numbers is 2-2-1, then the unique (not repeated) number is 1 and you would press '1' on the keyboard. Is that clear? After each series of

numbers appears, the numbers will quickly be replaced by a cross on the screen. You can still respond after the numbers are replaced by the cross, but go as quickly as you can."

Once the participant has indicated that he/she understands the task the experimenter reads from the following script:

"Now, place your index, middle, and ring fingers over the '1', '2', and '3' keys on the keyboard and get ready to start the task. Remember, this will be the practice trial of the number recognition task. Again, I will leave the room at that time until you have finished the task so as not to distract you. Once you press any key there will be a 'ready' screen, depress any key again and the task will begin. When you arrive at the screen that says 'The Task is Done', please inform me by opening the cubicle door".

Once the participant has indicated that he/she understands the task the experimenter reads from the following script:

"Remember, this will be the practice trial of the number recognition task. Again, I will leave the room at that time until you have finished the task so as not to distract you. Once you press any key there will be a 'ready' screen, depress any key again and the task will begin. When you arrive at the screen that says 'The Task is Done', please inform me by opening the cubicle door".

Experimenter leaves the cubicle and awaits door to open.
After the participant has completed the practice MSIT, the experimenter will return to the room. The experimenter will ask the participant the following question:

"Did you fully understand the task? We want to be absolutely sure you completely understand the task".

Once the participant has given affirmation, the experimenter will give the instruction:
The experimenter will launch the main trial version of the typing task, complete the session and participant number, and give the following instructions to the participant:

Ego-depletion group: "***Now, I will ask you to do the main trial for the typing task you did earlier, but you will use a different passage of text this time. I would also like you to exclude any letter 'e's and letter 'n's from the text you copy. In other words, don't use the 'e' and 'n' keys when you type. So you see the word "send" you will type "s-d". Again, please work as quickly and accurately as possible until you are stopped by the computer. If you make a mistake just carry on, you cannot use the delete or backspace keys. Are you ready*?"

No depletion group: "***Now, I will ask you to do the main trial for the typing task you did earlier, but you will use a different passage of text this time. Again, please work as quickly and accurately as possible until you are stopped by the computer. If you make a mistake just carry on, you cannot use the delete or backspace keys. Are you ready?***"

Experimental group: *"Now, if you put substantial effort into the task, you will be given, and get to keep, a $15 reward. I am giving you the money in advance, please put it somewhere safe like your pocket or purse. Just to be clear, this money is yours to keep, but*

only if you put a lot of effort into the next task. I will monitor your effort level from next door and I will know if you are putting in a lot of effort. If you put in a lot of effort you will be able to keep the $15. However, if you do not put in sufficient effort, you are going to have to give that money back to me. Do you understand?"

Once the participant has indicated that he/she understands the task the experimenter reads from the following script:

All participants: ***I will leave the room while you are doing the task. Please start the task when you are ready after I have left the room. When you have finished the task, please open the door of the cubicle and I will return. When you arrive at the screen that says 'The Task is Done', please inform me by opening the door".***

Experimenter inputs the password to start the trial and leaves the cubicle and awaits door to open.

Experimenter re-enters cubicle and addresses the participant with the following script:

Experimental group: ***"Thank you. I saw that you've put in a lot of effort into doing this task, so you can keep the money. Please sign here"***

Experimenter hands participants the receipt to sign.

All participants: ***"You will now go on to the main version of the number recognition task you practiced earlier."***

The experimenter will launch the main trial version of the MSIT, complete the session and participant number, and give the following instructions to the participant:

All participants: ***"I will leave the room while you are doing the task. Please re-read the instructions on the screen and start the task when you are ready after I have left the room. When you have finished the task, please open the door of the cubicle and I will return. When you're done, please inform me by opening the cubicle door."***

Experimenter leaves the cubicle and waits for the door to open. The experimenter re-enters cubicle and addresses the participant with the following script:

All participants: ***"Thank you. Now that you have finished the task, I would like you to complete the following questionnaire. There are no right or wrong answers, we just want to know how you feel."***

Experimenter then opens the webpage for to the Qualtrics™ questionnaire containing the effort, willpower, mindfulness, and depletion sensitivity items. While the participant is completing the questionnaires, the experimenter saves the files typed by the participant for later verification.

After the participant has completed the questionnaires, the experimenter will save the data and close down the window and provide the following instructions:
For control group, additional information is given through the following script:

Control group: ***"There is actually a $15 compensation for your participation in this study. Please take this with the thanks of the research team. [Hands participant cash reward] and sign here."***

Experimenter hands participants the money and gets them to sign the receipt. The experimenter will then complete the debriefing for both groups by the following script:

"Thank you for participating. It is typically good practice in experimentation to provide participants with a debrief outlining the true hypothesis of the study. However, it is also good practice not to reveal any details that would compromise the study in the population from which we are recruiting participants. In order to balance these two needs, we will provide a debrief, but not now. We will debrief participants by email after testing for this study has been completed. This should be in a few weeks time. Do you have any further questions? [Await response and answer questions if any]. Thank you very much for your participation. Goodbye."

Appendix B: Study 2 Participant Information Sheet

Title of Project: A study on word and number recognition and reaction time

You are being invited to take part in a student research study. Before you decide whether or not to take part, it is important for you to understand why the research is being conducted and what it will involve. Please take the time to read the following information carefully and decide if you want to take part in this study. Please feel free to ask questions if there is anything that is not clear or if you would like more information.

You will be asked to perform two simple computerised tasks that require you to respond to words and numbers presented on the computer screen using the keyboard according to certain rules. Full instructions on how to complete the tasks will be given to you. You will also be asked to complete a short questionnaire during the experiment. Each task will last roughly 10 minutes and the entire study will last less than 30 minutes.

Do I have to take part?

Participation in this study is totally voluntary, you are under no obligation to take part in this study. The data that you provide will be very useful for our study. If you decide to take part you will be given this information sheet to keep and will be asked to sign a consent form. You have the right to withdraw from the study at any time and without giving a reason.

For students participating to gain course credit for this study, the study is worth 3 course credit points.

What happens to the information I provide?

The information you provide will be confidential. No one apart from the experimenter and principal investigator (names given below) will have access to the information you provide. Your consent form will be kept separate from the observations collected during the course of the study. Data will be stored for a maximum of seven years in accordance with the University data storage policy. Once the data is analysed a report of the findings may be submitted for publication. Only broad trends will be reported and it will not be possible to identify any individuals. A summary of the results will be available from the experimenter on request once the study is complete.

If you have any questions or require any further information, please contact the experimenter or research supervisor.

Name of Experimenter: Nick Lee **E-mail:** nick.lee@postgrad.curtin.edu.au

Name of Supervisor: Nikos Chatzisarantis **E-mail:** nikos.chatzisarantis@curtin.edu.au

Thank you for taking the time to read this Participant Information Form and considering taking part in the study. This Participant Information Form is for you to keep. If you do wish to take part in the study, please sign the consent form.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number **RDHS-44-16.**). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email hrec@curtin.edu.au.

Appendix C: Study 2 Consent Form

Curtin University

Consent Form

Thank you for your interest in this project. Just to remind you, the data you provide in the course of this project will be treated in the strictest confidence and will be used for research purposes only. Furthermore, as a participant in this research you will never be identified in any outputs (e.g., reports, research articles) that arise from this project and your data will never be identifiable or viewed by any other party outside the research team.

Title of Experiment: Study on word and number recognition and reaction time
Name of Experimenter: NICK LEE

Please tick boxes

1. I confirm that I have read and understand the information sheet for the above experiment. ☐
2. I have had opportunities to ask questions and my questions have fully been answered. ☐
3. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. ☐
4. I have received enough information about the experiment. ☐
5. I agree to take part in the above experiment. ☐

"This experiment has been explained to me to my satisfaction, and I agree to take part. I understand that I am free to withdraw at any time."

_____	_____	_____
Name of Participant	Date	Signature

I have explained the experiment to the above participant and he/she has agreed to take part.

_____	_____	_____
Name of Experimenter	Date	Signature

Appendix D: Study 2 Debrief Sheet

Title of project: Effect of self-control resource depletion on task performance

Name of Researcher: NICK LEE

Thank you for taking part in this study. The sheet will provide you will full details of the study in which you participated.

The purpose of the study was to investigate the effect of self-control resource depletion on performance on tasks requiring self-control. Self-control, often called 'willpower', is considered important for achieving long-term goals and is often defined as someone's ability to overcome habitual, ingrained, or well-learned actions in favour of an alternative course of action. We are testing a particular model of self-control called the 'strength model' in the present study. In the model, self-control is viewed as a kind of energy or strength which allows people to exert self-control, but only for a limited amount of time after which it becomes depleted. This means that doing a task that requires self-control for a period of time may reduce one's self-control strength, so that ability on subsequent self-control tasks will be impaired.

You were allocated to an experimental (self-control) group or a control (no self-control) group. Task 1 required self-control for experimental participants in a typing task where you are instructed type out a passage but to omit all occurrences of the letter "E" and "N". Task 2 was a number-recognition task (known as a *multi-source interference task*), which required inhibiting responses to the position and size of numbers presented in favor of the identity of the target number (the correct response) and no self-control for control group participants (position of the number corresponds to the value). This task was the same for all participants. Your performance was measured based on speed and accuracy of task 2. We expected that participants in the experimental group would perform worse on task 2 compared to the control group. This is because participants in the experimental group should have reduced self-control 'strength' because task 1 (responding to words with the letter 'e' in them according to complex rules) required them to expend this self-control resource. Some aspects of the study were withheld from you so that your expectations would not affect the outcome, which is why we presented the tasks as separate experiments. For this reason, we ask that you do not discuss the study with anyone else until its conclusion (31/11/2016).

Thank you again for taking part. If there is anything you would like to discuss in relation to this study, please feel free to do so by contacting the researchers. If you would like to withdraw your data, please speak to the researcher now or contact him/her later.

Email address of Researcher: nick.lee@postgrad.curtin.edu.au

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number **RDHS-44-16**). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email hrec@curtin.edu.au.

Appendix E: Study 3 Step-by-Step Procedure

Participants will be recruited to a study and will be informed that it is a study of number recognition and reaction time

The experimenter will prepare the laboratory with the selective typing task ready to begin (with the participant's number recorded according to randomization schedule) and the questionnaires ready for completion. In addition, the multi-source interference task (MSIT; practice and main trial versions) will be accessible on the computer desktop or folder for the experimenter to easily 'launch' it during the course of the experiment.

On arrival to the laboratory, participants will be greeted by the experimenter, and asked to sit at a desk. The experimenter will introduce the study using the following script:

"Thank you very much for coming in. This is a number recognition and time reaction study. As part of the study, you will be asked to perform a series of simple tasks on a computer. The whole study will take between 30 to 60 minutes. You are free to withdraw at any time you want without any penalties and your participation points have already been given to you. Please read the following instruction sheet. You can then ask me questions and, if you agree to participate, please sign the consent form"

Experimenter hands participant information sheet and consent form (see Appendix F and G). After the participant has finished reading, asked any questions and signed the consent form, the experimenter will collect the information sheet and consent form, put them to one side, launch the practice version of the selective typing task on the computer, complete the session and participant number, and introduce task 1 using the following script:

"Now, on the computer screen in front of you are two text boxes. In the top box [indicates to top window on screen] will appear a passage of text, using the keyboard I want you to type the text exactly how it is printed into the computer using the keyboard. You will be able to see what you have typed in the lower box on the computer screen. Please work as quickly and accurately as possible until you are stopped by the computer. You cannot use the delete or backspace so if you make a mistake just carry on. Remember, this will be the practice trial of the typing task so it will be a short passage. Are you ready to begin? **Please begin the practice task".**

Experimenter depresses enter key and the participant engages in the typing task for two minutes. After two minutes, the program will stop with the instruction "Stop! Your experimenter will now give you some instructions". The experimenter will then close down the typing task practice and launch the practice version of the MSIT. The experimenter will introduce the practice task for the MSIT using the following script:

"Now you will practice task 2. On the screen you will be presented with a series of three numbers. When they appears on the screen, you need to use the '1', '2', and '3' keys on the keyboard to indicate the identity of the unique number, that is, the number that is not repeated. For example, if the set of numbers is 2-2-1, then the unique (not repeated) number is 1 and you would press '1' on the keyboard. Is that clear? After each series of numbers appears, the numbers will quickly be replaced by a cross on the screen. You can still respond after the numbers are replaced by the cross, but go as quickly as you can."

Once the participant has indicated that he/she understands the task the experimenter reads from the following script:

"Now, place your index, middle, and ring fingers over the '1', '2', and '3' keys on the keyboard and get ready to start the task. Remember, this will be the practice trial of the number recognition task. Again, I will leave the room at that time until you have finished the task so as not to distract you. Once you press any key there will be a 'ready' screen, depress any key again and the task will begin. When you arrive at the screen that says 'The Task is Done', please inform me by opening the cubicle door".

Once the participant has indicated that he/she understands the task the experimenter reads from the following script:

"Remember, this will be the practice trial of the number recognition task. Again, I will leave the room at that time until you have finished the task so as not to distract you. Once you press any key there will be a 'ready' screen, depress any key again and the task will begin. When you arrive at the screen that says 'The Task is Done', please inform me by opening the cubicle door".

Experimenter leaves the cubicle and awaits door to open.
After the participant has completed the practice MSIT, the experimenter will return to the room. The experimenter will ask the participant the following question:

"Did you fully understand the task? We want to be absolutely sure you completely understand the task".

Once the participant has given affirmation, the experimenter will give the instruction:
The experimenter will launch the main trial version of the typing task, complete the session and participant number, and give the following instructions to the participant:

Ego-depletion group: "***Now, I will ask you to do the main trial for the typing task you did earlier, but you will use a different passage of text this time. I would also like you to exclude any letter 'e's and letter 'n's from the text you copy. In other words, don't use the 'e' and 'n' keys when you type. So you see the word "send" you will type "s-d". Again, please work as quickly and accurately as possible until you are stopped by the computer. If you make a mistake just carry on, you cannot use the delete or backspace keys. Are you ready?***"

No depletion group: "***Now, I will ask you to do the main trial for the typing task you did earlier, but you will use a different passage of text this time. Again, please work as quickly and accurately as possible until you are stopped by the computer. If you make a mistake just carry on, you cannot use the delete or backspace keys. Are you ready?***"

Once the participant has indicated that he/she understands the task the experimenter reads from the following script:

All participants: ***I will leave the room while you are doing the task. Please start the task when you are ready after I have left the room. When you have finished the task, please***

open the door of the cubicle and I will return. When you arrive at the screen that says 'The Task is Done', please inform me by opening the door".

Experimenter inputs the password to start the trial and leaves the cubicle and awaits door to open.

Experimenter re-enters cubicle and addresses the participant with the following script:

All participants: *"You will now go on to the main version of the number recognition task you practiced earlier."*

The experimenter will launch the main trial version of the MSIT, complete the session and participant number, and give the following instructions to the participant:

All participants: *"I will leave the room while you are doing the task. Please re-read the instructions on the screen and start the task when you are ready after I have left the room. When you have finished the task, please open the door of the cubicle and I will return. When you're done, please inform me by opening the cubicle door."*

Experimenter leaves the cubicle and waits for the door to open. The experimenter re-enters cubicle and addresses the participant with the following script:

All participants: *"Thank you. Now that you have finished the task, I would like you to complete the following questionnaire. There are no right or wrong answers, we just want to know how you feel."*

Experimenter then opens the webpage for to the Qualtrics™ questionnaire containing the effort, willpower, mindfulness, and depletion sensitivity items. While the participant is completing the questionnaires, the experimenter saves the files typed by the participant for later verification.

After the participant has completed the questionnaires, the experimenter will save the data and close down the window and provide the following instructions:
For control group, additional information is given through the following script:

Experimenter hands participants the money and gets them to sign the receipt. The experimenter will then complete the debriefing for both groups by the following script:

"Thank you for participating. It is typically good practice in experimentation to provide participants with a debrief outlining the true hypothesis of the study. However, it is also good practice not to reveal any details that would compromise the study in the population from which we are recruiting participants. In order to balance these two needs, we will provide a debrief, but not now. We will debrief participants by email after testing for this study has been completed. This should be in a few weeks time. Do you have any further questions? [Await response and answer questions if any]. Thank you very much for your participation. Goodbye."

Appendix F: Study 3 Participant Information Sheet

Title of Project: A study on word and number recognition and reaction time

You are being invited to take part in a student research study. Before you decide whether or not to take part, it is important for you to understand why the research is being conducted and what it will involve. Please take the time to read the following information carefully and decide if you want to take part in this study. Please feel free to ask questions if there is anything that is not clear or if you would like more information.

You will be asked to perform two simple computerised tasks that require you to respond to words and numbers presented on the computer screen using the keyboard according to certain rules. Full instructions on how to complete the tasks will be given to you. You will also be asked to complete a short questionnaire during the experiment. Each task will last roughly 10 minutes and the entire study will last less than 30 minutes.

Do I have to take part?

Participation in this study is totally voluntary, you are under no obligation to take part in this study. The data that you provide will be very useful for our study. If you decide to take part you will be given this information sheet to keep and will be asked to sign a consent form. You have the right to withdraw from the study at any time and without giving a reason.

For students participating to gain course credit for this study, the study is worth 3 course credit points.

What happens to the information I provide?

The information you provide will be confidential. No one apart from the experimenter and principal investigator (names given below) will have access to the information you provide. Your consent form will be kept separate from the observations collected during the course of the study. Data will be stored for a maximum of seven years in accordance with the University data storage policy. Once the data is analysed a report of the findings may be submitted for publication. Only broad trends will be reported and it will not be possible to identify any individuals. A summary of the results will be available from the experimenter on request once the study is complete.

If you have any questions or require any further information, please contact the experimenter or research supervisor.

Name of Experimenter: Nick Lee **E-mail:** nick.lee@postgrad.curtin.edu.au

Name of Supervisor: Nikos Chatzisarantis **E-mail:** nikos.chatzisarantis@curtin.edu.au

Thank you for taking the time to read this Participant Information Form and considering taking part in the study. This Participant Information Form is for you to keep. If you do wish to take part in the study, please sign the consent form.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number **RDHS-44-16.**). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email hrec@curtin.edu.au.

Appendix G: Study 3 Consent Form

Consent Form

Thank you for your interest in this project. Just to remind you, the data you provide in the course of this project will be treated in the strictest confidence and will be used for research purposes only. Furthermore, as a participant in this research you will never be identified in any outputs (e.g., reports, research articles) that arise from this project and your data will never be identifiable or viewed by any other party outside the research team.

Title of Experiment: Study on word and number recognition and reaction time

Name of Experimenter: NICK LEE

Please tick boxes

1. I confirm that I have read and understand the information sheet for the above experiment. ☐
2. I have had opportunities to ask questions and my questions have fully been answered. ☐
3. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. ☐
4. I have received enough information about the experiment. ☐
5. I agree to take part in the above experiment. ☐

"This experiment has been explained to me to my satisfaction, and I agree to take part. I understand that I am free to withdraw at any time."

_____	_____	_____
Name of Participant	Date	Signature

I have explained the experiment to the above participant and he/she has agreed to take part.

_____	_____	_____
Name of Experimenter	Date	Signature

Appendix H: Study 3 Debrief Sheet

Title of project: Effect of self-control resource depletion on task performance

Name of Researcher: NICK LEE

Thank you for taking part in this study. The sheet will provide you will full details of the study in which you participated.

The purpose of the study was to investigate the effect of self-control resource depletion on performance on tasks requiring self-control. Self-control, often called 'willpower', is considered important for achieving long-term goals and is often defined as someone's ability to overcome habitual, ingrained, or well-learned actions in favour of an alternative course of action. We are testing a particular model of self-control called the 'strength model' in the present study. In the model, self-control is viewed as a kind of energy or strength which allows people to exert self-control, but only for a limited amount of time after which it becomes depleted. This means that doing a task that requires self-control for a period of time may reduce one's self-control strength, so that ability on subsequent self-control tasks will be impaired.

You were allocated to an experimental (self-control) group or a control (no self-control) group. Task 1 required self-control for experimental participants in a typing task where you are instructed type out a passage but to omit all occurrences of the letter "E" and "N". Task 2 was a number-recognition task (known as a *multi-source interference task*), which required inhibiting responses to the position and size of numbers presented in favor of the identity of the target number (the correct response) and no self-control for control group participants (position of the number corresponds to the value). This task was the same for all participants. Your performance was measured based on speed and accuracy of task 2. We expected that participants in the experimental group would perform worse on task 2 compared to the control group. This is because participants in the experimental group should have reduced self-control 'strength' because task 1 (responding to words with the letter 'e' in them according to complex rules) required them to expend this self-control resource. Some aspects of the study were withheld from you so that your expectations would not affect the outcome, which is why we presented the tasks as separate experiments. For this reason, we ask that you do not discuss the study with anyone else until its conclusion (31/11/2016).

Thank you again for taking part. If there is anything you would like to discuss in relation to this study, please feel free to do so by contacting the researchers. If you would like to withdraw your data, please speak to the researcher now or contact him/her later.

Email address of Researcher: nick.lee@postgrad.curtin.edu.au

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number **RDHS-44-16**). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email hrec@curtin.edu.au.

Appendix I: Motivation, Effort and Depletion Questionnaire

Please indicate how you felt when you were participating in the task by selecting a number on each of the scales below

None at all - A little - A bit - Somewhat - Quite a bit - A lot - Very much

1. How much effort did you put in to the first (typing) task?
2. How frustrating did you find the first (typing) task?
3. Do you feel depleted after doing the first (typing) task?
4. How difficult did you find the first (typing) task?
5. Right now, do you feel it would take a lot of effort for you to concentrate on something?
6. How interesting did you find the first (typing) task?
7. Do you feel mentally exhausted after doing the first (typing) task?
8. Have you given your best to complete the first (typing) task?
9. Do you feel drained after doing the first (typing) task?

For each of the following statements, please indicate how true it is for you.

10. I did the task because I will get a reward if I do.
11. I thought this task was quite enjoyable.
12. I am satisfied with my performance at this task.
13. I put a lot of effort into this task.
14. I felt pressured while doing this task.
15. I felt like I had to do this task.
16. I did the task because I will receive participation points for doing so.
17. This task did not hold my attention at all.
18. This was a task that I couldn’t do very well.
19. I tried very hard on this task.
20. I was very relaxed in doing the task.
21. I did this task because I wanted to.
22. I did the task because I will receive participation points for doing so.
23. I did the task because I will receive money for doing so.

Appendix J: Leisure Boredom Questionnaire

Read each of the following statements and decide how much you agree with each of the following statements. Please respond according to the following scale.

Not true at all - Somewhat not true - Somewhat true - Very true

1. For me, the first (typing) task just drags on and on.
2. During the first (typing) task, I became highly involved in what I do.
3. During the first (typing) task was boring.
4. During the first (typing) task, I feel like I'm just "spinning my wheels."
5. The first (typing) task got me excited and going.
6. I was very active when doing the first (typing).
7. The first (typing) task did not excite me.
8. I felt that the first (typing) task was very monotonous and repetitive.
9. I felt the first (typing) task went by slowly
10. I got tired doing the first (typing) task
11. I became irritable doing the first (typing) task
12. I became apathetic doing the first (typing) task
13. I daydreamed or thought about other things during the first (typing) task
14. I felt as if like the first (typing) task would never end
15. During the first (typing) task, I felt restless
16. I felt mentally sluggish when doing the first (typing) task
17. I started to get drowsy doing the first (typing) task
18. It was difficult to concentrate on the first (typing) task
19. I found the first (typing) task entertaining