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Research Paper

Evoking the ego-depletion effect using incentives and task duration in a sequential-task experiment

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ABSTRACT

Although there has been substantial support for the strength model of self-control (Baumeister's, 1998) in the last two decades, questions have been raised regarding its validity as a recent meta-analysis by Carter and McCullough (2014) concluded the ego-depletion effect was statistically negligible. We postulate that these results may be due to the previous studies not ascertaining how much exertion was put into the first task of a sequential-task experiment, resulting in conflicting outcomes of the depletion effect. The primary goal of this study was to explore possible methods to reliably evoke the ego-depletion effect during a strength model experiment. This project involves two laboratory experiments using the sequential-task experimental paradigm while attempting to manipulate the self-control effort exerted during the first task by either offering monetary incentives or extending task durations in order to manipulate self-control exertion level. Results found that neither offering of incentives nor extending of task duration was able to effectively trigger the ego-depletion effect. These results illuminated critical methodological shortcomings in the ways that strength model have been tested in the past and suggests the research focus in the immediate future is to re-examine some experiment protocols of strength model research.

Keywords: *Ego-Depletion, Sequential-Task Experiment, Self-Control, Strength Model, Task Duration*

Self-control is defined as one's capacity to change or overcome their natural impulses and habits (Baumeister, 2002). Over the years, there has been a number of models that attempted to illustrate psychological mechanisms by which self-control operates. The 'strength' model of self-control proposes that any act of self-control requires drawing self-control resource from a finite pool that is shared by different forms of self-control behavioural, cognitive and emotional control. Once this pool has been depleted, people will experience a brief period in which they are unable to maintain their self-control performance, a state known as ego-depletion (Baumeister et al, 1998).

The primary method of testing the ego-depletion effect is through the Sequential-Task Experimental Paradigm (Baumeister et al., 1998; Muraven, Tice, & Baumeister, 1998) whereby people are required to perform two tasks in sequence. In the experimental group,

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both tasks require self-control while only the second task has this requirement for the control group. Theoretically, by using their self-control resource when engaging the first task, the experimental group would experience the ego-depletion effect and perform poorly during the second task compared to the control group that is undertaking the second task with a "full tank" (Baumeister et al., 2007).

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). In addition to laboratory studies, the strength model has found to be applicable in health and social-related behavioural changes such as sexuality (Gailliot & Baumeister, 2007), alcoholism (Muraven et al., 2005), predicting impulse buying behaviour (Vohs & Faber, 2007), academic performances (Tangney et al., 2004) among others. Hagger, Wood, Stiff, and Chatzisarantis (2010) attempted to synthesize this literature through a a meta-analysis of 198 studies. Their results showed that the ego-depletion effect yielded a medium-size overall effect (d = 0.62 [95% CI: 0.57, 0.67]).

Although strength model has had an undeniable impact in Psychology, it does not do so without controversy. A subsequent meta-analysis conducted by Carter and colleagues (2014) found that Hagger et al. (2010) may have been affected by publication bias and small study effect. Multiple subsequent attempts were made to reanalyze the ego-depletion literature while correcting for these errors. Hagger, et al (2016) addressed the discrempency of finding by conducting a replication study, which supported the small effect size (d = 0.02 95% CI: [-0.09, 0.13]).

Although it is possible that the ego-depletion as a phenomenon does not exist, but rather it is merely a statistical artifact resulting from biased dissemination of findings (Carter & McCullough, 2014), it may also be true that the way in which experiments have been conducted had inherent methodological problems. It is due to these problems that the ego-depletion effect could not be observed reliably (Chatzisarantis & Hagger, 2015).

Current Project

So far, however, there has been little research in ascertaining whether participants actually exert themselves during task 1 (Inzlicht & Schmeichel, 2012). The primary goal of this project is to explore how self-control exertion could be accurately evoked and whether it actually impacts on self-control performances in a sequential-task experiment. Lee, Chatzisarantis, and Hagger (2016) proposed two possible methods by which self-control exertion during the initial task could be manipulated. The first is to offer monetary incentives to the participants to increase their motivation to for better task performance, and the other is to extend the duration of the first task itself to give participants more opportunities to exert themselves, both methods which shall be tested in the current project.

Study 1

One critical assumption regarding the association between self-control exertion and ego-depletion is the link between motivation and self-control exertion. One possible confounding variable in a sequential-task experiment are participants who may be a motivated to engage effortful control over themselves In particular, previous studies might have had underestimated the ego-depletion effects if participants did not expend sufficient amount of effort during the first task in the sequential task paradigm (Chatzsarantis & Hagger, 2015; Friese et al., 2008; Hofmann et al., 2009). This proposition follows directly from the

operational definition of the ego-depletion effect which states that performance on the second self-control task, in the sequential task paradigm, is impaired as a direct function of exercising self-control on the first task (Baumeister et al., 1998). If, for some reason, individuals do not attempt to exercise self-control during the first task, either because they are a motivated (Lurquin et al., 2016) or because they want to conserve their capacity for self-control (Muraven & Baumeister, 2000), resources are unlikely to be depleted and the ego-depletion effect predicted by the strength model is unlikely to be observed. Failure to observe the ego-depletion effect under these conditions does not falsify the limited resource model because the important precondition that experimental group participants should engage in effortful self-control on the first task is not satisfied. In accordance with this proposition, Lurquin et al. (2016) showed that a substantial number of participants who were prompted to control their attention did not actually do so during the first task in a sequential task paradigm. Analogously, Dang's (2016) reanalysis of Hagger et al.'s replication data identified a small but significant ego-depletion effect in groups of participants who reported to exerting high effort on the first task.

One theory outlining the cognitive dynamics of motivation is Vroom's (1964) expectancy-value model. Vroom conceptualize motivation as a relationship between one's perceived capacity in performing an act (instrumentality), the value placed on the outcome (valance), and the correlation between the amount of effort put in and the chances of success (expectancy). This principle of increasing outcome value by external means could be operationalized through providing incentives for task performance, such as monetary rewards. It should be noted that providing monetary incentives could not overcome the aversive feelings towards the task itself, but rather it serves to increase people's motivation to exert more self-control to overcoming the avoidance impulse.

The primary goal of this study is to explore whether it is possible to reliably evoke the ego-depletion effect through providing monetary incentives. Although monetary reward had been used in previous research to successfully overcoming the ego-depletion effect (e.g. Boucher & Kofos, 2012; Muraven & Slessareva, 2003), rewards in these studies were offered as a means to overcome the ego-depletion effect directly by eliciting greater performance in the second task. To date, there has been no attempt to employ monetary incentives to evoke the ego-depletion effect through increasing the performance of the first task. It is our hypothesis that motivated participants who are prompted to exert self-control in the first task in the sequential-task experiment through monetary incentives will exhibit higher levels of ego-depletion than participants who are not prompted to exert self-control.

METHODOLOGY

Participants and Design

Participants were students who participated in the study in return of a course credit (N = 140; male = 26, female = 114, age = 22.21, SD = 6.597). A priori power analysis based on the effect size of Hagger et al's 2010 meta-analysis, the minimum sample size for the current study is N=108. The current study employed a conventional sequential-task experiment, with a fully randomized controlled design, utilizing an additional manipulation of the incentive offer for task 1's. A 2 (depletion condition: depleting vs. non-depleting task) x 2 (incentive condition: incentivized vs. non-incentivized). A selective typing task was selected as task 1 while task 2 was a multi-source interference task (MSIT). This study was approved by Human Research Ethics Office of Curtin University (Approval number: RDHS-44-16)

Procedure and Manipulations

The ego-depletion effect was evoked by two separate means in the current study. Depletion condition was manipulated by difficulty levels of the selective typing task, and the experimental condition was manipulated by whether participants are offered monetary incentives for their performance.

Participants were informed of a cover story implying that the study was a typing speed experiment. The first was a selective typing task which was designed to engage an individual's vigilance (Muraven, Pogarsky, & Shmueli, 2006). Instructions on the selective typing task were then given and a practice trial run of two minutes duration commenced. All participants were presented with a passage of text on a computer screen and were required to type it out. No special rules applied and the non-depletion group and participants only needed to type the passage as it was. Those assigned to the depletion group, however, were instructed to omit all occurrences of the letter "e" and "n". This forced the participant to overcome their well-learned, automatic tendency of typing 'e' and 'n' letter (Rieger, 2004). Incentivized group was told that if they put a lot of effort into the task, they would receive $15 as a reward. This additional information was not provided for those assigned to the non-incentivized group. After the first task was completed, those in the incentivized group were told that they did demonstrate sufficient effort and were allowed to keep the money. The main trial of task 2 was then administrated and after completion, all participants filled out the Motivation and Effort Questionnaire. After the survey, participants were debriefed, and dismissed. In order to uphold equity, how well they performed on the task had no effect on the reward, and the non-incentivized group received the same monetary prize after the experiment is completed.

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's were typed was the dependent variable, indicating depletion, while the depletion (-1 = non-deplete condition, 1 = depleted condition) and duration condition (-1 = non-incentivized condition, 1 = incentivized condition) were the independent variables. Depletion and incentive condition were entered independently on in the first step stage of the analysis. In addition, in order to control for the effect of extrinsically motivated effort and extrinsic motivation were also entered in the first step of the regression to statistically control for its effect. The two-way interaction effect between the independent variables was entered in the second step.

Materials

Measurement of ego-depletion. While ego-depletion will be manipulated using the first task in the experiment, the MSIT is used as the dependent variable to measure the effect of the ego-depletion effect. The MSIT is a response inhibition task and it has been used in sequential task paradigms previously (Sripada et al., 2014). Participants are presented with numerical stimuli consecutively on a computer screen drawn at random from a pool of stimuli. The stimuli comprise sets of with three numerals arranged in a row. Each set comprises combinations of the numbers: 1, 2, 3, or 0. In each set, two numerals are repeated and one is unique. Participants' are required to press the key corresponding to the identity of the unique numeral. There are two types of items in the MSIT. For congruent items, the target digit (1, 2 or 3) always matches its position on the response keys, such as the number '1' will always appear in the first (leftmost) position in the set (i.e., 100, 020 or 113). In

addition, the digit size is always consistent with the target digit. For the incongruent items, the unique numeral never matches its position in the set and additional interference will also be caused by varying the size of the digits in the set. Participants must therefore suppress the competing tendency to identify the position or size of the numeral rather than its identity. As the incongruent items will require one to exert self-control, only accuracy rate and reaction time yielded from them will be used in the analysis process.

Motivation and Effort Questionnaire. In the current project we also measure motivation and effort as a way to control the main analysis. We composed a separate questionnaire called the Motivation and Effort Questionnaire for this purpose which consists of 23 items and is divided into two sections. The first, consisting of 9 items measures the level of effort the participant perceived they have put into the first task. An example item was "*have you given your best to complete the first (typing) task?*"). This item was measured on a 7–point scale ranging from "No effort" (1) to "A lot of effort" (7). The second part, consisting of 14 items measures the participant's domain of motivation when undertaking task 1. Items in the scale were selected 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).

RESULT

Manipulation Check

People who were assigned to the experimental group and were offered monetary incentives for task 1 performances reported that greater effort on the typing task, although the difference did not reach significant levels (F (1,138) = 1.00, p = .319). Similarly, participants who were given additional rules for task 1 also reported greater effort being required for its undertaking, although this difference did not reach significant levels (F (1,138) = 2.40, p = .123).

Test of Study Hypotheses

Additional rules applied to task 1 resulted in participants having higher reaction time during task 2 but the difference did not reach statistically significant levels (F(1,138) =.03, p = .860). Similarly, additional rules resulted in greater self-control failures in accuracy rate, although this did not reach statistically significant levels either (F(1,138) = .77, p = .381). Incentivizing participants with monetary rewards in task 1 resulted in slower reaction time during task 2, although this difference did not reach significant levels (F(1,138) = .281, p = .597, d = .067). Monetary incentive in task 1 led to a higher accuracy when participants engaged in task 2, although this difference again did not reach significant levels either (F(1,138) = .087, p = .768, d = 0.71).

Regression analysis found that neither the incentive condition, nor the depletion condition had a significant correlation with the reaction time or accuracy rate of task 2 performances (table 1). Additionally, incentive condition and depletion condition failed to achieve a significant interactive effect on the reaction time or accuracy rate either.

Table No. 1 Regression analysis predicting task two (MSIT) performance

Model		Reaction Time			Accuracy Rate		
		B	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

a. Duration condition variable: Normal (-1),Extended (1)
b. Depletion condition variable: Non-depleted (-1), Depletion (1)

DISCUSSION

The current study aims to address a key issue of the sequential-task experimental paradigm used to test it. Namely, to establish a methodological mechanism by which ego-depletion could be reliably evoked. In spite of this, we did not find any correlation between monetary incentives and task 2 performances.

While Hagger et al's (2010) meta-analysis did propose that motivation and effort in the first task may be a factor of whether the ego-depletion effect could be observed in a sequential-task experiment, evidence from the current study does not support this. We could derive two possible implications from this; the first is that monetary incentives are unable to motivate participants to exert themselves, the second being that extrinsic motivation via monetary reward is insufficient to trigger the ego-depletion effect in a laboratory setting. Regardless of which reason, the current study does not support the use of monetary reward to moderate ego-depletion effect.

Study 2

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.

In a previous meta-analysis (Hagger et al., 2010) it was found that the duration of the first task had a significant impact on the ego-depletion effect. Duration may increase ego-depletion because it provides more opportunities for the individual to exercise self-control. Therefore, the amount of self-control resource that is spent is the sum of the total instances where an individual attempts, and succeeds, in self-control acts. In accordance with this proposition, Hofmann, Vohs, and Baumeister (2012) found that ability to exert self-control decreased over the day, that the conflict between impulse and resistance eventually erodes away one's capacity to counteract the impulse. It should be noted that although study did not employ a sequential task experiment, the evidence points to a limited resource model. Vohs,

Baumeister and Schmeichel (2012) further examined the effects of take duration by increasing the number of tasks that participants engaged in before final task. Both experiments in this study showed that greater number of tasks, and therefore the total time spent on exerting self-control, resulted in lower performances in the final task. It should be noted, however, that evidence that challenges this proposition also exists. For example, both Converse and DeShon (2009), as well as Xiao and colleagues (2014) found that engaging self-control longer periods actually improved performance for subsequent tasks. However, in both these studies, cases where performance improved were those that engaged in three tasks rather than two, thereby increasing the time spent on maintaining self-control. Improvement of performance therefore, may be attributed to an adaptation process by which the effects of ego-depletion could be temporarily delayed. Another possibility is that neither task specifically instructed their participants to exert themselves during the tasks. As such, it is difficult to ascertain whether participants pushed themselves to the point of depletion, especially in the second task as they become aware of what is expected of them and may strategically lower their effort to conserve energy. Moreover, in both these studies the ego-depletion effect was observed in the two-task procedure, implying that this method may be best suited for experimenting on the strength model. Given these issues, the current study shall attempt to verify the effects of duration on ego-depletion empirically though a two-task experiment.

It is our hypothesis that motivated participants who are prompted to exert self-control in the first task in the sequential-task experiment for longer will experience higher levels of ego-depletion than participants who are prompted to exert self-control for shorter periods.

METHODS

Participants and Procedures

Participants were students who participated in the study in return of a course credit (N = 120; male = 36, female = 84, age = 21.70, SD = 5.149). Statistical analysis of this study is the same as that of study 1.

The experimental design is largely the same as that of study 1, employing the same tasks of the selective typing task in the first task as the means of manipulating depletion condition, and the MSIT in the second self-control task as the dependent variable. The only difference in the experimental protocol is that the incentives are not offered to the experimental group, but rather the duration of the initial task is extended. Participants assigned to the control group engaged in task 1 for 7 minutes, which is consistent with many tasks adopted in previous ego-depletion studies (Hagger et al., 2010), while the experimental group undertook task 1 for 20 minutes.

It should be noted that 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 addressed by measuring the levels of boredom the participant experienced and statistically controlling for it.

Motivation and Effort Questionnaire. The first 9 questions of the Motivation and Effort Questionnaire in this study is identical to the previous study. However, rather than measuring the extrinsic motivation, the second set of question was taken from the Leisure

Boredom Scale (LBS; Iso-Ahola & Weissinger, 1990). This is a 19-item questionnaire designed to assess an individual's experience of boredom during leisure time. An example item was "Was the task mentally exhausted". This item was measured on a 4-point scale ranging from "Not true at all" (1) to "Very true" (4).

RESULTS

Manipulation Check

People who were assigned to the experimental group engaged an extended task 1 reported that greater effort were needed to complete the task, although the difference did not reach significant levels ($F(1,118) = .67$, $p = .416$). Similarly, participants who were given additional rules for task 1 also reported greater effort being required for its undertaking, although this difference did not reach significant levels ($F(1,118) = .08$, $p = .783$).

Test of Study Hypotheses

Manipulation of difficulty levels of task 1 through additional rules resulted in higher reaction time during the MSIT but the difference did not reach statistically significant levels ($F(1,118) = .81$, $p = .369$). Similarly, additional rules resulted in greater self-control failures in accuracy rate, although this did not reach statistically significant levels either ($F(1,118) = 2.25$, $p = .137$). Although manipulation of task 1 duration resulted in higher reaction time during the MSIT for extended duration, the difference did not reach statistically significant levels ($F(1,118) = .52$, $p = .471$). Similarly, extending the task duration also resulted in greater self-control failures in accuracy rate, but this did not reach statistically significant levels either ($F(1,118) = 2.10$, $p = .150$).

Regression analysis found that neither the duration condition, nor the depletion condition had a significant correlation with the reaction time or accuracy rate of MSIT performance (table 2). Additionally, duration condition and depletion condition failed to achieve a significant interactive effect on the reaction time or accuracy rate either.

Table No. 2 Regression analysis predicting task two (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

a. Duration condition variable: Normal (-1),Extended (1)
b. Depletion condition variable: Non-depleted (-1), Depletion (1)

DISCUSSION

The purpose of this study was to test the strength model through extending the first task's duration of the sequential task experiment to evoke the ego-depletion effect. Contrary to our hypothesis, results from regression analysis showed that duration did not instigate the ego-

depletion effect. Broadly speaking participants who engaged in the first task for longer did not perform worse on the second task. These findings are inconsistent with the resource depletion approach.

Although Hagger et al's (2010) meta-analysis suggested that task duration was a factor that might have obscured the ego-depletion effect. However, the current study does not support this position. It is therefore inadvisable for future attempts to examine limited-resource to employ duration as being a variable to evoke the ego-depletion effect.

Another possible explanation is that 20 minutes of task engagement is still insufficient to push a participant to the ego-depletion state. We merely assumed that a 20-minute task is capable of triggering ego-depletion whereas 7 minutes of the same task could not. However, it is possible this assumption is incorrect and that an even greater duration is required for participants to reach the ego-depletion state. Decrease in self-control capacity was only observed in Hofmann, Vohs, and Baumeister (2012)'s study after a day's worth of self-control exertion. This suggests that the time needed to exert oneself to a point where ego-depletion is triggered may be longer than just 20 minutes. As such, then the manipulation in this study would have been ineffective and the outcomes do not refute the strength model of self-control.

GENERAL DICUSSION

The strength model's basic premise is acts of self-control require the individual to spend a limited resource, reducing their 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 is able to effectively incite people to exert their self-control and trigger the ego-depletion effect as well.

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 a 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 being skeptical 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. Skepticism 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. 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 performances. 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 offer 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.

Although we used task duration that was substantially longer than that which was 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 the 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.

One shortcoming of the studies 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 the task being performed 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 counteract each other, the accuracy rate and the reaction speed. 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.

The current study has 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 some of the key problems requiring further 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 can reliably push 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, heart rate and muscle tension (Wright, Rex Martin, & Bland, 2003). In addition, self-report measures of effort should also be 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 the 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 performances. Through replication studies across multiple laboratories, we may be able to develop such a procedure by which this conceptual lynchpin 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 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 proposing a rationale for the ego-depletion that are not based on circular logic.

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Conflict of Interest

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