Effect of Ego-Depletion Typing Task on Stroop Does Not Extend to Diverse Online Sample

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One of the most commonly reported effects in ego-depletion research is that ego-depletion worsens performance on the Stroop Task. The present study attempted to replicate the effect of ego-depletion (using a common ego-depletion typing task) on Stroop Task performance in a large, diverse online sample. The results did not yield a significant effect on any measures of accuracy or reaction time on the Stroop Task. One measure (change in reaction time from congruent to incongruent trials) was *marginally significant*, but it was so in the opposite direction predicted by ego-depletion research and reported in other papers. These results suggest that the ego-depletion effect may not yield as robust results in highly motivated online samples as it is with typical undergraduate samples.

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Hundreds of research articles since the late 1990's have reported that strong exertions of self-control decrease one's subsequent ability and/or motivation to exert self-control (Hagger, Wood, Stiff, & Chatzisarantis, 2010). This effect is coined ego-depletion (Baumeister, Bratslavsky, Muraven, & Tice, 1998). *Ego-depletion* is implicated in a wide range of behaviors including emotion regulation (Baumeister et al., 1998; Bruyneel, Dewitte, Franses, & Dekimpe, 2009; Osgood, 2015), prosocial behavior (Osgood & Muraven, 2015; Xu, Begue, & Bushman, 2012), and aggression (Stucke & Baumeister, 2006; Osgood & Muraven, 2016). Initial meta-analyses of ego-depletion reported moderate to large effect-sizes (Hagger et al., 2010). However, more recent investigations suggest that ego-depletion may suffer from a "file-drawer" problem where many null findings have gone unpublished, thus inflating the reliability of ego-depletion (Carter & McCullough, 2014). This concern has intensified by recent failures to replicate some ego-depletion effects in multi-lab pre-registered replication reports (e.g., Hagger et al., 2015). Although, some effects in those reports have successfully replicated (albeit at smaller effect sizes) and some researchers have criticized the methods and analytical procedures used in some of the replications (e.g., Baumeister & Vohs, 2016; Hagger & Chatzisarantis, 2014). An additional concern is that the vast majority of ego-depletion studies have used undergraduate college students. To add to the ongoing discussion about the robustness of ego-depletion, this paper attempted to replicate the effectiveness of a common ego-depletion technique on one of the most common dependent measures of self-control used in ego-depletion research (The Stroop task; Stroop, 1935) in a diverse online sample. Meta-analyses are mixed on the effect of ego-depletion on the Stroop Task. On the one hand, a 2010 meta-analysis reported that ego-depletion greatly decreases performance on the Stroop Task (See Hagger et al., 2010); on the other hand, a more recent meta-analysis suggests only a small, albeit still significant, effect of ego-depletion on the Stroop Task (Carter, Kofler, Forster, & McCullough, 2015).

This study utilized Amazon Mechanical Turk (MTURK.com). MTURK.COM enables researchers recruit participants for online experiments. This form of recruitment offers several advantages. Namely, it allows for a sample that is relatively more representative of the entire population than the undergraduate subject pool, substantially faster data collection, and larger sample sizes. Several recent empirical analyses have concluded that MTURK.COM samples are of comparable or better quality than undergraduate students if care is taken to screen out low-quality participants (Paolacci & Chandler, 2014) and are more representative of the national-population than undergraduate convenience samples (Berinsky, Huber, & Lenz, 2012). Research testing classic psychological effects using MTRUK.COM versus undergraduate students on the same experiments typically report equivalent results (Goodman, Cryder, & Cheema, 2013). Consequently, MTURK.COM has become a popular methodology for collecting data in social-science studies, with over 700 recent articles using MTURK.COM for participant recruitment (Berinsky, Huber, & Lenz, 2012). Because of the diversity in age, ethnicity, and educational background afforded by MTURK.com participant recruiting, it provides an important location to test the generalizability and replicability of a classic ego-depletion effect. Indeed, several ego-depletion studies have already been conducted using MTURK.COM (Chow, Hui, & Lau, 2015; Sevincer, Schlier, & Oettingen, 2015; VanDellen, Shea, Davisson, Koval, & Fitzsimons, 2014). However, given the file-drawer issue and replication failures previously discussed, replicating a stalwart ego-depletion effect in diverse online samples is important.

Methods

Participants and Design

Data collection was conducted online using Inquisit software. 128 participants (54 female; mean age = 33.9, *SD* = 10.2; 41.9% White, 36.6%, South Asian, 9.1% East Asian, 8.4% Black or African American, 3% Native American, .7% other), were recruited through Amazon.com Mechanical Turk (MTURK.COM). A website error caused the data for one participant to become lost. As such, data for 127 participants were completely collected for the experiment. To ensure that only high-quality participants were used, enrollment in the experiment was limited to only those MTURK.COM users who had received at least a 90% approval rate based on a minimum of 50 previously completed tasks on MTURK.COM. Participants were paid $1.00 for their successful completion, as the entire experiment could be completed in 10 minutes or fewer.

Materials

Ego-Depletion Manipulation. Participants were told to retype a paragraph as quickly and accurately as possible. In the experimental (depletion) condition, participants were asked to type the paragraph without using the letter e or the space bar. This requires overriding or inhibiting a well-learned action and is a common ego-depletion technique used in previous studies (e.g., Muraven et al., 2006). Furthermore, ego-depleting typing task manipulations have been used successfully in past ego-depletion research using MTURK. COM participants (Chow, Hui, & Lau, 2015; Sevincer, Schlier, & Oettingen, 2015; VanDellen, Shea, Davisson, Koval, & Fitzsimons, 2014). Participants in the non-depletion control group typed the paragraph exactly as it appeared. The passages were neutral paragraphs about Brazil nuts. Several measures were taken to ensure that participants completed the task correctly. First, both the mouse-cursor and "copy" and "paste" functions were disabled by the experimental website for the duration of the typing task. Second, the participants' retyped passages were recorded by the website and manually reviewed by the experimenter to verify that all participants followed the instructions correctly. Finally, the website recorded the amount of time participants spent working on the task to determine if any participants completed the task too quickly or too slowly.

Stroop Task. All participants then completed a computerized version of the Stroop task (Stroop, 1935) as provided by Millisecond (the creator of Inquisit). For this task, participants were presented with a series of color words which were displayed in various colors. There were three types of stimuli: congruent, incongruent, and control. For congruent stimuli, the font of the word was the same as the semantic meaning (e.g., the word "blue" displayed in blue font). For the incongruent stimuli, the font color of the word was incongruent with the semantic meaning of the word (e.g., the word "red" displayed in blue font). For the control stimuli, participants were exposed to solid color blocks (e.g., green square). Participants were asked to identify the color in which the word is displayed, not the semantic meaning of the word, as quickly as possible by pressing keys on the keyboard that represent each color. Participants performed several practice trials beforehand to ensure that they understood the instructions.

Manipulation Checks and Self-Reports. All participants responded to the following manipulation checks on a 7-point likert scale to verify that the depletion version

of the typing task used more self-control than the non-depletion version: "How much effort did you use on the typing task?" and "How much were you trying to control an impulse on the typing task?" Participants also completed a set of demographic questions at the end of the experiment that asked for their race, age, and sex.

Procedure

Upon arriving at the experiment website, all participants read and provided informed consent. The website then randomly assigned participants to complete either the ego-depletion or no-depletion typing task. Following this, all participants completed the Stroop Task. Finally, all participants completed a brief set of self-report manipulation checks and demographic questions.

Results

Depletion typing task

Participant's responses and completion times on the typing task were each reviewed by the experimenter to verify that the participant completed the typing task fully and correctly. Of the 127 participants for which complete data were collected, 115 (90.6%) completed the typing task completely (retyped the entire paragraphs) and followed the instructions. Of those 115, the non-depletion participants performed the typing task in a mean of 3.1 minutes (SD = 1.6 minutes). Those participants who completed the depletion version of the typing task took a mean of 4.8 minutes (SD = 2.2 minutes). Z-scores were computed for each participant within their condition to screen for extreme outliers (Z < 3 or Z > -3) who completed the task either very quickly or very slowly (suggesting a disengaged participant). No such Z-scores were found.

Manipulation Checks

The manipulation check responses were recoded such that higher numbers indicate more effort/controlling of impulses. Participants who completed the depletion version of the typing task reported exerting significantly more effort on the typing task than those who completed the non-depletion typing task (depletion: M = 5.5, SD = 0.9; non-depletion: M = 4.8, SD = 0.8), t (113) = -4.404, p < .001, d = 0.82. Similarly, participants who completed the depletion version of the typing task reported greater controlling of an impulse than those who completed the non-depletion typing task (depletion: M = 5.2, SD = 1.7; non-depletion: M = 3.3, SD = 1.7), t (113) = -5.798, p < .001, d = 1.1.

Stroop task

Stroop task performance (both accuracy and reaction times) is displayed on table 1. No significant differences were found between those who completed depletion and non-depletion typing tasks. However, the effect of ego-depletion on difference in response time from incongruent to congruent trials was marginally significant but in the opposite direction predicted by ego-depletion theory and prior research (see table 1).

Table 1. *Stroop Task Performance and Reaction Times*

Measure	Depletion Typing	Non-Depletion Typing	Mean Difference	df	t	p	d
1. Percent congruent correct	95.3%	94.1%	-1.3%	113	-.455	.650	-.10
2. Percent incongruent correct	91.0%	88.6%	-2.4%	113	-.872	.385	-.16
3. Percent control correct	95.5%	93.2%	-2.3%	113	-.854	.395	-.16
4. Mean congruent response time	1018ms	978ms	-40.5ms	113	-.549	.584	-.10
5. Mean incongruent response time	1165ms	1205ms	39.5ms	113	.477	.634	.09
6. Mean control response time	1011ms	1001ms	-10.9ms	113	-.149	.882	-.02
7. Congruent minus incongruent response time	-147ms	-227ms	-80.0ms	113	-1.926	.057	-.36
8. Control minus incongruent response time	-154ms	-204ms	-50.4ms	113	-1.093	.277	-.21

Discussion

The purpose of this study was to attempt to replicate a classic ego-depletion effect in a diverse online sample. Overall, this experiment uncovered no significant effects for ego-depletion on the Stroop Task. Although the change in response time from incongruent to congruent trials was marginally significant it was in the opposite direction of what is predicted by ego-depletion theory and commonly reported in other ego-depletion papers. In other words, the ego-depleted participant actually performed better (experienced less of a loss in reaction time from incongruent to congruent trials) than non-depleted participants. This is far from the mean effect size of $d = 0.76$ found in other studies (Hagger et al., 2010). Incidentally, this is the largest mean effect size for ego-depletion reported in the meta-analysis. This null result does not seem attributable to the online participants not taking the typing task seriously as every participant's response to the typing task was individually verified. Furthermore, the typing task produced very large effect-sizes on self-report measures of self-control exertion. Specifically, participants who completed the depletion

version of the typing task reported working significantly harder to control an impulse and found the task much more difficult than those who completed the non-depletion version of the typing task.

Thus, this study failed to replicate a commonly reported ego-depletion effect in a diverse online sample. It would be wrong to interpret this result as suggesting there is no effect of ego-depletion on the Stroop Task. Rather, these results simply recommend caution in generalizing ego-depletion to non-traditional samples. Indeed, one explanation for this could be a ceiling effect as overall accuracy on the Stroop task was very high for both depletion and non-depletion. Careful measures were taken to recruit only high quality participants and MTURK participants may be motivated to do very well out of fear that poor performance could jeopardize their payment (even though the informed consent said otherwise) As such, these results could suggest that the standard Stroop may not be difficult enough to detect ego-depletion effects in highly motivated samples.

Although this study alone certainly does not discredit the effect of ego-depletion on the Stroop Task, it does cast doubt on the generalizability of the ego-depletion effect to highly motivate, diverse online samples. This fits within a larger discussion currently taking place in social psychology about the robustness of ego-depletion. Most notably, prior research suggest that ego-depletion effect may be unique to young adult samples (Dahm et al., 2011). This finding, along with many others emphasizes the importance of reviewing the current field of ego-depletion research to separate the reliable findings from the unreliable ones and develop a solid grounding of the true mechanism and limits of ego-depletion.

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