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# Resource depletion does not influence prospective memory in college students

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## Abstract

This paper reports an experiment designed to investigate the potential influence of prior acts of self-control on subsequent prospective memory performance. College undergraduates ($n$ = 146) performed either a cognitively depleting initial task (e.g., mostly incongruent Stroop task) or a less resource-consuming version of that task (e.g., all congruent Stroop task). Subsequently, participants completed a prospective memory task that required attentionally demanding monitoring processes. The results demonstrated that prior acts of self-control do not impair the ability to execute a future intention in college-aged adults. We conceptually replicated these results in three additional depletion and prospective memory experiments. This research extends a growing number of studies demonstrating the boundary conditions of the resource depletion effect in cognitive tasks.

### Keywords

Prospective memory; Resource depletion; Self-control; Self-regulation; Delay interval; Executive control

## 1. Introduction

An impressive body of social psychology research has demonstrated that exertions of self-control, defined as effortful attempts to override one's automatic or habitual response tendencies (Baumeister & Vohs, 2003), negatively impact a wide range of subsequent behaviors and cognitive tests (see Hagger, Wood, Stiff, & Chatzisarantis, 2010, for a meta-analysis). According to the self-regulatory resource model (Baumeister, Bratslavsky, Muraven, & Tice, 1998), such impairment occurs because exertions of self-control expend cognitive resources and lead to a state of *resource depletion*. In a typical resource depletion paradigm participants perform an initial task that is either high or low in self-control demands, and then they complete a second task that measures self-control. Research has



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**Appendix A. Supplementary material**
Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.concog.2013.08.008.

demonstrated that high self-control demands during the first task result in subsequent self-control decrements such as decreased task persistence (e.g., Baumeister et al., 1998), impaired emotional regulation (Schmeichel, 2007), increased aggression (DeWall, Baumeister, Stillman, & Galliot, 2007), and greater expression of prejudice (Muraven, 2008). The present study sought to extend this line of research to the domain of a laboratory event-based *prospective memory* test to determine if the execution of a delayed intention (i.e., remembering to do something in the future) is susceptible to the consequences of resource depletion, or alternatively, if prospective memory intentions remain unaffected by depletion manipulations.

Influential extensions of the self-regulatory resource model (e.g., Schmeichel, 2007; Schmeichel, Vohs, & Baumeister, 2003) have argued that cognitive tasks utilizing the central executive fall within the domain of self-control and are susceptible to depletion effects. Supporting this view, Inzlicht and Gutsell (2007) found that suppressing emotional reactions to disturbing film clips led to higher Stroop interference, relative to a non-suppression group. Similarly, in a series of experiments, Schmeichel et al. (2003) demonstrated that performing an attentional control task (relative to a less-demanding task) impaired subsequent performance on tests measuring reasoning ability, analytical ability, and reading comprehension. Also, Schmeichel (2007) observed working memory deficits in participants who had previously completed a self-control task. Schmeichel et al. interpreted their findings in terms of the self-regulatory resource model (Baumeister et al., 1998), which argues that a domain-general system is responsible for all acts of self-control. From this perspective, all self-regulatory tasks utilize the same pool of resources regardless of the specific features of the task (e.g., inhibiting an emotional response, resisting temptation, solving difficult word problems).

Boundary conditions to depletion effects have also been observed. For example, Schmeichel et al. (2003) found that the same depletion manipulation that led to performance decrements on reasoning tasks had no depletion effect on tests of crystallized knowledge or a nonsense syllable memorization test. Schmeichel et al. explained the boundary conditions they observed based on assumptions of the self-regulatory resource framework that suggest that complex cognitive tasks, such as those requiring strategic reasoning skills, will be compromised by initial acts of self-control, whereas simpler cognitive tasks, such as those requiring rote memorization, will be less susceptible to the negative effects of resource depletion. In a later study that similarly revealed depletion effects in complex cognitive tasks requiring executive control, Schmeichel (2007) stated that “executive control operates like a limited and depletable resource.” (p. 251) and further argued that his results “lend support to the view that executive control is a unitary capacity insofar as different executive tasks influenced each other across time…” (p. 253; but see Inzlicht & Schmeichel, 2012 for a more nuanced view). By contrast, others have argued that depletion effects may be domain-specific, and consequently, depletion effects will not necessarily be observed across all executive control tasks (Healey, Hasher, & Danilova, 2011; Persson, Weish, Jonides, & Reuter-Lorenz, 2007).

In support of the domain-specific view, recent research suggests that depletion effects may not extend to all measures of self-control, particularly when the measure of self-control is characterized as an executive control task (Brewer, Spillers, McMillan, & Unsworth, 2011; Christiansen, Cole, & Field, 2012; Healey et al., 2011). For example, Brewer et al. (2011) demonstrated that performing an initial executive control task (antisaccade task) did not disrupt performance on any of three subsequent executive control tasks (Stroop task, operation span, and Raven’s Advanced Progressive Matrices). Similarly, Christiansen et al. (2012) found no evidence of significant depletion-related decrements on three aspects of executive function (inhibitory control, phonemic fluency, and delay discounting). Thus, the findings of Brewer et al. and Christiansen et al. suggest that depletion effects will not necessarily be observed on all measures of executive control.

The focus of the present research was to assess the possible effects of resource depletion on prospective memory. Prospective memory, which refers to remembering to perform intended actions at the appropriate time in the future, can require strategic processes that are assumed to place demands on executive control. Craik (1986) noted that remembering to perform future actions was one form of memory that often relies on self-initiated processing. He further characterized self-initiated processing as an effortful, resource-consuming cognitive process that is used to support memory when the present state of the environment (e.g., contextual cues) or internal state of the organism (e.g., being tired) is not conducive to remembering.

The typical laboratory prospective memory paradigm consists of an encoding phase followed by a short, activity-filled delay interval (used to better simulate real-world prospective memory situations and to avoid it becoming a vigilance task) before the intention execution phase (Einstein & McDaniel, 1990). Prior to the delay interval participants receive the prospective memory instructions to respond (e.g., press the ‘Q’ key) if a certain target cue (e.g., the syllable *tor*) appears while they are performing an ongoing task (e.g., a lexical decision task). According to the multiprocess framework, resource-consuming monitoring processes are necessary to detect prospective memory cues when the processing demands of the ongoing task do not direct attention to the prospective memory cue (referred to in the literature as *nonfocal* tasks). For example, a lexical decision task directs individuals to process words and so detecting something other than a word (e.g., the syllable *tor*) embedded in this task requires one to effortfully monitor for the cue. In the present study we will focus on these situations in which prospective memory retrieval is supported by effortful monitoring processes.

The importance of executive control to successful execution of nonfocal prospective memory tasks has been demonstrated in several ways. First, increasing the cognitive demands of the ongoing task (via complexity of ongoing processing or divided attention manipulations) leads to lower prospective memory performance (e.g., Einstein, Smith, McDaniel, & Shaw, 1997; Marsh, Hicks, & Watson, 2002; McDaniel, Robinson-Riegler, & Einstein, 1998; McDaniel & Scullin, 2010). Second, adding a nonfocal prospective memory cue to an ongoing task tends to slow down ongoing task performance, indicating that participants are allocating attentional resources away from the ongoing task and toward the prospective memory task (Einstein et al., 2005; Marsh, Hicks, Cook, Hansen, & Pallos, 2003). Third, in the absence of monitoring, nonfocal prospective memory performance has been shown to approach floor levels (Scullin, McDaniel, & Einstein, 2010; Scullin, McDaniel, Shelton, & Lee, 2010). Fourth, although working memory capacity does not predict performance on a focal prospective memory task, it does predict performance on a nonfocal task (Brewer, Knight, Marsh, & Unsworth, 2010). These complementary pieces of evidence converge on the idea that resource-demanding executive control processes are required for successful nonfocal prospective memory performance.

The present study extended the investigation of resource depletion to a nonfocal prospective memory task. Based on Craik’s (1986) notion of self-initiated processing, the multiprocess framework’s (McDaniel & Einstein, 2007) characterization of strategic monitoring processes for nonfocal prospective memory, and the self-regulatory resource model (Baumeister et al., 1998), one would expect resource depletion to impair performance on the nonfocal prospective memory task. Alternatively, in light of recent findings suggesting that depletion effects do not extend to all measures of executive control (Brewer et al., 2011;

Christiansen et al., 2012; Healey et al., 2011), we considered the possibility that depletion would not influence prospective memory performance in college students.

## 2. Present study

The purpose of this study was to examine whether prospective memory retrieval is susceptible to resource depletion effects; therefore the depletion manipulation took place immediately before the prospective memory retrieval interval. We selected the Stroop task for our depletion manipulation because it represents a standard executive control task (e.g., Miyake, Friedman, Emerson, Wizki, & Howerter, 2000), and the Stroop task has consistently produced significant depletion effects in a variety of self-control tasks (Bray, Ginis, Hicks, & Woodgate, 2008; Gailliot et al., 2007; Mead, Baumeister, Gino, Schweitzer, & Ariely, 2009; Wallace & Baumeister, 2002; Webb & Sheeran, 2003). In addition, a large sample was used to provide high power to detect a depletion effect. There was a .98 probability of detecting a medium-sized effect for prospective memory performance in the present study.

### 2.1. Method

**2.1.1. Participants and design—**A total of 146 participants were randomly assigned to either the depletion ($n$ = 75) or non-depletion ($n$ = 71) delay interval conditions. Participants were Washington University undergraduates who participated for either partial fulfillment of a course credit or for monetary compensation.

**2.1.2. Materials and procedure—**Participants first received instructions for the lexical decision task, which was used to embed the prospective memory targets. They were told that letter strings would appear one at a time on the computer monitor and to decide as quickly and accurately as possible if the letter string formed a word or nonword by pressing the key labeled ‘Y’ or ‘N’ (1 and 2 on the number pad). Participants then completed 20 lexical decision task practice trials and received speed and accuracy feedback.

Participants received the prospective memory instructions following the practice trials. They were told to press the ‘Q’ key whenever they saw a word that contained the syllable ‘tor’ during the lexical decision task. Participants were required to accurately repeat the prospective memory instructions to the experimenter before proceeding. Consistent with typical prospective memory procedures (e.g., Einstein et al., 2005), participants were instructed to perform the prospective memory task but also that their primary objective was to complete the lexical decision task trials as quickly and accurately as possible.

In the present study, depletion was manipulated by varying the type of Stroop task completed during the delay interval. During the Stroop task the words “red”, “blue”, “yellow”, and “green” were presented individually in red, blue, yellow, or green fonts. For each trial, a fixation cross appeared for 450 ms, followed by a word. Participants were instructed to respond as quickly and accurately as possible to the font color of the presented word by pressing the corresponding color-coded key. Participants completed 10 practice trials and received accuracy feedback, and then performed experimental trials for 7 min. In the non-depletion condition, the word and the font color matched on 100% of the trials (i.e., all congruent). All-congruent Stroop tasks are non-depleting because participants perform the task simply by reading the words, or by naming the colors without having to actively inhibit the words. In the depletion condition, word and font color matched on only 20% of the trials (i.e., mostly incongruent). Mostly-incongruent Stroop tasks are depleting because the participant must actively suppress the prepotent, automatic inclination to read the words and instead exert executive control to focus only on naming the font colors. After completing the Stroop task, participants were asked to rate (on a 1–5 scale) how difficult they thought this task was and how tired it made them (with 5 being the highest level of difficulty and tiredness).

Following the Stroop task, participants performed an experimental, lexical decision task block that contained 149 words, 157 nonwords, and 6 prospective memory cues. These cues appeared on trials 51, 102, 153, 204, 255, and 306 within the items tortoise, haptors, tordering, dormitory, gestorly, and tornado.

## 2.2. Results and discussion

**2.2.1. Stroop task—**We examined mean accuracy as well as mean response times for accurate Stroop trials to assess whether the Stroop manipulation created the intended differences in task difficulty. Accuracy rates were comparable in both the depletion condition (*M* = .94, *SD* = .09) and the non-depletion condition (*M* = .95, *SD* = .04), but importantly, as predicted, mean response times on the Stroop task in the depletion condition were slower (*M* = 680 ms; *SD* = 86 ms) than those in the non-depletion condition (*M* = 579 ms, *SD* = 67 ms), $t(144) = 7.95$, $p < .001$, *d* = 1.33, 95% *CI* = [76.02, 126.34]. This demonstrated that the Stroop task was more difficult in the depletion condition than in the non-depletion condition. In addition, participants in the depletion condition rated the Stroop task as more difficult (*M* = 2.56, *SD* = .79) than participants in the non-depletion condition (*M* = 2.11, *SD* = .91), $t(144) = 3.24$, $p = .002$, *d* = .54, 95% *CI*[.18 to .74]. There were, however, no significant differences in tiredness ratings between conditions, $t(144) = .79$, $p = .429$, *d* = .13, 95% *CI* = [−.20, .46].

**2.2.2. Prospective memory performance—**Prospective memory performance was evaluated using both a strict and lenient criterion. The strict criterion only counted Q presses that were made on the actual target trial, whereas the lenient criterion operationalized prospective memory performance as the number of Q presses within three trials of the target trial. A *t*-test was conducted on prospective memory accuracy (proportion correct) with condition (depletion/non-depletion) as the between-participants factor. Using the strict scoring criterion, there was no significant difference in nonfocal prospective memory performance between the depletion condition (*M* = .35, *SD* = .29) and the non-depletion condition (*M* = .35, *SD* = .30), $t$ (144) = .03, $p = .98$, *d* = .004, 95% *CI*[−.10, .10]. Using the liberal criterion, we also observed no differences between the depletion condition (*M* = .46, *SD* = .36) and the non-depletion condition (*M* = .48, *SD* = .38), $t$ (144) = .36, $p = .73$, *d* = .06, 95% CI[−.09, .13].

**2.2.3. Lexical decision task performance—**Lexical decision response accuracy and response times were examined to determine if the depletion manipulation impacted ongoing task performance. Mean reaction time on correct non-prospective memory target trials of the lexical decision task was broken down into sextile segments (50 trials prior to each target trial) to determine if depletion impacted any segment of the task. A 2 (Condition: depletion/non-depletion) × 6 (Segment: sextile) mixed-model ANOVA was conducted to analyze performance. There was a main effect of Segment, $F(5, 720) = 26.27$, $p < .001$, $\gamma^2_p = .154$, which was indicative of a practice effect (faster responses as the task progressed). Segment did not interact with Condition, $F(5, 720) = 1.34$, $p = .25$, $\gamma^2_p = .009$. In addition, there was no main effect of Condition, $F(1, 144) = 1.65$, $p = .20$, $\gamma^2_p = .011$, 95% *CI*[−13.49, 63.69], as overall response times on the lexical decision task were similar in the depletion condition (*M* = 811 ms, *SD* = 121 ms) and the non-depletion condition (*M* = 786 ms, *SD* = 115 ms).

A 2 (Condition: depletion/non-depletion) × 6 (Segment: sextile) mixed-model ANOVA was also conducted to analyze lexical decision accuracy, which was operationalized as proportion correct on non-prospective memory target trials across the segments (sextiles) of the task. The results revealed a main effect of Segment, $F(5, 720) = 21.36$, $p < .001$, $\gamma^2_p$ = .129, reflecting a practice effect (higher accuracy as the task progressed). The Segment variable did not interact with the Condition variable, $F(5, 720) = 1.91$, $p = .09$, $\gamma^2_p = .013$. There was also no main effect of Condition, $F(1, 144) = 1.22$, $p = .27$, $\gamma^2_p = .008$, as accuracy was similar in the depletion ($M = .94$, $SD = .03$) and non-depletion condition ($M = .94$, $SD = .04$), $F(1, 144) = 1.22$, $p = .27$, $\gamma^2_p = .129$, 95% $CI$[−.24, .86].

**2.2.4. Bayesian analysis—**Within traditional null-hypothesis testing, it is not appropriate to equate a lack of significant effects as evidence *for the null hypothesis*. In contrast, Bayesian analyses allow one to directly compute the probability of the null hypothesis being true, given the data, p ($H_0$|D). Accordingly, using the method developed by Wagenmakers (2007; see also Masson, 2011), we used Bayesian information criterion (BIC) values to estimate a Bayes factor (BF) and generate the posterior probability of the null hypothesis, $p_{BIC}$ ($H_0$|D). With prospective memory performance as the dependent measure, using the liberal criterion, BF = 11.54 and $p_{BIC}$ ($H_0$|D) = .92, and with the strict scoring criterion BF = 12.08 and the $p_{BIC}$ ($H_0$|D) = .92. In other words, given our data, there is a 92% posterior probability of the null hypothesis (i.e., depletion does not impact prospective memory), and this constitutes *positive support* for the null hypothesis, following the conventions developed by Raftery (1995). Similarly, for the lexical decision task, both accuracy (BF = 7.97, $p_{BIC}$ ($H_0$|D) = .89) and response time data (BF = 5.43, $p_{BIC}$ ($H_0$|D) = .85) provided positive support for the null hypothesis. These data support the view that the depletion manipulation had no effect on lexical decision or prospective memory task performance.

## 3. Additional experiments

We conducted three additional experiments to ensure that depletion effects would not be observed in nonfocal prospective memory tasks, and details of these experiments are presented in the Supplementary materials. A brief summary will be provided here and relevant descriptive statistics are presented in Table 1. In Supplementary Experiment 1, we increased the demands of the depletion task by having participants in the depletion condition perform an odd digit detection task concomitant with the mostly incongruent Stroop task (non-depletion condition consisted of the mostly congruent Stroop task while only listening to digits). In addition, 12 nonfocal prospective memory target events were used in an effort to encourage more strategic monitoring and, therefore, increase the likelihood of observing depletion effects. In Supplementary Experiment 2, we used the counting squares task (Garavan, Ross, Li, & Stein, 2000) as the depletion manipulation, along with the 12-target nonfocal prospective memory task. The counting squares task required participants to keep a running count of both the small and large squares presented during each trial. There were multiple switches between small and large squares in the depletion condition, while only one switch occurred in the non-depletion condition. In Supplementary Experiment 3, we used a crossing out letters task (also referred to as rule-following task) as the depletion task (modeled after Baumeister et al., 1998) because it has been demonstrated to be a particularly potent depletion manipulation (Hagger et al., 2010). In the control version of this task participants were told to cross out all instances of the letter e on a piece of paper, whereas participants in the depletion condition were given extra rules regarding which instances of *e* should be crossed out on the paper. In addition, the depletion manipulation took place immediately before prospective memory encoding (rather than after the intention was encoded as in the other experiments) to ensure that depletion did not hinder one's ability to encode the intention. No hint of a depletion effect was observed in any of the additional experiments despite using a variety of depletion manipulations and attempting to increase the amount of effort exerted on the prospective memory task.

## 4. General discussion

The results of the present study suggest that prior acts of self-control do not impair the ability to execute a subsequent prospective memory intention. The three additional experiments presented in the Supplementary materials all converged with this conclusion. The inability to detect depletion effects in prospective memory across the four experiments occurred despite using several different resource depletion manipulations, strategically placing the depletion task prior to both the encoding and retrieval phases of the prospective memory task, and using undergraduate samples taken from different universities. These results were somewhat unexpected from a theoretical perspective (Baumeister et al., 1998; Schmeichel, 2007); however, they dovetail nicely with recent research that suggests prior acts of self-control do not disrupt subsequent performance on all measures of executive control (Brewer et al., 2011; Christiansen et al., 2012; Healey et al., 2011). We next consider how the present results inform theories of resource depletion.

### 4.1. Theoretical considerations

According to the self-regulatory resource model, all acts of self-control, including cognitive exertions, drain a limited pool of resources, thereby hindering all subsequent acts of self-control (Baumeister et al., 1998). A variety of cognitive activities, including those involving analytical reasoning (Schmeichel et al., 2003) and working memory (Schmeichel, 2007) have demonstrated susceptibility to the negative consequences of resource depletion. In contrast, cognitive tasks requiring the retrieval of crystallized knowledge (Schmeichel et al., 2003) or rote memorization (Schmeichel, 2007; Schmeichel et al., 2003) are relatively unaffected by prior acts of self-control. Schmeichel et al. (2003) argued that tasks involving executive control are vulnerable to depletion effects, and tasks with minimal central executive involvement are relatively unaffected by depletion. Contrary to this prediction, depletion effects have not been observed in a number of tasks requiring executive control (Brewer et al., 2011; Christiansen et al., 2012; Healey et al., 2011). The present study provides new evidence that nonfocal prospective memory is seemingly impervious to resource depletion (at least under typical laboratory prospective memory conditions, such as those studied in the current report; cf. Li, Nie, Zeng, Huntoon, & Smith, 2013), even though nonfocal prospective memory tasks are widely believed to rely on executive control (e.g., Burgess, Scott, & Frith, 2003; Einstein & McDaniel, 2005; Marsh, Hicks, & Hancock, 2000; Meier & Graf, 2000; Scullin et al., 2010; Smith, Hunt, McVay, & McConnell, 2007).

One potential limitation of the present study is that the participants in the depletion condition did not subjectively report feeling more tired than participants in the non-depletion condition. The degree to which participants subjectively feel that the depletion task was tiring or difficult sometimes moderates the degree of the depletion effect (Hagger et al., 2010). Many studies, however, do not assess fatigue, and past research has revealed significant depletion effects despite having no differences in subjective fatigue (Segerstrom & Nes, 2007). Furthermore, Baumeister, Schmeichel, and Vohs (2007) stated that,

> " …sometimes depleted people rate themselves as more tired than other participants, but this effect has only been found in some studies and with some measures. It is possible that depletion is felt as tiredness only when it reaches a certain threshold even though its effect on behavior appears well before that." (p. 527)

Another worthwhile consideration is that the nonfocal prospective memory task and executive control tasks typically used in depletion paradigms (e.g., Stroop) may differ on a neurophysiological level. Whereas executive control tasks such as the Stroop task show heavy reliance on the dorsal lateral prefrontal cortex (Brodmann Area 46), the anterior prefrontal cortex supports prospective memory monitoring (Brodmann Area 10; Burgess et al., 2003; McDaniel, LaMontagne, Beck, Scullin, & Braver, 2013). Reynolds, West, and Braver (2009) supported this neurophysiological distinction by observing a qualitative distinction between the regions activated for *n*-back working memory performance (dorsal lateral prefrontal cortex) versus nonfocal prospective memory performance (anterior prefrontal cortex). Though some theoretical reasoning has posited that resource depletion will affect *any* executive control task, an emerging view is that depletion effects are only observed when the task used to deplete cognitive resources and the dependent measure utilizes overlapping brain regions (Persson et al., 2007). Consistent with this view, Healey et al. (2011) provided behavioral evidence suggesting that the prior-task effects on working memory are not due to resource depletion, per se, but they result from interference when the prior task involves similar stimuli to the working memory task. This theoretical analysis may help explain the key finding in the current study that depletion manipulations consistently produced no impairment on a task known to rely on resource-demanding executive control processes. Thus, depletion effects may vary widely, even among tasks typically classified as executive control tasks.

It is also possible that depletion effects are simply not present in many cognitive tasks. The notion that all acts of self-control (i.e., cognitive, emotional, etc.) will inevitably drain a limited pool of resources is likely oversimplifying the matter. Some research has suggested that individual difference factors could moderate depletion effects (see Hagger et al., 2010, for a review of some of these factors). Recently, Inzlicht and Schmeichel (2012) proposed an updated perspective on resource depletion effects that centers on the processes that are responsible for depletion effects. They argue that depletion effects could stem from motivational and attentional factors rather than simply reflecting resource limitations. From this perspective, it is possible that depletion effects are not observed in cognitive tasks, such as nonfocal prospective memory, because participants are either motivated to perform well on this particular cognitive task or the task requirements recruit attention in a manner that helps to protect against depletion effects. More research is needed to test the prediction that individual difference factors, such as motivation and attention, moderate depletion effects, particularly in cognitive tasks.

### 4.2. Methodological considerations

The issue of depletion effects in prospective memory also holds importance for prospective memory methodology. Research has demonstrated that the characteristics of the delay interval, such as the length of the filler task and the number of filler tasks completed, could produce unintended effects on later prospective remembering (Martin, Brown, & Hicks, 2011; also see Hicks, Marsh, & Russell, 2000). The present study investigated how the type of task completed during the delay interval of a prospective memory paradigm may impact subsequent performance (cf. Martin et al., 2011). In addition to length of delay interval and number of tasks completed, another potentially important factor might be the *type* of task performed during the delay interval. In many cases, the filler task chosen for this delay interval is arbitrary; researchers have used vocabulary tests (Einstein et al., 2005), fluid intelligence tests (Scullin et al., 2010), working memory span tests (Scullin & McDaniel, 2010), conscientiousness tests (Kelemen, Weinberg, Alford, Mulvey, & Kaeochinda, 2006), puzzles (Marsh et al., 2003), retrospective memory tasks (Einstein, Holland, McDaniel, & Guynn, 1992), and cartoon ratings (Hicks et al., 2000), to name just a few (see Martin et al., 2011, for review). Based on the resource-depletion literature, carry-over effects from the filler task to the subsequent prospective memory task might have seemed possible. Yet, the results from the present study suggest that the cognitive demand of the filler task may have no bearing on an individual’s ability to execute subsequent intentions, at least in younger adults.

For older adults, however, the filler task might have some influence on prospective memory performance. Shelton et al. (2011) used the same methodology as was used in the current research and demonstrated that initial engagement in a mostly incongruent Stroop task did, in fact, impair subsequent nonfocal prospective remembering in old-old adults (aged 72 and above); however, no depletion effects were observed in the young-old (aged 60-71). This contrast is important because it suggests that, in studies comparing prospective memory performance of younger and older adults, placing a cognitively draining task in the delay interval may impair older but not younger (or young-old) adults, thus exaggerating any true differences between the groups. Shelton et al.'s (2011) finding, along with the results of the present study, are suggestive of another boundary condition for depletion effects; that is, no influence of depletion on prospective memory (except for old-old adults).

## 5. Conclusions and future directions

The purpose of the present research was to evaluate whether prior resource depletion would affect performance on a subsequent nonfocal prospective memory task. In the present study, as well as in Supplementary Experiments 1–3, we consistently observed that nonfocal prospective memory performance was immune to depletion manipulations. There may exist some optimal set of experimental circumstances in which one might observe depletion effects in a prospective memory paradigm (e.g., Shelton et al., 2011, demonstration with old-old adults), but those circumstances do not follow clearly from the literature on depletion effects or from prominent theories (e.g., self-regulatory resource model) that suggest that depletion should affect all executive control processes. The results of this study, along with recent findings (Brewer et al., 2011; Christianson et al., 2012) demonstrated important boundary conditions for the depletion literature and suggests that some theoretical refinement is necessary for predicting when depletion will affect cognitive performance.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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**Table 1**

Means and standard deviations of prospective memory by condition in Supplementary Experiments.

| | **Depletion** ***M*** **(*SD*)** | **Non-depletion** ***M*** **(*SD*)** |
|---|---|---|
| Supp. Experiment 1 | .56 (38) | .55 (36) |
| Supp. Experiment 2 | .64 (27) | .69 (29) |
| Supp. Experiment 3 | .56 (.46) | .44 (.32) |

*Note*: Means and standard deviations of proportion correct on prospective memory task using the lenient scoring criterion; Supp. = Supplementary.