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When Perception Is More Than Reality: The Effects of Perceived Versus Actual Resource Depletion on Self-Regulatory Behavior

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Considerable research demonstrates that the depletion of self-regulatory resources impairs performance on subsequent tasks that demand these resources. The current research sought to assess the impact of perceived resource depletion on subsequent task performance at both high and low levels of actual depletion. The authors manipulated perceived resource depletion by having participants 1st complete a depleting or nondepleting task before being presented with feedback that did or did not provide a situational attribution for their internal state. Participants then persisted at a problem-solving task (Experiments 1–2), completed an attention-regulation task (Experiment 3), or responded to a persuasive message (Experiment 4). The findings consistently demonstrated that individuals who perceived themselves as less (vs. more) depleted, whether high or low in actual depletion, were more successful at subsequent self-regulation. Thus, perceived regulatory depletion can impact subsequent task performance—and this impact can be independent of one's actual state of depletion.

Keywords: self-regulation, ego depletion, metacognition, perception

Research within the area of self-regulation has argued that the amount of cognitive resources available to exert control over regulatory processes is limited (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Muraven, Tice, & Baumeister, 1998). The premise of this self-regulation as strength hypothesis is that any initial act of self-control depletes the resources needed to engage in subsequent self-regulatory behaviors, and work in this area has repeatedly demonstrated that the depletion of these resources impairs performance on subsequent tasks (for recent reviews, see Baumeister, 2002; Baumeister, Vohs, & Tice, 2007; Schmeichel & Baumeister, 2004). Consequently, this perspective contends that any exertion of conscious self-regulation carries a cost. That is, although an initial act of self-control might promote successful regulation of the current behavior (e.g., managing a favorable impression while on a morning job interview), it will be at the expense of the success of any follow-up regulatory attempts (e.g., avoiding dessert at lunch to maintain a diet), because the resources necessary to maintain regulatory control have been depleted by the initial act of self-regulation.

Since the time of the seminal ego-depletion papers of the late 1990s, this notion of depletable self-regulatory resources has been applied to a wide variety of phenomena, including social exclusion (e.g., Baumeister, DeWall, Ciarocco, & Twenge, 2005), interracial interactions and stereotype suppression (e.g., Richeson & Trawalter, 2005), impression management (e.g., Vohs, Baumeister, & Ciarocco, 2005), aggression (e.g., Stucke & Baumeister, 2006), thoughtful responding (e.g., Schmeichel, Vohs, & Baumeister, 2003), decision making (e.g., Vohs et al., 2008), and attitude change (e.g., Wheeler, Briñol, & Hermann, 2007). The concept is clearly pervasive, and its ubiquity demonstrates that much of what is termed "controlled" processing seems to require access to a limited reserve of cognitive resources—resources that are highly susceptible to depletion.

Recently, work within this domain has focused on parsing out the impact of motivation on the effects of depletion. Work by Muraven and colleagues has demonstrated that, even when depleted, individuals can still perform as well as nondepleted individuals on subsequent tasks when sufficiently motivated (e.g., Muraven, Shmueli, & Burkley, 2006; Muraven & Slessareva, 2003). The crux of this argument is that depleted individuals, though sufficiently depleted to undermine future self-regulation, are oftentimes not entirely exhausted of their mental resources (see Baumeister, 2002, for further discussion of this issue). In spite of their depleted state, then, individuals who are mentally exhausted still have cognitive resources available to access for future self-regulation. Increasing motivation is apparently one method by which those resources can be accessed, and future self-regulatory failure can be mitigated.

Perceived Versus Actual Depletion

The question motivating the present research is to what extent the findings afforded by this perspective in the self-regulation literature can be driven by the perception of depletion alone. To our knowledge, the role of people's perceptions of the availability of their mental resources—independent of actual levels of resource availability—has not been explicitly addressed in this domain.

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However, we think understanding the ways in which these subjective perceptions operate in self-regulatory situations offers novel ways to think about the resource depletion approach to self-control.

Consider two students both leaving a study session. One of the individuals feels mentally exhausted, the other feels mentally refreshed, and both are immediately confronted with a persuasive message in the form of a flyer from a political group on their campus. Assuming their actual levels of depletion are the same, might their perceptions of their mental exhaustion dictate how thoughtfully they respond to the persuasive appeal? Or perhaps on their drive home they are confronted with an aggressive driver in heavy traffic. Again, might their perceptions of their mental exhaustion dictate the restraint each exhibits toward the aggressive driver? If so, we believe the distinction between perceived and actual depletion offers a compelling and important layer to the self-regulation as strength perspective by defining strength in terms of not only actual ability to regulate behavior but perceived ability as well.

The Prevalence of Perception

Our hypothesis that perceptions of depletion are an important component of resource depletion builds upon similar distinctions made between perceptual and actual components of other social psychological phenomena. Research on information processing, for instance, has demonstrated that the mere perception of thoughtful processing can influence the strength of resulting judgments, even when equating for actual thought (Barden & Petty, 2008). Research on attitudinal ambivalence has also demonstrated that people can subjectively report feeling mentally conflicted at varying levels of objective ambivalence (Priester & Petty, 1996). In the domain of relationships as well, researchers have noted that, in terms of equity, people's perceptions of the amount of resources they invest into a relationship can be more predictive of relationship health than can the actual amount of resources people invest (Grote & Clark, 2001). Similarly, classic research on arousal indicates that people's subjective interpretation of their arousal is more important in predicting subsequent behavior than is their actual internal state (e.g., Dutton & Aron, 1974; Schachter & Singer, 1962).

Furthermore, at a broader level, the importance of perception is further highlighted in the recent surge of interest in the role of metacognition in people's judgments (see Petty, Briñol, Tormala, & Wegener, 2007, for a review). *Metacognition* is defined as people's thoughts about their thoughts, or a secondary cognition based on a primary cognition. For instance, although an individual may not like a new restaurant (primary cognition), that same individual might be uncertain about that unfavorable evaluation (secondary cognition), perhaps because the person has frequented the restaurant only once or ordered a new dish for the first time. Interestingly, a considerable amount of this work centers on the prediction of people's judgments and behavior on the basis of different metacognitive perceptions of the same objective experience (e.g., Schwarz et al., 1991; Tormala & Petty, 2002; Yzerbyt, Schadron, Levens, & Rocher, 1994).

Tormala, Clarkson, and Petty (2006), for instance, presented all participants with a counterattitudinal persuasive message. Following the message, they asked participants to generate as many thoughts as possible against the persuasive message. They then randomly assigned participants to receive either positive or negative [false] feedback regarding the strength of the counterarguments they generated against the persuasive appeal. Interestingly, they found that individuals across conditions resisted the message to the same degree (i.e., held equivalent postmessage attitudes) as well as generated counterarguments of equivalent number and strength. However, in spite of generating equivalent responses to the persuasive message, those individuals who perceived that they generated weak counterarguments reported less certainty in their attitudes and less attitude–behavioral intention correspondence than did individuals who perceived that they generated strong counterarguments. Thus, the mere perception of counterargument strength, independent of actual content, impacted people's attitudes and, most importantly, their resulting correspondence with behavior.

A Resource Attribution Hypothesis

In the Tormala et al. (2006) work, the mere perception of people's actions (i.e., their counterargument strength) impacted their resulting judgments and behavior in spite of the same objective experience. Might the same be true of perceived versus actual depletion? That is, might the perception of depletion impact resulting self-regulatory performance, independent of people's actual resource availability? The current research sought to address this question by assessing the role of perceived resource depletion on subsequent task performance at both high and low levels of actual depletion.

To manipulate the perception of depletion, we borrowed a paradigm from attribution research (e.g., Allen, Kenrick, Linder, & McCall, 1989; Dutton & Aron, 1974; Fried & Aronson, 1995; Schwarz et al., 1991). Specifically, we provided depleted and nondepleted people with external information (feedback) that either did or did not provide a situational attribution for their actual availability of mental resources. Within this paradigm, we anticipated obtaining any of three different outcomes. First, it could be the case that perceptions are influenced entirely by one's state of actual depletion (and our feedback manipulation has no effect), resulting in only a main effect of actual depletion. Second, given that people often look to situational cues to inform or explain their internal states (cf. M. Ross, 1989), individuals provided with a situational attribution for their state of depletion might perceive themselves as less depleted and, in turn, perform better on subsequent tests of self-regulation. That is, it could be that perceptions of depletion are entirely derived from the feedback manipulation and are independent of one's actual state of depletion. If this were the case, we might observe only a main effect for our feedback manipulation. However, it is our contention that, as a third possibility, perceptions of depletion depend on both one's actual state of depletion and the situational attribution information provided. Thus, we predicted an interaction between actual depletion state and the feedback manipulation. Interestingly, there are two possibilities regarding the form that this interaction could take.

It may well be the case that altering the perceptions of highly depleted individuals—that is, those who lack the resources to engage in subsequent self-regulation—would not allow such individuals to act as though they were nondepleted. A car without fuel will not start, for instance, regardless of one's perception of the

amount of fuel in the tank. Indeed, the current state of the literature on mental depletion would suggest that, in the absence of increased motivation or blood sugar (e.g., Gailliot et al., 2007; Muraven & Slessareva, 2003; Wan, Rucker, Tormala, & Clarkson, in press), we should see no differences in the self-regulatory performance of highly depleted individuals, regardless of the subjective perception of their mental resources. Thus, we might simply expect that situational attribution information will affect perceptions of one's mental resources and subsequent self-regulation only under low levels of depletion.

Although this is plausible, we ultimately find this hypothesis less than compelling given the robust effects of metacognitive perceptions on judgments and behavior reviewed earlier. Furthermore, individuals who are highly depleted, though relatively exhausted of mental resources, often still have mental resources available to successfully engage in subsequent regulatory behaviors (see Baumeister, 2002, for further discussion of this issue). As noted, even when depleted, individuals can still perform as well as nondepleted individuals on subsequent tasks—for instance, when sufficiently motivated (Muraven & Slessareva, 2003) or when actively monitoring their resources (Wan & Sternthal, 2008). Thus, we expected that even when individuals are under high levels of depletion, situational attribution information would affect their perceptions of their mental resources and therefore affect their subsequent self-regulatory performance.

In contrast, then, we propose a resource attribution hypothesis, which argues that the informational value of our situational feedback will differ depending on whether individuals are in a state of low or high depletion. That is, the same situational cue might induce different attribution processes depending on one's actual state of depletion. For instance, consider an individual who is informed by some situational cue that a facet of the current task has been shown to deplete people's mental resources. Attribution research has shown that if the person is in a state of high depletion, he or she will look to social cues to explain their internal state. Indeed, the work of Schwarz and colleagues (Clore, Schwarz, & Conway, 1994; Schwarz et al., 1991; Schwarz & Clore, 1983) has demonstrated that people often attribute concrete internal feelings (e.g., mood, perceptual fluency) to external causes. Schwarz and Clore (1983), for instance, found that mood is profoundly influenced by ambient weather conditions. That is, people use weather conditions to explain their current mood. As a result, individuals questioned on sunny days report a higher level of current life satisfaction than do those questioned on rainy days. This research offers one example of people seeking out information from the social situation to explain their tangible internal experiences—in this case, their current mood. We would expect, on the basis of this work, that high depletion participants who are told that a situational cue causes feelings of mental exhaustion would report reduced perceptions of depletion, given that the situational cue provides an explanation for their tangible state of resource availability.

However, we believe that if an individual is in a state of low depletion, then the role of the situational cue changes, because the state of high depletion is arguably a more tangible/less ambiguous subjective experience than is the state of low depletion.[1] If this individual is not actually depleted by the task (low depletion condition), then the person might still feel some ambiguity about his or her current state. Under these conditions, we might anticipate that if such participants were told that a situational cue causes feelings of mental exhaustion, then they would report elevated perceptions of depletion, given that the situational cue offers an interpretation of one's ambiguous state of resource availability. Indeed, attribution research has consistently shown that when people experience an ambiguous state, they look to social cues to interpret their state, often by engaging in a biased memory search to identify evidence consistent with the situational feedback (e.g., Anderson, Lepper, & Ross, 1980; Jennings, Lepper, & Ross, 1981; Lepper, Ross, & Lau, 1986; L. Ross, Lepper, & Hubbard, 1975). L. Ross et al. (1975), for instance, had participants complete several trials in which they had to decide which of two suicide notes was real (vs. fictitious). The experimenter then provided these participants with random feedback that they succeeded or failed at this task. Interestingly, in spite of the randomness of the feedback provided by the experimenter, participants used the experimenter's feedback to define their level of accuracy (which for experimental purposes was left intentionally ambiguous). Furthermore, this feedback was internalized to such an extent that even after the experimenter debriefed participants on the arbitrary nature—and thus uselessness—of the feedback, participants continued to use the situational feedback provided in the study to predict their level of accuracy on future tasks.

Thus, we hypothesize that the same situational cue will induce different perceptions of depletion in individuals through different processes, with the exact perception elicited by the situational cue dependent on the specific state of depletion. Additionally, we anticipate that, as occurs when increasing task importance (Muraven & Slessareva, 2003) or actively monitoring resources (Wan & Sternthal, 2008), varying these perceptions of depletion will impact participants' ability to self-regulate on subsequent tasks (see Table 1 for complete predictions for the resource attribution hypothesis).

Overview of the Present Research

The primary objective of the present research is to assess the impact of perceived resource depletion on subsequent task performance at both high and low levels of actual depletion. As noted, our manipulation of perceived resource depletion consisted of two phases. First, participants completed an initial task shown by previous research to differentially deplete individuals' cognitive resources. Second, participants were presented with (false) feedback informing them that a specific aspect of the initial task—specifically, the color tone of the paper upon which it was completed—has been shown in other research to either replenish or exhaust one's mental resources/abilities. To assess the consequences of these perceptions for subsequent self-regulation performance, we exposed participants to a problem-solving task (Ex-

[1] In support of this claim, Hirt and Clarkson (2009) showed indirect evidence that people view the state of low (vs. high) depletion as more ambiguous. Following a thought suppression task intended to differentially deplete participants' mental resources (see Muraven et al., 1998, Study 2), participants reported how confident they were of their current level of mental energy. Results revealed that depleted individuals were significantly more confident of their current mental energy than were nondepleted individuals, $t(24) = 2.08$, $p < .05$.

Table 1
Hypothesized Effects of Depletion and Situational Feedback on Perceptions of Depletion and Subsequent Self-Regulatory Performance for Experiments 1–4

	Low depletion		High depletion	
Prediction	Depleted feedback	Replenished feedback	Depleted feedback	Replenished feedback
Perceptions of depletion	High	Low	Low	High
Impact on subsequent self-regulatory performance	Negative	Positive	Positive	Negative

periments 1 and 2), an attention-regulation task (Experiment 3), or a persuasive message (Experiment 4).

Experiment 1

Experiment 1 sought to address the impact of the subjective perception of one's actual mental resource availability on subsequent self-regulatory behavior. To test this possibility, we presented participants with a task shown in prior research to differentially deplete self-regulatory resources. That is, we used a classic manipulation of self-regulatory depletion to vary the actual amount of cognitive resources available to participants. We then provided participants with feedback intended to match or mismatch their current state of mental depletion. Specifically, participants were told that aspects of the depletion task have been shown to mentally deplete or mentally replenish their self-regulatory resources. Finally, participants were presented with a subsequent self-regulatory activity—a problem-solving task—and persistence on the problem-solving task was our index of subsequent self-regulation (e.g., Baumeister et al., 1998; Muraven et al., 1998; Vohs et al., 2008).

We expected that, consistent with the resource attribution hypothesis, the feedback would affect individuals in the low and high depletion states differently. Specifically, participants in the low depletion condition were expected to use our feedback to interpret their amount of available mental resources and, consequently, to persist longer on our problem-solving task when given the replenished (vs. depleted) feedback. Conversely, participants in the high depletion condition were expected to use our feedback to explain their amount of available mental resources and, consequently, to persist longer on our problem-solving task when given the depleted (vs. replenished) feedback.

Additionally, to assess the degree to which our manipulations would impact subsequent self-regulatory performance, we included two control conditions. In these conditions, participants received only the high or low depletion manipulation. That is, participants in the control conditions did not receive our feedback manipulation. The inclusion of these conditions allowed us to compare the magnitude of any potential effects of perceived mental resource availability to the effects of actual mental resource availability.

Method

Participants. Ninety-six undergraduates at Indiana University participated in partial fulfillment of an introductory psychology course requirement. Each participant was randomly assigned to one of six conditions in a 2 (depletion: high vs. low) × 3 (feedback: depleted vs. replenished vs. control/no feedback) between-participants design.

Procedure. All participants were welcomed into the lab by an experimenter and seated at individual computer stations to complete the study. They were told that the research goals of the study were twofold—to gather student assessments of perceptual accuracy as well as to assess actual student performance on a problem-solving task—and that they would be participating in a variety of activities to achieve these goals.

After receiving these instructions, participants were told that they would be participating in a letter recognition task ostensibly designed to assess perceptual accuracy. In reality, this task served as a cover story for our manipulation of people's mental resource availability (see the Depletion Manipulation section).

Immediately following the letter recognition task, participants received feedback about the effect of the task on their mental resources—specifically, that facets of the task (e.g., the light yellow paper used in both tasks) have been shown to either deplete or replenish people's mental abilities (see the Feedback Manipulation section). Following this feedback, participants proceeded to the final activity.

The final activity of the experiment, ostensibly an assessment of problem-solving abilities, consisted of a multiple-solution anagram. Specifically, participants were told that they would be presented with seven letters to unscramble to form "real, English" words. They were instructed that the words had to be at least three letters long, that no letter could be used twice in a single word, and that they could generate as many words as possible. Importantly, it was made clear to participants that there was no time limit for the task—they were even encouraged to take as much time as needed, because their problem-solving ability would be judged on the number of correct words generated. Finally, they were instructed to press the Escape key, which would end the task, when they could no longer generate solutions.

Participants were then presented with the anagram (i.e., U R A E O C G) on their computer screens and allowed to spend as much time as needed to input as many words as possible in boxes that appeared at the bottom of the screen. The computer recorded the amount of time participants spent on the task. As was done in previous depletion research, we interpreted the amount of time spent generating solutions to the anagram as an assessment of task persistence, with greater reaction times indicating greater persistence and thus greater self-regulation (e.g., Baumeister et al., 1998; Vohs et al., 2008).

Independent variables.

Depletion manipulation. Participants were randomly assigned to a high or low depletion condition. At each computer station,

participants were provided with a packet labeled *Perceptual Accuracy Task*. The packet consisted of two unrelated pages of text from a graduate-level statistics textbook, one labeled *Task 1* and the other *Task 2*. Important for our feedback manipulation, both pages were copied onto light yellow paper. After hearing a brief explanation about the packet, participants were asked to proceed to the first task.

For the first task, all participants were given the following instructions:

> You have been provided a packet. Inside that packet is a sheet of paper labeled 'TASK 1.' Starting at the beginning, your task is to cross out every 'e' you can locate in the text on the sheet. When you come across an 'e', simply draw a line through it. You will have five minutes to work on this task, and you will be judged on accuracy and completeness . . . click 'continue' to begin.

After the 5 min had elapsed, participants were instructed by computer to stop and proceed to the next task.

For the second task, we varied the instruction set. Specifically, individuals randomly assigned to the low depletion condition were instructed to edit the new page of text according to the same rules as in the first task. That is, their instructions for the second task were essentially identical to those for the first task with the exception of referencing Task 2 instead of Task 1. Individuals randomly assigned to the high depletion condition were instructed to complete the second letter-recognition task according to a different set of rules. This new set of rules was designed to force participants to override the habitual response patterned in the first task and thus require the exertion of additional self-regulatory resources. More specifically, participants in the high depletion condition were given the following instructions:

> Inside the provided packet is another sheet of paper labeled 'TASK 2.' Starting at the beginning, your task is to cross out every 'e' you can locate in the passage, except when another vowel follows the 'e' in the same word (e.g., 'read') or when a vowel is one letter removed from the 'e' in either direction (e.g., 'vowel'). When you come across an 'e' that does not fit these exceptions, simply draw a line through it. You will have five minutes to work on this task, and you will be judged on accuracy and completeness . . . click 'continue' to begin.

Furthermore, we enhanced participants' need to exert self-regulatory resources in the high depletion condition by giving them a faded copy of the statistics text. This task has been shown in previous research to successfully vary the depletion of self-regulatory resources (e.g., Baumeister et al., 1998; Wheeler et al., 2007).

Importantly, we included two control conditions in this experiment. Participants in these conditions were exposed to only the depletion manipulation. That is, they did not receive any feedback about the supposed effects of task on their mental abilities. Instead, they received either the low or high depletion manipulation prior to completing the multiple-solution anagram.

Feedback manipulation. At the beginning of the experiment, participants were randomly assigned to one of three feedback conditions—the depleted condition, the replenished condition, or a control condition in which no feedback was presented. This manipulation was adapted from similar manipulations used in previous misattribution research (e.g., Allen et al., 1989; Dutton & Aron, 1974; Fried & Aronson, 1995; Schwarz et al., 1991).

Once participants completed the letter-recognition task, a message informing the participants of some important information regarding the letter-recognition task immediately appeared on the computer screen. Participants assigned to receive feedback were all told the following:

> The letter recognition task you just completed is adapted from a classic paper in cognitive psychology on perceptual accuracy (see Sharp & Hutchinson, 1974). For various reasons, these researchers used the specific color yellow as the background for their letter recognition task. In keeping to their original methods, we too have used the same color of paper . . .

Participants were then given feedback informing them of the effects of this color on people's mental abilities.

In the depleted feedback condition, participants were led to believe that that particular color depletes mental resources. Specifically, participants were told the following:

> Recent research in color perception (e.g., Rutherford et al., 2003) shows very clearly that this color tone can have very *negative effects* on people's mental abilities, in particular when this hue is used as a background—as it is in our letter recognition task. Specifically, this color tone has been shown to *exhaust and deplete* one's ability to attend to information. In short, research shows that using this color tone as a background *mentally exhausts* our abilities to think carefully. [emphasis added to indicate manipulated words]

In the replenished feedback condition, participants were led to believe that that particular color replenishes mental resources. Specifically, participants were told the following:

> Recent research in color perception (e.g., Rutherford et al., 2003) shows very clearly that this color tone can have very *positive effects* on people's mental abilities, in particular when this hue is used as a background—as it is in our letter recognition task. Specifically, this color tone has been shown to *energize and replenish* one's ability to attend to information. In short, research shows that using this color tone as a background *mentally replenishes* our abilities to think carefully. [emphasis added to indicate manipulated words]

Following the feedback manipulation (or the depletion manipulation in the case of the controls), participants proceeded directly to the anagram task.

Results

Because the persistence data were highly skewed, we first performed a square root transformation on the persistence scores before submitting them to analysis. Transformed means for all conditions are listed in Table 2.

Preliminary analysis. First, we wanted to establish that our depletion manipulation was successful. A t test examining the persistence scores in just the two (low and high depletion) control conditions revealed a nice replication of past research: Individuals in the low depletion condition persisted significantly longer on the multiple-solution anagram than did individuals in the high depletion condition, $t(30) = 2.20$, $p < .04$.

Main analysis. We then submitted the persistence scores to a two-way analysis of variance (ANOVA), with depletion (high vs. low) and feedback (depleted vs. replenished) as the independent variables. Neither of the main effects were significant (all Fs < 1).

Table 2
Persistence on the Multiple-Solution Anagram as a Function of Depletion and Situational Feedback in Experiment 1

	Low depletion			High depletion		
Persistence	Depleted feedback	Replenished feedback	No feedback	Depleted feedback	Replenished feedback	No feedback
M	125.54_a	217.95_b	260.93_b	243.33_b	137.38_a	151.07_a
SD	47.70	134.41	186.48	156.78	63.79	70.62

Note. Data are measured in seconds. Means with the same subscript do not differ from each other.

However, the results did reveal the predicted Depletion × Feedback interaction, $F(1, 60) = 12.55$, $p = .001$. In the low depletion condition, participants persisted significantly longer when given the replenished, as opposed to depleted, feedback, $t(30) = -2.52$, $p < .02$. In the high depletion condition, participants persisted significantly longer when given the depleted, as opposed to replenished, feedback, $t(30) = 2.50$, $p < .02$. This pattern of results is consistent with the resource attribution hypothesis.[2]

Secondary analyses. We also sought to test the extent to which the persistence scores in the feedback conditions were similar to the persistence scores of our respective control conditions (i.e., those individuals who received the depletion manipulation but no situational feedback).

Persistence: Low levels of depletion. We first compared the persistence of nondepleted individuals who received either the depleted or the replenished feedback with the high and low depletion control conditions. We submitted all four conditions to a one-way ANOVA, and a significant main effect emerged, $F(3, 60) = 3.93$, $p = .01$. Orthogonal contrasts revealed that the persistence of nondepleted individuals given the replenished feedback did not differ from that of nondepleted controls ($p > .32$). Additionally, the persistence of nondepleted individuals given the depleted feedback did not differ from that of depleted controls ($F < 1$). However, nondepleted individuals given the replenished feedback and nondepleted controls persisted significantly longer than did nondepleted individuals given the depleted feedback and depleted controls, $F(1, 60) = 10.68$, $p < .01$. Thus, it appears that individuals in the low depletion condition given feedback that they are mentally fatigued interpret their ambiguous state accordingly and behave comparably to the depleted controls.

Persistence: High levels of depletion. We then compared the persistence of depleted individuals who received either the depleted or the replenished feedback with the high and low depletion control conditions. The result of this one-way ANOVA also revealed a significant main effect, $F(3, 60) = 3.71$, $p < .02$. Orthogonal contrasts revealed that the persistence of depleted individuals given the depleted feedback did not differ from that of nondepleted controls ($F < 1$). Additionally, the persistence of depleted individuals given the replenished feedback did not differ from that of depleted controls ($F < 1$). However, depleted individuals given the depleted feedback and nondepleted controls persisted significantly longer than did depleted individuals given the replenished feedback and depleted controls, $F(1, 60) = 10.89$, $p < .01$. Thus, it appears that highly depleted individuals who can misattribute their current state of depletion to the paper color behave comparably to nondepleted controls.

Discussion

These results provide initial support for the importance of the subjective perception of one's actual mental resource availability on subsequent self-regulatory behavior. In this experiment, both high and low depletion participants were presented with situational feedback regarding their state of depletion prior to persisting at a problem-solving task. Interestingly, we observed an interaction between level of depletion and the situational feedback on task persistence. More specifically, nondepleted individuals given the replenished (vs. depleted) feedback persisted significantly longer on the problem-solving task, whereas depleted individuals given the depleted (vs. replenished) feedback persisted significantly longer on the problem-solving task.

Interestingly, these results demonstrated that the self-regulatory abilities of those individuals who are highly depleted of their mental resources can be affected by situational feedback regarding their mental resources. This difference in perceived depletion among high depletion participants is somewhat surprising, given that recent physiological findings might predict no differences under high depletion (e.g., Gailliot et al., 2007). Similar to increasing motivation (e.g., Muraven & Slessareva, 2003) or active resource monitoring (Wan & Sternthal, 2008), then, providing people with a situational explanation for their mental state appears to be another method of increasing the availability of mental resources that would otherwise remain unavailable.

Furthermore, the analyses of the control conditions offer insight into the magnitude of the effects observed. The findings suggest that the persistence of nondepleted individuals given the replenished feedback and the persistence of depleted individuals given the depleted feedback are comparable to the persistence of nondepleted individuals. Similarly, the persistence of nondepleted individuals given the depleted feedback and the persistence of depleted individuals given the replenished feedback are comparable to the persistence of depleted individuals. Thus, these data provide compelling evidence that the effects of manipulating perceptions of high and low depletion are comparable in magnitude to

[2] For those interested, we also analyzed all six conditions simultaneously. That is, we submitted the persistence scores to a two-way ANOVA, with depletion (high vs. low) and feedback (depleted vs. replenished vs. no feedback/control) as the independent variables. Neither of the main effects was significant (all Fs < 1). However, the results did reveal a significant Depletion × Feedback interaction, $F(1, 90) = 8.05$, $p = .001$.

the effects of manipulating the states of high and low depletion, respectively.[3]

Experiment 2

The results of Experiment 1 indicate that self-regulation is dependent upon both one's actual state of depletion and the situational cue/feedback manipulation. Experiment 2 sought to build upon the findings of Experiment 1 by empirically replicating the interactive effect demonstrated in the first study. Indeed, although our Experiment 1 results are entirely consistent with the resource attribution hypothesis, we must admit that we have not shown that individuals' subjective perceptions of their current state of depletion are affected as we have predicted. Thus, Experiment 2 included an assessment of participants' perceived level of depletion in an attempt to provide direct evidence for the resource attribution hypothesis. If our manipulation were affecting perceptions of depletion, as predicted by the resource attribution hypothesis, then we would expect an interaction on participants' perceptions of depletion. Specifically, we would predict that individuals low in actual depletion would report lower levels of perceived depletion when given the replenished (vs. depleted) feedback, whereas individuals high in actual depletion would report lower levels of perceived depletion when given the depleted (vs. replenished) feedback.

Furthermore, Experiment 2 sought to address two plausible alternative explanations to the proposed resource attribution hypothesis. First, we assessed the possibility that mood differences (specifically, differences in arousal) were responsible for the findings of the previous experiment. It is possible that our depletion and feedback manipulations could be altering participants' perceived level of arousal instead of (or in addition to) their perceived resource depletion, and it is possible that this boost in arousal might lead to greater persistence on the problem-solving task when provided a situational explanation for their state of depletion. We also assessed the possibility that motivational differences were responsible for our pattern of self-regulation in Experiment 1. One could argue that our manipulations affected participants' desire to expend effort on the anagram task. If so, then we might also expect participants given an external attribution for their state of depletion to persist longer on the problem-solving task. Consequently, we included measures of participants' arousal upon completing the depletion and feedback manipulations as well as participants' motivation to perform well on the task.

In Experiment 2, we also amended our self-regulation task to assess not only a quantitative index of performance (i.e., persistence) but also a qualitative index. Clearly, it could be argued that persistence reflects motivation as well as ability as a dependent measure, and we wanted to be able to demonstrate convincingly that perceptions of depletion have consequences for the quality of subsequent self-regulatory performance. Specifically, the computer was programmed to record not just the amount of time participants spent on the anagram but each of the particular responses that participants provided as well. These latter data allowed us to compute a qualitative index of task performance in the form of an error rate for each participant (cf. Muraven et al., 2006; Vohs et al., 2008). We hoped these additional data would provide convergent evidence of improved self-regulatory behavior, such that perceived depletion affects not only task persistence (i.e., longer time spent on the task before quitting) but also the quality of task performance (i.e., lower error rates).

Method

Participants. Sixty-six Indiana University undergraduates participated in partial fulfillment of a requirement for their introductory psychology course. Three participants were removed for not completing all of the measures, leaving a final sample of 63 participants. These participants were randomly assigned to conditions in a 2 (depletion: high vs. low) × 2 (feedback: depleted vs. replenished) between-participants design.

Procedure. All participants were welcomed into the lab and, as in the previous study, told that the research goals of the study were twofold: to gather student assessments of perceptual accuracy as well as to assess student performance on a problem-solving task. Participants were then randomly assigned to receive our depletion manipulation, ostensibly presented as the perceptual accuracy task described in the previous study. Immediately following the letter-recognition task, participants were randomly assigned to one of the two feedback conditions described in Experiment 1. Following this feedback, mood was immediately assessed with a widely accepted mood measure, the Brief Mood Introspection Scale (BMIS; Mayer & Gaschke, 1988), which includes an arousal subscale.

Participants then completed a multiple-solution anagram, as in the previous study, though the letters were different (i.e., L C R A E K G). Importantly, in this study, self-regulatory success on the anagram task was assessed by recording the amount of time participants persisted on the task, as well as calculating an error rate for each participant. This error rate was computed by dividing the total number of errors (i.e., incorrect responses/nonwords, incomplete responses, repeated responses) for each participant by the total number of errors plus the total number of correct/valid solutions for each participant (see Vohs et al., 2008, for a similar measure).

After the anagram task, we assessed participants' level of motivation toward the task. We then measured participants' perceived level of depletion. Following these measures, participants were debriefed and thanked for their time.

Independent variables.

Depletion manipulation. Participants completed the same depletion manipulation (i.e., letter-recognition task) as in Experiment 1.

Feedback manipulation. Participants received the same feedback manipulation as in Experiment 1.

Dependent variables.

Mood. We examined participants' mood by gauging responses to the 16-item BMIS (Mayer & Gaschke, 1988). The scale includes two subscales: arousal and valence. The subscales present partic-

[3] Readers may be curious about why we did not observe enhanced performance among those participants who perceived themselves to be mentally replenished relative to the low depletion control. Although it is the case that augmentation effects are notoriously difficult to observe in the laboratory (cf. Feick & Rhodewalt, 1997), we believe this might be due to the nature of the feedback used in this study. Recall that our feedback manipulation informed participants that they were replenished, a term that implies a return to baseline mental ability. Had we used a term that implied a boost in mental ability (e.g., *energized*), then perhaps such augmentation effects would be more likely. We are currently investigating this possibility in our lab.

ipants with either arousal-related (e.g., active, calm) or valence-related (e.g., happy, sad) adjectives. We amended the subscales to ask participants to report the extent to which they currently feel the specific adjective on a 7-point scale ranging from 1 (*definitely do not feel*) to 7 (*definitely feel*). Responses were averaged to form composite indices for both the arousal ($\alpha = .76$) and valence ($\alpha = .84$) subscales.

Motivation. To assess participants' motivation in doing the subsequent problem-solving task, we asked them to report how important it was for them to do well on the anagram task, how much effort they put into it, and how hard they tried on it. Participants responded on 7-point scales, with higher numbers indicating greater motivation. Responses were averaged to form a composite index ($\alpha = .79$).

Perceptions of depletion. At the conclusion of the study, participants were asked to report their perception of how mentally exhausting they found it to work on the anagram task. They responded to the single global item on a 7-point scale ranging from 1 (*not at all exhausting*) to 7 (*extremely exhausting*).

Results

Preliminary analyses.

Perceptions of depletion. To test for differences in perceived depletion across conditions, we submitted the perceived depletion data to a two-way ANOVA, with depletion and feedback conditions as the independent variables. This analysis revealed a significant Depletion × Feedback interaction, $F(1, 59) = 5.92$, $p < .02$. Participants in the low depletion condition reported, consistent with the resource attribution hypothesis, greater levels of mental exhaustion following the depleted ($M = 4.54$, $SD = 1.33$), relative to the replenished ($M = 3.71$, $SD = 1.40$), feedback condition, though this difference was nonsignificant, $t(29) = 1.87$, $p = .07$. Moreover, participants in the high depletion condition reported greater levels of mental exhaustion following the replenished ($M = 4.38$, $SD = 1.86$), relative to the depleted ($M = 3.29$, $SD = 1.53$), feedback condition, $t(31) = 2.09$, $p < .05$.

Mood. We also submitted the arousal data to the same analysis. Unlike the perceived depletion data, however, no effects were significant (all ps $> .15$). We then submitted the valence data to the same analysis, and again, no effects were significant (all ps $> .09$). These results are consistent with the notion that participants' mood was equally affected by our depletion and feedback manipulations.

Motivation. Finally, we submitted the motivation index to the same two-way ANOVA. As with the mood data, no effects were significant (all ps $> .41$). Consequently, these results are consistent with the notion that participants were equally motivated across conditions to complete the subsequent (i.e., problem solving) task.

Main analyses.

Task persistence. We again performed a square root transformation on the persistence scores and submitted these scores to the Depletion × Feedback ANOVA. Neither of the main effects were significant (all Fs < 1). However, as depicted in the top panel of Figure 1, the results did reveal a Depletion × Feedback interaction, $F(1, 59) = 10.70$, $p < .01$. In the low depletion condition, participants persisted significantly longer on the anagram task when given the replenished, as opposed to depleted, feedback, $t(28) = 2.05$, $p = .05$. In the high depletion condition, the opposite effect emerged; participants persisted significantly longer on the anagram task when given the depleted, as opposed to replenished, feedback, $t(31) = -2.59$, $p < .02$. These results are consistent with the interactive effects of the feedback and depletion manipulations on self-regulatory behavior observed in Experiment 1.

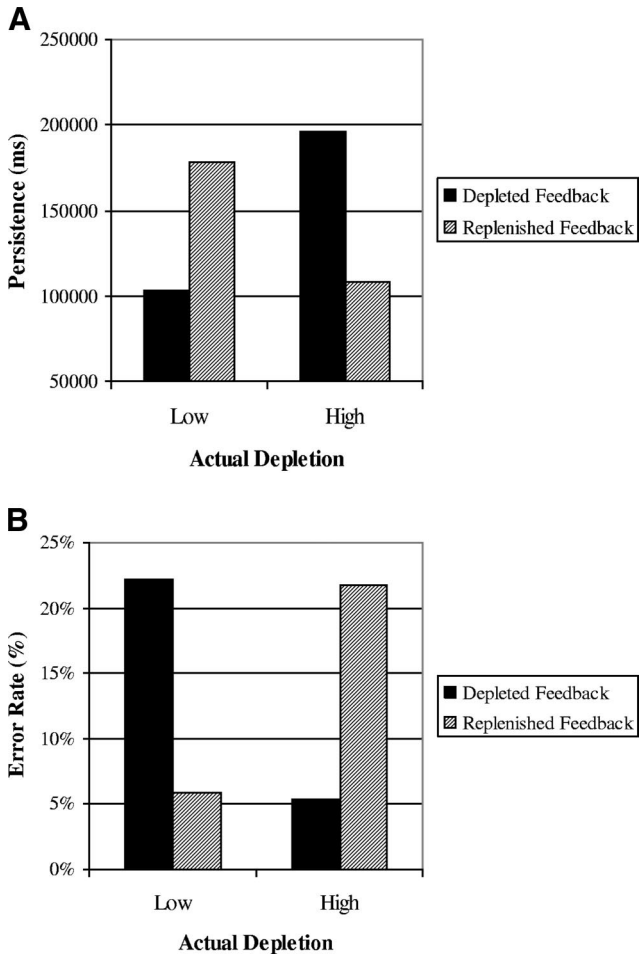

Figure 1. Persistence on the multiple-solution anagram (Panel A) and percentage of errors per correct response (Panel B) as a function of depleted and replenished feedback in Experiment 2. Higher reaction times indicate greater task persistence, whereas lower error rates indicate greater task performance.

Task performance. We then submitted the error rate composite to the same two-way ANOVA. As with the persistence data, neither of the main effects was significant (all Fs < 1). However, as depicted in the bottom panel of Figure 1, the results revealed a significant Depletion × Feedback interaction, $F(1, 59) = 13.89$, $p < .001$. In the low depletion condition, participants exhibited a lower error rate when given the replenished, as opposed to depleted, feedback, $t(28) = 2.24$, $p < .05$. In the high depletion condition, the opposite effect emerged; participants exhibited a lower error rate when given the depleted, as opposed to replenished, feedback, $t(31) = 3.21$, $p < .01$. These data illustrate that, in addition to changes in task persistence, the quality of task performance was also affected, in accord with our predictions by our experimental manipulations. These results, in combination with the task persistence data, provide powerful convergent evi-

dence of improved self-regulatory behavior for those individuals given a situational attribution for their internal (i.e., high or low depleted) state.[4]

Discussion

The results of Experiment 2 extend the findings of Experiment 1 by providing a conceptual replication of the perceived depletion effects. Consistent with Experiment 1, when nondepleted participants were given replenished (vs. depleted) feedback, they exhibited greater self-regulation, whereas when highly depleted participants were given depleted (vs. replenished) feedback, they exhibited greater self-regulation. In this experiment, however, self-regulation was assessed with measures of both task persistence and task performance. Interestingly, individuals who persisted longer on the problem-solving task also performed better and made fewer errors while completing the task. That is, both the amount and quality of time spent on the anagram task were affected by the manipulations.

Experiment 2 also allowed us to directly assess whether our manipulations affected perceptions of mental fatigue and depletion, as predicted by the resource attribution hypothesis, as well as to rule out other potential accounts, such as differences in participants' levels of arousal or motivation. Our results indicate that the experimental manipulations affected only participants' perceptions of their own depletion, such that individuals provided with a situational explanation for their internal state of depletion perceived the problem-solving task as less depleting than did individuals not provided with a situational explanation. Furthermore, those individuals who reported lower levels of perceived depletion persisted longer and made fewer errors on the problem-solving task, whereas those individuals who reported higher levels of perceived depletion persisted less and made more errors on the problem-solving task. These findings provide converging support for the resource attribution hypothesis while simultaneously demonstrating that the self-regulatory effects observed thus far are not being driven by differential levels of arousal or motivation.

Experiment 3

Experiments 1 and 2 provide converging evidence that individuals provided with situational feedback about their current state of mental resources perceived themselves as differentially depleted depending on their current level of mental depletion. Furthermore, these differential perceptions of depletion were shown to have important consequences for future task performance. Specifically, individuals who perceived themselves as low in depletion persisted significantly longer and were significantly more accurate than were individuals who perceived themselves as high in depletion. As noted, these findings are consistent with the proposed resource attribution hypothesis.

However, skeptics might still claim we have not convincingly demonstrated that perceptions of depletion affect participants' ability to engage in subsequent self-regulation tasks. Perhaps people who perceive themselves as depleted simply become more passive as they perform the task, attempting to conserve their mental resources. Could it be that these perceptions of depletion are simply triggering the conservation of people's mental resources? Muraven et al. (2006) argued that individuals actively engage in resource conservation on subsequent tasks of self-regulation when their resources are depleted. In a series of studies, they repeatedly demonstrated that depleted individuals performed significantly more poorly on subsequent self-regulatory tasks than did either nondepleted individuals or depleted individuals who were highly motivated to succeed on the subsequent task. Consequently, it could be that our pattern of self-regulatory results for individuals who perceive they are depleted are due to mere passivity on the part of these participants and not a lack of ability to perform, as argued by the resource attribution hypothesis. That is, it could be that the perception of depletion—for individuals both high and low in actual depletion—induces the conscious motivation to conserve mental resources, thus leading to poorer self-regulatory performance on subsequent tasks.

We acknowledge that the paradigm used in Experiments 1 and 2 does not afford us the possibility of definitively ruling out this alternative account. Although we found no differences across conditions in participants' reported level of motivation, these items assessed general motivation to engage in the problem-solving task, not participants' motivation to conserve resources. Thus, in Experiment 3, we explicitly asked participants at the end of the experiment to report the extent to which they had engaged in resource conservation during the subsequent task. We expected to find, consistent with our resource attribution hypothesis, no differences on these items across conditions.

We also made several other procedural changes in Experiment 3 to enhance the generalizability of our findings. First, we changed the nature of our depletion manipulation. Specifically, participants completed a writing task that required them to engage (or not engage) in thought suppression (e.g., Muraven et al., 1998). Second, we assessed subsequent self-regulation performance using an attention-regulation task developed by Muraven et al. (2006), a task we believe is more sensitive for addressing this passivity hypothesis, given that it requires participants' constant attention and vigilance throughout the entire duration of the task in order to respond quickly and accurately. Specifically, this task presents a continuous string of numbers and requires participants to recognize when a particular pair of numbers appears in sequence. In sum, these procedural changes implemented in Experiment 3 provide us with an opportunity not only to demonstrate that our effects generalize to different manipulations of depletion as well as different indices of subsequent self-regulatory performance, but also to directly address a resource conservation/passivity account for our effects, thereby providing a more stringent test of the resource attribution hypothesis.

[4] The astute reader may be interested in whether these error rate data reflected the generation of a greater number of correct solutions, generation of fewer erroneous responses, or a combination of both. Thus, we submitted the total number of correct responses and total number of errors to the same two-way analysis. Both effects revealed significant interactions—$F(1, 59) = 4.52$, $p < .04$, for the total number of correct solutions and $F(1, 59) = 6.61$, $p < .02$, for the total number of errors—in patterns consistent with the resource attribution hypothesis, suggesting that greater perceived depletion not only reduced the number of correct solutions generated but also enhanced the likelihood of errors.

Method

Participants. Fifty-two Indiana University undergraduates participated in partial fulfillment of a requirement for their introductory psychology course. These participants were randomly assigned to conditions in a 2 (depletion: high vs. low) × 2 (feedback: depleted vs. replenished) between-participants design.

Procedure. All participants were welcomed into the lab by an experimenter and seated at individual computer stations to complete the study. They were told that the goal of the study was to understand the role of memory in judgments of visual perception. After receiving these instructions, participants were told that they would first be participating in a memory task. This memory task served as the cover story for our manipulation of participants' available mental resources (see Depletion Manipulation section that follows).

Immediately following the memory task, participants received feedback about the effect of the memory task on their mental resources. As in the two previous experiments, participants were informed that the light yellow paper that they used to record their memories during the memory task has been shown to either deplete or replenish people's mental abilities (see Feedback Manipulation section later in text). Following this feedback, participants completed an assessment of their mood before proceeding to the visual perception task.

The visual perception task was our primary dependent measure. This task, ostensibly an assessment of visual perception, was in reality a measure of attention regulation. Successful attention regulation has been shown to require access to self-regulatory resources (see Muraven et al., 2006). Participants were told that a series of numbers would be presented on the computer screen. The numbers would appear one at a time in a random sequence, and their goal was to press the space bar whenever the number "4" followed the number "6." Participants were told that if they saw, for example, the sequence *8, 6, 4, 3*, then they would need to press the space bar when they saw the number "4." Furthermore, participants were told that they would need to press the space bar as quickly as possible. In fact, participants were told that their score wouldn't count if they failed to press the space bar before the next number, in this case the number "3," appeared.

The numbers each appeared on the screen for a relatively short duration (300 ms), and the time between number presentation was held constant (750 ms). The task lasted a total of approximately six minutes. We indexed self-regulation by having the computer record both the number of correct responses and the response latency for correct responses (i.e., the speed with which participants pressed the space bar when the number *4* followed the number *6*).

Following the visual perception task, we assessed participants' level of motivation toward the task. We also measured the extent to which participants actively engaged in resource conservation during the visual perception task. Once they completed these measures, participants were debriefed and thanked for their time.

Independent variables.

Depletion manipulation. Participants were randomly assigned to a high or low depletion condition. As noted, the depletion manipulation took the form of a memory task. Specifically, participants were told that the task investigates how people use words in naturally occurring sentences and that they were therefore to think about whatever came to mind. They were then told to write those thoughts in full sentences on the piece of paper provided until a screen appeared on the computer instructing them to proceed to the next part of the experiment. Participants were all given 5 min to record their thoughts.

We manipulated resource depletion by having participants give additional information about the thoughts they were to write. Specifically, in the low depletion condition, participants were told: "To help direct your thoughts, you can choose to think about a white bear." Conversely, in the high depletion condition, participants were told: "To help direct your thoughts, you should try not to think about a white bear." Thus, the distinguishing feature of each condition was whether participants were to engage in thought suppression, as the act of thought suppression has been shown in past research to deplete self-regulatory resources (e.g., Fischer, Greitemeyer, & Frey, 2007; Gailliot, Schmeichel, & Baumeister, 2006; Muraven et al., 2006; Muraven et al., 1998).

Feedback manipulation. At the beginning of the experiment, participants were randomly assigned to one of two feedback conditions—the depleted condition or the replenished condition. This feedback was identical to the manipulation used in Experiments 1 and 2.

Dependent variables.

Motivation. To assess participants' motivation toward the subsequent self-regulatory task, we asked them to report how motivated they were to complete the visual perception task (adapted from Muraven & Slessareva, 2003). This item was presented immediately after the completion of the visual perception task. Participants responded to the item on a 9-point scale ranging from 1 (*Not at all*) to 9 (*Very much*). Higher numbers indicated greater motivation.

Resource conservation. We also sought to examine the extent to which participants actively engaged in resource conservation during the visual perception task. Consequently, at the end of the experiment, participants were also presented with two items to assess the extent to which they consciously engaged in resource conservation following the initial task (adapted from Muraven et al., 2006). Specifically, we asked participants to report how important it was for them to conserve their energy as well as how much they were trying to conserve their energy during the visual perception task. Both items were assessed on 9-point scales ranging from 1 (*Not at all)* to 9 (*Very much*). Responses were highly correlated ($r = .89$, $p < .001$) and thus averaged to form a composite index of resource conservation, with higher scores indicating greater conservation of mental resources.

Results

Preliminary analyses.

Motivation. We submitted the motivation data to a two-way ANOVA, with depletion and feedback conditions as the independent variables. No effects were significant (all ps $> .26$).

Resource conservation. We also submitted the resource conservation index to the same two-way ANOVA. No effects, however, were significant (all Fs < 1).

Main analyses.

Number of correct responses. We submitted the total number of correct responses to the same Depletion × Feedback ANOVA.

Interestingly, neither the main effects nor the interaction were significant (all *p*s > .08). In fact, participants were extremely accurate throughout this task across conditions (total $M = 0.99$).

Response latencies. Given that the latency scores were highly skewed, we first performed a square root transformation on the response latency scores. We then submitted the transformed response latency scores to the Depletion × Feedback ANOVA. Although neither of the main effects were significant (all Fs < 1), the results did reveal a Depletion × Feedback interaction, $F(1, 48) = 11.55$, $p < .01$ (see Figure 2). In the low depletion condition, participants were significantly faster to respond when given the replenished ($M = 19.02$, $SD = 1.12$), as opposed to depleted ($M = 20.75$, $SD = 2.64$), feedback, $t(25) = 2.25$, $p = .03$. In the high depletion condition, participants were significantly faster to respond when given the depleted ($M = 18.88$, $SD = 1.10$), as opposed to replenished ($M = 20.41$, $SD = 1.58$), feedback, $t(23) = -2.78$, $p = .01$.[5]

Discussion

The primary objective of Experiment 3 was to provide a more stringent test of the resource attribution hypothesis. Despite changes to the nature of the depletion manipulation as well as the subsequent self-regulatory behavior, we observed the same pattern of data as in the previous experiments: Low depleted individuals demonstrated increased self-regulatory performance when provided the replenished (vs. depleted) feedback, whereas high depleted individuals demonstrated increased self-regulatory performance when provided the depleted (vs. replenished) feedback. Furthermore, this interaction occurred in the absence of differences in participants' motivation or resource conservation. The null effects on these latter two measures were especially insightful, because they further suggest that these effects are not due to differences in motivation to conserve or response passivity. Indeed, participants were equally motivated to engage in the subsequent self-regulation task and to conserve their mental resources during the task, regardless of their perceived depletion.

Experiment 4

In Experiment 4, we attempted to extend our findings to a new performance task, one that afforded us a better opportunity to explore the qualitative aspects of processing affected by perceived resource depletion. Thus, Experiment 4 assessed the impact of perceived depletion on thoughtful information processing, because previous research has shown that depletion significantly impairs the degree to which people can process information in an active (e.g., Vohs et al., 2008), intelligent (e.g., Baumeister & DeWall, 2005; Schmeichel et al., 2003), and thoughtful (Burkley, 2008; Wheeler et al., 2007) manner.

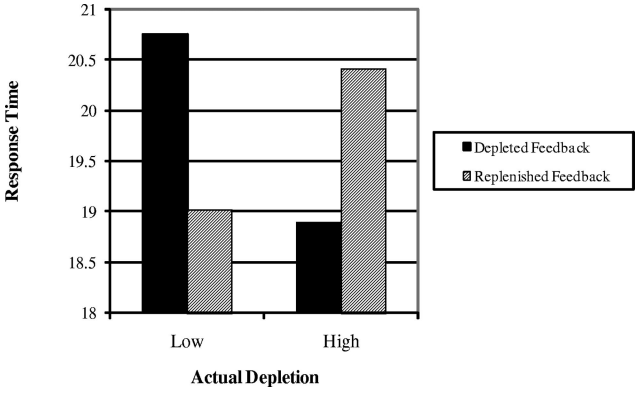

Figure 2. Average response time on an attention regulation task as a function of depleted and replenished feedback in Experiment 3. Lower response times indicate greater attention regulation.

For example, Wheeler et al. (2007) had participants complete the same depletion manipulation used in Experiments 1 and 2 (i.e., the letter-recognition task) to differentially deplete participants. The authors then presented participants with a counterattitudinal persuasive message and randomly assigned participants to receive a message consisting of either strong or weak persuasive arguments in support of the counterattitudinal appeal. They found that individuals who were nondepleted were able to differentiate between the strong and weak persuasive arguments, as indicated by relatively more favorable attitudes toward the strong message and less favorable attitudes toward the weak message. However, individuals who were highly depleted showed no distinction in their attitudes as a function of argument quality. Furthermore, Wheeler and his colleagues assessed participants' thoughts toward the counterattitudinal issue. This afforded them the opportunity to identify counterargument generation as the critical mediator in the participants' depletion effects: Depletion significantly inhibited participants' ability to successfully generate counterarguments, which prevented them from being able to distinguish between strong and weak messages. In other words, participants in the depletion conditions were unable to thoughtfully respond to the persuasive appeal.

[5] It should be noted that we obtained behavioral differences in only response latencies (i.e., the speed with which participants pressed the space bar), not in the number of errors committed across conditions during the attention-regulation task (as observed by Muraven et al., 2006). We attribute this lack of effect on error rates to several changes we made to the attention-regulation task used in the Muraven et al. (2006) work. For instance, although the numbers each appeared on the screen for a relatively short amount of time, they were presented at a constant (as opposed to random) interval. Furthermore, participants worked on the visual perception task for a shorter amount of time (approximately six, as opposed to twelve, minutes). These changes appear to have made the task easier for participants, as evidenced by their almost perfect accuracy (99%). Nonetheless, the fact that participants performed so well provides further evidence against a passivity argument, in that participants maintained their vigilance throughout the full duration of the study.

Given that we switched the nature of our self-regulatory dependent variable in Experiment 3, readers may also be interested in whether these differences in response latencies would emerge among control participants (i.e., those not given the feedback manipulation). To test this, we ran two external control conditions ($n = 20$). Participants in the control conditions received either the high or low depletion manipulation described in Experiment 3. Importantly, these conditions did not receive any feedback. The t test of the transformed response latency scores revealed a significant main effect of depletion on response latencies, $t(18) = 4.98$, $p < .04$. Individuals in the low actual depletion condition ($M = 19.39$, $SD = 1.04$) were, consistent with the perceived depletion data, significantly faster to respond than were individuals in the high actual depletion condition ($M = 20.73$, $SD = 1.64$). Additionally, there were no differences in number of correct responses, even among the control conditions ($p > .13$).

The work by Wheeler et al. (2007) is consistent with several other studies showing impairment of participants' ability to engage in thoughtful information processing when highly depleted. Given the importance of the ability to process information in an active, intelligent, and thoughtful manner, this change to a thoughtful-information-processing task in Experiment 4 presented the opportunity to further assess qualitative differences in the responses of those who perceive themselves either low or high in resource depletion.

Our assessment of thoughtful information processing replicated the Wheeler et al. (2007) study. That is, to index thoughtful information processing, we presented participants with a persuasive message but varied the strength of the arguments in the persuasive message and assessed both the attitude toward the message and the valence of the thoughts generated toward the message. Both measures are well-established indicators of thoughtful information processing in persuasion (see Petty & Cacioppo, 1986). We also assessed participants' perceived depletion.

We expected that, consistent with the resource attribution hypothesis, only those individuals who perceived themselves as less depleted would engage in thoughtful processing of the persuasive message—as evidenced by relatively more favorable attitudes and thoughts toward the strong (vs. weak) message. In other words, we expected discrimination between strong and weak arguments on both the attitude and thought data under conditions of low perceived depletion. Conversely, under conditions of high perceived depletion, we expected little to no differences in participants' attitudes or thought responses toward the messages of varying strengths.

Furthermore, we again assessed participants' perceptions of their state of exhaustion. However, unlike in Experiment 2, where perceived depletion was assessed at the end of the study, our index of perceived depletion in the current study came directly after the initial task to avoid any potential influence from the subsequent task on people's perceptions. Consequently, we expected to replicate the Depletion × Feedback interaction on people's perceptions of their mental resources observed in Experiment 2, with individuals in the low depletion condition perceiving themselves as relatively less depleted following the replenished (vs. depleted) feedback and individuals in the high depletion condition perceiving themselves as relatively less depleted following the depleted (vs. replenished) feedback.

Method

Participants and design. One hundred fourteen Indiana University undergraduates participated in partial fulfillment of a requirement for their introductory psychology course. Participants were randomly assigned to conditions in a 2 (depletion: high vs. low) × 2 (feedback: depleted vs. replenished) × 2 (argument quality: strong vs. weak) between-participants design.

Procedure. As in the previous studies, all participants were welcomed into the lab by an experimenter and seated at individual computer stations to complete the study. They were told that the research goals of the study were to gather student assessments of perceptual accuracy and to assess student reactions to a new policy currently under consideration at Indiana University. After receiving instructions, participants were presented with the depletion and feedback manipulations described in the first two experiments. Immediately following the feedback manipulation, participants reported their perceptions of their mental exhaustion.

After reporting perceptions of their mental resources, participants were told that we were interested in their perspective on a policy currently under consideration at Indiana University. They were informed that they would be given the opportunity to read about the policy and that afterward we would ask them about their reactions. Participants then responded to a persuasive message containing either strong or weak arguments (see upcoming Argument Quality section), because differentiating between the strengths of arguments in a persuasive communication is a widely accepted indicator of thoughtful information processing (Petty & Cacioppo, 1986). After reading the persuasive message, participants completed the remaining dependent measures and were then debriefed and thanked for their time.

Independent variables.

Depletion manipulation. Participants completed the same depletion manipulation as in Experiments 1 and 2.

Feedback manipulation. Participants received the same feedback manipulation as in Experiments 1–3.

Argument quality. Participants were randomly assigned to receive, for the persuasive message, either strong or weak arguments in favor of comprehensive exams (see Petty & Cacioppo, 1986). In the strong argument condition, participants received a series of compelling reasons to implement the exam policy (e.g., comprehensive exams increased undergraduate grade point averages at another university where they had been implemented). In the weak argument condition, participants received a series of less compelling reasons to implement the exam policy (e.g., implementing comprehensive exams would help the university join a national trend).

Dependent measures.

Perceptions of depletion. We again wanted to assess participants' perceptions of their cognitive resources following the initial (i.e., perceptual accuracy) task. Consequently, immediately after completing the letter-recognition task and receiving the feedback manipulation, participants were asked to report their perceptions of how mentally exhausting, interesting, and effortful they found the letter-recognition task on a series of 9-point scales. Importantly, scores were coded such that higher numbers indicated greater perceived depletion. Although these items were only modestly correlated ($\alpha = .31$), they were consistent with items used as manipulation checks of mental exhaustion in many past studies of ego depletion (e.g., Baumeister et al., 1998; Muraven et al., 1998; Schmeichel et al., 2003).

Attitudes. Immediately following the persuasive message, participants reported their attitude toward the comprehensive exam policy on a single 9-point semantic differential scale ranging from 1 (*positive*) to 9 (*negative*). Higher numbers indicated more favorable attitudes toward comprehensive exams.

Thought favorability. After reporting their attitudes toward the target issue, participants were asked to list their thoughts about the comprehensive exam policy. They were instructed to type these thoughts into a series of boxes appearing on the screen and were told not to worry about spelling or grammar as long as they recorded the main idea of each thought (see Cacioppo & Petty, 1981). Two independent judges, blind to experimental condition, coded the thoughts generated by each participant as to whether each thought was favorable, unfavorable, or neutral with

respect to comprehensive exams or the exam message. The two coders' ratings were highly correlated ($r = .87$, $p < .001$) and were thus averaged. A thought valence index was then computed for each participant by subtracting the number of negative thoughts from the number of positive thoughts and dividing this difference by the total number of thoughts listed. Higher values thus reflected a greater frequency of positive relative to negative thoughts. This index was adopted from previous research (e.g., Tormala & Clarkson, 2007).

Motivation. We again assessed participants' motivation toward the subsequent second task, though in this study we measured participants' motivation to thoughtfully process the persuasive message by adopting several items from previous research (e.g., Wheeler et al., 2007). These items asked participants to report how much attention they paid to the comprehensive exam proposal, how much effort they put into reading the proposal, and how deeply they thought about the proposal. Participants responded on a series of 9-point scales, with higher numbers indicating greater motivation to process the persuasive message. Responses were averaged to form a composite index of motivation ($\alpha = .93$).

Results

Preliminary analyses.

Perceptions of depletion. Given that participants reported their perceived level of depletion before the persuasive message, we excluded the argument quality manipulation from this analysis and submitted the perceptual data to a two-way ANOVA, with depletion and feedback conditions as the independent variables. Neither of the main effects were significant (all Fs < 1), though the results did reveal a significant depletion by feedback interaction, $F(1, 110) = 9.17$, $p = .003$ (see Figure 3). In the low depletion condition, participants perceived themselves as less depleted when given the replenished, as opposed to depleted, feedback, $t(56) = 2.32$, $p = .02$. In the high depletion condition, participants perceived themselves as less depleted when given the depleted, as opposed to replenished, feedback, $t(54) = -1.96$, $p = .05$.

Motivation. To test for differences in motivation across conditions, we submitted the motivation index to the same two-way ANOVA, with depletion and feedback conditions as the independent variables. As in Experiments 2 and 3, no effect of the manipulations on the index of motivation was significant (all ps $> .14$). These results are consistent with the notion that participants were equally motivated to process the persuasive message across conditions.[6]

Main analyses.

Attitudes. We submitted the attitude data to a 2 × 2 × 2 ANOVA with depletion (high or low), feedback (depleted or replenished), and argument quality (strong or weak) as the independent variables. The results revealed a significant main effect of argument quality, $F(1, 106) = 18.85$, $p < .001$. However, this main effect was qualified by a significant three-way interaction, $F(1, 106) = 10.42$, $p = .002$. As illustrated in Figure 4, this three-way interaction involved two opposing two-way interactions.

In the low depletion condition, the Argument Quality × Feedback interaction was significant, $F(1, 54) = 6.07$, $p < .02$, with individuals showing more discrimination between strong and weak arguments when given replenished, $t(30) = -4.17$, $p < .001$, as opposed to depleted ($t < 1$) feedback. In the high depletion condition, the Argument Quality × Feedback interaction was also significant, $F(1, 52) = 4.42$, $p = .04$, though in this condition individuals showed more discrimination between argument quality when given depleted, $t(25) = -4.08$, $p < .001$, as opposed to replenished ($t < 1$) feedback. No other effects were significant (all ps $> .17$). These results indicate that individuals engage in greater processing when the perception of depletion is relatively low, irrespective of actual level of depletion—findings consistent with the perceived depletion data.

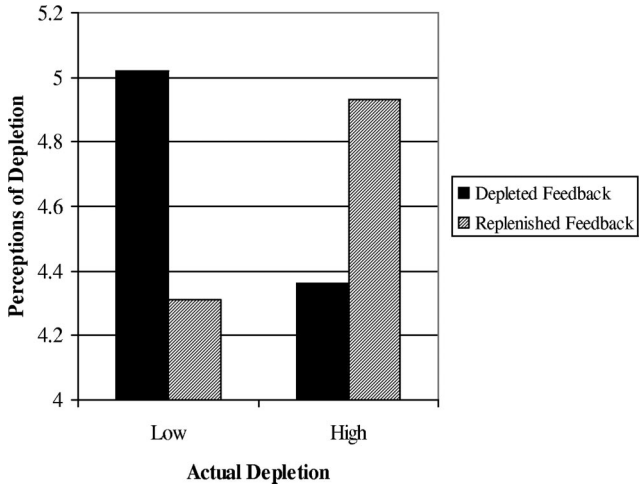

Figure 3. Perceived mental depletion as a function of depleted and replenished feedback in Experiment 4. Higher values indicate greater perceived resource depletion.

Thought favorability. The thought favorability index was submitted to the same 2 × 2 × 2 ANOVA. In short, this analysis

[6] It is worth noting that the motivational items in Experiments 2–4 came directly after the subsequent self-regulatory task. We thought it prudent to ask these motivational questions after the task to avoid influencing participants' responses on the task. However, our lack of effects on the motivational items might be due to the placement of the items. For instance, people might have compensated for their lack of effort on the task by self-reporting after the fact that they were, indeed, motivated to perform the task.

Although we find this argument somewhat speculative given that we were able to rule out motivational differences across a variety of items following very different self-regulatory tasks, we ultimately decided to test this possibility by running a replication of Experiment 4 ($n = 45$), with two important modifications. First, the motivation items were moved to directly after the false feedback manipulation. Second, participants were not actually presented with the subsequent persuasive message (i.e., there was no argument quality manipulation), even though the instructions led them to believe they would be exposed to the proposal, as in Experiment 4. We submitted the same index of motivation as in Experiment 4 ($\alpha = .97$) to a Depletion × Feedback ANOVA, and the results coincided with the findings of Experiments 2–4: No effects of our manipulations on participants' motivation were significant (all ps $> .25$). Thus, it appears that although an interesting possibility, the depletion and feedback manipulations do not differentially affect participants' motivation, irrespective of whether the items assessing motivation come before or after the subsequent self-regulatory task.

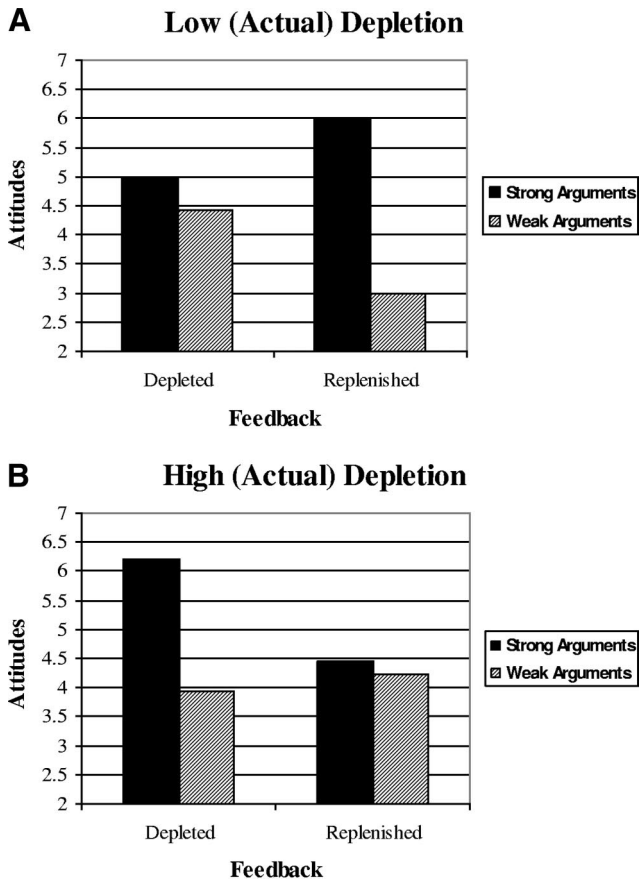

Figure 4. Attitudes as a function of feedback and argument quality for low (Panel A) and high (Panel B) depletion conditions in Experiment 4.

produced the same pattern of effects as did the analysis of the attitude data. That is, the results revealed a significant main effect of argument quality, $F(1, 106) = 6.37$, $p < .02$, which was qualified by a significant three-way interaction, $F(1, 106) = 13.01$, $p < .001$.

In the low depletion condition, the Argument Quality × Feedback interaction was significant, $F(1, 54) = 6.67$, $p < .02$; individuals in the replenished feedback condition reported relatively more favorable thoughts after receiving the strong ($M = -0.04$, $SD = 0.81$) rather than weak ($M = -0.73$, $SD = 0.44$) arguments, $t(30) = -2.97$, $p < .01$, whereas individuals in the depleted feedback condition reported no differentiation in their thought favorability following either strong ($M = -0.50$, $SD = 0.65$) or weak ($M = -0.22$, $SD = 0.87$) arguments ($t < 1$).

In the high depletion condition, the Argument Quality × Feedback interaction was also significant, $F(1, 52) = 6.42$, $p < .02$, though as with the attitude data the pattern of this interaction was opposite to that of the low depletion condition. That is, individuals in the depleted feedback condition reported more favorable thoughts after receiving the strong ($M = 0.14$, $SD = 0.70$) rather than weak ($M = -0.72$, $SD = 0.46$) arguments, $t(25) = -3.71$, $p = .001$, whereas individuals in the replenished feedback condition reported no differentiation in their thought favorability following either the strong ($M = -0.49$, $SD = 0.64$) or weak ($M = -0.50$, $SD = 0.65$) arguments ($t < 1$). As with the attitude data, then, these results are consistent with the notion that individuals engage in greater processing when the perception of depletion is relatively low, irrespective of the actual level of depletion.

Mediation. Finally, if perceived depletion is truly impacting thoughtful information processing, then we would expect the thought favorability data to mediate the attitude responses toward the persuasive message (cf. Wheeler et al., 2007). To test this hypothesis, we conducted a series of regression analyses, following the recommendation of Baron and Kenny (1986), treating the Depletion × Feedback × Argument Quality interaction term (controlling for the main effect and two-way interaction terms) as the primary predictor variable. As already established, there was a significant Depletion × Feedback × Argument Quality interaction on both attitudes ($\beta = -.76$), $t(106) = -3.23$, $p = .002$, and thought favorability ($\beta = -.89$), $t(106) = -3.61$, $p < .001$. In addition, thought favorability predicted attitudes ($\beta = .66$), $t(106) = 9.23$, $p < .001$. When the Depletion × Feedback × Argument Quality interaction (along with the main effect and two-way interaction terms) and thought favorability were entered into a simultaneous regression model predicting attitudes, thought favorability continued to predict attitudes ($\beta = .57$), $t(105) = 7.62$, $p < .001$, whereas the Depletion × Feedback × Argument Quality interaction did not ($\beta = -.25$), $t(105) = -1.26$, $p = .21$. This mediational pathway from the Depletion × Feedback × Argument Quality interaction to attitudes through thought favorability was significant ($z = -3.05$, $p < .01$).

Discussion

Experiment 4 sought to extend the generalizability of the previous three studies by assessing the impact of perceived depletion on thoughtful information processing. Though the depletion of regulatory resources has been applied to various information-processing situations (e.g., Baumeister & DeWall, 2005; Schmeichel et al., 2003; Vohs et al., 2008), we focused on the impact of perceived depletion on the thoughtful processing of a persuasive message (Burkley, 2008; Wheeler et al., 2007). The results provided a conceptual replication and extension of these previous studies. We were able to provide further empirical support for the resource attribution hypothesis by again assessing participants' perceptions of their own depletion. Consistent with Experiment 2, the depletion and feedback manipulations varied the perception of resource depletion and, equally important, not the degree of motivation. Furthermore, individuals who perceived themselves as less depleted (independent of their actual level of depletion) showed greater thoughtful information processing, as indicated by greater discrimination between the strong and weak arguments on both the attitude and thought data. Subsequent analyses demonstrated that people's attitudes were mediated by their thoughts toward the message. Thus, the same group of participants who demonstrated greater persistence and performance (see Experiments 1–2) and greater attention regulation (see Experiment 3) also showed more thoughtful information processing in the current experiment. It would appear, then, that perceived depletion impacts both quantitative and qualitative responding at both high and low levels of actual depletion.

General Discussion

The goal of the current research was to assess the role of perceived mental resources in the domain of self-regulation. Taken as a whole, the results offer initial—albeit compelling—support for the impact of perceived resource depletion on subsequent self-regulatory behavior. Across four experiments, individuals who perceived they were highly depleted repeatedly performed more poorly on a subsequent self-regulatory task than did individuals who perceived they were modestly depleted. Specifically, the perception of high (vs. low) depletion decreased persistence on a problem-solving task (Experiments 1–2), increased the number of errors made on a problem-solving task (Experiment 2), delayed response time on an attention-regulation task (Experiment 3), and impaired the ability to thoughtfully process a persuasive message (Experiment 4). Furthermore, these effects were shown to be independent of actual resource depletion, as individuals both high and low in actual depletion succumbed to their perceptions of mental resource availability. Thus, people's perceptions of their own resource availability clearly impaired subsequent self-regulation, irrespective of actual resource availability.

As noted, we argue that these perceptions—and the subsequent results they entail—are driven by different attribution processes. More specifically, we contend that the same situational cue (i.e., our feedback manipulation) can induce different attribution processes depending on one's actual state of depletion; individuals low in depletion, for instance, appear to be using our situational feedback to *interpret* their state (e.g., L. Ross et al., 1975), whereas individuals high in depletion appear to be using our situational feedback to *explain* their state (e.g., Schwarz & Clore, 1983). Thus, we view these findings as consistent with a resource attribution hypothesis, in which the informational value of an external cue is anticipated to differ depending on people's available mental resources.

Furthermore, we view the perseverance of the feedback to the subsequent task in the low depletion condition as evidence that participants are not merely taking the feedback at face value but are in fact engaging in a biased memory recall in support of evidence to confirm the feedback (i.e., *the debriefing paradigm*: L. Ross et al., 1975). Recall that work on the debriefing paradigm demonstrates that individuals given random feedback continue to believe bogus experimenter feedback even after experimenters confess to the randomness of the feedback in the debriefing. Moreover, the perseverance of this belief is linked to confirmatory evidence generated by participants in support of the feedback—generated to such an extent, in fact, that the belief persists even after the initial feedback has been repudiated (Anderson et al., 1980). Although none of the current studies assesses the generation of confirmatory evidence in support of our false feedback for low depletion individuals, we find it unlikely that our feedback regarding the effects of yellow paper on people's resource availability would translate to a subsequent task in which the feedback is irrelevant (i.e., the task does not involve yellow paper)—unless, that is, the feedback spurred a biased memory recall in support of confirmatory evidence.

Interestingly, the past decade has witnessed an influx of research guided by the assumption that self-regulation depends on a limited supply of mental resources (see Schmeichel & Baumeister, 2004, for a review), and once that limited supply is depleted, subsequent self-regulation suffers. Although some may view our findings as a challenge to the self-regulation as strength perspective, we view the distinction between perceived and actual depletion as an extension of this research—arguing that the current findings posit an important layer to the self-regulation as strength theory by defining *strength* not only in terms of actual ability to regulate behavior but perceived ability as well. Ultimately, then, we view the current findings as an alternative way to consider how one defines *strength* in self-regulation, and we believe that understanding how these perceptions operate in self-regulatory behaviors offers novel ways to consider the resource depletion approach to self-regulation.

Furthermore, we also view the current findings as complementary to other research demonstrating that subsequent self-regulation need not always suffer under conditions of high depletion (e.g., Muraven & Slessareva, 2003). However, much of this work focused on boosting the motivation of individuals high in resource depletion. Given that differences in motivation were ruled out as a plausible explanation for our findings in Experiments 2–4, we have an inherent paradox in our results: Why are people who supposedly have no available resources performing as well on subsequent self-regulatory tasks as people who have available resources? That is, in the absence of motivational incentives, why are we still observing such compelling success on subsequent self-regulation for depleted individuals?

The most direct answer, as alluded to earlier, is that depletion does not necessarily exhaust one's supply of mental resources (Muraven et al., 2006; see Baumeister, 2002). The findings of our studies demonstrate that these resources can be accessed—and thus people's ability to self-regulate can increase—by altering people's perceptions of their available mental resources. Consequently, it is clear that increasing depleted individuals' perception of their resource availability affords them the opportunity to still successfully self-regulate—even in the absence of motivational incentives.

Implications

There is no doubt that self-regulation is an integral part of the human experience and that the depletion model of self-control has offered considerable advancement in how self-regulation can be improved. For instance, the self-regulation as strength model has been applied to the treatment of a variety of behaviors that are self-defeating (e.g., alcoholism: Muraven, Collins, & Nienhaus, 2002) as well as self-improving (e.g., dieting: Vohs & Heatherton, 2000; coping with death: Gailliot et al., 2006). The current findings, we believe, complement this work by arguing that inducing the perception of low depletion, even at high levels of actual depletion, should add in the continuance of self-regulation. For example, according to the resource attribution hypothesis, when people are highly depleted of their mental resources, providing them with a situational explanation for their depleted state should lead them to perceive themselves as less depleted and, consequently, to better regulate their resistance to negative behaviors and/or their persistence in positive behaviors. Therefore, the idea of reframing strength in terms of perceptions could be a useful treatment tool, especially in instances of relatively high resource depletion.

New Questions

Although the current findings provide initial evidence of the role of perceived depletion in the resource depletion perspective on

self-regulation, there are several important questions that remain to be answered. Ultimately, we see these questions as opening the door to new research that will expand our understanding of the current findings and the conditions under which they are most likely to emerge.

Severity of initial depletion. In all four studies, we elected to use depletion manipulations shown in prior research to successfully differentiate between high and low depleted participants (e.g., Baumeister et al., 1998; Muraven et al., 1998; Wheeler et al., 2007). However, we wonder what effect the severity of the initially depleting task might have on the future self-regulatory success of highly depleted individuals. Although this issue is not necessarily germane to the present research—because we were able to obtain self-regulatory differences in perceived depletion irrespective of actual depletion—it does suggest that perhaps a more severe depletion manipulation might not allow for our perceived depletion manipulation to improve subsequent self-regulation performance for highly depleted individuals. As previously stated, our perceived depletion manipulation arguably depends on highly depleted individuals still having access to available mental resources, resources that a more severe initial task might more drastically exhaust. Given that this issue is a concern for any method of improving subsequent self-regulation performance for highly depleted individuals (e.g., increasing motivation: Muraven & Slessareva, 2003), we look to future research to assess the role of initial task severity in moderating the effect of resource perceptions on subsequent self-regulation—especially for highly depleted individuals.

Alternative means to perceived depletion. In the current research, we have proposed a resource attribution hypothesis to account for the interactive impact of situational feedback and people's resource depletion state on subsequent self-regulation. Crucial to this hypothesis is that perceptions of depletion derive from a process in which individuals use situational feedback to either define or explain their state of resource depletion. Indeed, perceptual data from Experiments 2 and 4 align with this hypothesis. However, it should be noted that the resource attribution hypothesis is specific to situations in which individuals use situational information to make inferences about their internal state of depletion, because perceptions of depletion can derive from a variety of processes. In the absence of situational feedback, for instance, perceptions of mental exhaustion have at times been shown to covary with people's actual state of depletion (e.g., Baumeister et al., 1998; Fischer et al., 2008; Muraven et al., 1998; Schmeichel et al., 2003; Tice, Baumeister, Schmueli, & Muraven, 2007). Thus, it could be the case that individuals hold similar perceptions of mental exhaustion but derive those perceptions by different means. For instance, the perceptions of individuals who show chronic tendencies to engage in mental heuristics might be sensitive to their internal state, whereas the perceptions of individuals who show chronic tendencies to engage in metacognition might be more sensitive to situational feedback relative to their internal state of depletion. We look to future research to assess the situations under which different sources of information are used to form perceptions of depletion.

Perceived depletion as a cue to conservation. Experiments 2–4 suggest that the observed differences in subsequent self-regulatory performance for individuals of high and low perceived depletion are due to a lack of ability, because motivation did not differ across conditions in all three experiments. Furthermore, Experiment 3 explicitly assessed the extent to which participants engaged in resource conservation as well as their general level of motivation and again found no differences. Thus, considerable evidence across experiments supports the lack of effect of our manipulations on people's level of motivation.

Still, it is interesting that we obtained no differences in motivation toward the subsequent self-regulatory task given that—as noted in the introduction to Experiment 3—one might intuitively expect the perception of being depleted to motivate the conservation of resources. As such, we wonder whether there are situations in which perceptions of depletion serve as a cue to conserve mental resources. For instance, might the perception of depletion induce resource conservation when participants anticipate a future task? That is, if participants were led to believe that another task—especially one high in importance—would follow our second task (i.e., Muraven et al., 2006), then perhaps under such conditions perceived depletion would serve as a cue to conservation. We look to future research to assess these and other conditions in which the perception of depletion affects motivation.

Mechanism of change. Research in self-regulation has demonstrated that manipulations of resource depletion can induce physiological changes within the human body (Gailliot & Baumeister, 2007; Gailliot et al., 2007), such that lower levels of glucose—a source of energy to the body—follow a high (vs. low) depletion manipulation. Emerging research also suggests the depletion of regulatory resources is related to cognitive changes in the form of impaired executive functioning (Hofmann, Gschwendner, Friese, Wiers, & Schmitt, 2008; Schmeichel, 2007; Schmeichel, Volokhov, & Demaree, 2008). Both mechanisms provide cogent support that the depletion of regulatory resources inhibits one's ability to successfully regulate the self.

As noted, the current research suggests that the pattern of self-regulatory results across all four studies is also driven by differences in ability to successfully regulate the self. What, then, might be driving these differences in self-regulatory ability? Could the mere perception of depletion induce changes in glucose levels and/or executive control?

We look to further research to elucidate answers to this question, believing that the answer might offer insight into the conditions under which self-regulatory failure is driven by either physiological or cognitive changes. Specifically, it could be that the perceptual differences demonstrated in the current research are driven more by cognitive than physiological changes in ability. If so, this pattern of results would suggest that in certain situations, self-regulatory failure is due to impairment of one type of ability constraint (i.e., executive functioning) independent of another type of ability constraint (i.e., glucose level). For now, we leave these questions open for future research.

Conclusion

Our goal was to build upon significant contributions made by previous research guided by an assumption that self-regulation depends on a limited reserve of mental resources. Specifically, the present research assessed the extent to which the findings afforded by this perspective in the self-regulation literature can be driven by perceptions alone. The findings across four studies provide converging support for a resource attribution hypothesis, whereby

individuals' perceptions of depletion—at both high and low levels of actual depletion—predict performance on subsequent self-regulatory tasks. The current research, then, provides clear evidence that perceived resource depletion can override actual resource depletion and, in doing so, further contribute to a broader body of research demonstrating that perceptions can influence people's behaviors apart from what reality might predict. Ultimately, we hope, these findings will encourage new and innovative approaches to self-regulation research, especially those programs focused on defining *self-regulation* in terms of strength.

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