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# What Is Ego Depletion? Toward a Mechanistic Revision of the Resource Model of Self-Control

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## Abstract

According to the resource model of self-control, overriding one's predominant response tendencies consumes and temporarily depletes a limited inner resource. Over 100 experiments have lent support to this model of ego depletion by observing that acts of self-control at Time 1 reduce performance on subsequent, seemingly unrelated self-control tasks at Time 2. The time is now ripe, therefore, not only to broaden the scope of the model but to start gaining a precise, mechanistic account of it. Accordingly, in the current article, the authors probe the particular cognitive, affective, and motivational mechanics of self-control and its depletion, asking, "What is ego depletion?" This study proposes a process model of depletion, suggesting that exerting self-control at Time 1 causes temporary shifts in both motivation and attention that undermine self-control at Time 2. The article highlights evidence in support of this model but also highlights where evidence is lacking, thus providing a blueprint for future research. Though the process model of depletion may sacrifice the elegance of the resource metaphor, it paints a more precise picture of ego depletion and suggests several nuanced predictions for future research.

## Keywords

ego depletion, self-control, mechanism, motivation, attention

Self-control is a fundamental ability. It allows us to direct our hearts, bodies, and minds away from immediate temptation and toward other ambitions. Self-control, known colloquially as willpower, is one of the defining features of the human animal, referring to the mental capacity individuals have to override or alter their own thoughts, emotions, and behaviors. It relies on controlled processes to regulate urges, to juggle competing goals, and to sustain attention. Its failure is one of the central problems of human society, being implicated in phenomena ranging from criminality to obesity, from personal debt to drug abuse. Self-control, therefore, is of interest to many areas of social science.

Although studied for decades (e.g., Mischel & Gilligan, 1964), interest in self-control really began to take hold—especially among social psychologists—in the early 2000s. There are many possible reasons for this spike in interest, but one definite reason was the introduction of a new and elegant theory by Roy Baumeister and his colleagues called the resource (or strength) model of self-control. This model casts self-control as an inner capacity that relies on some limited internal resource or energy (Baumeister & Heatherton, 1996; Baumeister, Heatherton, & Tice, 1994; Baumeister & Tierney, 2011; Muraven & Baumeister, 2000).

The central (and most tested) prediction of the resource model of self-control is that engaging in controlled, willful action quickly consumes and depletes this limited inner capacity, leaving one in a state of "ego depletion." In this depleted state, further efforts at self-control are prone to failure. The main evidence in support of ego depletion comes from studies showing that exerting self-control on one task impairs performance on subsequent, ostensibly unrelated self-control tasks. For instance, regulating one's emotions can reduce performance on subsequent tasks, such as solving a difficult puzzle, squeezing a handgrip exerciser, sustaining mental representations in working memory, or naming the color of printed words in a Stroop task (Johns, Inzlicht, & Schmader, 2008; Muraven, Tice, & Baumeister, 1998; Schmeichel, 2007).

One of the first empirical tests of the limited resource model of self-control found that resisting the temptation to eat fresh cookies and chocolates caused a drop in persistence on a subsequent mental challenge (Baumeister, Bratslavsky, Muraven, & Tice, 1998). This initial demonstration of ego depletion is now a citation classic, being cited over 1,300 times (see also Muraven et al., 1998).[1] By confirming the main prediction of the resource model, it also introduced the principal experimental method

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from which evidence of self-control's resource-like qualities emerged, the sequential task paradigm. Experiments using the sequential task paradigm have consistently produced evidence that engaging in self-control at Time 1 undermines self-control at Time 2.

The resource model has done what any good theory does—it has directed attention to a neglected area in the field, acted as a generative heuristic, and provided an organizing framework to understand a vital property of self-control. And the sequential task paradigm has been a flexible tool, allowing researchers to demonstrate all of the different domains affected by self-control depletion. The time is now ripe, therefore, not only to broaden the scope of the model but also to start gaining a precise, mechanistic account of it. Accordingly, in the current article, we probe the particular cognitive, affective, and motivational mechanics of self-control and its depletion. Plainly put, we ask, "What is ego depletion?"

## Brief Overview of the Process Model of Ego Depletion

In this article, we present a process model of ego depletion, whereby we try to answer why engaging in self-control at Time 1 reduces self-control at Time 2. In a nutshell, we propose that engaging in self-control at Time 1 sets in motion a pair of interdependent and iterative processes that culminate in poorer self-control at Time 2 (see Fig. 1). Specifically, we propose that after engaging in self-control at Time 1, people experience (a) a shift in motivational orientation and (b) a shift in attentional focus that together combine to undermine self-control at Time 2.

The first process is a shift in motivational orientation away from suppressing and inhibiting desires and toward approaching and gratifying them. What we mean by this is that initial acts of control lead people to become less motivated to engage in further deliberative control and more motivated to engage in things that are more personally rewarding, interesting, and enjoyable.

The second process, which occurs in tandem with the first, is a shift in attention away from cues signaling the need to exert control and toward cues signaling gratification. Self-control is often initiated when discrepancies between desired states and current states are detected (Carver & Scheier, 1981), and ample evidence attests to the importance of monitoring in control processes (e.g., Wegner, 1994; see Robinson, Schmeichel, & Inzlicht, 2010). We propose that after an initial

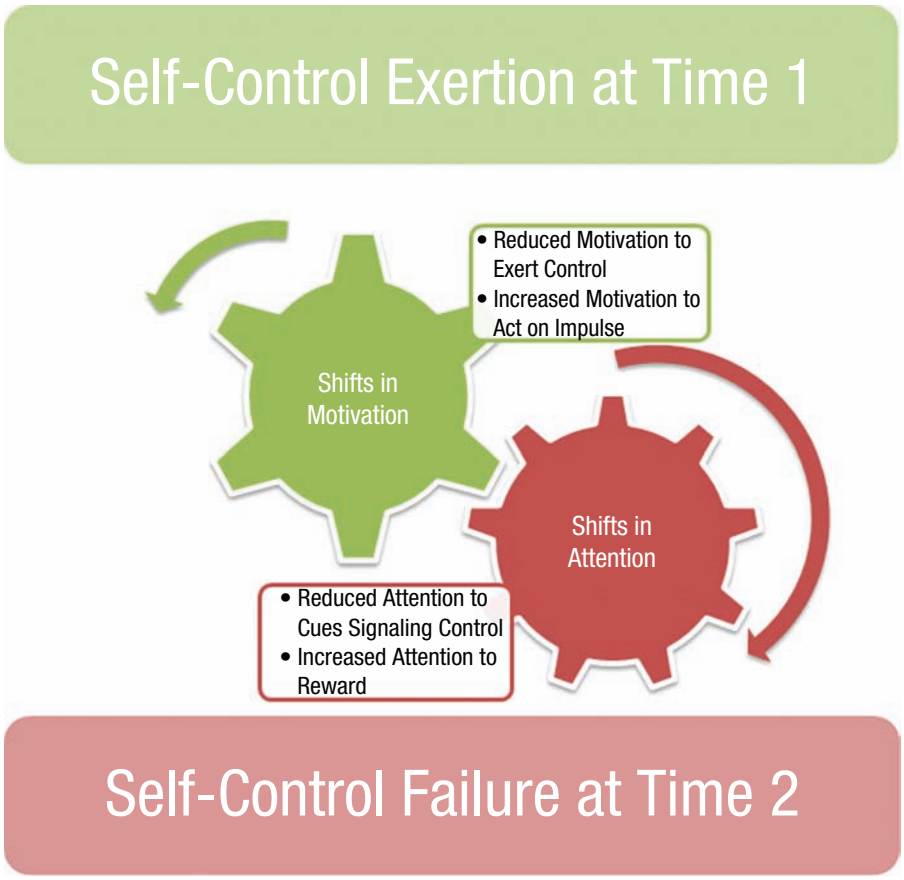


**Fig. 1.** The process model of ego depletion. Self-control exertion at Time 1 leads to self-control failure at Time 2 by inducing shifts in motivation away from self-regulation and toward self-gratification and attendant shifts in attention away from cues signaling the need for control and toward cues signaling reward.

act of self-control, people experience a shift in this monitoring process, such that they become less attentive to cognitive and affective signals indicating a conflict or discrepancy between desired and current states. Instead, they notice and attend to cues associated with reward and gratification.

With shifts in motivation away from restraint and toward gratification and parallel shifts in attention away from conflict and discrepancy and toward the possibility of reward, people become prone to disinhibited behavior, approaching appetitive stimuli with abandon. In other words, self-control depletion is not some mysterious result of lost self-control resources but rather the result of shifts in motivation, attention, and emotion. Before delving more deeply into the process model of ego depletion, we first provide more background on the resource model itself and on recent findings that challenge the model, making plain the need for a more precise, mechanistic account of the ego depletion effect.

## The Resource Model of Control

Research on the limited resource model suggests that all manner of self-regulation and self-control rely on the same depletable resource. The evidence thus far has linked habit breaking, choice making, rational thinking, response inhibition, mental and physical endurance, and several other self-regulated responses to the same resource. For example, several studies have observed that people who have recently exerted self-control respond more aggressively to insults, suggesting a reduced capacity to regulate aggression. In one study, resisting (versus not resisting) tempting foods during the first phase of the experiment made participants more likely to denigrate an insulter's competence during the second phase of the experiment (Stucke & Baumeister, 2006). Another study found that ignoring (versus not ignoring) salient visual stimuli at Time 1 caused an increase in aversive noise blasts directed toward an insulter at Time 2 (DeWall, Baumeister, Stillman, & Gailliot, 2007). These findings and several others (e.g., Denson, Pederson, Friese, Hahm, & Roberts, 2011; Finkel, DeWall, Slotter, Oaten, & Foshee, 2009) suggest that the self-regulation of aggressive impulses is reduced by prior, unrelated acts of self-control.

Other studies have found similar evidence using quite different forms of self-regulation at Time 1 and Time 2, respectively. For example, one study reported by Vohs and colleagues (2008) found that making many choices between consumer products, as one might do at a Wal-Mart or at the cereal aisle of a grocery store, causes a reduction in tolerance on a subsequent pain test. Tolerating pain requires more self-control than does indulging the desire to reduce or eliminate the experience of pain, so the evidence for reduced pain tolerance suggests poorer self-control after making a series of choices. These findings and over 100 more lend support to the idea that all manner of self-regulation relies on a limited inner resource or strength (for a recent meta-analysis, see Hagger, Wood, Stiff, & Chatzisarantis, 2010).

But what is the resource? It seems to underlie an impressive array of behaviors, but most experiments do not directly observe it. Rather, they infer its presence or absence based on performance of the second of two sequential self-control tasks. This inference is consistent with the resource model, but most evidence derived from the sequential task paradigm does not specify or more completely characterize the nature of the resource. Is it anything more than a metaphor?

Perhaps the most notable attempt to locate the metaphorical resource in physical reality emerged from studies on glucose levels in the bloodstream. Gailliot, Baumeister, and colleagues (2007) argued and found that exerting self-control quickly consumes glucose, that drops in glucose help to mediate the ego depletion effect, and that adding glucose to the bloodstream counteracts the effect. Together, the three interrelated findings strongly suggested that the resource is, in fact, more than a metaphor.

But the glucose findings have proven controversial. The evidence that exerting self-control consumes more glucose compared with other tasks has been challenged on multiple grounds (e.g., Beedie & Lane, 2012; Kurzban, 2010; Molden et al., in press). This is important because the central prediction of the resource model is that exerting self-control consumes and depletes the resource. If exerting self-control does not reliably reduce blood glucose levels, then the idea that glucose is the physical manifestation of the metaphorical resource is in doubt. Self-control may nevertheless operate on the basis of some limited inner resource, but the resource must be something other than glucose.

At the same time, several experiments have now found that consuming (e.g., Denson, von Hippel, Kemp, & Teo, 2010) or simply gurgling (Molden et al., in press) glucose-laden beverages enhances self-control and eliminates the ego depletion effect (e.g., Masicampo & Baumeister, 2008). But it remains an open question whether the limited resource model or some other model of self-control better characterizes these benefits. We suppose the link between glucose and behavior is more complex than the one-to-one relationship implied by the resource model, but a more specific understanding of the proximal mechanisms involved in the ego depletion effect will be needed to locate the metaphor in physical reality.

As the nature of the resource has remained in doubt, findings have accumulated to challenge the resource model. For example, Muraven and Slessareva (2003) found that motivational incentives to perform self-control at Time 2 eliminate the ego depletion effect, which suggests that ego depletion may be a motivational deficit, not a resource deficit. Clarkson, Hirt, Jia, and Alexander (2010) found that perceptions of resource depletion predicted performance patterns in the sequential task paradigm better than did actual depletion (i.e., actual exertion of self-control), which suggests that the ego depletion effect may be driven by subjective perceptions rather than reduced resources. Job, Dweck, and Walton (2010) found that personal or lay beliefs about willpower, specifically beliefs about whether it is a limited or unlimited resource, can

moderate the ego depletion effect, which suggests that merely believing that willpower is unlimited can eliminate the effect. Wan and Sternthal (2008) found that factors that enhance monitoring of behavior, such as explicit feedback about task performance and individual differences in self-monitoring, can counter the depletion effect, which suggests that depletion may be a monitoring issue more than a resource depletion issue (see also Alberts, Martijn, & de Vries, 2011; Seeley & Gardner, 2003). Last, research by Tice, Baumeister, Shmueli, and Muraven (2007) found that the induction of positive mood could reverse depletion, and Schmeichel and Vohs (2009) found that self-affirmation had a similar effect. These two findings pose a challenge to the resource model because it is unclear how affirming a core value or watching a funny video could instantly restore a limited resource, particularly one thought to be based on glucose.

These findings suggest both that something very much like the ego depletion effect (i.e., poorer self-control at Time 2 in the sequential task paradigm) can emerge even when actual resource depletion seems unlikely to have occurred and that beliefs, affirmations, moods, and other variables can mitigate against poorer self-control at Time 2. In this light, it is reasonable to wonder about both the sufficiency and the necessity of the resource metaphor for explaining self-control. We think a more detailed, more specific model is needed before the resource metaphor is stretched too thin.

## The Process Model of Ego Depletion

Given the manifest problems with the resource model—including the limits of what can be inferred from the sequential task paradigm (Hagger et al., 2010) and general difficulties in confirming resource models (Navon, 1984)—we propose that the time is now ripe to dig deeply and consider more mechanistic accounts of why self-control seems limited. Before we embark on a detailed account of the model, we would like to caution that there has been surprisingly little empirical research exploring the mechanisms of ego depletion. Research in the area has sacrificed deep explorations of process for broad explorations of application. The result is that we know a considerable amount about the domains affected by depletion (e.g., aggression, eating, cognitive performance, self-presentation) but surprisingly little about the process of depletion. Thus, when discussing the process model, we highlight not only existing evidence but also where evidence is lacking.

The dearth of process research also means that much of the evidence we review is of studies that explored the moderation of the depletion effect and not necessarily its mediation. Although some theorists have observed that evidence of moderation is not evidence for mediation (e.g., Baumeister & Vohs, 2007), moderation may offer clues to mediation. Spencer, Zanna, and Fong (2005) even suggested that manipulating a putative mediator in a moderator study can provide a better understanding of underlying causal processes than measuring it in a mediation study (see also Sigall & Mills, 1998). Thus, we suspect moderator studies can point to likely mechanisms of experimental effects, although in the case of ego depletion we acknowledge that more direct studies of mediation are needed as well.

Further, it is important to note that the process model offers a proximate explanation of depletion, not an ultimate one. When asking why engaging in self-control at Time 1 diminishes control at Time 2, two broad categories of answers are possible. The first type of answer, termed proximate, addresses how depletion works. The second type of answer, termed ultimate, addresses why depletion exists (Scott-Phillips, Dickins, & West, 2011). These two types of answers are complementary, and each is important in its own right. Whereas others have taken the ultimate route, addressing how depletion may serve some adaptive function (e.g., Beedie & Lane, 2012), here we take the proximate route, addressing how depletion functions.

### *Shifts in motivation: I do not want to control myself*

One process that contributes to self-control failure is motivational in nature. We propose that initial acts of self-control shift people's motivation away from further restraint and toward gratification. Engaging in self-control, by definition, is hard work; it involves deliberation, attention, and vigilance (Muraven & Baumeister, 2000). For example, when people override their emotional expressions while watching a disturbing movie, they expend more effort than they would if they watched the same movie free of constraints (Muraven et al., 1998; Schmeichel, Vohs, & Baumeister, 2003). And after people have done this work, after they have expended this effort, they are less motivated to do any further work or to expend further effort.

Note that in almost every experiment on ego depletion, participants are offered little or no incentive for performing at Time 1. Typically they receive some form of compensation for their participation in the experiment (e.g., extra credit, modest cash payment), but tangible rewards for performing specific tasks in the experiment (e.g., task at Time 1) have been virtually nonexistent. We think this is an underappreciated feature of the sequential task paradigm and the ego depletion effect: Participants in the depletion conditions work harder at Time 1 than control participants but receive no additional benefit. The result of this is that participants in the depletion condition may be less inclined to control themselves any further.

When participants in a study work hard, they may not feel like working very hard afterward. In a sense, participants may feel they have done their part for the experiment, that they have fully met their commitment to the study, and are in fact "owed" a break. Another way to think of this is that after engaging in an initial act of self-control, people feel justified in slacking off (Kivetz & Simonson, 2002). This type of "self-licensing" (De Witt Huberts, Evers, & De Ridder, in press) suggests that failures of self-control on the second task of the

sequential task paradigm may not reflect a deficit in some central self-control resource—they may instead reflect motivational deficits or self-justified indulgences. The point here is that expending initial effort demotivates people from expending further effort. So the first step intervening between self-control at Time 1 leading to self-control failure at Time 2 is that people become unmotivated to regulate themselves; it is not that they cannot regulate but that they choose not to regulate.

This idea is consistent with an emerging evolutionary account of glucose and resource allocation (Beedie & Lane, 2012). This new formulation does not challenge glucose's importance in the control of behavior (cf. Kurzban, 2010; Molden et al., in press) but challenges the notion that self-control failure is the result of a lack of glucose available in the bloodstream. Instead, this formulation suggests that glucose is readily available in the brain and body but that its allocation depends on the person's motivational state. When a person is not motivated to engage in a specific behavior, glucose will not be allocated to engage in that behavior.

Support for motivation as a key element of the ego depletion effect was first uncovered by Muraven and Slessareva (2003), who found that although engaging in self-control at Time 1 indeed depleted self-control at Time 2, depletion was overcome when participants were offered incentives (e.g., money) for performing self-control at Time 2. Motivation, in other words, moderated the typical depletion effect observed in the sequential task paradigm.

Muraven, Shmueli, and Burkley (2006) further found that ego depletion was dependent on whether participants expected to perform a demanding task in the future (see also Tyler & Burns, 2009). When participants expected to engage in three sequential tasks, they slackened effort on the second of these tasks compared with when they expected only to engage in two sequential tasks. The implication is that participants strategically applied and withheld effort on the second task, depending on what they expected to do next. When they expected to work hard at some future time, they were motivated to conserve their effort on the current task. So what appears to be depletion of a limited resource may actually be the motivated and strategic withholding of effort.[2]

By indicating that motivation moderates depletion, these lines of research suggest that motivation—but not necessarily the presence or absence of some central volitional resource—influences self-control outcomes. Given that underlying processes can be understood through experimental moderation (Sigall & Mills, 1998; Spencer et al., 2005), these results can be taken as evidence that motivation is part of the process. They hint at the possibility that engaging in control at Time 1 may lower the motivation to engage in control at Time 2 and shift motivation toward engaging in something more gratifying.

For example, when dieters restrain themselves on an initial task, they are more likely to subsequently overeat (Vohs & Heatherton, 2000). Is this evidence that initial acts of control deplete dieters' self-control resources, leaving them unable to restrain their desires to eat? Or is it also possible that after working hard on an initial task that the dieters simply did not feel like regulating their impulses, preferring to gratify themselves instead? Similarly, past research indicates that initial acts of control lead people to spend less time on ensuing tasks that are physically demanding, for example, squeezing a handgrip exerciser (Inzlicht, McKay, & Aronson, 2006; Muraven et al., 1998) or submerging one's hand in very cold water (Schmeichel & Vohs, 2009). Do these studies provide evidence that initial acts of control deplete some central volitional resource, leaving people incapable of long bouts of physical endurance? Or is it also possible that after engaging in initial acts of control, participants feel they have worked hard enough and justify withholding effort on yet another difficult task, preferring to gratify some more pressing desire (e.g., finishing the experiment)? Many—if not all—of the depletion findings can be interpreted in this light, but the extant findings do not adequately distinguish between reduced ability versus reduced motivation.

So what is the evidence that engaging in control at Time 1 directly diminishes the motivation to further regulate? Although mediation can be tested by experimentally manipulating a putative mediator such as motivation, it would also be desirable to measure motivation. To our surprise, we found only one published study that bothered to measure engagement with the Time 2 task (Muraven, Rosman, & Gagne, 2007, Study 3), and this study examined only self-reported engagement and interest in the Time 2 task, not the motivation to self-regulate on the task. Nonetheless, this study failed to find a significant difference in self-reported engagement between those who did and those who did not exert self-control on the Time 1 task. Although the null result suggested similar levels of interest and engagement in the two conditions, this study's status as the sole attempt to measure the motivation to exert self-control as a process variable points to a significant gap in the literature.

Clearly, more research is needed to examine the possibility that depletion is mediated by lower motivation to regulate. For example, of the handful of studies that have included motivational incentives, none have offered motivational incentives for the Time 1 task. There is reason to think that being rewarded for exerting self-control on Task 1 may motivate good performance on that task (Eisenberger, 1992) and lead to no depletion or even enhanced performance on the Time 2 task (e.g., Converse & DeShon, 2009). Here is one avenue for future research that could further elucidate motivational aspects of the depletion effect. We urge researchers to measure and manipulate motivation, especially the motivation to exert self-control, in addition to measuring behavior, and to do so by complementing simple measures of self-reports by using the full range of tools available in the social cognitive affective neuroscience toolbox. On the basis of the process model of depletion, we would expect that participants who exercised self-control on Task 1 would report less motivation to perform

well on Task 2 and may show more subtle signs of reduced motivation to exert control on Task 2 (e.g., less pupil dilation, less energy mobilization as assessed by cardiac and skin conductance reactivity).

## Shifts in motivation: I want to go with my gut

We do not mean to suggest that people are completely demotivated after exerting self-control on Task 1. Indeed, several experiments have found that exerting self-control increases subsequent behaviors that are widely assumed to reflect strong motivation, including aggressive behavior, cigarette smoking, and alcohol consumption (Muraven, Collins, & Neinhaus, 2002; Shmueli & Prochaska, 2009; Stucke & Baumeister, 2006). Rather, we propose that depleted individuals exhibit a shift in motivational orientation. They become less inclined to control themselves, and at the same time they become more apt to act on impulse.

Self-control can be construed as a competition between two opposing forces: the force that motivates the expression of an impulse (i.e., impulse strength) versus the countervailing force that overrides the impulse (i.e., self-control strength). In this view, self-control succeeds when the impulse is relatively weak, when control is relatively strong, or through some combination of both of these factors (Heatherton & Wagner, 2011; Hofmann, Friese, & Strack, 2009; Strack & Deutsch, 2004). Conversely, failures of self-control may stem from strong impulses, weak control, or a combination of both factors.

Research on the resource model of self-control has focused on the control side of the equation, and the dominant interpretation of the ego depletion effect is that it represents a temporary reduction in self-control strength. But several findings in the ego depletion literature are open to the alternative interpretation that behavior at Time 2 represents increased impulse strength, rather than or in addition to reduced self-control strength.

For example, Inzlicht and Kang (2010) observed that coping with stereotype threat, believed to require self-regulatory resources (Inzlicht, Tullett, Legault, & Kang, 2011; Schmader, Johns, & Forbes, 2008; see Inzlicht & Schmader, 2011), causes participants to overeat ice cream later on. The authors interpreted their finding as evidence that performing the initial self-control task reduces the capacity to control unhealthy food intake at Time 2, consistent with the limited resource model. But on logical grounds, it is also possible that performing the initial self-control task increased participants' motivation to consume delicious food. The behavioral outcome—more ice cream eaten—by itself is not sufficient to reveal whether weak control or strong impulses were the root cause.

We suspect that exerting self-control at Time 1 can lead to subsequent increases in impulse strength. Recent research by Schmeichel, Harmon-Jones, and Harmon-Jones (2010) confirmed this view by finding that approach-motivated impulses increase in strength under ego depletion. They reasoned that although several approach-motivated behaviors, such as eating and aggression, are frequent targets of self-control, some approach-motivated behaviors should be relatively free from the influence of self-control because the person has no interest or inclination to control them. For example, although gambling for high-stakes winnings can reflect both low self-control and high approach, gambling for low-stakes winnings (e.g., Monopoly money) reflects mainly approach motivation because there is no need to restrain such behavior. Indeed, Schmeichel and colleagues (2010) found that betting on low-stakes gambles was sensitive to variations in trait levels of incentive salience but not to variations in trait levels of self-control. That is to say, individuals with higher (versus lower) approach motivation bet more often on low-stakes gambles, but individuals with higher self-control bet just as frequently as those with low self-control. Crucially, Schmeichel et al. (2010) found that exerting self-control at Time 1 increased betting on low-stakes gambles. This suggests that exerting self-control can increase an approach-oriented response even when self-control is seemingly irrelevant.

Several additional findings lend indirect support to the idea that exercising self-control increases approach-motivated impulse strength, though admittedly most of these suffer from the typical ambiguity of whether strong impulses or weak control is the culprit. For example, when engaging in self-control at Time 1 increases aggression at Time 2 (e.g., Stucke & Baumeister, 2006), is this because self-control exertion depletes people of the resource needed to restrain aggressive acts? Or is it because exertion increases anger, a strong approach-related emotion (Carver & Harmon-Jones, 2009)?

The first focused effort to distinguish the effects of prior control on subsequent impulse strength found evidence for stronger approach-motivated impulses (Schmeichel et al., 2010). Initial exertions of self-control motivate people to pursue incentives and possibly to experience all manner of incipient impulses more intensely. To our knowledge, this is the only series of studies that has bothered testing for an effect of self-control exertion on subsequent strengthening of impulsive tendencies. More research is needed.

## Shifts in attention: Do I need to control myself now?

The second major process in the model concerns attention. As described in the previous section, we propose that after people engage in self-control, they become less motivated to engage in further control and instead become motivated to gratify their urges and desires. We further propose that this shift in motivation away from restraint and toward gratification is accompanied by a parallel shift in attention away from cues signaling the need to control and toward cues signaling the possibility of reward. Self-control failure in the sequential task paradigm may come about, in other words, because people fail to notice when control is actually needed. Ego depletion may be less a result of people being unable to exert control and more about changes in attention so that people fail to notice when control is actually required.

We touched on the central role of monitoring in self-control earlier in this article, but here we provide a more complete account. A number of models posit a prominent role for attention in signaling when control is needed, most notably cybernetic models of control. Cybernetic or feedback loop models emphasize both the "motor" of self-control and a process that gets the motor started—a monitoring or attentional process (Wiener, 1948). Cybernetic models invariably imbue control with three components: (a) goals or standards, (b) comparators or monitors, and (c) effectors or operators. Goals or standards are desired set points or criteria; comparators or monitors attend to the current state of the environment to detect and alert for discrepancies or conflicts between goals and standards; and effectors or operators are the "motors" of self-control that are called on to make corrections and adjustment to reduce the size of state or goal discrepancies.

Social and personality psychologists have elaborated on this structure, postulating, for example, test versus operating mechanisms in action control (Carver & Scheier, 1981) or monitoring versus operating processes in thought control (Wegner, 1994). Similarly, neuroscientists have described cognitive control as relying on two separate neural systems that operate once a goal has been established. The first, described as a conflict-monitoring or error-detecting system (Botvinick, Braver, Barch, Carter, & Cohen, 2001; Gehring, Goss, Coles, Meyer, & Donchin, 1993; Holroyd & Coles, 2002), monitors ongoing behavior and is sensitive to conflicts between intended and actual responses. When a discrepancy is detected, this information is passed to the second regulatory system, which implements the desired response while suppressing incompatible responses. Neuroimaging studies have suggested that the monitoring and control systems are implemented by the anterior cingulate cortex (ACC) and the prefrontal cortex, respectively (e.g., Dehaene, Posner, & Tucker, 1994; Heatherton & Wagner, 2011; Kerns, Cohen, MacDonald, Stenger, & Carter, 2004).

According to cybernetic models, then, self-control can fail because of problems with the motor of control, such as when a person does not have the ability to regulate his or her impulses. In addition, self-control can fail because of problems with the monitoring system, such as when individuals fail to notice a discrepancy between their current state and their standards or goals. For example, when people make more errors on the Stroop task after an initial act of control (Johns et al., 2008), it could be because they were unable to override their prepotent word-reading response, or it could also be because they stopped paying attention to their goal of naming the color of words (but not reading them). Although both operating and monitoring processes are important, the monitoring process is thought to be especially important because without it control would not be engaged in the first place (Botvinick et al., 2001). The resource model of self-control has focused on the operating process and has generally neglected the monitoring process (Robinson et al., 2010; Wan & Sternthal, 2008). The process model acknowledges the importance of the monitoring process, suggesting that initial acts of control lead to failures of attention, more specifically a neglect of the self-control goal at hand (Kane & Engle, 2003), thereby contributing to subsequent self-control failures.

But why should engaging in an initial act of control affect attention in such a way? As we discuss in detail below, shifts in motivation and attention are interdependent and iterative processes. One way that self-control at Time 1 affects attention, then, is through its related effects on motivation: When people are less motivated to regulate and more motivated to indulge, they may pay less attention to cues signaling the need for control and more attention to cues signaling reward. Engaging in prolonged periods of self-control at Time 1 may also entrain a specific kind of mindset that facilitates success at the Time 1 task but also spills over to directly influence attention at Time 2. This entrained mindset can facilitate control when the Time 1 and Time 2 tasks are similar, but it disrupts subsequent control when the two tasks differ (Dewitte, Bruyneel, & Geyskens, 2009; Wan & Agrawal, 2011). The bulk of studies on resource depletion use different forms of self-control in each part of the sequential priming task, suggesting that the typical ego depletion study may disrupt attention through the costs associated with switching between mindsets or tasks (Monsell, 2003).

Research by Inzlicht and Gutsell (2007) supports the attentional disruption view by suggesting that initial exertions of self-control dull the monitoring system that is responsible for getting self-control started. They found that the neural system that monitors for discrepancies between goals and current states is weakened after initial acts of control and in fact mediates the ego depletion effect. Specifically, Inzlicht and Gutsell (2007) examined the impact of self-control at Time 1 on the error-related negativity (ERN), an evoked brain potential thought to be generated by the ACC and theorized to be a neural correlate of the monitoring system (Botvinick et al., 2001; Dehaene et al., 1994; Falkenstein, Hohnsbein, & Hoormann, 1990; Gehring et al., 1993). The ERN is evoked when people make errors on speeded reaction time tasks. Although there is considerable debate about the significance of the ERN (e.g., Inzlicht & Al-Khindi, in press; Weinberg, Riesel, & Hajcak, in press; Yeung, 2004), many agree that it reflects some aspect of a performance or conflict monitoring system and therefore is important for self-control (e.g., Yeung, Botvinik, & Cohen, 2004).

In their study, Inzlicht and Gutsell (2007) found that participants who engaged in self-control at Time 1 showed poorer attentional control on the Stroop task at Time 2. Crucially, participants in the depletion group also exhibited depressed ERN amplitudes when making errors on the Stroop task, and these lower ERNs mediated the effect of depletion on poor attentional control. What this suggests is that depletion weakens monitoring of self-control failures; it blunts attention, leading to a kind of goal neglect, so that people are less likely to notice instances when regulation and control are required. In short, depletion dulls the systems that monitors for discrepancies between desired and current states

To our knowledge, this is the first focused attempt to probe the attentional—and attendant emotional (Inzlicht & Al-Khindi, in press)—repercussions of ego depletion. This study suggests that initial exertions of self-control dull the attentional system that is responsible for getting self-control started. Other data lend indirect support to this suggestion. Using a moderator approach, Wan and Sternthal (2008) found that performance feedback eliminated the typical ego depletion effect. If we consider performance feedback as a kind of external cue that signals discrepancies between desired and actual levels of performance, this finding suggests that getting people to pay attention to the self-control demands of a situation can prevent self-control failure at Time 2. Other factors that similarly hone attention moderate depletion in the same way. For example, both individual differences in self-monitoring (Seeley & Gardner, 2003; Wan & Sternthal, 2008) and situational changes in self-awareness (Alberts et al., 2011) moderate the effect of self-control exertions on subsequent performance. Although some might argue that these sorts of findings merely indicate that attention moderates depletion, there are good reasons why they might also indicate that attention mediates the effect (Spencer et al., 2005).

Taken together, these studies indicate that when people exert self-control at Time 1, they are less likely to attend and react at Time 2 to cues suggesting that self-control is needed. For example, when engaging in self-control at Time 1 leads to more alcohol consumption among men about to take a driving test (Muraven et al., 2002), is this because people's self-control resources are depleted? Or is it because these men did not properly attend and react to the fact that consuming alcohol could make them poorer drivers? Clearly, more research is needed to shed light on these questions.

## *Shifts in attention: I see rewards*

We do not mean to imply that depletion weakens attention more generally. Rather, we propose that depletion leads to a shift in attention away from signs of goal conflict and discrepancy and instead toward signs of possible reward and gratification. According to revised reinforcement sensitivity theory (Corr, 2008; Gray & McNaughton, 2000), behavior depends on three underlying attentional and motivational systems. One is the behavioral activation system, which is strongly related to approach motivation; second is the fight–flight–freeze system, which mediates reactions to aversive stimuli; third is the behavioral inhibition system (BIS), which is sensitive to conflicts that arise within and between the other two systems and is conceptually and empirically related to the conflict monitoring system discussed above (Amodio, Master, Yee, & Taylor, 2008). According to the joint subsystems hypothesis (Corr, 2008; Nash, Inzlicht, & McGregor, 2012), the system attuned to cues for goal conflict has a reciprocal relationship with the system attuned to cues for approach. This implies that when depletion dampens the conflict monitoring system (Inzlicht & Gutsell, 2007), it may amplify attention to cues for approach.

One of the consequences of depletion-dampened BIS (Inzlicht & Gutsell, 2007) might be that people will become more sensitive to rewards; they might attend more to immediate gratification or any signal that reward is possible. For example, when depleted participants are presented with an array of consumer products (Vohs & Faber, 2007), they may overlook the fact that they could save their money for other occasions and instead focus on the attractiveness of the products and overspend on them as a result. In short, by weakening an attentional system sensitive to goal conflicts, depletion may strengthen the attention system sensitive to reward and pleasure.

Recent research by Schmeichel and colleagues (2010; Study 3) is consistent with this view, insofar as they found that depletion heightens attention to reward-related stimuli. In this study, participants engaged in a writing task at Time 1, with participants in the depletion group being asked to engage in controlled writing (e.g., no use of words with the letters "A" or "N") versus free writing for participants who wrote without restrictions. At Time 2, all participants were then exposed to visual symbols that are associated with reward (a dollar sign) or to symbols not associated with reward (a percent sign) and asked to make quick identity judgments about these symbols. Results indicated that exerting self-control at Time 1 led participants to more accurately perceive and detect the dollar signs but not percent signs, relative to participants who had not previously exercised self-control. Depletion, that is, facilitated the perception of a symbol associated with a prominent reward—money—but did not facilitate the perception of a symbol that was not associated with reward. It is not the case that exercising self-control improved perception generally; rather, only the perception of the reward-relevant symbol was improved. As far as we know, this is the only study examining attention to reward-relevant stimuli after initial self-control exertion.

It is important to note that although there is evidence that depletion dampens attention to cues signaling the need for control (Inzlicht & Gutsell, 2007) and heightens attention to cues signaling reward (Schmeichel et al., 2010), we know of no evidence that depletion heightens attention to reward cues because it dampens attention to control cues. Future work is therefore needed to test our attention shifting hypotheses, with designs that capture the interaction between attention dampening and intensifying effects. As with our shifting motivation hypothesis, we urge researchers to explicitly test for the effects of depletion on attention and to do so by moving beyond self-report.

## *Interaction between motivation and attention*

In sum, we propose that two interrelated and iterative processes mediate the effect of self-control exertion at Time 1 on

self-control failure at Time 2. First, initial exertion leads to a shift in motivation away from control and toward gratification, and second, exertion leads to a shift in attention away from cues that control is needed (e.g., goal conflict) and toward cues signaling indulgence (e.g., rewarding stimuli). The model also assumes that motivation and attention each affect the other.

When people become motivated to perform a task, they show increased signs of brain-implemented performance monitoring. For example, paying participants with cash incentives (Hajcak, Moser, Yeung, & Simons, 2005), closely monitoring the accuracy of their performance (Gehring et al., 1993), or giving them a choice to perform an intrinsically interesting task (Legault & Inzlicht, 2012)—all of which effectively increase task motivation—can all boost the functioning of the ACC-generated performance-monitoring system, as measured by the ERN. Conversely, when participants feel unmotivated to perform a task, they show signs of dulled performance monitoring (Legault & Inzlicht, 2012). Motivation, then, directly influences the operation of the attentional system that initiates control. When people become depleted by working on a task continuously for 2 hr, they show less brain-implemented performance monitoring; but once they are motivated by cash incentives, their performance monitoring rebounds to pre-depletion levels (Boksem, Meijman, & Lorist, 2006). So here is evidence that (a) depletion affects the monitoring system, (b) motivation counteracts depletion, and (c) motivation sharpens monitoring.

Although we have cast the process as shifts in motivation leading to shifts in attention, the reverse order of causation is also possible, with attention affecting motivation (see Mann & Ward, 2007). For example, when a person's attentional resources become narrowly focused on goal-violating central cues in the environment (e.g., when dieters are seated in front of photographs of delicious food), they become motivated to indulge themselves. In contrast, when they become focused on goal-enhancing cues (e.g., when dieters are seated in front of a scale), they become motivated to inhibit their impulses (Mann & Ward, 2007). In theory, if people attend less to cues signaling the need to control and more toward cues signaling the possibility of reward, they might show attendant shifts in motivation away from further control and toward the gratification of impulses. In short, we suspect that the effects of depletion on attention and motivation are iterative, but clearly, more research is needed to verify this claim.

## Integrating the Process Model With Other Models and Findings

Our goal in presenting a process model of ego depletion is to move research about self-control and its depletion in the direction of a more precise, mechanistic account. The process model may not be as elegant as the original resource model, but by sacrificing simplicity, we suggest that it can not only account for more findings—especially the ones at odds with the original resource model—but also allow for integration with other, complementary models of self-control.

### *Accommodating conflicting results*

A growing number of findings are difficult to reconcile with a strict resource model (e.g., Ackerman, Goldstein, Shapiro, & Bargh, 2009; Clarkson et al., 2010; Dahm et al., 2011; Job et al., 2010; Tice et al., 2007; Wan & Sternthal, 2008). Although a thorough review of these discrepant findings is beyond the scope of the current review, we discuss three to illustrate how the process model can accommodate them.

Job and colleagues (2010) mounted perhaps the most serious challenge to the resource model when they found that personal theories of willpower—whether people think willpower is limited versus unlimited—moderate the effect of Time 1 exertion on Time 2 performance. In a series of studies combining both correlational and experimental designs and both lab-based and field studies, Job and colleagues (2010) found that when people believe willpower is fixed and limited, their performance is diminished at Time 2, as is the typical depletion pattern. However, when people believe willpower is self-renewing, they are not so easily depleted and capably exert self-control in the Time 2 task. Job and her colleagues suggested that self-control is what you make of it, that willpower is "in your head."

The evidence that willpower beliefs moderate the ego depletion effect challenges the original formulation of the resource model because it suggests that there is no special resource underlying self-control. But shifts in motivation, as assumed by the process model, can account for those findings. Personal theories of the self dramatically affect motivation (Dweck, 2000), and we suspect that personal theories of the nature of willpower are no different. Specifically, people who think that willpower is limited may be on the lookout for internal signs of depletion or fatigue, and when they detect such signs, they might slacken their motivation and stop exerting effort at self-regulation altogether. People who believe willpower is not so limited, conversely, may notice signs of being tired but interpret them as cues to work harder to get the job done. In short, we construe the findings that personal theories can moderate ego depletion as falling under the broader category of self-control exertion hindering subsequent motivation to exert control.

We offer a similar interpretation of the results of Clarkson and colleagues (2010). These researchers found that people's subjective appraisals of the effort they had exerted at Time 1 was more important in determining self-control at Time 2 than the actual amount of effort exerted at Time 1. As with Job et al.'s (2010) findings, beliefs about one's own mental capacity determine self-control performance. This runs counter to the notion that self-control relies on some limited energy source. Here again, our process model can accommodate these results under the broader category of motivation

affecting control. When people appraise themselves as having few volitional resources (even if they did not previously exert self-control at Time 1), they might slacken self-regulatory efforts and instead be motivated to please their more pressing desires. In contrast, when people appraise themselves as having lots of volitional resources (even if they did in fact exert themselves at Time 1), they might not feel like they are "owed" a break and so remain committed to the experiment and continue to work as hard as they can.

Further, Schmeichel and Vohs (2009) presented additional findings that are difficult to reconcile with the original conceptualization of the resource model. In a series of studies, they found that self-affirmation could stem the ego depletion effect. Specifically, Schmeichel and Vohs (2009) found that participants who engaged in control at Time 1 did not show the typical depletion effect at Time 2 if they were given the opportunity to think and write about their most cherished value in the interim between the two tasks. This evidence challenges the resource model because it is unclear how thinking about a cherished value can instantly change the amount of self-control "energy" available to participants.

By proposing that depletion dulls attention to self-control cues and heightens impulsivity, however, the process model can account for these findings. Self-affirmation heightens the degree to which people attend and react to self-control failures; self-affirmation also buffers approach motivation. New research indicates that self-affirmation kick-starts the same monitoring system (Legault, Al-Khindi, & Inzlicht, in press) and dampens the same approach system (Crowell, Nikitin, & Schmeichel, 2012) that are implicated by the process model. Self-affirmation, that is, amplifies the same ACC-generated conflict monitoring system (i.e., the ERN) that is reduced by depletion (Inzlicht & Gutsell, 2007); it also reduces the same approach-motivated responding that is amplified by depletion (Schmeichel et al., 2010). Self-affirmation may thus counteract depletion by getting people to attend to instances when self-control is required and by curbing impulsive desires, which is an interpretation that is perfectly aligned with the process model.

### *Integrating other models*

Self-control is a broad construct, and models of self-control abound (Vohs & Baumeister, 2011). A thorough review of even some of these models is beyond the scope of the present review. Nonetheless, because we believe there is value in integrating models and theories so as to gain unified views of important psychological constructs (e.g., Hofmann, Schmeichel, & Baddeley, 2012; Proulx, Inzlicht, & Harmon-Jones, 2012), we briefly sketch two models of self-control and describe how they may be seen as complementary to our own process model.

According to the attentional myopia model of self-control (Mann & Ward, 2004, 2007; Ward & Mann, 2000), self-control failure can occur when attention becomes too narrowly focused on central cues in the environment at the expense of focusing on more peripheral cues. This "attentional myopia" can lead to self-control failure whenever salient cues promote a behavior that violates self-standards. For example, one reason smokers fail to quit is because under certain situations their attention becomes so constrained that they have a hard time training their attention away from goal-violating cues in the environment (e.g., an advertisement depicting an attractive woman smoking a cigarette). We view the attentional myopia model as in line with our process model. Specifically, we suggest that self-control fails at Time 2 partly because of shifts in attention away from cues signaling the need for control and toward cues signaling the possibility of reward. Consistent with the attentional myopia model, then, our process model also recognizes that attentional shifts contribute to self-control failure.

The second related model comes from research on self-licensing and related phenomena (Kivetz & Simonson, 2002; Mukhopadhyay & Johar, 2009). This research suggests that people fail to engage in self-control not because they cannot control themselves but because they choose not to. For example, when cruise ship vacationers overindulge at the midnight buffet despite their long-standing goal of losing weight, it is unlikely that a day of rest and relaxation left them depleted of volitional resources. So why did they overeat? According to research on self-licensing, despite having the self-control capacity to overcome their desires, these vacationers may overeat because they willingly abandoned their weight loss goal. In other words, they justified overeating (e.g., "I'm on vacation!") and permitted themselves to indulge (De Witt et al., in press). As with the attentional myopia model above, we understand self-licensing as very much in line with our own process model. In particular, we recognize that self-control failure stems from motivational deficits. When people self-license, they allow themselves to indulge. That is, they shift their motivation away from restricting and toward gratifying themselves. This identical motivational shift plays a key role in the process model.

## Blueprint for Future Research

We close our review by offering suggestions for future research that we hope will guide the field in testing the process model but also in exploring mechanistic explanations of depletion more generally. In conducting our review, we were surprised at how few studies in the relevant literature have incorporated measures of process. For example, although a number of researchers have implied that depletion dampens motivation to exert control (e.g., Beedie & Lane, 2012; Muraven & Slessareva, 2003), we know of only one study that has actually tested this prediction directly (Muraven et al., 2007). This needs to change. Our first recommendation to researchers, therefore, is to measure process variables, especially those implicated by the process model: motivation to restrain and approach and attention to cues for control and reward.

We also recommend that researchers measure process variables outside the confines of the sequential task paradigm. Measuring a process variable after the Time 1 task but before the Time 2 task might allow for the calculation of statistical mediation, but such designs say less about process than is commonly assumed (e.g., Fiedler, Schott, & Meiser, 2011). They may also discourage the kinds of designs and measurements that could prove more fruitful for understanding process. For example, if one wants to test the process model prediction that depletion dulls the monitoring system and transfers attention from one type of environmental cue to another, one could assess attention on the dot-probe task after participants have exerted themselves at Time 1. If one relied solely on the sequential task paradigm, however, one may test these predictions only by using quicker and less cumbersome measurement techniques, such as self-report. We note that of the few extant studies that have successfully tackled process, a number have strayed from the sequential task paradigm (e.g., Schmeichel et al., 2010).

Measuring process is not enough, however. Some processes may prove difficult to measure directly (e.g., motivation to regulate), and thus manipulating putative process variables is equally important (Spencer et al., 2005). Indeed, moderator studies have greatly informed the process model. We recommend that researchers continue to pursue this strategy but also consider how their moderators might inform process, especially those invoked by the process model. For example, we predict that experimentally manipulating attention toward and away from self-control cues on the Time 2 task (e.g., Mann & Ward, 2004) would moderate depletion and thus inform questions of process.

Further, we recommend that researchers take an individual differences approach to mediation. As with moderator studies, individual difference studies can shed light on the core processes underlying how engaging in self-control at Time 1 hinders control at Time 2. Although a number of studies have examined how trait self-control moderates depletion (e.g., Dvorak & Simons, 2009; Gailliot, Schmeichel, & Maner, 2007), very few have examined broader types of personality traits (Hagger et al., 2010). This is unfortunate because an analysis of how various individual differences can moderate depletion can offer deep insight into mechanism. We therefore encourage researchers to consider a broad set of individual difference moderators, especially those that relate to motivation and attention.

## Conclusion

Self-control appears to operate on the basis of a limited inner resource or strength. We both admire and have contributed to the corpus of evidence in support of the limited resource view, namely, research on the ego depletion effect. In the current review, we have proposed a more mechanistic, less metaphorical account of ego depletion that is intended to advance research on this vital topic. Our goal in presenting a process model of ego depletion is to move research beyond elaborations of the breadth of the phenomenon and toward an elaboration of its core processes. That self-control exertion at Time 1 affects self-control at Time 2 has been replicated over 100 separate times. Now we need to gain a more precise understanding of why that is.

The process model can account for several findings that have challenged the need to invoke inner resources to explain self-control failure. In our view, exerting self-control at Time 1 reduces success at self-control at Time 2 by initiating shifts in motivation and attention that conspire to reduce self-control and increase immediate gratification. The implication of the model is that poorer self-control at Time 2 is best explained by reduced motivation to exert control, reduced attention to cues signaling a need for control, increased motivation to act on impulse, and increased attention to reward-relevant cues. Furthermore, we emphasize that these precursors to self-control failure can be influenced by prior exertions of self-control as well as by other factors. Our model thereby fits nicely with other prominent approaches to the study of self-control that have little or nothing to do with limited resources.

Rather than stretching the resource metaphor thin to explain all the relevant findings, we have attempted to develop a more precise account of the cognitive, affective, and motivational consequences of self-control exertion. It is our hope that such a model advances research and theory on self-control and opens up new avenues for combating self-control failure.

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### Notes

1. A Google Scholar search for this paper on May 8, 2012, revealed 1,303 unique hits.
2. The resource model has been stretched to accommodate such results by suggesting that initial acts of self-control only partially deplete the resource and that ego depletion occurs because people are unwilling to draw further from their reserves (Baumeister & Vohs, 2007). This "energy conservation" account is, at the very least, consistent with the view that diminished motivation to engage in self-control moderates depletion (Hagger, Wood, Stiff, & Chatzisarantis, 2010). We suspect that it may also be consistent with the view that it mediates depletion (Spencer, Zanna, & Fong, 2005).

## References


Ackerman, J. M., Goldstein, N. J., Shapiro, J. R., & Bargh, J. A. (2009). You wear me out: The vicarious depletion of self-control. *Psychological Science, 20*, 326–332.

Alberts, H. J. E. M., Martijn, C., & de Vries, N. K. (2011). Fighting self-control failure: Overcoming ego depletion by increasing self-awareness. *Journal of Experimental Social Psychology, 47*, 58–62.

Amodio, D., Master, S., Yee, C., & Taylor, S. (2008). Neurocognitive components of the behavioral inhibition and activation systems: Implications for theories of self-regulation. *Psychophysiology, 45*, 11–19.

Baumeister, R. F., Bratslavsky, E., Muraven, M., & Tice, D. M. (1998). Ego depletion: Is the active self a limited resource? *Journal of Personality and Social Psychology, 74*, 1252–1265.

Baumeister, R. F., & Heatherton, T. (1996). Self-regulation failure: An overview. *Psychological Inquiry, 7*, 1–15.

Baumeister, R. F., Heatherton, T., & Tice, D. M. (1994). *Losing control: How and why people fail at self-regulation*. San Diego, CA: Academic Press.

Baumeister, R. F., & Tierney, J. (2011). *Willpower: Rediscovering the greatest human strength*. New York, NY: Penguin Press.

Baumeister, R. F., & Vohs, K. D. (2007). Self-regulation, ego depletion, and motivation. *Social and Personality Psychology Compass, 1*, 115–128.

Beedie, C. J., & Lane, A. M. (2012). The role of glucose in self-control: Another look at the evidence and an alternative conceptualization. *Personality and Social Psychology Review, 16*, 143–153.

Boksem, M., Meijman, T., & Lorist, M. (2006). Mental fatigue, motivation and action monitoring. *Biological Psychology, 72*, 123–132.

Botvinick, M., Braver, T., Barch, D., Carter, C., & Cohen, J. (2001). Conflict monitoring and cognitive control. *Psychological Review, 108*, 624–652.

Carver, C. S., & Harmon-Jones, E. (2009). Anger is an approach-related affect: Evidence and implications. *Psychological Bulletin, 135*(2), 183–204.

Carver, C. S., & Scheier, M. F. (1981). *Attention and self-regulation: A control theory approach to human behavior*. New York, NY: Springer-Verlag.

Clarkson, J., Hirt, E., Jia, L., & Alexander, M. (2010). When perception is more than reality: The effects of perceived versus actual resource depletion on self-regulatory behavior. *Journal of Personality and Social Psychology, 98*, 29–46.

Converse, P. D., & DeShon, R. P. (2009). A tale of two tasks: Reversing the self-regulatory resource depletion effect. *Journal of Applied Psychology, 94*, 1318–1324.

Corr, P. (2008). *The reinforcement sensitivity theory of personality*. Cambridge, England: Cambridge University Press.

Crowell, A., Nikitin, J., & Schmeichel, B. J. (2012). *Affirmed and demotivated: Self-affirmation reduces approach-related responding to affective and social stimuli*. Manuscript submitted for publication.

Dahm, T., Neshat-Doost, H. T., Golden, A.-M., Horn, E., Hagger, M., & Dalgleish, T. (2011). Age shall not weary us: Deleterious effects of self-regulation depletion are specific to younger adults. *PLoS ONE, 6*, e26351. doi:10.1371/journal.pone.0026351

Dehaene, S., Posner, M., & Tucker, D. (1994). Localization of a neural system for error detection and compensation. *Psychological Science, 5*, 303–305.

Denson, T., Pederson, W., Friese, M., Hahm, A., & Roberts, L. (2011). Understanding impulsive aggression: Angry rumination and reduced self-control capacity are mechanisms underlying the provocation–aggression relationship. *Personality and Social Psychology Bulletin, 37*, 850–862.

Denson, T., von Hippel, W., Kemp, R., & Teo, L. (2010). Glucose consumption decreases impulsive aggression in response to provocation in aggressive individuals. *Journal of Experimental Social Psychology, 46*, 1023–1028.

DeWall, C., Baumeister, R. F., Stillman, T., & Gailliot, M. (2007). Violence restrained: Effects of self-regulation and its depletion on aggression. *Journal of Experimental Social Psychology, 43*, 62–76.

Dewitte, S., Bruyneel, S., & Geyskens, K. (2009). Self-regulating enhances self-regulation in subsequent consumer decisions involving similar response conflicts. *Journal of Consumer Research, 36*, 394–405.

De Witt Huberts, J. C., Evers, C., & De Ridder, D. (in press). License to sin: Self-licensing as a mechanism underlying hedonic consumption. *European Journal of Social Psychology*.

Dvorak, R. D., & Simons, J. S. (2009). Moderation of resource depletion in the self-control strength model: Differing effects of two modes of self-control. *Personality and Social Psychology Bulletin, 35*, 572–583.

Dweck, C. S. (2000). *Self-theories: Their role in motivation, personality, and development*. Philadelphia, PA: Taylor and Francis.

Eisenberger, R. (1992). Learned industriousness. *Psychological Review, 99*, 248–267.

Falkenstein, M., Hohnsbein, J., & Hoormann, J. (1990). Effects of errors in choice reaction tasks on the ERP under focused and divided attention. In C. H. M. Brunia, W. K. Gailard, & A. Kok (Eds.), *Psychophysiological brain research* (Vol. 1, pp. 192–195). Tilburg, Netherlands: Tilburg University Press.

Fiedler, K., Schott, M., & Meiser, T. (2011).What mediation analysis can (not) do. *Journal of Experimental Social Psychology, 47*, 1231–1236.

Finkel, E., DeWall, C., Slotter, E., Oaten, M., & Foshee, V. (2009). Self-regulatory failure and intimate partner violence perpetration. *Journal of Personality and Social Psychology, 97*, 483–499.

Gailliot, M. T., Baumeister, R., DeWall, C., Maner, J., Plant, E., Tice, D. M., . . . Schmeichel, B. J. (2007). Self-control relies on glucose as a limited energy source: Willpower is more than a metaphor. *Journal of Personality and Social Psychology, 92*, 325–336.

Gailliot, M. T., Schmeichel, B. J., & Maner, J. K. (2007). Differentiating the effects of self-control and self-esteem on reactions to mortality salience. *Journal of Experimental Social Psychology, 43*, 894–901.

Gehring, W., Goss, B., Coles, M., Meyer, D., & Donchin, E. (1993). A neural system for error detection and compensation. *Psychological Science, 4*, 385–390.

Gray, J., & McNaughton, N. (2000). *The neuropsychology of anxiety* (2nd ed.). New York, NY: Oxford University Press.

Hagger, M., Wood, C., Stiff, C., & Chatzisarantis, N. (2010). Ego depletion and the strength model of self-control: A meta-analysis. *Psychological Bulletin, 136*, 495–525.

Hajcak, G., Moser, J. S., Yeung, N., & Simons, R. F. (2005). On the ERN and the significance of errors. *Psychophysiology, 42*, 151–160.

Heatherton, T. F., & Wagner, D. D. (2011). Cognitive neuroscience of self-regulation failure. *Trends in Cognitive Sciences, 15*, 132–139.

Hofmann, W., Friese, M., & Strack, F. (2009). Impulse and self-control from a dual-systems perspective. *Perspectives on Psychological Science, 4*, 162–176.

Hofmann, W., Schmeichel, B. J., & Baddeley, A. D. (2012). Executive functions and self-regulation. *Trends in Cognitive Sciences, 16*, 174–180.

Holroyd, C., & Coles, M. (2002). The neural basis of human error processing: Reinforcement learning, dopamine, and the error-related negativity. *Psychological Review, 109*, 679–709.

Inzlicht, M., & Al-Khindi, T. (in press). ERN and the placebo: A misattribution approach to studying the arousal properties of the error-related negativity. *Journal of Experimental Psychology: General*. doi:10.1037/a0027586

Inzlicht, M., & Gutsell, J. (2007). Running on empty: Neural signals for self-control failure. *Psychological Science, 18*, 933–937.

Inzlicht, M., & Kang, S. (2010). Stereotype threat spillover: How coping with threats to social identity affects aggression, eating, decision making, and attention. *Journal of Personality and Social Psychology, 99*, 467–481.

Inzlicht, M., McKay, L., & Aronson, J. (2006). Stigma as ego-depletion: How being the target of prejudice affects self-control. *Psychological Science, 17*, 262–269.

Inzlicht, M., & Schmader, T. (2011). *Stereotype threat: Theory, process, and application*. New York, NY: Oxford University Press.

Inzlicht, M., Tullett, A. M., Legault, L., & Kang, S. K. (2011). Lingering effects: Stereotype threat hurts more than you think. *Social Issues and Policy Review, 5*, 227–256.

Job, V., Dweck, C., & Walton, G. (2010). Ego depletion: Is it all in your head? Implicit theories about willpower affect self-regulation. *Psychological Science, 21*, 1686–1693.

Johns, M., Inzlicht, M., & Schmader, T. (2008). Stereotype threat and executive resource depletion: Examining the influence of emotion regulation. *Journal of Experimental Psychology: General, 137*, 691–705.

Kane, M., & Engle, R. W. (2003). Working-memory capacity and the control of attention: The contributions of goal neglect, response competition, and task set to Stroop interference. *Journal of Experimental Psychology: General, 132*, 47–70.

Kerns, J., Cohen, J., MacDonald, A., III, Stenger, V. C. R., & Carter, C. (2004). Anterior cingulate, conflict monitoring, and adjustments in control. *Science, 303*, 1023–1026.

Kivetz, R., & Simonson, I. (2002). Earning the right to indulge: Effort as a determinant of customer preferences toward frequency program rewards. *Journal of Marketing Research, 39*, 155–170.

Kurzban, R. (2010). Does the brain consume additional glucose during self-control tasks? *Evolutionary Psychology, 8*, 244–259.

Legault, L., Al-Khindi, T., & Inzlicht, M. (in press). Preserving integrity in the face of performance threat: Self-affirmation enhances neurophysiological responsiveness to task errors. *Psychological Science*.

Legault, L., & Inzlicht, M. (2012). *The self-determined brain: Autonomous (but not controlled) motivation improves self-control by increasing neural responses to errors*. Manuscript submitted for publication.

Mann, T., & Ward, A. (2004). To eat or not to eat: Implications of the attentional myopia model for restrained eaters. *Journal of Abnormal Psychology, 113*, 90–98.

Mann, T., & Ward, A. (2007). Attention, self-control, and health behaviors. *Current Directions in Psychological Science, 16*(5), 280–283.

Masicampo, E., & Baumeister, R. F. (2008). Toward a physiology of dual-process reasoning and judgment: Lemonade, willpower, and expensive rule-based analysis. *Psychological Science, 19*, 255–260.

Mischel, W., & Gilligan, C. (1964). Delay of gratification, motivation for the prohibited gratification, and responses to temptation. *The Journal of Abnormal and Social Psychology, 69*, 411–417.

Molden, D. C., Ming Hui, C., Scholer, A. A., Meier, B. P., Noreen, E. E., D'Agostino, P. R., & Martin, V. (in press). The motivational versus metabolic effects of carbohydrates on self-control. *Psychological Science*.

Monsell, S. (2003). Task switching. *Trends in Cognitive Sciences, 7*, 134–140.

Mukhopadhyay, A., & Johar, G. V. (2009). Indulgence as self-reward for prior shopping restraint: A justification-based mechanism. *Journal of Consumer Psychology, 19*, 334–345.

Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin, 126*, 247–259.

Muraven, M., Collins, R., & Neinhaus, K. (2002). Self-control and alcohol restraint: An initial application of the self-control strength model. *Psychology of Addictive Behaviors, 16*, 113–120.

Muraven, M., Rosman, H., & Gagne, M. (2007). Lack of autonomy and self-control: Performance contingent rewards lead to greater depletion. *Motivation and Emotion, 31*, 322–330.

Muraven, M., Shmueli, D., & Burkley, E. (2006). Conserving self-control strength. *Journal of Personality and Social Psychology, 91*, 524–537.

Muraven, M., & Slessareva, E. (2003). Mechanisms of self-control failure: Motivation and limited resources. *Personality and Social Psychology Bulletin, 29*, 894–906.

Muraven, M., Tice, D. M., & Baumeister, R. F. (1998). Self-control as a limited resource: Regulatory depletion patterns. *Journal of Personality and Social Psychology, 74*, 774–789.

Nash, K. N., Inzlicht, M., & McGregor, I. D. (2012). Approach-related left prefrontal EEG asymmetry predicts muted error-related negativity. *Biological Psychology, 91*, 96–102.

Navon, D. (1984). Resources—A theoretical soup stone? *Psychological Review, 91*, 216–234.

Proulx, T., Inzlicht, M., & Harmon-Jones, E. (2012). Understanding all inconsistency compensation as a palliative response to violated expectations. *Trends in Cognitive Sciences, 16*, 285–291.

Robinson, M., Schmeichel, B. J., & Inzlicht, M. (2010). A cognitive control perspective of self-control strength and its depletion. *Social and Personality Psychology Compass, 4*, 189–200.

Schmader, T., Johns, M., & Forbes, C. (2008). An integrated process model of stereotype threat effects on performance. *Psychological Review, 115*, 336–356.

Schmeichel, B. J. (2007). Attention control, memory updating, and emotion regulation temporarily reduce the capacity for executive control. *Journal of Experimental Psychology: General, 136*, 241–255.

Schmeichel, B. J., Harmon-Jones, C., & Harmon-Jones, E. (2010). Exercising self-control increases approach motivation. *Journal of Personality and Social Psychology, 99*, 162–173.

Schmeichel, B. J., & Vohs, K. D. (2009). Self-affirmation and self-control: Affirming core values counteracts ego depletion. *Journal of Personality and Social Psychology, 96*, 770–782.

Schmeichel, B. J., Vohs, K. D., & Baumeister, R. F. (2003). Intellectual performance and ego depletion: Role of the self in logical reasoning and other information processing. *Journal of Personality and Social Psychology, 85*, 33–46.

Scott-Phillips, T. C., Dickins, T. E., & West, S. A. (2011). Evolutionary theory and the ultimate-proximate distinction in the human behavioral sciences. *Perspectives on Psychological Science, 6*, 38–47.

Seeley, E. A., & Gardner, W. L. (2003). The "selfless" and self-regulation: The role of chronic other-orientation in averting self-regulatory depletion. *Self and Identity, 2*, 103–118.

Shmueli, D., & Prochaska, J. J. (2009). Resisting tempting foods and smoking behavior: Implications from a self-control theory perspective. *Health Psychology, 28*, 300–306.

Sigall, H., & Mills, J. (1998). Measures of independent variables and mediators are useful in social psychology experiments: But are they necessary? *Personality and Social Psychology Review, 2*, 218–226.

Spencer, S. J., Zanna, M. P., & Fong, G. T. (2005). Establishing a causal chain: Why experiments are often more effective than mediational analyses in examining psychological processes. *Journal of Personality and Social Psychology, 89*, 845–851.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review, 8*, 220–247.

Stucke, T., & Baumeister, R. F. (2006). Ego depletion and aggressive behavior: Is the inhibition of aggression a limited resource? *European Journal of Social Psychology, 36*, 1–13.

Tice, D. M., Baumeister, R. F., Shmueli, D., & Muraven, M. (2007). Restoring the self: Positive affect helps improve self-regulation following ego depletion. *Journal of Experimental Social Psychology, 43*, 379–384.

Tyler, J., & Burns, K. (2009). Triggering conservation of the self's regulatory resources. *Basic and Applied Social Psychology, 31*, 255–266.

Vohs, K. D., & Baumeister, R. F. (2011). *Handbook of self-regulation: Research, theory, and applications* (2nd ed.). New York, NY: Guilford.

Vohs, K. D., Baumeister, R. F., Schmeichel, B., Twenge, J., Nelson, N., & Tice, D. M. (2008). Making choices impairs subsequent self-control: A limited-resource account of decision making, self-regulation, and active initiative. *Journal of Personality and Social Psychology, 94*, 883–898.

Vohs, K. D., & Faber, R. (2007). Spent resources: Self-regulatory resource availability affects impulse buying. *Journal of Consumer Research, 33*, 537–547.

Vohs, K. D., & Heatherton, T. (2000). Self-regulatory failure: A resource-depletion approach. *Psychological Science, 11*, 249–254.

Wan, E. W., & Agrawal, N. (2011). Carryover effects of self-control on decision making: A construal-level perspective. *Journal of Consumer Research, 38*, 199–214.

Wan, E. W., & Sternthal, B. (2008). Regulating the effects of depletion through monitoring. *Personality and Social Psychology Bulletin, 34*, 32–46.

Ward, A., & Mann, T. A. (2000). Don't mind if I do: Disinhibited eating under cognitive load. *Journal of Personality and Social Psychology, 78*, 753–763.

Wegner, D. (1994). Ironic processes of mental control. *Psychological Review, 101*, 34–52.

Weinberg, A., Riesel, A., & Hajcak, G. (in press). Integrating multiple perspectives on error related brain activity: The ERN as a neurobehavioral trait. *Motivation and Emotion*.

Wiener, N. (1948). *Cybernetics: Or control and communication in the animal and the machine*. Oxford, England: John Wiley.

Yeung, N. (2004). Relating cognitive and affective theories of the error-related negativity. In M. Ullsperger & M. Falkenstein (Eds.), *Errors, conflicts, and the brain: Current opinions on performance monitoring* (pp. 63–70). Leipzig, Germany: Max Planck Institute of Cognitive Neuroscience.

Yeung, N., Botvinik, M., & Cohen, J. (2004). The neural basis of error detection: Conflict monitoring and the error-related negativity. *Psychological Review, 111*(4), 931–959.