How Depletion Operates in an Integrative Theory of Self-Control

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Citation
Abstract

This chapter explains how depletion operates within the conceptual framework of integrative self-control theory (SCT; Kotabe & Hofmann, 2015). SCT is a broad and integrative model of self-control which comprises seven components or “nodes”: *desire, higher-order goal, desire-goal conflict, control motivation, control capacity, control effort,* and *enactment constraints.* The interplay of these components results in temptation enactment (“self-control failure”) or temptation nonenactment (“self-control success”). Research on depletion suggests that self-control at Time 1 reduces self-control at a proximate Time 2. What happens between Time 1 and Time 2 is a subject of much debate. We propose that depletion affects effort-related processes via at least three mechanisms: (a) increasing desire strength, (b) decreasing control motivation, and (c) decreasing control capacity. These mechanisms separately increase the likelihood that control effort at Time 2 is insufficient to effectively control temptation. This view suggests that self-control and depletion research would benefit from focusing more on control effort relative to desire strength.

*Keywords:* depletion, ego depletion, self-control depletion, self-control, self-regulation, desire, cognitive control, cognitive effort, cognitive labor, cognitive leisure
Self-control research is fragmented, resulting in definitional, organizational, and integrational problems. Integrating the key components of self-control can be useful for understanding important self-control phenomena, such as “ego depletion” (Baumeister, Bratslavsky, Muraven, & Tice, 1998). In this chapter, we outline integrative self-control theory (SCT) (Kotabe & Hofmann, 2015) on which we base our approach to explaining the depletion effect. We first spell out the key assumptions of SCT in detail. Then, we explain how depletion operates within this theoretical framework. In short, we argue that depletion affects effort-related processes by increasing desire strength, decreasing control motivation, and decreasing control capacity. These mechanisms separately increase the likelihood that after self-control at Time 1, control effort at Time 2 is insufficient to effectively control temptation.

SCT is an integrative model of self-control which applies to self-control cases which involve intrapsychic conflict between desire and a higher-order goal (cf. Carnevale and Fujita’s chapter). Myriad human behavioral phenomena are included such as the dieter tempted by a mouthwatering desert, the designated driver tempted by free cocktails, the faithful spouse tempted by an attractive colleague, the ex-smoker tempted by a pack of cigarettes, the frugal consumer tempted by fashionable but expensive clothes, and the student tempted to sleep in after another long day of exam preparations. The thread entwining these cases is that they revolve around what we call desire-goal (D-G) conflicts. Although D-G conflicts are key to self-control, it is worth mentioning conflicts between desires can conflict with each other and so can goals. There can be desire-desire (D-D) conflicts (i.e., conflicts between two desires such as to one party or another) as well as goal-goal (G-G) conflicts (i.e., conflicts between two goals such as to study versus to exercise). In the case of self-control and depletion, we propose that focusing on the “asymmetric” (Hofmann, Friese, & Strack, 2009; Scholer & Higgins, 2010) case has several
benefits including: stimulating discussion of the characteristics and determinants of two qualitatively different psychological “forces” (Lewin, 1951), their neuropsychological foundations (e.g., triggers and mechanisms of reward-processing in the case of desire; executive operations in the case of higher-order goal pursuit), and how they conflict; drawing attention to possible differences in how people deal with asymmetric desire-goal conflicts versus symmetric D-D or G-G conflicts (e.g., Hofmann, Fisher, Luhmann, Vohs, & Baumeister, 2014); presenting qualitatively different ways through which self-control can fail or succeed (e.g., desire may be mentally overwhelming—a “hot” route—or commitment to higher-order goals may be too weak—a “cold” route); and highlighting novel ways to improve self-control in the long run (e.g., changing desire experiences through evaluative conditioning or motivational retraining while boosting goal commitment through risk education programs).

**SCT in a Nutshell**

SCT proposes that the behavioral outcome of a self-control episode is determined by the interplay of seven core psychological components which could be represented as nodes in a graph (see Figure 1):

1. **Desire.** A driving force which begins as a subcortically-mediated visceral state of ‘wanting’ (as defined by Berridge, Robinson, & Aldridge, 2009), often followed by cognitive elaboration, which directs a person towards immediate reward-related stimuli.

2. **Higher-order goal.** A more cortically-mediated and largely cognitive construct associated with an endorsed end state that motivates instrumental psychological (cognitive, affective, and behavioral) activity. Unlike desires, higher-order goals are often pursued intentionally and associated with declarative expectations of long-term benefits.

3. **D-G conflict.** A form of response conflict caused by the coactivation of a given desire
and an at least partly incompatible higher-order goal. D-G conflict turns desire into temptation and the higher-order goal into a self-control goal.

4. **Control motivation.** The aspiration to control desire. As such, control motivation is determined by the self-control goal as well as additional factors that increase this aspiration.

5. **Control capacity.** All the potential non-motivational cognitive resources a person can use to facilitate the control of temptation (e.g., directed attention and inhibitory capacity).

6. **Control effort.** The effective use of control capacity.

7. **Enactment constraints.** Environmental factors that limit one’s behavioral options.

In a nutshell, SCT proposes that the first three components—desire, higher-order goal, and D-G conflict—are involved in activating self-control (*activation cluster*): A desire (e.g., for relaxation) in itself is unproblematic and perhaps fully endorsed. It is only when an incompatible higher-order goal (e.g., to meet a tight deadline) is present that the desire *becomes* a temptation and the higher-order goal *becomes* a self-control goal. The extent of D-G conflict experienced is a function of the strength of the desire, the strength of the higher-order goal, and the degree to which they are incompatible. D-G conflict activates self-control exertion by triggering control motivation. Control motivation and control capacity are major determinants of control effort. Together, these three components form the *exertion cluster*. Higher control motivation and control capacity yield higher potential control effort—the amount of control effort that one is prepared to spend towards combating temptation. SCT proposes that the strength of temptation, the perceived skill with which one can handle said temptation, and competing goals determine actual control effort—the amount of control effort that one actually uses to effectively combat temptation. If the investment of actual control effort reaches a threshold to prevail over desire
strength, then self-control will “succeed” (i.e., temptation will not be enacted), provided that enactment constraints do not prevent success. If actual control effort does not reach this threshold, then self-control will fail (i.e., temptation will be enacted), provided that enactment constraints do not prevent failure.

**How Depletion Operates in Integrative Self-Control Theory**

One of the major benefits of this integrative approach is that it facilitates a rigorous, mechanistic approach to explaining important self-control phenomena such as the depletion effect. To include the wide range of research on this topic, we define depletion as an effect according to which the investment of self-control effort at Time 1 reduces self-control success at a proximate Time 2. In this section, we apply SCT to explaining the depletion effect, taking a perspective from which depletion can have multiple effects on multiple components of SCT. Specifically, we argue that, within the realm of D-G motivational conflicts, depletion may operate via three separable mechanisms: (a) an increase in desire strength, (b) a decrease in control motivation, and (c) a decrease in control capacity.

**Depletion Increases Desire Strength**

Desire is a psychological driving force that varies in strength and is rooted in innate or learned need states (e.g., for food, alcohol, drugs, sex, rest, social connection, gambling, etc.). It directs a person towards immediate, rewarding stimuli. A person can experience desire even without being cognizant of why he or she is experiencing desire (e.g., imagine the gambler who desires to gamble even when he is certain that he is done for the night). Desire originates as a state of ‘wanting’ (Berridge et al., 2009) when subcortical reward processing regions such as the nucleus accumbens are involved in evaluating external stimuli against the backdrop of internal need states and one’s learning history (Hofmann & Kotabe, 2013). Relatively fast associative
processes give rise to spontaneous, intrusive thoughts about the appetitive target. When those intrusive thoughts signal the possibility of pleasure or relief, cognitive elaboration usually ensues (Kavanagh, Andrade, & May, 2005). Through cognitive elaboration, desires can “crowd out” concurrent cognitive activity associated with higher-order goals (Hofmann, Friese, Schmeichel, & Baddeley, 2011; Hofmann & Van Dillen, 2012; Kavanagh et al., 2005). Cognitive elaboration also maintains the desired target in working memory over an extended period.

There is mounting evidence that depletion increases desire strength (the desire-based depletion hypothesis) (see Schmeichel and Crowell’s chapter). Recent research lending support to this hypothesis suggests that depletion heightens urges and feelings. In an experience sampling study and two follow-up experiments, Vohs et al. (2013) showed that depletion led to stronger desires, not only when measured at one moment in time after a depletion manipulation but also when measured continuously for two minutes, suggesting that depletion may increase desire strength not just momentarily but for an extended period. Furthermore, in three additional experiments, they showed that manipulating depletion led to more extreme evaluations of pleasant and unpleasant images, as well as unfamiliar Chinese character. We should note here that although desire is not always correlated with pleasantness or ‘liking,’ it usually is, and likewise, although dread is not always correlated with unpleasantness or ‘disliking,’ it usually is. Thus, these bidirectionally valenced results suggest that depletion might induce not only stronger desires, but also stronger dread, though this requires further research. These intense motivational states may share similar physiological underpinnings (Faure, Reynolds, Richard, & Berridge, 2008; Reynolds & Berridge, 2008).

Relatedly, a standard depletion manipulation that utilizes a task that demands attentional control over an extended period (the extended-attentional-control task) (see Schmeichel, Vohs,
& Baumeister, 2003, Experiment 1), has been shown to cause brain activity in dieters that is associated with increased sensitivity to rewards (Wagner, Altman, Boswell, Kelley, & Heatherton, 2013) (see also Wagner and Heatherton’s chapter). Compared with nondepleted dieters, depleted dieters exhibited greater activity in the orbitofrontal cortex in response to images of appetizing foods. This brain area has been associated with encoding the reward value and pleasantness of various sensory experiences including taste (Rolls, 2000).

Our research on anticipated emotions and self-control also supports that depletion increases desire strength (Kotabe, Righetti, & Hofmann, 2016). In one experiment, we manipulated depletion with the extended-attentional-control task before participants read vignettes portraying common self-control scenarios. They then forecasted the pleasure and guilt they would experience if they were to enact the temptation described in the scenario and the pride and frustration they would experience if they were to resist enacting this temptation. Next, they indicated how likely they would be to exert self-control in these scenarios. Compared to the nondepleted group, those who were depleted weighted anticipated pleasure more and anticipated guilt less into these self-control judgments. And as predicted, anticipated pleasure was related with judgments calling for less self-control, and anticipated guilt was related with judgments calling for more self-control. These results align with Inzlicht and Schmeichel’s (2012) process model of depletion (see Francis and Inzlicht’s chapter), and they also suggest one possible mechanism underlying the observed increase in reward sensitivity under depletion.

Also relevant here is that depletion may lower construal-level, which may increase desire strength according to early self-control research by Mischel and Baker (1975). Mischel and Baker (1975) showed that low-level consummatory ideation directed at relevant rewarding stimuli hindered effective delay in the delay of gratification paradigm, presumably because such
ideation increases desire strength. In contrast, higher-level ideation of relevant rewards which focused on their nonconsummatory qualities facilitated delay behavior, presumably because such ideation decreases desire strength. Therefore, if depletion lowers construal level, it may decrease desire strength. Recent research suggests depletion lowers construal level. Wan and Agrawal (2011) inferred this based on the effects of using self-control at Time 1 on construal-dependent judgments and choices at Time 2 in six experiments. Bruyneel and Dewitte (2012) showed across four experiments that people who used self-control at Time 1 (vs. those who did not) provided lower egocentric spatial distance estimates, formed more groups when categorizing objects, and used more concrete language when describing the behavior of cartoon characters at Time 2.

Collectively, these results begin to corroborate that depletion increases desire strength, which is one mechanism by which depletion via self-control at Time 1 could reduce self-control at Time 2. In SCT, an increase in desire strength would necessitate an increase in actual control effort to effectively control temptation. This may require an increase in potential control effort—a function of both control motivation and control capacity. The problem is that, at the same time, depletion seems to reduce control motivation and control capacity, thus limiting potential control effort. We elaborate on this next.

**Depletion Reduces Control Motivation**

There is now substantial evidence that self-control exertion at Time 1 decreases control motivation at Time 2 (the motivation-based depletion hypothesis). An early test of this hypothesis comes from Muraven and Slessareva (2003). The three experiments they reported suggest that incentivizing people after they are depleted counteracts the effect of depletion on self-control performance. In Experiment 1, after a depleting task, they led one group to believe
that their performance on a following task would provide useful data for the development of new therapies for patients with Alzheimer’s disease. Compared to another depleted group who was not presented with this performance incentive, people in the experimental group tended to persist longer on unsolvable puzzles suggesting greater control motivation. In contrast, the Alzheimer’s information did not have a significant effect on people who did a nondepleting control task. In Experiment 2, after a different depleting task, they led one group to believe that practice at a frustrating task would improve performance on that task. Compared to another group who was led to believe that practice would have little benefit, the experimental group practiced longer at the frustrating task, again suggesting greater control motivation. In contrast, there was no significant effect of the practice-efficacy manipulation on people who performed a non-depleting control task. In Experiment 3, after another different depleting task, they had people consume a relatively unpleasant beverage (Kool-Aid containing vinegar). They manipulated incentives by giving one group only $0.01 per ounce of bad-tasting beverage consumed whereas another group was given $0.25 per ounce consumed. People in the $0.25 group drank significantly more of the bad tasting beverage suggesting increased motivation to control the temptation to stop, which would result in less monetary gain. There was no significant effect of incentives in a non-depleted control group, nor within the group who drank a relatively pleasant beverage (Kool-Aid containing sugar) which presumably required less self-control to drink, suggesting that stronger incentives specifically counteracted effects of depletion on self-control.

Another area of research relevant to the motivation-based depletion hypothesis suggests that effects of depletion on self-control performance can be counteracted by believing that self-control can be used limitlessly (Job, Dweck, & Walton, 2010; Mukhopadhyay & Johar, 2005) (see Job’s chapter). Job et al. (2010) conducted a correlational study, two experiments, and a
longitudinal field study to test whether a “limitless-resource theory” would play a role in counteracting the effect of depletion on self-control performance. In one of their experiments, they manipulated self-control beliefs prior to a standard depletion manipulation. Subsequently, participants self-reported their subjective exhaustion, and then they performed a Stroop task and eight challenging IQ problems. The limited-resource theory group showed depletion effects on the Stroop task and IQ task whereas the limitless-resource theory group did not show detectable depletion effects. Interestingly, there was no main effect of implicit-theory condition nor an interactive effect of depletion condition and implicit-theory condition on self-reported exhaustion. Despite this, self-reported exhaustion predicted performance on the Stoop and IQ tasks in the limited-resource-theory group but not in the limitless-resource-theory group. This suggests that people in the two theory conditions did not differ much, on average, in terms of how exhausted they felt by the depletion task. Nevertheless, those in the limitless-theory group did not show the depletion effect, suggesting that they had more control motivation.

Closely related to research on self-control beliefs, there is another area of research that concerns how an illusory sense of depletion affects self-control (see Clarkson, Oto, and Roseann’s chapter). Clarkson, Hirt, Jia, and Alexander (2010) conducted four experiments that suggest that people who perceive themselves as not depleted, regardless of whether they are actually depleted, tend to exert self-control more than people who perceive themselves as more depleted. To illustrate, in one experiment they had people do a task which involves inhibiting a learned response over an extended period (the perceptual-vigilance task, a.k.a. the “e-crossing” task) (Baumeister et al., 1998, Experiment 4) before some of them were told that the color of the paper used for task was replenishing whereas others were told that it was depleting. Next, they all worked on an anagram task until they decided to quit. People who perceived themselves as
Depleted did not persist as long at solving anagrams. Note that they argued that these are not motivational effects, however, they did not directly assess in these experiments whether people in the low-perceived-depletion group were specifically less motivated to control themselves. We think it is plausible that—regardless of whether one is actually depleted—perceiving oneself as depleted may decrease control motivation.

What the research reviewed in this section demonstrates is that depletion may not be just about a reduction of control capacity (the classical view) but also a reduction of control motivation. In simple words, whereas earlier models argued that people would not be able to control themselves anymore, more recent approaches argue that people do not try to control themselves anymore. More generally, several psychologists have recently argued that resource allocation (a motivational process, see Molden, Hui, and Scholer’s chapter) is as important as or more important than resource depletion (a capacity process) when it comes to explaining depletion phenomena (e.g., Beedie & Lane, 2012; Inzlicht, Schmeichel, & Macrae, 2014; Kurzban, Duckworth, Kable, & Myers, 2013; Molden et al., 2012). In particular, these psychologists cast doubt on the “glucose hypothesis” which proposes that single acts of self-control cause reductions in blood glucose which then impairs self-control (Gailliot et al., 2007).

Beedie and Lane (2012) argued against the glucose hypothesis from three perspectives: first, the evolution of self-control at the species level; second, the adaptation of self-control at the individual level; and third, the physiology of glucose transport. From the first perspective, they suggest that we ask, why would humans evolve to have an energy-expensive ability to self-control without an adequate energy supply for it? From the second perspective, they suggest we ask, why would the physiological systems involved in self-control not have adapted to the repeated demands for self-control? From the third perspective, the suggest we ask, would the
body really not replenish glucose as fast as it is used by the brain for self-control, especially considering that the amount of glucose used by the brain per unit time is extremely small compared to the amount used by the whole body (see Kurzban, 2010)?

Some empirical support for the resource-allocation account comes from Molden et al. (2012). Across four experiments, they showed both that using self-control had minimal effect on blood glucose levels and that rinsing with a carbohydrate solution increased self-control without significantly affecting blood glucose levels. In Experiment 1, they manipulated depletion with the perceptual-vigilance task before making precise measurements of blood glucose levels. This widely-used manipulation of depletion did not significantly affect blood glucose levels. In Experiment 2, they manipulated depletion the same way, then randomly assigned participants to rinse their mouths either with a carbohydrate solution or a solution without carbohydrates before measuring persistence on a task involving squeezing a high-tension handgrip. Persisting on this task despite growing discomfort has been widely used as an index of self-control (Hagger, Wood, Stiff, & Chatzisarantis, 2010). The carbohydrate rinse reduced the effect of the depletion manipulation on persistence—there was a significant effect of depletion on persistence in the noncarbohydrate-rinse-group but not in the carbohydrate-rinse-group. In Experiment 3, everyone was depleted with the attentional-control depletion task. Then they manipulated the rinsing procedure used in Experiment 2 before assessing reaction time in a Stroop task. On average, people in the carbohydrate-rinse condition responded faster to incongruent trials, suggesting quicker resolution to response conflicts. In Experiment 4, they provided evidence that the carbohydrate rinse did not release substantial endogenous energy stores.

Inzlicht et al. (2014) proposed the elaborated process model of self-control to explain such results that are inconsistent with a purely capacity-based depletion model. In this model,
apparent self-control failures reflect “the motivated switching of task priorities as people strive to strike an optimal balance between engaging cognitive labor to pursue ‘have-to’ goals versus preferring cognitive leisure in the pursuit of ‘want-to’ goals.” After self-control exertion at Time 1, the model proposes that there are shifts in attention, emotion, and motivation away from ‘have-to’ tasks and towards ‘want-to’ tasks resulting in what appears to be self-control failure at Time 2.

Another area of research relevant to how depletion may reduce control motivation concerns a phenomenon called “motivated reasoning.” Motivated reasoning is a kind of reasoning that biases people towards particular desired conclusions by making thoughts that support the desired conclusions more accessible (De Witt Huberts, Evers, & De Ridder, 2013; Kunda, 1990). For example, a dieter who lapses once at self-control by drinking a milkshake with dinner may think, “oh what the hell, dieting is done for today,” then subsequently indulge again by eating ice cream for dessert (Herman & Mack, 1975). Or, a person may rationalize indulgence in the here and now by instilling a sense of deservingness or justify why controlling oneself is unwarranted by augmenting the costs of self-control and/or downplaying possible risks of desire enactment. It follows from the elaborated process model of self-control (Inzlicht et al., 2014) that depletion may result in motivated reasoning that disfavors pursuing the ‘have-to’ task. In other words, depletion-induced motivated reasoning may decrease higher-order goal strength which, holding all else equal, would reduce control motivation. Such motivated reasoning may lead to arguably insensible behaviors—for example, a depleted dieter may not control the desire to order a ridiculously unhealthy entrée, justifying it because it came with a salad (Chernev, 2011).

Perhaps subsumed under motivated reasoning, “self-licensing”—the phenomena in
which, after a self-attributed virtuous act, people are more likely to indulge due to a sense of deservingness (Khan & Dhar, 2006; Mukhopadhyay & Johar, 2009; see also Fishbach & Dhar, 2005)—lends support to the motivation-based depletion hypothesis. Because self-control in itself is thought to be a virtue (Baumeister & Juola Exline, 1999; Hofmann, Wisneski, Brandt, & Skitka, 2014; Read, Loewenstein, & Kalyanaraman, 1999), a prior act of self-control could reduce control motivation via a self-licensing effect. Although not traditionally considered in relation to depletion, this view suggests that this is one way depletion could operate.

Germaine to the motivation-based depletion hypothesis, De Witt Huberts, Evers, and De Ridder (2012) conducted two experiments that aimed to rule out capacity-based explanations for self-licensing effects in favor of the view that self-licensing is a motivational phenomenon. For these experiments, they manipulated self-licensing by making people feel as if they put high-effort or low-effort into a task. Perceiving that one put high effort into the task was presumed to grant the “license to indulge” later. In both conditions, people were told that they would be doing a validation task for a new dyslexia screener. The task involved indicating the first letter of 240 words. Halfway through, there was a one-minute break in which participants in the high-effort group were led to believe that they might randomly be selected to do the task again to establish its reliability when really all of them were asked to finish the second half of the task. People in the low-effort group also had a one-minute break but they simply were told that they were to take a short break before continuing to the second half of the task. A pilot experiment confirmed that people in the high-effort group perceived themselves as having exerted more effort than people in the low-effort group. Importantly, the pilot experiment also showed that this manipulation had no detectable effect on control capacity as indexed by Stroop performance. In their follow-up experiment, they utilized this manipulation before having people do a bogus taste test which was
actually a test of how much people would eat after the manipulation. They showed that people ate more after manipulating perceptions of high-effort than after manipulating perceptions of low-effort. Assuming this manipulation had a minimal effect on control capacity, it would suggest that self-licensing occurred because of control motivation was decreased by the sense that one already had exerted much effort.

**Speculations and future directions.** According to SCT, there are at least three key moderators of control motivation beyond the higher-order goal and desire strength as mediated by D-G conflict. First, as one of the axioms of psychology is that people generally aspire to feel effective and in control (Bandura, 1977; Deci & Ryan, 1985; Higgins, 2011; White, 1959), SCT holds that this basic motive is superordinate and independent of the strength of the higher-order goal in conflict with desire. Second, it holds that expectations of future higher-order-goal-consistent behaviors and beliefs regarding how D-G conflicts should be balanced over time also affect control motivation. Third, it holds that people aspire to control temptations to experience positive self-conscious emotions such as pride or to not experience negative self-conscious emotions such as guilt. There could be additional sources of control motivation. Basically, anything that moderates the value of controlling temptation should result in corresponding fluctuations in control motivation.

We speculate that depletion could reduce control motivation by way of these three sources of control motivation. For example, depletion might temporarily reduce people’s chronic need to feel in control. There is at least one study suggesting that a threat to one’s sense of control decreases self-control (Chae & Zhu, 2014), however, it is possible that a threat to one’s sense of control due to depletion could result in attempts to restore that sense of control (Kay, Whitson, Gaucher, & Galinsky, 2009). The question of whether threats to personal control
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decrease or increase motivation to control is debatable may depend on some key moderator.
Depletion might affect people’s beliefs concerning how to best balance D-G conflicts over
time—with a bias towards allowing desire to run its course more frequently. This idea resonates
with the idea of a fluctuating “optimal balance” between engaging in cognitive labor to pursue
‘have-to’ goals and engaging in cognitive leisure to pursue ‘want-to’ goals put forward by
Inzlicht et al. (2014). Or depletion may increase the extent to which anticipated pleasure guides
judgments concerning whether to self-control while decreasing the influence of anticipated guilt
(Kotabe et al., 2016). Such possibilities present potential directions for future research.

**Depletion Decreases Control Capacity**

The classical view of depletion was that prior exertion of self-control impairs subsequent
self-control by drawing on a person’s *exhaustible and replenishable* capacity for self-control (the
*capacity-based depletion hypothesis*) (see Baumeister’s chapter)—thus the term “depletion.”
Despite the arguments supporting a motivational account that we reviewed above, we think there
is insufficient evidence to abandon capacity-based mechanisms of depletion altogether (the baby
might be thrown out with the bathwater). There is some empirical evidence supporting that
capacity-based mechanisms are at work too, though there is definitely room for improvement in
this area of research. Also, are we to think that human ability really does not matter in the realm
of self-control (or even more far-fetched, that it does not exist)? And that, out of pure motivation,
people can endlessly exert self-control?

Consider this thought experiment: Sam is a talented journalist working on a highly
important report late into the night. He is facing a tight deadline so despite a strong desire to take
a break, he keeps on pushing himself to write more. He notices that the quality of his writing has
seriously deteriorated. His sentences lack coherence and his reasoning is increasingly flawed.
Thirty minutes pass in which he finds himself in a cycle of writing a poor sentence, deleting it, and repeating. He has run into more than one mental roadblock. The report is due early in the morning so he has no option but to continue or fail to finish in time. If he fails to finish in time, he might lose his job. Even if Sam mustered all the motivation in the world (imagine he has a gun to his head), would his writing suddenly flow with the grace and skill that he has when not severely depleted? Even if endogenous energy stores could restore his mental state temporarily, how long could this really last before maintaining peak performance became physically impossible?

Although the point of a thought experiment is to learn about reality without empirical evidence, we will review select empirical evidence anyway to bolster the argument for control capacity. First, what should we think about observations of self-control impairment following lesions to frontal and prefrontal regions of the brain if not a capacity-based impairment? As a classic example, take Phineas Gage—neuroscience’s most famous patient. In 1848, Gage, 25, was laying railroad bed in Cavendish, Vermont. He was packing explosive powder into a hole with a tamping iron. The powder detonated, launching the meter long tamping iron through his left cheek, ripping through his left frontal lobe (and possibly part of the right), and exiting through the top of his skull. Gage survived but his friends saw him as “no longer Gage.” The doctor who treated him observed that Gage could not stick to plans, he uttered gross profanities, and he was offensive and disrespectful. In short, Gage seemed to be driven by primitive animal propensities with little to no restraint. He lost the faculty of self-control. If Gage were motivated enough, would he have been able to keep his primitive impulses at bay?

Phineas Gage is not the only person to show behavioral changes after damage to frontal brain regions. Many studies of patients with closed head injuries, brain tumors, stroke lesions,
and focal epilepsy have demonstrated a correspondence between damage or dysfunction to frontal regions and behavioral disinhibition (Clark, Manes, Antoun, Sahakian, & Robbins, 2003; Shallice & Burgess, 1991; Starkstein & Robinson, 1997; Tranel, Bechara, & Denburg, 2002). Relatedly, disruption to brain activity using repetitive transcranial magnetic stimulation (TMS) over the course of several minutes has been used to provide evidence that prefrontal regions are causally involved in self-control-relevant behaviors such as risk-taking (Knoch & Fehr, 2007) and intertemporal choice (Figner et al., 2010).

Another implication of a purely motivation-based depletion hypothesis that is hard to reconcile with reality is the prediction that if incentives are strong enough, there would not be individual differences in self-control performance. Simply put, given enough motivation, everyone would do equally well at self-control. Research relating individual differences in executive functioning to self-control suggests that this is not true (for a review, see Hofmann, Schmeichel, & Baddeley, 2012). A more plausible reality is that there are natural boundaries based on individual differences in control capacity.

A lot of the early work on ego depletion inferred that control capacity was affected by self-control at Time 1 based on self-control performance at Time 2. Recent debates about the role of motivation have made it clear that it is hard to tease apart the effects of motivation and capacity effects based on such observations. In fact, most of the research on depletion does not clearly show effects of motivation versus capacity. There are a few exceptions that are better than others at making this distinction. We review these exceptional studies below, then in the following section we propose a few new ways to study the relative effects of depletion on control motivation and control capacity.

One study on the separable effects of motivation and capacity was conducted by Vohs,
Baumeister, and Schmeichel (2012). They noticed that recent studies showed that the depletion effect could be counteracted by incentives or implicit beliefs. However, they also noted that all of these experiments only manipulated mild depletion. They asked, can increasing motivation counteract any amount of depletion? They randomly depleted some participants to a more severe degree than is reached in the typical depletion experiment, then tested whether implicit beliefs or incentives could still fully counteract the severe depletion manipulation. In short, it seems not. In Experiment 1, they followed procedures used by Job et al. (2010) in their investigation of the role of implicit beliefs in counteracting depletion effects. The main difference was that they added a “severe depletion” condition in which participants had to complete four self-control tasks at Time 1 as a depletion manipulation prior to two more self-control tasks at Time 2 as a depletion assessment. In the “mild depletion” condition, participants completed two self-control tasks at Time 1, and in the control condition, participants did not do any self-control tasks at Time 1. For the depletion assessment, all participants were tested on delay of gratification using the intertemporal choice paradigm (Loewenstein, Thaler, Goldstein, & Hogarth, 1997) and the Cognitive Estimation Test (Bullard et al., 2004) which is thought to involve active, logical thinking and extrapolation. They found that a limitless-resource theory counteracted depletion in the “mild depletion” group but not in the “severe depletion” group. In fact, after the strong depletion manipulation, people in the limitless-resource theory group showed worse CET scores than people in the limited-resource theory group—perhaps because having a limitless-resource theory promoted relatively non-conservative resource expenditure (Muraven, Shmueli, & Burkley, 2006). In addition, holding a limitless-resource theory counteracted depletion effects on delay of gratification in the “mild depletion” group but not in the “severe depletion” group. In contrast, self-control beliefs did not have significant effects in the control group, consistent with
what was found by Job et al. (2010). In Experiment 2, they followed a procedure used by Muraven and Slessareva (2003) to manipulate incentives for self-control. They also manipulated mild and strong depletion—this time, by having participants do one or three self-control tasks prior to the depletion assessment (the control group did no self-control tasks). The depletion assessment was the same as in Experiment 1. They found that the incentivization counteracted depletion in the “mild depletion” group but not in the “strong depletion” group. Similar to Experiment 1, and consistent with what was found by Muraven and Slessareva (2003), there were no significant effects of incentives in the control group. The results of these experiments suggest that notions that self-control is a purely motivational phenomena should be tempered.

More evidence for a role of control capacity comes from Schmeichel (2007), who conducted four experiments that suggest that using various executive functions impaired subsequent executive function performance and provided evidence against non-capacity-based mechanisms such as motivation, mood, and task difficulty. In one of his experiments, he had people do an attentional-control depletion task or a control task before they were assessed on working memory span with an operation span test or a sentence span test. (The attentional-control task requires sustained directed attention which seems to be a key cognitive resource depleted and shared by self-control and executive functioning, Kaplan and Berman (2010)) On average, people in the depletion group did worse at both the operation span test and the sentence span test as indexed by number of word sets recalled, longest set recalled, number of words in correct sets, and total words recalled. The effect does not seem to be due to motivation or mood. People in both groups worked similarly long at the working memory span tasks, suggesting that neither group rushed through due to a lack of control motivation. Furthermore, statistically controlling for mood did not change the main pattern of results.
Coping with stress requires self-control (Muraven & Baumeister, 2000). Schoofs, Preuß, and Wolf (2008) conducted an experiment to test whether a social stress task impairs working memory—that is, does it deplete this *cognitive ability* rather than having some sort of motivational effect. They randomly assigned people to do the Trier Social Stress Test (Kirschbaum, Pirke, & Hellhammer, 1993) or a comparable control task before an n-back task (Kirchner, 1958) that assess working memory performance. One should note that worsened performance on the n-back task could be due to depletion or a motivational shift—that is, resource depletion or resource allocation, respectively. Thus, importantly, they found that regardless of condition, most participants seemed to be motivated in the n-back task. Only four of the 40 participants showed lack of motivation (as indicated by highly repetitive single-key pressing the n-back task) and only one of them was in the depletion group. One of their key results was that the reduction in working memory performance due to depletion was evident only at the beginning of the n-back task. This might be due to an interaction between depletion and practice. Or, it could reflect the gradual restoration of energy to active working memory regions of the brain as blood is diverted to those regions from less active regions. Again, this would be consistent with the view that self-control relies on an exhaustible and replenishable capacity, and it would add nuance to what it takes to replenish this resource.

The addition of control capacity to a coherent integrative model of self-control is theoretically justified, particularly with regard to depletion at group and individual levels, in that it adds substantial explanatory power while adding only one additional component. Researchers often prefer and are attracted to simple explanations such as a purely capacity-based or purely motivation-based model and the pendulum seems to be swinging from one extreme to the other. Perhaps there is some danger in holding a one-sided view (e.g., theory-induced blindness). We
believe that the future of self-control research will best be served by integrative models, not unlike the integrative models of the past which have proved to be generative for their respective fields (e.g., Fazio’s (1990) MODE model of attitude-behavior relations; Gross’s (1998) process model of emotion regulation).

A Few Ways to Study Motivation Versus Capacity

It is clear that empirically disentangling motivation and capacity is a major challenge. For example, as alluded to above, there is a general problem underlying inferences concerning the relative effects of motivation versus capacity in any achievement-oriented tasks such as those used extensively in research on executive functions. Namely, if one were to observe a decrement in performance at some achievement-oriented task at one time following mild depletion, how can one possibly attribute it to motivation or capacity? A few useful approaches may be to assess performance across time, or by comparing mild versus severe depletion (as in Vohs et al., 2012), or some combination of these two approaches in a depletion study involving incentivized performance (see Figure 2). First, the multiple-times approach is like the standard depletion study except that performance is incentivized and effects of the depletion manipulation are observed not only at Time 2 but also several subsequent times. The prediction is that at Time 2 one may observe no significant difference in performance because of control motivation, but at subsequent times up to and including Time n, one may observe significant differences in performance because of control capacity. Second, the severe-depletion approach is also like the standard depletion study except performance is incentivized and there is an additional comparison group that is severely depleted at Time 1. The prediction is that at Time 2, one may observe no significant difference in performance in the mild depletion group because of control motivation, but may observe a significant difference in performance in the severe depletion
group because of control capacity (as in Vohs et al., 2012). Lastly, the combined approach incorporates everything stated above about the multiple-times approach and the severe-depletion approach. In addition, one can observe differential effects of mild vs. severe depletion on performance at times up to and including Time n.

**Integrating Motivation and Capacity Into a Model of Control Effort Investment**

SCT is, at its core, a model of control effort investment. Because of its ultimate focus on control effort as the countervailing “force” to desire strength, SCT is able to integrate both capacity-based and motivation-based limitations on how much control effort can be invested at any given point in time. In the following, we spell out this integration and then apply it to the depletion case.

Based on formulations of effort in cognitive energetics theory (Kruglanski et al., 2012), SCT proposes that control motivation and control capacity may determine the potential control effort that can be invested in a given moment. How much control capacity is actually used in battling desire is dynamically moderated by additional factors including desire strength, perceived skill, and competing goals. Potential control effort \( E_P \) is proposed to be proportional to the product of control motivation \( M \) and control capacity \( C \) at a given point in time:

\[
E_P \sim M \times C, \text{ where } 0 < M < 1
\]

The multiplicative relation implies that, in terms of determining the level of potential control effort, control motivation and control capacity are functionally interchangeable (see Figure 3, row A). Further, the terms imply that how much control effort could be invested *in principle* is a joint function of the various sources that factor into control motivation and of trait differences (e.g., in executive functions) and state influences (e.g., cognitive load, alcohol intoxication, stereotype threat) that factor into control capacity. The range of \( M \) implies that potential effort is
capped by the control capacity at a given time.

Now, regarding why people don't always fully exert themselves, control motivation and control capacity determine how much control effort can be exerted, but how much control effort is actually exerted may depend on additional moderators. First, according to the effort mobilization literature, actual control effort investment should depend on the difficulty of controlling desire. Most centrally, effort allocation is assumed to be guided by a basic concern for energy conservation (Brehm & Self, 1989; Fiske & Taylor, 1991; Kruglanski et al., 2012). Further, recent research suggests that cognitive effort is intrinsically costly (Kool, McGuire, Wang, & Botvinick, 2013). These views support that, like the use of money or time, the use of effort should be economical and contingent on one’s available “budget.” In fact, Kool and Botvinick (2014) showed that labor/leisure decisions in humans (i.e., choosing between using cognitive effort or “taking it easy”) resemble labor/leisure decisions predicted by economic models of labor supply. The point is that multiple streams of research converge on the idea that people try to efficiently allocate control effort to effectively deal with the desire at hand. Thus, it follows that people usually allocate less effort to control weak desires than strong desires (row B) (Hofmann & Van Dillen, 2012; Kavanagh et al., 2005). However, this linear relationship holds up only to the point where the perceived strength of desire is too high in relation to one’s potential control effort—resulting in (temporary) disengagement (see Brehm & Self, 1989; Gendolla & Richter, 2010).

A second moderator is perceived skill. Some people may see themselves as more tacitly able to use their available control capacity in the service of self-control than others (Reber, 1989; Wagner & Sternberg, 1985). Additionally, some people may believe they have more and/or better self-control strategies at their disposal in a given situation than others.
(see Sheppes & Meiran, 2008). In both cases, the degree of perceived skill would inversely vary with control effort engagement because of energy conservation concerns (row C). The emphasis on perceived skill suggests that people may downplay the difficulty of combating a given desire or make overly confident judgments about their skill in controlling it, perhaps due to unrealistic perceptions of self-efficacy. Such “control illusions” may lead them to actually allocate less control effort than required (leading to a mismatch between desire strength and actual control effort) and might thus lead to self-control failure (Nordgren, Van Harreveld, & Van Der Pligt, 2009).

Third, as self-control does not occur in a vacuum, one may (have to) allocate control resources, even unintentionally, to competing goals (row D) (Hassin, Bargh, & Zimerman, 2009; Kruglanski et al., 2012; Shah & Kruglanski, 2002). For example, imagine a person tempted to go to the next bar despite knowing he should go home to get rest for work the next day. However, he is simultaneously socializing with his clients which demands some cognitive resources that otherwise could be utilized in pursuit of his self-control goal to call it a night. In this example, even if potential control effort were high, a consequence of the competing goal may be insufficient available resources for the self-control goal.

In sum, whereas control capacity and control motivation factor into determining the potential amount of control effort that can be used at a given time, how much control effort is invested may depend on the additive effects of at least three moderators: desire strength, perceived skill, and competing goals. Accordingly, actual control effort expenditure would be highest when desire strength is high, perceived skill is low, and competing goals are absent. Oppositely, actual control effort expenditure would be lowest when desire strength is low, perceived skill is high, and competing goals are present.
Depletion and Control Effort

This model implies that depletion could reduce control effort in several ways (see Figure 4). First, depletion could reduce control motivation and control capacity, thus reducing potential control effort. Reducing control effort places a restriction on the maximum actual control effort that can be exerted to combat temptation. So if desire strength increases, thus increasing task demands, then more control effort needs to be recruited to effectively deal with it. This may not be a problem when control motivation and control capacity are high (see Figure 4, left panel). However when control motivation is reduced and control capacity is exhausted, the same desire may almost reach a point of effort disengagement (where the actual effort needed to effectively control temptation exceeds the amount of effort one is prepared to invest). And if depletion increases desire strength even by a little, the temptation “tipping point” may be reached, resulting in self-control failure (see Figure 4, right panel).

Implications and future directions. SCT, and in particular the central component of control effort, has important implications for how to operationalize and assess self-control. That is, one implication of the model is that perhaps the most useful and direct index of self-control is the extent to which people engage control effort relative to desire strength, rather than whether temptation was enacted or not (the ultimate behavioral level determined by the interplay of control effort, desire strength, and enactment constraints), or whether people were motivated or able to control themselves (antecedents of control effort). Regarding the former, observed self-control success—especially in field settings or when inferred from people’s self-reports—has the problem of possibly being influenced or even determined by enactment constraints. To illustrate, imagine a student at a school cafeteria. He might appear to succeed at self-control because he chose an apple instead of a cookie when checking out at the cafeteria, when in fact, he was
unprepared (not motivated and able) to resist the cookie but only chose the apple because the student in front of him took the last cookie. That is, the desire to effort ratio in this case was $> 1$, but nevertheless, he did not enact temptation because of the fortuitous constraints imposed by the other student. Or imagine the student chose a cookie instead of an apple. He might appear to fail at self-control, when in fact, he was prepared (motivated and able) to resist the cookie but ended up choosing the cookie anyway because it was the only option left after the student in front of him took the apple. That is, the desire to effort ratio in this case was $< 1$ but he nevertheless enacted temptation because of the unfortunate enactment constraints imposed by the other student.

**Concluding Remarks**

In this chapter, we demonstrated how SCT can be used to make sense of a complicated self-control phenomena—ego depletion. Our analysis suggests that future research on depletion would benefit from a stronger focus on control effort relative to desire strength. We argue that the most supported effects of depletion most directly concern these components. Depletion either decreases potential control effort (via effects on control motivation and control capacity) or it increases the actual control effort required for self-control success (via effects on desire strength). By applying SCT to the problem of depletion, we were able to see how important the effort component is for depletion research. This insight could only be gathered by looking at the forest.
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Figure 1. A diagram of SCT. The coactivation of desire and an at least partly incompatible higher-order goal induces D-G conflict, which triggers self-control exertion processes by yielding control motivation. Control motivation and control capacity determine the upper limit of control effort (see Figure 3 for further explanation). If control effort prevails over desire, then self-control will succeed provided that enactment constraints do not prevent higher-order goal enactment. If desire prevails over control effort, then self-control will fail provided that enactment constraints do not prevent desire enactment. Adapted from “On Integrating the Components of Self-Control,” by H. P. Kotabe and W. Hofmann, in press, *Perspectives on Psychological Science*. Copyright 2015 by H. P. Kotabe and W. Hofmann. Reprinted with permission.
Figure 2. Three approaches to disentangling control motivation and control capacity in an incentivized-performance depletion study.
**Figure 3.** An illustration of the model assumptions regarding potential control effort ($E_P$) and actual control effort ($E_A$). State control motivation $\times$ state control capacity determines potential control effort, $E_P$, the upper limit of actual control effort, $E_A$ (row A). $E_A$ (light grey area) is further determined by moderators including desire strength (row B), perceived skill (row C), and competing goals (row D). White areas signify available mental resources not invested due to effort conservation. Dark grey areas represent mental resources allotted to competing goals.
Figure 4. A diagram of how depletion could lead to self-control failure by decreasing control motivation and control capacity while increasing desire strength. As potential control effort is multiplicatively determined by control motivation and control capacity, a decrease in control motivation and control capacity decreases potential control effort (dotted line), thus lowering the upper limit of actual control effort (y-axis). Before depletion (left panel), self-control succeeds because desire strength is not past the point of disengagement, which is defined by the point at which desire strength demands the maximum control effort that one is prepared to invest (i.e., where actual control effort = potential control effort). After depletion affects desire strength, control motivation, and control capacity (right panel), self-control fails because desire strength is past the point of disengagement.