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# Effortful experiences of self-control foster lay theories that self-control is limited☆

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ABSTRACT

Though recent motivational accounts of self-control highlight the importance of experiences of effort and fatigue for continued goal pursuit in the moment, less research has investigated potential longer-term effects of these experiences. In three studies, we tested the hypothesis that experiencing self-control as effortful and exhausting would lead to a general belief that the capacity for self-control is limited (Job, Dweck, & Walton, 2010). When participants reflected on a high- versus a low-effort self-control experience (Study 1), engaged in a high- versus low-effort self-control task (Study 2) or experienced a two-week period of self-control practice as more versus less effortful (Study 3), they were more likely to endorse lay theories that self-control is limited. In turn, these limited lay theories led to impairments in self-control performance under high regulatory demand (Study 3). We discuss implications for understanding what limits self-control and the development of lay theories related to self-control.

## 1. Introduction

Effective self-control—the overriding of immediate impulses or desires in favor of more distal goals—is associated with many positive outcomes, including psychological well-being, social adjustment, work achievement, and physical health (de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012; Mischel, Shoda, & Peake, 1988; Moffitt et al., 2011). Effective self-control not only has benefits at the individual level, but also for society more broadly, and is associated with decreases in obesity, smoking, expression of stereotypes, and violent crime (Elfhag & Morey, 2008; Gailliot, Plant, Butz, & Baumeister, 2007; Gottfredson & Hirschi, 1990; Muraven, 2010b).

Sustaining self-control over time, however, is notoriously difficult. Many studies have found that completing an initial task requiring self-control leads to performance decrements in subsequent, unrelated tasks that also require self-control (for a meta-analytic review see Hagger, Wood, Stiff, & Chatzisarantis, 2010; but also see Carter, Kofler, Forster, & McCullough, 2015; Hagger et al., 2016). The predominant explanation for these types of findings has long come from the *strength model* of self-control, which argues that such control relies on a limited supply of energy that, like a muscle, becomes depleted and renders one unable to continue to exert further self-control (e.g., Baumeister, Heatherton, & Tice, 1994; Baumeister, Vohs, & Tice, 2007; Muraven & Baumeister, 2000). More recent research, however, has questioned the strength model, highlighting the importance of shifting beliefs about, expectations for, and the valuing of self-control in explaining performance decrements (e.g., Clarkson, Hirt, Jia, & Alexander, 2010; Hagger & Chatzisarantis, 2013; Job et al., 2010; Moller, Deci, & Ryan, 2006; Molden et al., 2012; Muraven & Slessareva, 2003). This research has given rise to new, alternative models of self-control that explain performance in terms of the motivated allocation of effort and attention rather than to any true limited capacity for self-control (e.g., Inzlicht & Schmeichel, 2012; Kurzban, Duckworth, Kable, & Myers, 2013; Molden, Hui, & Scholer, 2016, 2018). Drawing from these new models, the present research examines how people's experiences of effort during self-control can directly affect their beliefs about effort and exerting control, as well as their performance on tasks that require control.

### 1.1. The role of effort in sustaining self-control

One important process in exerting self-control highlighted by newly emerging models is how the phenomenological experience of effort and fatigue while engaged in control affects subsequent performance (Evans, Boggero, & Segerstrom, 2016; Hockey, 2013; Kurzban et al.,

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2013). Simply engaging in an initial act of self-control is not enough to shift performance on subsequent tasks; instead, what appears to influence whether or not individuals are likely to persist on subsequent tasks is the extent to which they perceive this initial exertion of self-control to be highly effortful and exhausting (Molden et al., 2016, 2018). For example, when tasks are framed as fun or are autonomously chosen rather than framed as work or externally assigned, they are experienced as less effortful and fatiguing and do not produce the same decrements in subsequent self-control (e.g., Laran & Janiszewski, 2011; Moller et al., 2006; Muraven, Gagné, & Rosman, 2008; see also Clarkson et al., 2010). Similarly, independent of the objective level of demand, believing one has exerted relatively high effort compared to others also leads to worse subsequent self-control (Kivetz & Zheng, 2006). Furthermore, when some initial exertion of self-control is followed by experiences that increase relaxation or boost tolerance for effort—such as watching a humorous video clip or favorite television program (Derrick, 2013; Tice, Baumeister, Shmueli, & Muraven, 2007), affirming one's core values (Schmeichel & Vohs, 2009), or meditating (Friese, Messner, & Schaffner, 2012)—this too reduces subsequent decrements of self-control (for a review see Masicampo, Martin, & Anderson, 2014). Thus, regardless of the source of one's perceptions of increased or decreased effort, these perceptions appear to influence subsequent exertions of effort and self-control (e.g., Evans et al., 2016, Kurzban et al., 2013; Molden et al., 2016, 2018).

Building upon these findings, we propose that experiences of effort may not only affect whether people sustain self-control in the moment, but may also, over time, more broadly influence their beliefs about the nature of self-control. Previous research has shown that individuals differ in their *lay theories*—their fundamental beliefs about the ways the world works (see Molden & Dweck, 2006)—with respect to whether self-control is limited and can be exhausted (Job et al., 2010; Martijn, Tenbült, Merckelbach, Dreezens, & de Vries, 2002). The present studies examine whether the phenomenological experience of self-control as effortful and exhausting—especially over time—may increase the likelihood that people come to believe that there is a limit to their ability to exert self-control (e.g., "I must be reaching a limit if I feel so exhausted"). Moreover, as reviewed in the following section, we further test whether such limited theories of self-control may in turn lead to decrements in self-control performance when demands for effort are high (e.g., Bernecker & Job, 2015; Job et al., 2010; Job, Walton, Bernecker, & Dweck, 2015; Miller et al., 2012). Although, as reviewed above, previous studies have examined the proximal effects of effort perceptions on self-control performance, an important question that has received less attention is how such perceptions may shift broader lay theories of self-control, which could then further influence self-control performance days or even weeks later.

### 1.2. Lay theories of self-control

Because the environments in which people live are complex and multi-faceted, people often formulate a set of basic assumptions about the fundamental nature of these environments. These assumptions—or lay theories—then create a broader system of meaning that provides people with a sense of understanding, prediction, and control in their judgments and behaviors (Dweck, Chiu, & Hong, 1995; Plaks, 2017; Molden & Dweck, 2006). That is, lay theories function both as beliefs about what is fundamentally true in world and as frameworks that explain and organize the world (Levy, Chiu, & Hong, 2006), and thus provide an interpretive framework for noticing, categorizing, and processing information.

In the domain of self-control, research has shown that individuals vary in their lay theories about the extent to which such control is limited (e.g., Bernecker & Job, 2015; Job et al., 2010; Job, Walton, et al., 2015; Martijn et al., 2002; Miller et al., 2012). Individuals who hold a *limited* theory of self-control or willpower believe, much like the core tenet of the strength model, that engaging in such control consumes energy and exhausts their capacity for subsequent acts of control. For example, individuals with lay theories that important aspects of self-control, such as resisting temptation or engaging in strenuous mental activity, are limited more strongly endorse the idea that "it is particularly difficult to resist a temptation after resisting another temptation right before" or that "after a strenuous mental activity your energy is depleted and you must rest to get it refueled again" (Job et al., 2010). In contrast, individuals who hold a *non-limited* theory of various aspects of self-control believe that engaging in acts of control has no influence on, or may even energize, one's capacity to engage in subsequent acts of self-control. For example, individuals with non-limited theories endorse the idea that "resisting temptations activates your willpower and you become better able to face new upcoming temptations" or that "your mental stamina fuels itself; even after strenuous mental exertion you can continue doing more of it" (Job et al., 2010).

Multiple studies examining the consequences of lay theories of self-control have found that these theories predict and influence how people exert control in ways that are consistent with the content of the theory they hold. Lay theories of self-control do not appear to consistently affect the moderate exertion of self-control in the short term; however, they do begin to affect self-control when it must be sustained over longer periods of time or when it becomes particularly strenuous, which is when people with limited theories might be expected to begin withdrawing effort and "conserving" these presumably limited resources. For example, Job et al. (2010) found that while lay theories of self-control did not predict students' control-related behaviors (i.e., better eating habits, study habits, and personal goal-striving) during a non-stressful time of the academic term, individuals with stronger non-limited theories of control did display more of these behaviors during a stressful final-exam period. In addition, Miller et al. (2012) demonstrated that, while participants holding limited vs. non-limited theories of self-control performed equally well at the beginning of a long, strenuous mental task, individuals who more strongly endorsed non-limited theories sustained this level of performance throughout the task whereas individuals who more strongly endorsed limited theories did not. Similarly, Bernecker and Job (2015) found that individuals with stronger non-limited theories had higher expectations for goal progress than students who endorsed limited theories, but only on days directly following a highly demanding day. Job, Walton, et al. (2015) also found that students who more strongly endorsed non-limited theories earned higher grades than students who more strongly endorsed limited theories, but only when taking a particularly heavy course load.

Although such findings illustrate how lay theories of self-control have important influences on performance when self-control becomes particularly effortful, these types of studies have not examined whether or how everyday experiences with exerting effortful self-control might itself also affect the lay theories that people come to hold. Given the existing evidence that people's limited or non-limited theories of self-control can be readily manipulated and primed (e.g., Job et al., 2010; Mukhopadhyay & Johar, 2005), it seems likely that both types of beliefs are available to everyone, even if specific individuals tend to have one of these beliefs more chronically accessible than the other (Higgins, 1996). What has not yet been established, however, is what types of experiences occurring in people's daily lives might also influence such accessibility and naturally shift people's lay theories of self-control.

We thus propose to investigate how everyday experiences with exerting effortful self-control can lead to changes in people's lay theories and, ultimately, affect self-control outcomes. Research on the phenomenological experience of effort suggests that effort may serve as a signal about the value of continued investment in a current task given other opportunities and goals (see Hockey, 2013). The utility of such signals for self-regulation is that there are limits on how one's mental resources can be *simultaneously* invested, even if there are no absolute limits on the capacity of those resources (Kurzban et al., 2013). Thus, experiences of effort and fatigue may help people effectively allocate

resources across tasks. However, we propose that individuals may also infer from their experiences of effort, regardless of the origins, that there is a finite self-regulatory capacity. When effort and exhaustion are highly salient, people may conflate this signal about what can be done simultaneously with a signal about the approaching limits of their *general* capacity. In other words, people may generalize from their experiences of effort and also infer "if I am feeling drained, then there is a capacity to be drained."

Given that the key difference between limited versus non-limited lay theories of self-control is the extent to which self-control is perceived to drain a finite resource, we propose that subjective experiences of effort and exhaustion are one viable candidate for how such beliefs arise and become more chronically accessible. Specifically, as outlined above, we predict that effort is a salient cue that may influence whether individuals infer that they are mentally drained in the moment and subsequently come to more broadly view self-control capacity as something that is limited (for a slightly different, but not incompatible perspective, see Clarkson, Otto, Hirt, & Egan, 2016). That is, to the extent that individuals experience self-control as particularly exhausting, whether in the moment or over time, they may be more likely to endorse beliefs that self-control is a limited resource.

Although we believe that perceived effort is a promising candidate for explaining how people's ongoing experiences influence their beliefs about and performance at self-control, another possible candidate might simply be how often people perceive that they have succeeded or failed at self-control. Success is a salient signal that individuals monitor during self-regulation as well (e.g., Carver & Scheier, 1982; Schunk, 1982) and perceiving success can lead to elevated mood and increased feelings of self-efficacy (Kavanagh & Bower, 1985). However, these types of experiences may not necessarily influence lay theories of self-control as directly as experiences of effort. That is, success could lead people to feel increasingly confident in their abilities (e.g., believe that their self-control strength has increased and their pool of resources has expanded), and yet still allow them to believe that the exertion of self-control itself drains that limited resource, eventually leading to "conservation" and the withdrawal of effort. Indeed, prior work by Job et al. (2010) suggests that self-control success does *not* change people's lay theories; students' history of success at self-control in earlier sessions of a study did not predict their lay theories of self-control in subsequent sessions. Nevertheless, to further test the relative influence of perceived success as compared to experiences of effort in determining lay theories of self-control, we measured both variables in our studies.

### 1.3. Overview of the present studies

We conducted three studies to test whether perceived effort associated with exerting self-control influences whether people endorse lay theories of self-control as more or less limited. In Study 1, participants reflected on a recent self-control experience involving either high- or low-effort and then reported their lay theories of self-control immediately thereafter. In Study 2, participants engaged in a self-control task involving high or low effort and then reported their lay theories of self-control. In Study 3, participants reported on their experiences with exerting self-control over a two-week period. We examined how experiences of effortful self-control predicted changes in their lay theories of self-control and their subsequent performance on laboratory tasks assessing control. If our theoretical extension of the emerging research on the importance of perceived effort in self-control is correct, then people's reported experiences of greater effort during self-control should predict stronger endorsement of limited theories of self-control (Studies 1–3) and reduced self-control performance when such control was particularly strenuous and had to be sustained over time (Study 3). We disclose all measures, manipulations, and exclusions for these studies either in the main text or in the supplemental materials.

In all three studies, we assessed people's lay theories using a measure developed by Job et al. (2010) that included two separate subscales: one that measured the extent to which people perceived limits in their capacity for engaging in mental exertion and one that measured the extent to which people perceived limits in their capacity for resisting temptation, as alluded to above. Researchers using this scale have frequently alternated between averaging across these two subscales (e.g., Job et al., 2010; Job, Bernecker, Miketta, & Friese, 2015) and focusing only on the mental exertion subscale (e.g., Clarkson et al., 2016; Job, Walton, et al., 2015; Napolitano & Job, in press). Combining the data from all three of the present studies ($N = 534$), the correlation between the mental exertion and resisting temptation subscales was significant but only moderate in size, $r = .35$, $t = 8.77$, $p < .001$. Therefore, we chose to analyze and report the results of these two subscales separately throughout this article.

Beyond the empirical reasons for analyzing these subscales separately, such an approach also allows us to examine some important theoretical questions as well. Self-control is multifaceted and can involve a variety of different behaviors, some of which people might most saliently experience as continuously engaging in mental exertion and some of which people might most saliently experience as resisting tempting impulses or desires. To the extent that people make broad and general inferences about their overall experiences of effort, then regardless of the specific self-control behavior that produces this experience, people should report more limited theories of both mental exertion and resisting temptation. That is, they should interpret their current experiences of effort as indicating that self-control in general is draining and has a limited capacity. In contrast, to the extent that people make more narrow inferences about their experiences of effort, a different pattern would be expected. If these experiences arise from behaviors focused more on continued mental exertion, people may primarily make inferences about the limited capacity of such exertion and not necessarily come to view their capacity for resisting temptation in the same way. If their experiences of effort arise from behaviors focused more on resisting temptation, then the reverse could be true. The three studies reported here varied in the extent to which they made aspects of self-control related to mental exertion versus resisting temptation more salient; therefore, if the results for the different subscales of the lay theories questionnaire differ from study to study, this provides at least preliminary evidence that people are more narrowly interpreting their experiences of effort.

## 2. Study 1

In Study 1 participants were asked to reflect on a high or low effort self-control experience and then complete the lay theories subscales. In this study, self-control was defined for participants as "what we use to resist temptations or immediate desires in favor of longer-term goals." This study thus provided an initial opportunity to examine the extent to which participants might make broader or narrower inferences about self-control capacity based on effortful experiences of self-control. If participants make narrower inferences about self-control capacity, we would expect to observe stronger effects of condition on the resisting temptations, rather than mental exertion, subscale.

### 2.1. Method

#### 2.1.1. Participants and design

We recruited 208 individuals via Amazon's Mechanical Turk online marketplace to participate for monetary compensation (Buhrmester, Kwang, & Gosling, 2011). Participants were randomly assigned to a condition in which they recalled a high-effort or low-effort instance of self-control. One person dropped out after assignment to the *high-effort* condition and 29 either did not write about a recalled instance of self-control as instructed or did not complete the writing prompt at all (11 in the *high-effort condition* and 18 in the *low-effort* condition). The attrition rate did not differ across conditions, $\chi(1) = 1.32$, $p = .25$, ruling out the potential influences of selective attrition (Zhou & Fishbach,

**Table 1**
*Mean differences by condition (Study 1).*

| | High-effort | | Low-effort | | Difference | |
|---|---|---|---|---|---|---|
| | M | SD | M | SD | 95% CI | *d* |
| *Manipulation check* | | | | | | |
| Perceived effort | 4.19 | 0.98 | 3.08 | 1.20 | −1.43, −0.78 | 1.01 |
| *Control variables* | | | | | | |
| Perceived success | 4.73 | 0.92 | 4.79 | 0.90 | −0.21, 0.33 | 0.06 |
| Event salience | 5.64 | 1.50 | 6.06 | 1.52 | −0.03, 0.87 | 0.28 |
| *Lay theories of self-control* | | | | | | |
| Mental exertion | 3.78 | 0.93 | 3.54 | 1.03 | −0.53, 0.05 | 0.24 |
| Resisting Temptations | 3.24 | 0.82 | 2.90 | 0.93 | −0.59, −0.07 | 0.39 |

*Note.* The effect of condition on lay theories of resisting temptations remains significant when controlling for event salience, as detailed in the SOM.

2016).

The final sample consisted of 178 individuals (42% female; $M_{age}$ = 31.37 years, SD = 9.01; 53.9% Whites, 30.3% Asian Americans, 6.2% African Americans, 6.2% Hispanic Americans, and 3.4% other).[1] Based on calculations made using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007), this final sample provided power of 0.80 to detect a small to moderate effect size ($d$ = .42), an effect size typical for social psychological research (Richard, Bond, & Stokes-Zoota, 2003).

#### 2.1.2. Procedure and materials

Participants first wrote a short reflection on an experience of self-control, which contained our self-control effort manipulation. All participants first read that "self-control is what we use to resist temptations or immediate desires in favor of longer-term goals." In the *high-effort* condition, they then read the following prompt:

> We're interested in different experiences people have with self-control – especially cases where people put in a lot of effort. Think of a recent time in your life that self-control felt extremely effortful and demanding. Please describe this experience: What was the context and goal you were working towards? How did you feel?

In the *low-effort* condition, they read the following prompt:

> We're interested in different experiences people have with self-control – especially cases where self-control requires very little effort. Think of a recent time in your life that self-control felt extremely easy, even effortless. Please describe this experience: What was the context and goal you were working towards? How did you feel?

Sample responses from both conditions are included in the supplemental materials. To obscure the connection between the reflection task and our measure of self-control lay theories, participants next completed two filler scales: the 10-item Personality Inventory (Gosling, Rentfrow, & Swann, 2003) and the 20-item Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988).

Participants then completed the key dependent measure, Job et al.'s (2010) self-control lay theories questionnaire that included the six-item mental exertion subscale (e.g., "After a strenuous mental activity, your energy is depleted and you must rest to get it refueled again"; α = .87) and the six-item resisting temptations subscale (e.g., "Resisting temptations makes you feel more vulnerable to the next temptations that come along"; α = .80), using a six-point scale from 1(*strongly disagree*) to 6(*strongly agree*). Responses were reverse-coded where appropriate so that higher scores represented more limited theories of self-control.

To examine whether the recalled events differed in subjective experiences beyond effort, we then asked participants to think back to the event they described at the beginning of the study and respond to several manipulation checks. Participants responded to two questions about the extent to which the experience was effortful and exhausting ("Overall, exerting self-control felt effortful"; "Overall, exerting self-control felt exhausting", $r$ = .46), and three items about perceived success (e.g., "Overall, exerting self-control felt successful", α = .83). These five items all used a six-point scale from 1(*strongly disagree*) to 6(*strongly agree*). Participants also responded to three items about the overall salience of the event, (e.g., "How easy was it for you to think of an event like the one described by the prompt?" on a seven-point scale from 1(*not easy at all*) to 7(*very easy*), α = .66). Participants were then thanked and debriefed.

### 2.2. Results

#### 2.2.1. Manipulation checks

We first examined whether participants in the high (vs. low) effort condition rated their recall event as feeling more effortful. As shown in Table 1, using a composite of the two effort items, we found that those in the high-effort condition indeed recalled significantly higher exertion of effort than those in the low-effort condition, $t(176) = 6.73$, $p < .001$.[2]

As also shown in Table 1, there were no significant differences in perceived success. Using a composite of the 3 success items, we found similar perceptions of success in the high-effort condition and low-effort condition, $t(176) = 0.43$, $p = .67$. There was no significant difference in event salience as a function of condition $t(176) = 1.86$, $p = .07$, though there was a trend that salience was higher in the low effort versus high effort condition.

#### 2.2.2. Coding free responses

We also had two independent coders, blind to condition, evaluate each response according to whether it was primarily a) temptation-related, b) mental exertion-related, c) both temptation and mental-exertion related, or d) neither. Across coders, 78% of responses were assessed as being temptation-relevant, with 63% of responses rated as being exclusively temptation-relevant (kappa = .65, an adequate-to-substantial level of agreement; Fleiss, Levin, & Paik, 2003; Landis & Koch, 1977). There was no difference in the frequency of temptation-relevant content between the high and low effort conditions, $\chi^2 = .22$, $p = .64$. Given that participants were instructed to consider episodes of self-control defined as "what we use to resist temptations or immediate desires in favor of longer-term goals," it is not particularly surprising that participants were more likely to describe experiences related to resisting temptations.

#### 2.2.3. Primary analyses

Our central question was whether recalling a high (vs. low)-effort experience of self-control would affect lay theories of self-control regarding temptations or mental exertion, or both. Based on the explicit instructions and coding analyses, if people make more narrow inferences from effortful self-control experiences, larger effects should emerge for the resisting temptation subscale as compared to the mental exertion subscale. Indeed, those in the high-effort condition reported significantly more limited theories of resisting temptations than those

[1] All effects reported maintain the same direction and level of statistical significance when including the 29 who did not follow the instructions of the writing prompt but continued on to the rest of the study.

[2] Our a priori intention was to create an index of the two effort items. Given the moderate correlation between the two items ($r$ = .46), we also examined each item individually. Differences by condition were significant both for the index and the items individually. Those in the high-effort condition recalled an event that was significantly more "effortful" ($M$ = 4.60, $SD$ = 1.03) than those in the low-effort condition ($M$ = 3.31, $SD$ = 1.44), 95% CI [−1.66, −0.92], $t(176) = -6.85$, $p < .001$, $d$ = 1.03. In addition, those in the high-effort condition recalled an event that was significantly more "exhausting" ($M$ = 3.77, $SD$ = 1.42) than those in the low-effort condition ($M$ = 2.86, $SD$ = 1.35), 95% CI [−1.33, −0.51], $t(176) = -4.41$, $p < .001$, $d$ = .66.

**Table 2**
*Pearson correlations (Study 1).*

| Measures | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. Perceived effort | – | | | | |
| 2. Perceived success | −0.02 | – | | | |
| 3. Event salience | −0.34*** | 0.21*** | – | | |
| 4. Mental exertion theories | 0.31*** | 0.03 | 0.05 | – | |
| 5. Resisting temptations theories | 0.33*** | −0.21** | −0.25*** | 0.35*** | – |

** $p < .01$.
*** $p < .001$.

in the low-effort condition, $t(176) = 2.54$, $p = .01$. Lay theories of mental exertion did not differ between conditions, $t(176) = 1.62$, $p = .11$. Interestingly, perceived effort was significantly positively correlated with both lay theories of resisting temptations and lay theories of mental exertion (see Table 2).

### 2.3. Discussion

Study 1 provided initial evidence that experiences of effort during self-control may have consequences beyond one's immediate performance and influence the broader lay theories people develop about exerting control. Specifically, increasing the accessibility of an effortful (vs. a relatively easy) experience with self-control affected people's lay theories about their capacity to exert self-control with regards to resisting temptations.

Notably, there was no significant effect of condition on lay theories about mental exertion. Given that the definition of self-control provided to participants was about resisting temptations, and given that participants' responses were indeed coded as being primarily about resisting temptations, this pattern provides at least suggestive evidence that people's inferences about effortful self-control experiences are relatively narrow (i.e., applying only to new self-control experiences of a similar type). We return to this issue in Studies 2 and 3.

Although Study 1 provided preliminary evidence that effortful and exhausting experiences of self-control may change lay theories of self-control, the nature of the manipulation presents some limitations. As a recall manipulation, it is conceivable that its effects on lay theories may differ from an actual experience of self-control. It is also possible that participants recalled episodes of self-control that differed in other key ways, apart from effort, and that the experience of effort was not as central to changes in lay theories as we posited. For instance, perhaps high effort experiences are less autonomous than low effort experiences and it is this difference in autonomy that drives changes in lay theories. Study 2 was designed to address these limitations.

## 3. Study 2

To further examine how the prolonged experience of effort in self-control influences lay theories, participants in Study 2 were randomly assigned to engage in a high or low effort self-control task that involved persistence and mental exertion and then reported their lay theories of self-control. As in Study 1, we predicted that experiencing self-control as more effortful would lead to more limited lay theories of self-control. Given that in Study 1, changes in lay theories were specific to resisting temptations (the focus of the recall prompt), we were interested to see if this would be similarly observed in Study 2. Specifically, this study provided an opportunity to examine if experiencing greater effort on a mentally demanding task would lead to stronger effects on lay theories of mental exertion versus lay theories of resisting temptations.

As in Study 1, we also assessed other aspects of participants' task experience in order to rigorously examine if perceived effort indeed appears to be a key factor in the development of more limited theories. After completing the typing task, participants reported not only their subjective experience of effort, but also their subjective experience of success, autonomy, and the extent to which they perceived the task as involving self-control.

### 3.1. Method

#### 3.1.1. Participants and design

We recruited 195 university students (61% female, 1.5% other; $M_{age} = 20.33$ years, SD = 3.26; 41% White, 36.4% Asian, 6.2% Black, 2.6% Hispanic, and 14.9% other) to participate in an online study for partial course credit. Participants were randomly assigned to a condition in which they completed a high-effort or low-effort typing task. Given the nature of the manipulation, we excluded participants who indicated that they were extremely poor typists ($N = 12$, 6%), resulting in a final sample of 183 individuals.[3] This final sample provided power of 0.80 to detect an effect size of $d = .42$.

#### 3.1.2. Procedure and materials

All participants were first told that they would be completing a typing task that was related to self-control. Specifically, all participants were told:

> You will begin with a retyping task that requires self-control. Success at self-control helps us meet many important long-term goals. A major component of success at self-control goals is how well people can focus and sustain their attention. This typing task requires that you use self-control to consistently monitor your attention and performance.

In the *high-effort* condition, participants were instructed to re-type the presented text with the rules that they should remove all “e's” and spaces and change all lower-case “a's” to “A's.” The passage was taken from an advanced statistics text. Participants spent 15 min on this task before they were automatically advanced to the second part of the study (participants were not permitted to advance before the 15 min were up). In the *low-effort* condition, participants were instructed to re-type the given text exactly as presented. The text was taken from beginner typing exercises (e.g., “i will now just tell you the story of the time i went to the zoo…”). Participants spent 3 min on this task before they were automatically advanced to the second part of the study.

As in Study 1, to obscure the connection between the typing task and our measure of self-control lay theories, participants next completed the same two filler scales included in Study 1: the 10-item Personality Inventory (Gosling et al., 2003) and the 20-item Positive and Negative Affect Schedule (Watson et al., 1988).

Participants then completed the key dependent measure also used in Study 1, Job et al.'s (2010) self-control lay theories questionnaire that included the six-item mental exertion subscale ($\alpha = .89$) and the six-item resisting temptations subscale ($\alpha = .81$), on a six-point scale from 1(*strongly disagree*) to 6(*strongly agree*). Responses were reverse-coded where appropriate so that higher scores represented more limited theories of self-control.

To assess perceived effort, we then asked participants to think back to the typing task. Participants responded to six questions about the extent to which the experience was effortful and exhausting (“How much was the typing task demanding of your attention? How hard was it to completely focus on the typing task? How difficult was it to concentrate on the typing task? How mentally exhausted did you feel while

[3] This exclusion criterion was based on pilot work in which we observed that even typing tasks resembling the low effort condition in this study were perceived as challenging for poor typists, thus creating a ceiling effect for this group of participants. One might argue that we should exclude any participant who indicated that they were a below-average typist, not only those who indicated that they were extremely poor typists. Doing so results in the exclusion of an additional 28 participants. Excluding these participants does not change the direction or significance of the reported analyses. Including all participants does not change the significance of the indirect effects, but does result in a non-significant direct effect. Details are reported in the SOM.

working on the typing task? How tiring was it to work on the typing task? How draining was it to work on the typing task?", α = .91). These six items all used a seven-point scale from 1(*not at all*) to 7(*extremely*).[4]

Participants also responded to one question about perceived success (e.g., "How successful do you think you were at the typing task?") on a seven-point scale from 1(*not at all*) to 7(*extremely*). Participants also responded to two items about the extent to which the typing task involved self-control ("For people to perform well on the typing task, they must exert self-control"; "The typing task involved willpower", $r = .72$) and two items about the extent to which participants felt autonomous while working on the typing task ("It was my choice whether or not to work hard on the task"; "I felt free to work as hard or as little as I wanted on the task", $r = .37$) on a seven-point scale from 1(*strongly disagree*) to 7(*strongly agree*).

Participants then completed demographic information, including their level of typing expertise, by categorizing their general typing ability as extremely poor, somewhat poor, average, somewhat expert, or extremely expert.

### 3.2. Results

#### 3.2.1. Typing task subjective experiences

We first examined whether participants in the high (vs. low) effort condition indeed experienced the typing task as more effortful. As shown in Table 3, using a composite of the six effort and fatigue items, we found that those in the high-effort condition reported exerting greater effort and experiencing more fatigue than those in the low-effort condition, $t(180) = 14.61$, $p < .001$. As also shown in Table 3, there were significant differences in perceived success, $t(180) = 3.91$, $p < .001$ and the extent to which the task involved self-control, $t(180) = 5.82$, $p < .001$. There was no significant difference in perceived autonomy, $t(180) = 0.87$, $p = .38$.

#### 3.2.2. Lay theories

Our central question was whether engaging in a high (vs. low)-effort self-control task would affect one's lay theories of self-control as a function of experiencing greater subjective effort. As predicted, those in the high-effort condition reported significantly more limited theories of mental exertion than those in the low-effort condition, $t(177) = 2.00$, $p = .047$. There was no difference between conditions in lay theories of resisting temptations, $t(177) = 0.03$, $p = .97$.

Importantly, this difference in lay theories of mental exertion was associated with differences in perceived effort and not with differences in perceived success or perceived self-control relevance. When examining the correlations between our task experience variables and lay theories, the only significant correlation was a positive correlation between perceived effort and lay theories of mental exertion (see Table 4). Using the bootstrapping method (Hayes, 2013), the indirect path from condition to lay theories of mental exertion through perceived effort was statistically significant, 95% Bootstrap CI with 10,000 samples [0.03, 0.37] (Fig. 1).[5]

### 3.3. Discussion

Study 2 provides further evidence that experiencing self-control as effortful may influence lay theories of self-control. In contrast to Study 1, we observed that participants in the high versus low effort condition reported more limited theories of self-control regarding mental exertion, but not more limited theories of self-control about resisting temptations. However, whereas Study 1 directed participants to think about instances in which self-control involved resisting temptations,

**Table 3**
*Mean differences by condition (Study 2).*

| | High-effort | | Low-effort | | Difference | |
|---|---|---|---|---|---|---|
| | M | SD | M | SD | 95% CI | *d* |
| *Task experience* | | | | | | |
| Perceived effort | 5.17 | 1.10 | 2.80 | 1.03 | −2.68, −2.04 | 2.22 |
| Perceived success | 3.36 | 1.46 | 4.28 | 1.60 | 0.46, 1.38 | 0.60 |
| Involved self-control | 5.37 | 1.12 | 4.21 | 1.41 | −1.55, −0.76 | 0.91 |
| Perceived autonomy | 5.04 | 0.98 | 5.20 | 1.30 | −0.20, 0.52 | 0.14 |
| *Self-control lay theories* | | | | | | |
| Mental exertion | 4.27 | 0.97 | 3.98 | 0.93 | −0.58, −0.004 | 0.31 |
| Resisting temptation | 0.34 | 0.80 | 3.33 | 0.77 | −0.24, 0.23 | 0.01 |

**Table 4**
*Pearson correlations (Study 2).*

| Measures | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1. Perceived effort | – | | | | | |
| 2. Perceived success | −0.27*** | – | | | | |
| 3. Involved self-control | 0.49*** | −0.20** | – | | | |
| 4. Perceived autonomy | −0.13 | 0.03 | 0.09 | – | | |
| 5. Mental exertion theories | 0.23** | −0.01 | 0.03 | −0.01 | – | |
| 6. Resisting temptation theories | 0.12 | −0.04 | −0.04 | −0.15* | 0.36*** | – |

* $p < .05$.
** $p < .01$.
*** $p < .001$.

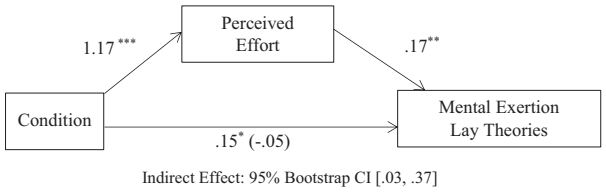


**Fig. 1.** *Effects of condition on lay theories of mental exertion via perceived effort (Study 2).*
*Note.* Unstandardized regression coefficients for the relationship between condition and mental exertion lay theories as mediated by perceived effort. Bootstrap with 10,000 samples.
*$p < .05$, **$p = .01$, ***$p < .001$.

Study 2 focused on an act of self-control that was both introduced as an act of mental exertion and did indeed involve sustained persistence and attention over time. This pattern of results again provides at least preliminary evidence that people's experiences of effort have more narrow and specific effects on their lay theories of self-control based on the types of self-control behaviors that are currently salient.

One potential criticism of this design is whether the low effort self-control condition truly involved self-control. Indeed, participants judged this condition as only moderately involving self-control relative to the high effort condition. Practically, it may be hard to distinguish instances of low-effort and of no effort. However, this does not undermine the interpretation of the high effort condition. Even if participants in the low-effort condition did not experience the task as involving self-control to the degree we hoped, the results still provide evidence that an effortful experience of self-control shifted people's lay theories compared to not using self-control. Furthermore, the difference in lay theory endorsement between the high and low effort conditions was unrelated to perceptions of self-control relevance.

Although Studies 1 and 2 provide evidence of a relationship between effort and limited lay theories, these studies do not indicate whether changes in lay theories of self-control might have subsequent effects on the future exertion of self-control. Additionally, because Study 1 manipulated the accessibility of a single high- or low-effort

[4] We also examined the effort and exhaustion items separately, as detailed in the SOM.
[5] As detailed in the SOM, this mediation remained significant when including positive affect in the model.

experience and Study 2 manipulated the effort involved in a single act of self-control, these findings do not speak directly to the influence of experiencing self-control as particularly effortful over time. Study 3 attempts to address both of these limitations by longitudinally examining how more prolonged experiences of effortful self-control predict people's subsequent lay theories of self-control and their performance on tasks requiring control.

## 4. Study 3

Study 3 assessed how experiencing self-control as more or less effortful on a day-to-day basis might change lay theories of self-control. We directed each participant to perform a specific self-control task for two weeks and measured overall perceptions of effort and success at the end of that period. Similar to Study 1, these tasks were presented as being primarily about resisting temptations, rather than mental exertion. Both before and after the two-week directed-control period, participants completed a measure of self-control lay theories. In addition, both before and after this period, we measured self-control performance in two domains unrelated to the directed-control tasks. In an initial laboratory session, participants completed several different consecutive tasks that each required self-control. This allowed us to assess self-control performance in the presence of cumulatively increasing self-control demands (cf., Bernecker & Job, 2015; Job et al., 2010; Job, Walton, et al., 2015; Muraven, 2010a, 2010b). The measures and analyses reported here are those most relevant to the present focus on shifts in lay theories of self-control. Full details on additional measures included in the longitudinal study and some relevant ancillary analyses are presented in the supplemental materials.

If the effort experienced while exerting self-control over the directed-control period influences people's lay theories of self-control, as consistent with Studies 1 and 2, individuals who experience greater effort during this period should report more limited lay theories at the end of this period. As noted in detail below, most participants were engaged in effort primarily characterized by resisting temptations. This study therefore provided another opportunity to examine if the effects would be more narrowly restricted to lay theories about resisting temptations versus mental exertion.

In addition, if endorsing more limited lay theories further influences self-control performance, this shift toward more limited lay theories at the end of the directed-control period should predict worse subsequent self-control performance. Finally, as noted earlier, previous research demonstrates that limited theories of self-control affect control performance particularly when regulatory demands are high (e.g., Bernecker & Job, 2015; Job et al., 2010; Job, Walton, et al., 2015; Miller et al., 2012). Thus, this association between lay theories and self-control performance should be most likely to emerge under high-demand conditions—i.e., on the final task following two previous self-control tasks.

Given prior work suggesting that success in exerting self-control is not related to changes in lay theories (Job et al., 2010), perceptions of success in exerting control during the directed-control period were not expected to be related to changes in lay theories. However, we assessed these overall perceptions of success to directly test this idea and control for such perceptions in our primary analyses.

### 4.1. Method

#### 4.1.1. Participants and design

173 undergraduate students in psychology courses at a large Canadian university were recruited to participate in this study for $20 and course credit. Additionally, participants received a ticket for a $100 lottery for each of the 14 daily online questionnaires they completed. Out of the initial 173 participants, nine participants dropped out after completing the initial online questionnaire; an additional four participants did not complete the first lab session due to external circumstances (e.g., technical error, snow day). Four participants dropped out after completing the initial lab session (i.e., during the directed-control period), leaving 156 participants who completed the entire study (80% female; $M_{age}$ = 20.26 years, SD = 1.94; 48.7% Asian Canadians, 34.0% Whites, 3.2% African Canadians, 2.6% Middle Eastern, 1.9% Hispanic Canadians, and 9.0% other). Based on calculations using G*Power (Faul et al., 2007), this final sample provided power of 0.80 to detect an association between participants' experience of effort and their lay theories following the directed-control period, as well as an association between their lay theories and their performance on the final self-control task, equivalent in size to $d$ = .45.

#### 4.1.2. Procedure and materials

Participants first completed an initial online questionnaire including the lay theories of self-control scale. They then came to a laboratory session that assessed baseline self-control performance three to seven days later ($M$ = 4.68 days, $SD$ = 2.19). These were the *Time 1* assessments. Next participants were randomly assigned to perform one of three self-control tasks for a 14-day period. Finally, participants completed a second online questionnaire one to three days after the directed-control period ($M$ = 1.56 days, $SD$ = 0.88), and a final laboratory assessment of self-control one to three days after the second online questionnaire ($M$ = 1.36 days, $SD$ = 0.96). These were the *Time 2* assessments.

##### 4.1.2.1. Online questionnaires

*4.1.2.1.1. Self-control lay theories.* Both in the Time 1 and Time 2 online questionnaires, participants completed the same six-item mental exertion subscale (time 1 α = .85, time 2 α = .86) and the six-item resisting temptations subscale (time 1 α = .86, time 2 α = .84) on a six-point scale from 1 (*strongly disagree*) to 6(*strongly agree*), as in previous studies. Responses were reverse-coded where appropriate so that higher scores represented more limited theories of self-control.

*4.1.2.1.2. Perceived effort and success.* At the beginning of the Time 2 online questionnaire, there was a set of items about participants' overall experience during the two-week practice period. This included 3 items intended to assess effort ("Practicing was effortful"; "Practicing was demanding"; "Practicing was exhausting"), which participants rated on a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*), α = .79. In addition, there were three items assessing perceived success ("I did well at the practice tasks"; "I got better at the practice tasks"; "I got worse at the practice tasks", last item reverse-scored), using the same response scale, α = .79.

*4.1.2.2. In-lab assessment of self-control performance under high demand.* Both the Time 1 and Time 2 lab sessions involved three consecutive tasks frequently used to engage and assess self-control (see Hagger et al., 2010). The first was the Stroop (1935) task, which involves inhibitory control. The second was a text-processing task involving response monitoring and inhibition of previously learned response rules. The third was an anagram task involving effortful persistence. The tasks were administered in the same way and in the same order at Time 1 and Time 2, but the specific materials used at each time point varied. The first and second tasks were intended to increase the cumulative self-regulatory demands participants experienced and the third task served as the assessment of self-control performance under high self-regulatory demand (see also Muraven, 2010a, 2010b). We report additional, exploratory analyses of performance on the first and second tasks in the online supplement.

*4.1.2.2.1. Task 1 (regulatory demand).* For the Stroop task, participants were presented with one of four color words on a screen. On *congruent* trials, the ink color matched the text (e.g., the word *red* displayed in red font). On *incongruent* trials, the ink color did not correspond to the text (e.g., the word *red* displayed in blue font). Thus, on incongruent trials, participants must override the dominant response to read the color word. In a third set of *control* trials the character string

**Table 5**
*Prediction of Time 2 lay theories of limited self-control by experienced effort, controlling for Time 1 lay theories of limited self-control (Study 3).*

| Predictor | *B* (*SE*) | 95% CI | *t* | *ß* |
|---|---|---|---|---|
| *Mental Exertion Subscale* | | | | |
| Effort | 0.13 (0.04) | 0.05, 0.21 | 3.16** | 0.20 |
| T1 limited theories | 0.63 (0.06) | 0.50, 0.75 | 10.05*** | 0.62 |
| *Resisting Temptation Subscale* | | | | |
| Effort | 0.20 (0.05) | 0.10, 0.30 | 3.74*** | 0.28 |
| T1 limited theories | 0.27 (0.08) | 0.11, 0.44 | 3.25** | 0.25 |

*Note.* Both predictors were entered into the regression equation simultaneously.
** $p < .01$.
*** $p < .001$.

"XXXXXX" was presented in one of the four colors, which provided a baseline response-time free from any facilitation effects on congruent trials and isolates the interference effects from incongruent trials. The letters *R*, *T*, *Y*, and *U* on the keyboard were labeled with a red, blue, yellow, and green sticker, respectively, and the task of participants was to respond by pressing the key for the color in which the word or letter sequence was written as quickly and accurately as possible. After three examples and 12 practice trials, participants did 96 experimental trials: a randomized combination of 32 congruent trials, 32 incongruent trials, and 32 control trials.

*4.1.2.2.2. Task 2 (regulatory demand).* Following the Stroop task, all participants completed a difficult version of the e-crossing task frequently used to induce effortful monitoring and inhibition of prepotent responses (e.g., Baumeister, Bratslavsky, Muraven, & Tice, 1998; Molden et al., 2012). Participants were first given a sheet of typewritten text and asked to cross out each instance of the letter *e*. After learning this rule, they were given a second sheet of typewritten text and asked to follow a different rule of crossing out every *e*, unless another vowel was found two letters preceding it or the next letter after. Thus, participants had to follow a complex new rule and inhibit the rule they had previously used.

*4.1.2.2.3. Task 3 (self-control assessment following regulatory demand).* The last self-control task was a multiple-solution anagram task, another commonly used measure of self-control (e.g., Clarkson et al., 2010; Gordijn, Hindriks, Koomen, Dijksterhuis, & Van Knippenberg, 2004). Participants were given 7 letters ("U, R, A, E, O, C, G" at Time 1 and "C, L, A, T, P, S, I" at Time 2) and had as long as they wanted to form as many words from those letters as they could without repeating any. Thus, to perform well on this task, participants must choose to persist and resist the temptation to quit (Baumeister et al., 1998). The length of time participants persisted was recorded and served as our primary dependent variable (Muraven, Shmueli, & Burkley, 2006; Tyler & Burns, 2009).

*4.1.2.3. Directed self-control instructions.* Between the Time 1 and Time 2 assessments, participants were instructed to engage daily in a specific self-control task for 14 days. Some participants were instructed not to eat sweets ($N = 36$). Some participants kept a daily journal of their use of self-control ($N = 84$), which was defined for them as behaviors such as "resisting the urge to eat dessert, craving an alcoholic drink but not having one, or wanting to scream in anger but maintaining your composure." Some performed a daily set of math problems ($N = 36$). Thus, the large majority of participants in this study (77%) were considering self-control behaviors that were primarily related to resisting temptations rather than mental exertion. Using the exact instructions and materials developed by Muraven (2010a),[6] all participants were told that their assigned task involved exerting self-control and that practicing the task regularly often leads to broad improvements in self-control–i.e., "Remember that people who practice a task like this are often able to increase their self-control in general, including in other domains of their lives that matter to them." Because, unlike Muraven (2010a), preliminary analyses revealed that the type of self-control task did not moderate any of the results reported below, we collapsed across this condition. Details of these additional analyses involving task condition are reported in the supplement.

*4.1.2.4. Monitoring compliance.* In all task conditions, participants were instructed to complete reports each evening in which they indicated whether or not they performed the assigned tasks. For the 156 participants who completed the study, both the average number of reports they completed ($M = 11.57$, $SD = 3.56$) and the average number days they reported performing the tasks were reasonably high ($M = 9.29$, $SD = 4.02$).[7]

### 4.2. Results

#### 4.2.1. Primary analyses

We first examined whether higher perceived effort in performing the assigned self-control task across the 14-day period predicted a shift toward more limited lay theories of self-control. To accomplish this, we separately regressed Time 2 lay theories of mental exertion and lay theories of resisting temptation on the index of perceived effort during the directed-control period while including matching Time 1 lay theories as a covariate so that the dependent variable was interpretable as the change from participants' baseline (see Kutner, Nachtsheim, Neter, & Li, 2005). As displayed in Table 5, results showed a significant association between perceptions of effort and greater subsequent endorsement of limited lay theories of both mental exertion and resisting temptation.

Next, we tested whether shifts in lay theories of self-control would, in turn, mediate worse self-control performance under high regulatory demand (i.e., less anagram persistence). We first assessed the direct effect of perceived effort on Time 2 anagram persistence. As shown in Table 6, perceived effort negatively predicted Time 2 anagram persistence as measured in seconds. We then separately regressed Time 2 anagram persistence on perceived effort and Time 2 lay theories of mental exertion and resisting temptation, while again partialling out the matching Time 1 lay theories so that the Time 2 lay theories measure was interpretable as a change from participants' baseline. As also shown in Table 6, shifting to a more limited theory of resisting temptation at Time 2 significantly predicted less anagram persistence while the relationship between reported effort and anagram persistence was no longer significant. However, shifting to a more limited theory of mental exertion at Time 2 did not predict anagram persistence and the relationship between reported effort and anagram persistence remained significant. As shown in Fig. 2, using the bootstrapping method (Hayes, 2013) with 10,000 samples, we tested the indirect path from perceived effort to reduced anagram persistence through shifting lay theories of resisting temptation (i.e., Time 2 theories controlling for Time 1 theories), which was statistically significant.[8]

[6] Special thanks to Mark Muraven for providing these materials.

[7] 78.7% of participants completed at least 10 daily reports and 86.4% completed at least seven daily reports. 54.5% or participants reported performing their assigned task in at least 10 of their reports and 73.8% reported performing their task in at least seven reports.

[8] Our primary analyses focused only on how experiences of effort and changes in lay theories from Time 1 to Time 2 predicted Time 2 anagram performance because this provided the clearest test of the immediate subsequent impact of these experiences and shifts in theory. However, it was also possible to analyze how experiences of effort and changes in lay theories further predicted changes in anagram-persistence from Time 1 to Time 2. This was done by repeating all of the above analyses on Time 2 anagram persistence partialling out Time 1 anagram-persistence, so that the Time 2 anagram persistence was also interpretable as a change from baseline. These results showed that effort did not directly predict decreases in anagram persistence from Time 1 to Time 2, $B = -21.22$, $SE = 12.79$, 95% CI with 10,000 samples [−46.49, 4.05], $t(145) = -1.66$,

**Table 6**
*Prediction of Time 2 anagram persistence by experienced effort and lay theories of limited self-control (Study 3).*

| Predictor | *B* (*SE*) | 95% CI | *t* | *ß* |
|---|---|---|---|---|
| *Step 1* | | | | |
| Effort | −38.23 (15.89) | −69.64, −6.82 | 2.41* | 0.19 |
| *Step 2* | | | | |
| *Mental Exertion Subscale* | | | | |
| Effort | −33.44 (16.49) | −66.02, −0.86 | 2.03* | 0.17 |
| T1 limited theories | −10.85 (31.87) | −73.83, 52.13 | 0.34 | 0.04 |
| T2 limited theories | −25.85 (32.43) | −89.74, 38.04 | 0.80 | 0.09 |
| *Resisting Temptation Subscale* | | | | |
| Effort | −29.01 (16.51) | −61.63, 3.61 | 1.76 | 0.15 |
| T1 limited theories | 52.40 (25.60) | 1.81, 102.99 | 2.05* | 0.20 |
| T2 limited theories | −67.94 (28.52) | −124.30, −11.58 | 2.38* | 0.25 |

*Note.* In Step 1, effort was the sole predictor of Time 2 lay theories in the regression. In Step 2, all three predictors were entered into the regression equation simultaneously.
* $p < .05$.

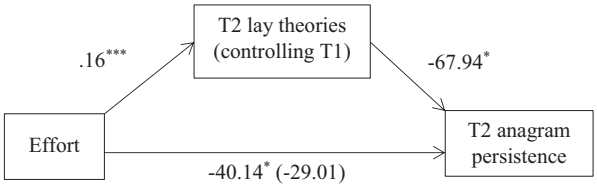


**Fig. 2.** *Effects of experienced effort on Time 2 anagram persistence via a shift in lay theories of resisting temptation (Study 3).*
*Note.* Unstandardized regression coefficients for the relationship between effort and T2 anagram persistence as mediated by T2 lay theories of resisting temptation (controlling for T1 lay theories of resisting temptation). Bootstrap with 10,000 samples.
*$p < .05$, **$p < .01$, ***$p < .001$.

In follow-up analyses, we additionally tested whether participants' initial lay theories of self-control at the beginning of the study predicted their perceived effort. Consistent with previous research (see Job et al., 2010, Job, Bernecker, et al., 2015; see also Mrazek et al., 2018), lay theories of mental exertion and resisting temptation did not predict participants perceptions of effort while performing the assigned self-control task, $|Bs| < 0.18$, $ts(148) < 1.67$, $ps > 0.10$, $ßs < 0.13$. We further tested whether the observed associations of high effort with shifting lay theories and anagram persistence were moderated by participants' initial lay theories of self-control. However, adding the interaction of perceived effort following directed-control and Time 1 lay theories to the regressions predicting Time 2 lay theories described above did not reveal any additional significant effects, $|Bs| < 0.03$, $ts(146) < 0.5$, $ps > 0.57$, $ßs < 0.04$. Adding this same interaction term to the regressions predicting anagram persistence also did not reveal any additional significant effects, $|Bs| < = 7.75$, $ts(144) < 0.4$, $ps > 0.65$, $ßs < 0.04$. Thus, there is no evidence that the above analyses of participants' shifts in lay theories from Time 1 to Time 2 were biased by pre-existing differences in the lay theories of people who experienced greater effort during directed-control or in how pre-existing lay theories altered the impact of these experiences.

Lastly, we repeated the primary analyses substituting perceived success rather than perceived effort during self-control. Perceived success showed a moderate negative correlation with perceived effort, $r = -0.20$, $p = .013$, such that high effort was related to low perceived success. Therefore, for ease of interpretation, we reverse-coded perceived success. Low perceived success did not predict shifts toward more limited lay theories of mental exertion, $B = 0.00$, $SE = 0.04$, 95% CI [−0.08 0.08], $t(147) = 0.01$, $p > 0.99$, $ß = 0.00$, and marginally predicted shifts toward more limited lay theories of resisting temptation, $B = 0.11$, $SE = 0.06$, 95% CI [−0.001, 0.22], $t(147) = 2.00$, $p = .05$, $ß = 0.13$, from Time 1 to Time 2. However, for both lay theories, when simultaneously regressing Time 2 theories on Time 1 theories and both perceived effort and low success, the association with perceived effort remained significant ($Bs > 0.13$, $ts(146) > 3.22$, $ps < 0.002$, $ßs > 0.20$), whereas the association of low perceived success was not significant ($Bs < 0.07$, $ts(146) < 1.36$, $ps > 0.18$, $ßs < 0.10$).[9] In addition, unlike perceived effort, the association of low perceived success with subsequent anagram persistence was non-significant ($B = -14.00$, $SE = 16.02$, 95% CI [−45.66, 17.67], $t(148) = -0.87$, $p = .38$, $ß = 0.07$).

### 4.3. Discussion

Study 3 extended Studies 1 and 2 and provided additional evidence that experiences of self-control not only influence immediate performance (Brehm & Self, 1989; Clarkson et al., 2010; Kivetz & Zheng, 2006; Muraven et al., 2008), but also more broadly influence people's lay theories and future performance. Experiences of relatively high effort during a two-week period of a directed self-control task were associated with shifts toward stronger endorsement of a lay theory that self-control capacity is limited, regardless of one's initial lay theory of self-control. These shifts toward more limited lay theories of self-control, at least in the form of resisting temptation, in turn, were associated with reduced self-control performance when regulatory demands were high. Furthermore, shifts in lay theories of self-control and self-control performance were uniquely associated with perceptions of effort, but not with perceptions of success.

Although, as in Study 1, the majority of participants in this study engaged in directed self-control tasks that focused on resisting temptations, results revealed that perceived effort at engaging in these tasks over an extended period of time was associated with shifts to more limited theories of both mental exertion and resisting temptation. This could potentially indicate that even self-control tasks that are primarily perceived as involving resisting temptation will also be seen as involving mental exertion if they must be sustained over time. However, more similar to the narrow effects of exerting self-control observed in Studies 1 and 2, only shifts in lay theories of resisting temptation were related to performance in demanding self-control behaviors at the second lab session. This could perhaps indicate that the prominent factor in how people's lay theories influence their willingness to sustain self-control under high demands has more to do with how they experience the temptation to disengage from this control (e.g., to give in to the feeling that they have “done enough”, see Kurzban et al., 2013). These possibilities are important topics for further research.

As discussed, the associations between people' lay theories of self-control and their task performance emerged for a self-control task that was preceded by two other tasks demanding self-control, but as detailed in the supplement, not for the two initial tasks. This finding replicates

(*footnote continued*)
p = .10, β = 0.11, though there was a trend to that effect. When controlling for effort, changes in lay theories of resisting temptation significantly predicted changes in anagram persistence, $B = -61.26$, $SE = 22.46$, 95% CI with 10,000 samples [−105.64, −16.87], $t(144) = 2.73$, $p = .007$, $β = 0.22$. The indirect path from increased perceptions of effort to more negative changes in anagram persistence through changes toward more limited lay theories of resisting temptation was again significant, 95% Bootstrap CI with 10,000 samples [−22.41, −0.98]. Parallel analyses substituting participants' lay theories of mental exertion showed that changes in these lay theories did not predict changes in anagram persistence, $B = -34.00$, $SE = 25.72$, 95% CI with 10,000 samples [−84.82, 16.82], $t(144) = 1.32$, $p = .19$, $β = 0.11$ nor was there a significant indirect effect, 95% Bootstrap CI with 10,000 samples [−12.36, 1.77].

[9] All other reported associations of perceived effort also maintain the same direction and significance level when controlling for perceived success.

previous research and theory that the influences of people's experiences of performing self-control over time (Muraven, 2010b) and their lay theories of limited control (e.g., Bernecker & Job, 2015; Job et al., 2010; Job, Walton, et al., 2015; Miller et al., 2012) should primarily emerge when the cumulative demands for control are high (e.g., on the last of a consecutive set of self-control tasks). Given that this pattern replicates previous research, we think it is likely that we observed an effect of lay theories on the anagram task because it most clearly met the conditions for a "high demand" task. However, since the tasks were completed in a fixed order, we acknowledge the possibility that the anagram task itself may have been particularly sensitive to picking up performance differences as a function of lay theories. This is a limitation of the present design, and worthy of exploration in future research.

## 5. General discussion

Emerging research on self-control reveals that one important factor in determining whether or not people sustain control is their experiences of effort while exerting control. In three studies, we examined how these experiences of effort might also have broader effects in terms of altering people's fundamental beliefs about the nature of self-control. Results of all three studies indicated that self-control experiences characterized by high versus low perceived effort were associated with stronger endorsement of lay theories that self-control is limited and can be exhausted through continuous use.

Two studies experimentally manipulated whether participants reflected on a high-effort or low-effort experience of self-control (Study 1) or engaged in a high- or low-effort self-control task (Study 2); in both studies, participants endorsed lay theories of self-control as more limited in the high-effort condition. Furthermore, Study 2 indicated that the effects of condition on lay theories were uniquely mediated by perceived effort. Study 3 assessed the degree of effort and fatigue participants experienced during a two-week period of performing an assigned self-control task and examined its association with changes in lay theories of self-control following this period. Results similarly showed that participants who experienced more effort and fatigue also endorsed lay theories of self-control as more limited, regardless of what their initial lay theory had been. Thus, across three different paradigms, two that prioritized experimental control (Studies 1–2) and one that prioritized ecological validity (Study 3), we found converging evidence of the relation between perceived effort and lay theories of self-control. In addition, Study 3 provided further evidence for the downstream effects of increased experiences of effort during self-control on subsequent self-control performance. Consistent with prior research on lay theories of self-control (Bernecker & Job, 2015; Job et al., 2010; Job, Walton, et al., 2015; Miller et al., 2012), the shifts toward lay theories of self-control as limited further mediated reduced self-control performance following such experiences. Moreover, also consistent with previous research, the mediational pathway was only observed for the final self-control-related task in the experimental session when cumulative demands for control were relatively high.

Interestingly, the effects of perceived effort on lay theories of self-control were largely specific to the type of self-control experience that was salient. In Studies 1 and 3, in which self-control was defined for and experienced by participants as being primarily about resisting temptations, effort was related most strongly to lay theories of resisting temptation, not mental exertion. In contrast, in Study 2, in which self-control was defined for participants as being primarily about mental exertion, perceived effort was related to lay theories of mental exertion, but not to lay theories of resisting temptation. These contrasting patterns of results suggest that individuals may be relying on effort signals to draw more narrow and specific inferences about their capacity in particular self-control situations, not about their self-regulatory capacity more broadly. Although more systematic research will be necessary to confirm the specificity of such inferences, our findings indicate that there is potential value in examining different lay theories about self-control separately rather than analyzing them as one general construct.

### 5.1. The role of effort and fatigue as key self-regulatory signals

These findings provide new insights into how the experience of self-control as effortful and exhausting may affect not only proximal, but also distal, self-control outcomes. Although recent motivational accounts of self-control (e.g., Inzlicht & Schmeichel, 2012; Kurzban et al., 2013; Molden et al., 2016, 2018) vary in a number of details, there is general recognition that whereas signals of exhaustion and effort may not reflect a literal state of resource depletion, they may still function as key signals about how much to continue to invest in goal pursuit. The current studies extend this idea further by suggesting that people may make important inferences about the nature of self-control based on these feelings of effort and exhaustion. These inferences can then influence people's lay theories about self-control and affect self-control performance in unrelated situations. The present results thus provide some initial evidence that high-effort cues can impact self-control well beyond the immediate situation. In particular, they suggest that the experience of high effort and exhaustion during self-control can itself lead to reduced self-control performance in new situations where regulatory demands are high.

These results are particularly interesting in light of the conclusions drawn by Vohs, Baumeister, and Schmeichel (2012) concerning the effects of "severely depleting" experiences and the evidence this provides for the limited capacity of self-control. Vohs et al. presented a study in which they first temporarily activated either more limited or non-limited lay theories of self-control by having people rate their agreement with statements biased toward one of the two theories (see Job et al., 2010). Temporarily increasing endorsement of a non-limited versus a limited theory of self-control in this manner bolstered subsequent performance on self-control tasks when participants were presented with two consecutive self-control tasks, which was presumably experienced as moderately taxing; however, this manipulation did not affect performance when participants were presented with four consecutive self-control tasks, which was presumably experienced as extremely taxing. Vohs et al. concluded that these findings confirm that, although perceptions and interpretations of effort during self-control might affect such control in some cases, there is still a limited capacity that will be depleted if people have to sustain self-control for a long enough period of time or at high enough levels. In the context of studies reviewed earlier (Bernecker & Job, 2015; Job et al., 2010; Job, Walton, et al., 2015; Miller et al., 2012), these findings could be interpreted as suggesting that under conditions of extremely high demand, lay theories are no longer influential.

The present findings, however, question the necessity of this conclusion. If the lengthier and more taxing condition of the Vohs et al. (2012) experiment was indeed experienced as more effortful and fatiguing, then these experiences could readily have shifted people's lay theories back toward a more limited view of self-control, counteracting any influence of the initial manipulation. That is, we would argue (see also Molden et al., 2016) that whatever temporary accessibility for non-limited theories of self-control was created at the beginning of the experiment could have been overridden by the more recent and prolonged experience of effort and fatigue involved with completing four consecutive self-control-relevant tasks (see Higgins, 1996). Indeed, it is even possible that the violation of expectations experienced by participants who were encouraged to endorse non-limited theories of self-control but then experienced high levels of effort and fatigue from the prolonged series of tasks they performed made the implications of these later experiences more salient. This would explain the particularly low performance observed in this condition of the experiment. Thus, overall, complementing previous findings on the role of people's perceptions and experiences in explaining results previously interpreted as a depleted capacity for self-control (e.g., Clarkson et al., 2010; Laran & Janiszewski, 2011; Moller et al., 2006; Muraven et al., 2008), the

results presented here suggest that even apparent instances of "severe depletion" can be understood in terms of people's perceptions and experiences of effort rather than as the exhaustion of some self-control resource.

A broader question concerning the influences of effort on sustained self-control that is important for future research is whether experiences of effort during self-control are directly equivalent to experiences of fatigue. Although, colloquially, the two terms are often used interchangeably and we did not have adequate measures to distinguish these constructs in the present studies, they could be theoretically distinct in critical ways. For instance, prior work has shown that effort can—but does not necessarily—produce fatigue (e.g., Brehm & Self, 1989; Csikszentmihalyi, 1997). Indeed, Molden et al. (2016, 2018) argue that effort (i.e., sustained attention) itself may simply be one input to determining fatigue. Specifically, in their motivated effort-allocation (MEA) model of self-regulation, the relationship between effort and fatigue further depends on the perceived progress toward some desired outcome produced by the effort exerted. It is only when people's efforts are not perceived to be producing sufficient progress—i.e., when this effort does not seem to be entirely worthwhile—that fatigue is proposed to arise. Indeed, there might be cases when experiences of effort actually lead to *less* limited theories if perceived effort is positively correlated with perceptions of worth; under these conditions, it is possible that individuals might actually infer that effort is energizing and that their capacity for regulation is expanding or limitless (see Mrazek et al., 2018). Thus, it will be important in future research to develop effective means of separately assessing effort versus fatigue. This could involve the development of both more sensitive self-report measures as well as the use of physiological indicators of self-regulatory effort and fatigue (e.g., Hui et al., 2009; Segerstrom & Nes, 2007).

In addition, although our account of how the experience of effort influences lay theories is based on the inferences people make, the studies did not directly test the mechanism by which perceptions of effort affects lay theories. Experiences of effort might also affect what factors are most salient when reflecting on lay beliefs, may change the perceived value of effort, or may more generally affect individuals' confidence about their self-regulatory capabilities, leading them to make more conservative estimates of what they (and perhaps even others) are capable of doing. In future work it will be interesting to directly examine potential mechanisms, of which we recognize that the inference account we have proposed is only one possibility.

### 5.2. Implications for improving self-control

Another way to consider the present findings that experiencing self-control as effortful may produce more limited lay theories of control and impair subsequent performance is the reverse: that experiencing self-control as low effort may support more non-limited theories of control and bolster performance in the face of high regulatory demands. The studies reported here do not speak directly to whether experiences of high versus low effort and exhaustion are relatively more influential in shifting lay theories, which is an interesting direction for future research to address. Nevertheless, these findings confirm the potential of methods to bolster self-control by directly altering how people experience and interpret the effort involved.

Indeed, the present findings could help further explain why proactive strategies of self-control, in which people alter their environments and behaviors so as to minimize their potential of actually having to engage in effortful control, are often so effective (see Ent, Baumeister, & Tice, 2015; Fujita, 2011; Hofmann, Baumeister, Förster, & Vohs, 2012; Trope & Fishbach, 2000; Wertenbroch, 1998). If effort and fatigue are not frequently experienced, then people's broader lay theories of self-control may remain more non-limited, further bolstering whatever efforts they may need to make in the future. Our findings could also help explain why strategies of engaging in consistent self-control "practice," in contrast, may not always be effective and could sometimes even backfire. Although this type of intervention has shown some promise for improving self-control (e.g., Job, Friese, & Bernecker, 2015; Muraven, 2010a; Muraven, 2010b), the cumulative evidence for its effectiveness is less certain (Inzlicht & Berkman, 2015; Miles et al., 2016). This mixed evidence could arise because the experiences that people have during self-control practice may determine how well such an intervention succeeds. Difficult self-control tasks that have a high likelihood of being experienced as effortful and exhausting may actually undermine self-control performance in the future. For instance, one study found that participants who practiced controlling their moods over a two-week period actually showed a subsequent decrease (from baseline) in self-control performance (Muraven, Baumeister, & Tice, 1999). In contrast, practice tasks such as keeping good posture (Sultan, Joireman, & Sprott, 2012) and using one's non-dominant hand for certain tasks (Denson, Capper, Oaten, Friese, & Schofield, 2011), instead improved self-control. These latter tasks may, on average, have been experienced as less effortful and exhausting compared to a practice task like controlling one's moods. Investigating the influence of different types of practice, and the role of the effort and fatigue they evoke, is thus an interesting direction for future work.

Beyond the actual experience of effort itself, another important point made by the present research is that it would benefit any proposed method to improve self-control to take into account its implications for people's broader lay theories of control. That is, to develop effective interventions for self-control, it may ultimately be important to understand how people's repeated experiences of exerting self-control in the context of the interventions themselves shape the development of their lay theories. The present findings illustrate the potential connection between these types of experiences and lay theories, but leave many other questions still unanswered. For example, it is not clear how long any changes in people's lay theories brought about by their experiences endure. Study 3 evaluated people's experiences over a two-week period, but only assessed the influence of these experiences several days later. Presumably more prolonged and consistent experiences of effort and fatigue produce more prolonged and stable changes to people's lay theories, but these broader developmental questions need to be assessed in future research.

In addition, more research is needed to understand the extent to which people connect the various experiences of effort and fatigue they have in their daily lives to their exertion of self-control. That is, in all three studies, participants were directly prompted to interpret their experiences in terms of self-control; we explicitly defined what we meant by self-control and, in Studies 2 and 3, emphasized that their assigned tasks would involve self-control. But, the question still remains under what conditions individuals spontaneously link experiences of effort and exhaustion on a given task to the exertion of self-control in their everyday life; and indeed, answering this question is an important step in developing effective interventions to improve self-control.

In conclusion, the studies presented here provide new insights into how the experiences of effort and exhaustion influence people's thoughts about and enactment of self-control. Not only may experiencing high levels of fatigue serve as a signal for how to allocate one's effort and attention, as suggested by previous research (Brehm & Self, 1989; Clarkson et al., 2010; Kivetz & Zheng, 2006; Muraven et al., 2008), but these experiences may also have broader consequences concerning the lay theories people form about self-control as something that is limited and must be conserved when the demands for it get too high. The present work thus helps to further our understanding of why self-control may be so difficult to sustain over time, and suggests important new directions for exploring methods for reducing this difficulty and bolstering self-control.

## Appendix A. Supplemental materials

Supplementary materials and analyses for this article can be found online at https://doi.org/10.1016/j.jesp.2018.04.006.

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