CHAPTER

10

Perceived Mental Fatigue and Self-Control

J.J. Clarkson[1], *A.S. Otto*[2], *R. Hassey*[1], *E.R. Hirt*[3]

[1]University of Cincinnati, Cincinnati, OH, United States; [2]Baylor University, Waco, TX, United States; [3]Indiana University, Bloomington, IN, United States

Pause for a moment and consider your level of mental alertness—that is, how well can you focus and concentrate right now? Are you rather energized and able to focus or are you struggling to regulate your attention? We can all relate to the ebb and flow of mental alertness throughout the day, transitioning from feeling alert, focused, and energized to tired, exhausted, and drained. As such, this question of mental alertness is one with which we all are not only very familiar but also tend to consider with sufficient regularity.

Yet while these questions may seem rather mundane, recent research has shown that the manner in which individuals respond to these types of questions has immense impact on their subsequent abilities for self-control. That is, individuals' observations of their own mental alertness define their *perceptions of mental fatigue,* a label that can be more formally characterized as a subjective assessment of one's ability to engage in mental activity (Clarkson, Hirt, Chapman, & Jia, 2011; Clarkson, Hirt, Jia, & Alexander, 2010; see also Smets, Garssen, Bonke, & De Haes, 1995). Of most importance, however, these perceptions of mental fatigue have been shown to have immense consequence for individuals' ability to regulate attention, stifle impulses, delay gratification, and otherwise engage in self-control.[1]

[1]We use the term *self-control* in this chapter to reflect a multitude of cognitive and motivational regulatory processes. However, we recognize the ongoing debate regarding definitional issues surrounding terms such as self-control (Fujita, 2011; see Chapter 5) and acknowledge that, while our work does not speak to this debate, it is important to consider the implications of mental fatigue for different regulatory processes.

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The purpose of this chapter is to outline the empirical work to date regarding the importance of these subjective perceptions of mental fatigue for self-control. We first review existing research on the causal link between perceptions of mental fatigue and self-control. Next, we discuss factors shown to impact or alter individuals' perceptions of mental fatigue. We then present a meta-analysis to provide insight into the direct impact of perceived mental fatigue on self-control. Finally, we speak to the implications of this research for the manner in which self-control is conceptualized within a limited resource model specifically as well as models of self-control more broadly.

PERCEPTIONS OF MENTAL FATIGUE

In the early work on the phenomenon of ego depletion, researchers often used ad hoc measures of subjective fatigue as checks for their resource depletion manipulations. The consistent finding was that those exposed to a high depletion manipulation reported feeling more fatigued than did those exposed to a low depletion manipulation (eg, Baumeister, Bratslavsky, Muraven, & Tice, 1998; Muraven, Tice, & Baumeister, 1998; Schmeichel, Vohs, & Baumeister, 2003). These individuals then exhibited differential levels of self-control. Thus, this early work offers direct evidence that perceptions of mental fatigue covary with variations in resource depletion. However, this work only provides indirect evidence that these perceptions might exert their own impact on self-control performance. That is, though this early research showed that perceptions of mental fatigue covary with actual resource availability, these findings are unable to disambiguate the effects of perceived versus actual mental fatigue on self-control.

To offer insight into the extent to which perceptions of mental fatigue could impact self-control performance independent of individuals' actual resource availability, Clarkson et al. (2010) relied on a classic misattribution paradigm to tease apart the effect of what they believed to be two separate constructs. Specifically, they had participants complete a classic depletion manipulation (ie, the e-crossing task) on yellow paper and afterward told participants that the color yellow generally had either a depleting or a replenishing effect on people. They found that those in the low depletion condition perceived themselves as less fatigued and subsequently performed better when told that the paper color was replenishing (versus depleting). Conversely, those in the high depletion condition perceived themselves as less fatigued and subsequently performed better when told that the paper color was depleting (versus replenishing).

Importantly, then, individuals who reported being less mentally fatigued elicited greater self-control performance, and this performance

was independent of their actual resource availability. Indeed, this effect was demonstrated across various well-documented manipulations of resource depletion and different indices of self-control. For instance, perceptions of mental fatigue impacted individuals' persistence, attention regulation, and elaborative thought.

The Malleability of Working Memory

Documenting the role of perceptions in altering self-control performance, researchers next turned to understanding the means by which perceptions impact self-control. That is, by what means or mechanisms does this shift in perception result in enhanced or undermined self-control?

To address this question, Clarkson et al. (2011) focused on the role of *working memory*—formally defined as the capacity to temporarily store and manipulate information (Baddeley, 1986; Just & Carpenter, 1992). Research has demonstrated a clear link between working memory capacity and self-control performance (Hofmann, Gschwender, Friese, Wiers, & Schmitt, 2008; Schmeichel, Volokhov, & Demaree, 2008; Shamosh & Gray, 2007; see Hofmann, Schmeichel, & Baddeley, 2012). Indeed, Schmeichel (2007) demonstrated that manipulations of ego depletion directly impacted working memory capacity, such that those high in resource depletion showed less resource availability in the form of a more restricted working memory capacity than did those low in resource depletion. To that end, Clarkson et al. (2011) wondered if altering individuals' perceptions of their mental fatigue was sufficient to vary the accessibility of regulatory resources in the form of working memory capacity.

In many ways, this *resource allocation hypothesis* stands in direct contrast to the dominant perspective on working memory capacity, a perspective that conceptualizes working memory capacity as a stable individual difference (see Engle, 2002). However, external cues have been shown to alter individuals' working memory capacity. For instance, heightened salience of demographics associated with aversive stereotypes (eg, age, race, gender) has been shown to restrict working memory capacity and reduce cognitive performance (Rydell, McConnell, & Beilock, 2009; Schmader & Johns, 2003). Additionally, increasing performance expectations has been shown to expand working memory capacity and improve cognitive performance (Beilock & Carr, 2005). Thus, while working memory may reflect a rather stable individual difference, external cues are clearly capable of expanding and constricting resource availability (in the form of working memory capacity; Schmeichel, 2007) and consequently impacting subsequent performance.

To offer direct insight into the possibility that perceptions of mental fatigue are sufficient to impact working memory capacity, Clarkson et al. (2011) presented individuals with the same misattribution paradigm

used in their original research (Clarkson et al., 2010) but made two critical changes. First, rather than focusing on self-control consequences, they presented participants with a popular measure of working memory capacity—the automated operation span task (*Aospan*; Unsworth, Heitz, Schrock, & Engle, 2005). This change was driven by the desire to demonstrate that differences in working memory capacity were responsible for the previously documented differences in self-control performance. Second, after receiving the misattribution feedback concerning the yellow paper, they asked participants to complete the mental fatigue subscale of the multidimensional fatigue inventory (*MFI*; Smets et al., 1995). This change was driven by the desire to utilize a formal index of mental fatigue to explore the mediating role of perceptions of mental fatigue on working memory.

With respect to findings, Clarkson et al. (2011) demonstrated a pattern for individuals' working memory capacity that mirrored the performance data observed in prior research. That is, those in the low depletion condition exhibited greater working memory capacity when told that the paper color was replenishing (versus depleting), whereas those in the high depletion condition exhibited greater working memory capacity when told that the paper color was depleting (versus replenishing). Moreover, the same pattern was observed on the mental fatigue subscale of the MFI, and these perceptions of mental fatigue both predicted working memory scores and mediated the effect of the misattribution manipulation on working memory. Consistent with other research on external cues and working memory, then, the perception of mental fatigue was shown to alter accessibility to resources critical for self-control performance (see also Egan, Clarkson, & Hirt, 2015; Egan & Hirt, 2015).

Of course, working memory capacity could be argued as an alternative performance index of self-control. However, as argued by other researchers (see Schmeichel, 2007), working memory capacity represents a cognitive instantiation of what could more broadly be construed as self-regulatory resources. That is, working memory capacity reflects the means or resources by which individuals are subsequently able to engage (or not) in successful self-control. These findings then illustrate a seemingly minor but important distinction for self-control, as perceptions of mental fatigue influence the availability of regulatory resources but not necessarily the subsequent allocation of those resources to a specific task of self-control. Indeed, the extent to which this expanded or constricted capacity of resources is allocated to a specific task could depend on factors beyond perceptions (Inzlicht & Schmeichel, 2012), such as the desire to conserve resources for future self-control tasks (Muraven, Shmueli, & Burkley, 2006).

That said, subsequent research has shown that the effect of perceived mental fatigue on self-control performance can be driven by differences in working memory capacity (Egan et al., 2015). Through exploring the

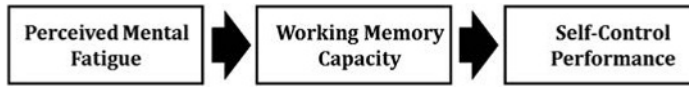

FIGURE 10.1 Path model of perceived mental fatigue on self-control performance through working memory capacity.

effects of positive mood on self-control, Egan and colleagues had participants complete indices of perceived mental fatigue, working memory capacity, and self-control and demonstrated the mediation model that has become the dominant empirical explanation for the effect of perceived mental fatigue on self-control performance (see Fig. 10.1). Thus, while the distinction between resource availability and allocation is critical to acknowledge, the data appear to suggest that the effect of perceived mental fatigue on resource availability subsequently impacts resource allocation (Egan et al., 2015; see also Egan & Hirt, 2015).

Alternative Mechanisms

Importantly, while research supports this resource allocation hypothesis, other potential mechanisms apart from working memory capacity are certainly plausible. For instance, the perception of being mentally fatigued could elicit negative feelings in general, and research shows that negative mood can undermine self-control performance (Tice, Baumeister, Shmueli, & Muraven, 2007; see also Egan et al., 2015). Similarly, the perception of being mentally fatigued could either undermine individuals' motivation to perform well or, more likely, elicit a desire to conserve one's remaining resources for future tasks (Muraven et al., 2006). However, research has not found any effect of perceptions of mental fatigue on individuals' subsequent mood (Clarkson et al., 2010, 2011), direct or indirect motivation to perform well (Clarkson et al., 2010, 2011; Egan et al., 2015), or desire to engage in resource conservation (Clarkson et al., 2010, 2011; Egan et al., 2015).

Of course, these findings do not mean these mechanisms could not exert an influence under specifiable conditions or that they could not have a direct effect on perceptions of mental fatigue. For instance, heightened perceptions of mental fatigue might elicit greater resource conservation when individuals have an explicit reason to hold back their effort—such as when completing a series of tasks that end with a task of high importance. Moreover, these findings do not rule out additional constructs that could account for the impact of perceptions of mental fatigue on self-control, such as individuals' confidence in their ability to self-regulate (ie, self-efficacy; Bandura, 1977) or an inaction goal (Albarracín et al., 2008; Albarracín, Hepler, & Tannenbaum, 2011). That is, heightened perceptions of mental fatigue could undermine individuals' confidence in

their ability to successfully perform a task of self-control or heighten a general inaction goal. However, the collective empirical support at this time points toward the malleability of working memory capacity in driving the effect of individuals' perceptions of mental fatigue on subsequent self-control performance.

ANTECEDENTS OF PERCEIVED MENTAL FATIGUE

Given the importance of individuals' perceptions of mental fatigue for self-control, research has focused on identifying the factors that alter these perceptions. We outline several factors that have been shown to impact individuals' self-control performance by altering their perceptions of mental fatigue.

State Feedback

The work by Clarkson et al. (2010, 2011) provided participants with false feedback concerning the impact of a specific aspect of a prior task on their mental abilities. Specifically, participants completed a task on yellow paper and were then later told that the color yellow has been consistently shown to either exhaust or restore people's mental abilities. Though one might suppose the feedback would be taken at face value, such that those in the exhaust condition reported being more fatigued and those in the replenish condition reported being less fatigued, it turned out that the manner in which the task feedback was interpreted depended on individuals' actual state of resource availability. Individuals attributed the feedback to their mental abilities differently as a function of whether they were high or low in resource depletion, and these different attributions resulted in different implications for individuals' perceptions of their mental resources.

Though not intuitive, this finding is consistent with the *resource attribution hypothesis* posited by Clarkson et al. (2010). This hypothesis states that the manner in which individuals use situational cues (such as task feedback) to inform their perceptions of mental fatigue varies as a function of the ambiguity of their mental state and thus provides the basis for a clear distinction between two categories of attributions. In particular, they argued that individuals seek out information to help **explain** concrete states but to **interpret** ambiguous states. Moreover, they showed that individuals report high-resource depletion as a more concrete state than low-resource depletion. Consequently, those high in resource depletion are more likely to engage in an *explanation* attribution, whereas those low in resource depletion are more likely to engage in an *interpretation* attribution.

This distinction is important because, as noted, the same task feedback is then interpreted in different ways depending on whether individuals are high or low in resource depletion. For those high in resource depletion, they seek an *explanation* for their mental fatigue. Thus, when provided with the depleting feedback, the fatigue is now explained and—given the depleting stimulus (eg, the yellow paper) is now absent—they now perceive themselves as less fatigued. Yet when provided with the replenishing feedback, the fatigue is not explained—in fact, their state is incongruent with the feedback. As such, the only explanation must be that they are so fatigued that even the paper could not help them and—even with the replenishing stimulus absent—they perceive themselves as highly fatigued (for a similar rationale, see Schachter & Singer, 1962).

However, for those low in resource depletion, they seek an *interpretation* for their current state. Thus, when given any feedback, they engage in a form of biased hypothesis confirmation whereby they identify instances beyond the yellow paper that confirm the feedback. For instance, those in the depleting feedback condition recall instances that reinforce being depleted (eg, not getting a good night's sleep), whereas those in the replenishing feedback condition recall instances that reinforce being replenished (eg, eating a good breakfast). Consequently, their perceptions are consistent with the feedback and persist even when the stimulus (eg, the yellow paper) is removed, as they have now generated a list of alternative reasons consistent with the feedback (for a similar rationale, see Ross, Lepper, & Hubbard, 1975).

Theories of Willpower Capacity

Researchers have demonstrated that individuals hold very different lay beliefs or theories concerning the extent to which their capacity for available resources is limited (Job, Dweck, & Walton, 2010, 2013, 2015; Job, Bernecker, Miketta, & Friese, 2015; Martijn, Tenbült, Merckelbach, Dreezens, & De Vries, 2002; Miller et al., 2012). Specifically, Job and colleagues distinguish between those who believe self-control resources are relatively exhaustible (*limited theorists*) and those who believe self-control resources are relatively inexhaustible (*nonlimited theorists*). This research has focused largely on the ability of nonlimited theorists to overcome the deleterious effects of resource depletion on self-control relative to limited theorists. Specifically, nonlimited theorists are relatively immune to the traditional depletion effect, presumably due to their belief that their resources are, in fact, not depletable (for a more in-depth review of this construct, see Chapter 11).

Interestingly, this work offers evidence that individuals' perceptions of mental fatigue serve an important role in predicting the performance of willpower theorists. Specifically, Job et al. (2010) argued that perceptions

of mental fatigue serve as a signal to individuals that they are running out of resources critical to success. Consistent with this argument, they further showed that perceptions of mental fatigue mediated the self-control performance of limited, but not nonlimited, theorists. The rationale for this mediation pattern, they argued, is that limited theorists are more sensitive to perceptions of mental fatigue than are nonlimited theorists, as only limited theorists believe that their resources can be depleted.

However, recent work suggests perceptions of mental fatigue can impact both limited and nonlimited willpower theorists when not experiencing resource depletion (Clarkson, Otto, Hirt, & Egan, 2016). Specifically, this research argues that nonlimited theorists may implicitly perceive themselves as less mentally depleted than limited theorists. That is, due to their belief in what could be argued as a larger storehouse of regulatory resources, nonlimited theorists may hold to a lower baseline level of perceived mental fatigue than limited theorists, and that this baseline difference in perceptions can drive subsequent self-control. In support of these hypotheses, this work demonstrates that nonlimited theorists do indeed perceive themselves as generally less mentally fatigued than do limited theorists, and that this perceptual difference predicted individuals' cognitive abilities, impulsivity, and delayed gratification.

Moreover, Clarkson, Hirt, and Jia (2016) further show that these baseline perceptions of these implicit theories are not fixed. Across a series of experiments, they demonstrate that the efficacy of these willpower theories vary as a function of the fluency—and thus confidence—associated with these theories. For instance, when individuals doubted their *nonlimited* theory, they reported elevated levels of mental fatigue and reduced self-control. Conversely, when individuals doubted their *limited* theory, they reported reduced levels of mental fatigue and elevated self-control. Thus, while unlimited theorists may naturally exhibit a lower baseline perception of mental fatigue, these perceptions—and the self-control consequences they elicit—are malleable (here, as a function of individuals' confidence in their willpower theory).

Positive Mood

Positive mood has been shown to impact self-control (Fredrickson, Mancuso, Branigan, & Tugade, 2000; Leith & Baumeister, 1996) and, in particular, individuals' self-control recovery (Tice et al., 2007). Specifically, Tice et al. (2007) showed that individuals initially depleted of their regulatory resources replenished those resources faster when in a positive mood. That is, when mentally depleted, individuals exposed to a positive mood induction performed better on a subsequent task of self-control relative to a control condition. Indeed, those initially depleted but then exposed to a positive mood induction performed as well as those never initially depleted. Positive mood, then, appears to accelerate self-control recovery.

Tice et al. (2007) argued that the positive mood induction restores self-control resources by elevating individuals' arousal, though no evidence was presented in support of this mechanism. In response, Egan et al. (2015) posited that psychological factors might explain the restorative effects of positive mood independent of any potential physiological factors (eg, elevations in arousal). Specifically, they argued that positive mood elicits expectations of energy restoration (see Chapter 12 for a more detailed discussion of the importance of expectations for self-control), which leads individuals experiencing a positive mood to perceive themselves as less mentally fatigued than those in a negative mood. In support of this psychological-based perspective, these researchers demonstrated that individuals presented with a positive (versus negative) mood induction reported feeling less mentally fatigued as well as greater working memory capacity and restored self-control. Furthermore, the effect of positive mood on individuals' working memory capacity and self-control performance was predicted by individuals' perceptions of mental fatigue.

Power

Researchers have documented the beneficial impact of interpersonal power for several constructs related to self-control, such as higher action tendencies (Galinsky, Gruenfeld, & Magee, 2003), greater creativity (Galinsky, Magee, Gruenfeld, Whitson, & Liljenquist, 2008), and decreased procrastination (Judge & Bono, 2001). While various reasons exist for the effects of power on these diverse indices of self-control, recent work demonstrates that feelings of power can impact executive functioning (Egan & Hirt, 2015). Indeed, across several studies, Egan and Hirt (2015) show that heightened feelings of power have a direct and positive impact on individuals' self-control performance.

Importantly, however, this effect of power on self-control performance was moderated by social dominance orientation (SDO; see Pratto, Sidanius, Stallworth, & Malle, 1994). That is, Egan and Hirt (2015) showed that SDO affected individuals' expectations of mental restoration and subsequent perceptions of mental fatigue. SDO focuses on individuals' belief in the importance of status and social hierarchy, with those high in this belief viewing power as a necessary and important component to effective functioning (see Altemeyer, 1998). Given the importance attributed to interpersonal power for general efficacy by those high in SDO, Egan and Hirt reasoned and subsequently showed that those high in SDO expected power to be mentally energizing and thus reported themselves less mentally fatigued following a power manipulation than did those low in SDO. As a result, these changes in mental fatigue altered working memory capacity and subsequent self-control performance.

POINTS OF CLARIFICATION

The research discussed in this chapter provides a novel lens by which to consider strength in self-control. Yet this work tends to consistently raise a handful of questions. For instance, how aware are individuals of their state of mental fatigue? In the work described here, the effects occurred regardless of whether individuals' perceptions of mental fatigue were assessed or not, which suggests that individuals are impacted by their perceptions even without being prompted to reflect on them. Yet presumably these effects are contingent on these perceptions being salient to individuals, and we certainly believe there are aspects of the situation that can impact the salience and thus awareness of individuals' state of mental fatigue. For instance, in the e-crossing depletion task (Baumeister et al., 1998), participants are instructed to complete two tasks—one as a baseline (to establish a habit) and a second to either continue or to disrupt that habit. In this and other dual-task paradigms, we would suspect completing the second task in light of a baseline task increases the salience of mental fatigue. Thus, while individuals seem to exhibit a general awareness of their mental fatigue, certainly facets of the self-control context should heighten this awareness and thus the impact of these perceptions on subsequent performance.

Additionally, individuals might be more or less predisposed to be aware of their mental fatigue. We spoke earlier in this chapter about work on individuals' implicit theories concerning the limits of their willpower capacity (see Chapter 11). Research within this stream has shown that while both limited and nonlimited theorists report similar levels of awareness regarding their perceptions of mental fatigue, only limited theorists are responsive to their level of mental fatigue (see Job et al., 2010). Given the diagnosticity of these perceptions for subsequent performance, it seems to reason that limited theorists might place greater weight on their perceptions of mental fatigue that results in a heightened salience across multiple self-control contexts relative to nonlimited theorists. Similarly, the subjective vitality scale (Ryan & Frederick, 1997) measures perceptual differences in the amount of energy available to the self (see Chapter 4 for further discussion of this construct), and this scale could presumably serve as a dispositional index of individuals' awareness of their mental fatigue.

Finally, individuals should use different information as the basis for their perceptions. That is, individuals should not necessarily rely on the same information when formulating their perceptions of mental fatigue. Indeed, Clarkson, Hirt, et al. (2016) directly addressed this question by presenting individuals high and low in need for cognition (Cacioppo & Petty, 1982) with the misattribution paradigm described in Clarkson et al. (2010). Consistent with the findings reported herein, they found that

perceptions of mental fatigue predicted self-control performance, irrespective of individuals' need for cognition. Interestingly, however, these perceptions were based on different information. Specifically, those high in need for cognition based their perceptions on the implied effect of the yellow paper on their mental resource capacity, whereas those low in need for cognition based their perceptions solely on the depletion manipulation. In other words, the misattribution feedback only affected those high in need for cognition. This finding is consistent with work showing those high in need for cognition are more likely to engage in effortful, metacognitive thought (Petty, Briñol, Tormala, & Wegener, 2007). Yet as a result of this motivational difference in reflection, those low in need for cognition were less susceptible to the misattribution paradigm and thus more accurate in forming perceptions that were consistent with their actual level of available resources. Thus, while perceptions of mental fatigue continued to exert a consistent influence on self-control performance, the basis of these perceptions can and do vary in systematic ways.

AN ANALYSIS OF EFFECT SIZE

While the consequences of perceived mental fatigue on self-control performance have been well documented, we sought to offer some level of appreciation for the overall relationship between perceptions of mental fatigue and self-control. For instance, in a key meta-analysis on the resource depletion model, Hagger and colleagues (Hagger, Wood, Stiff, & Chatzisarantis, 2010) reported that measures of subjective fatigue elicit a medium effect size (*Cohen's d* = 0.44). Though valuable, this analysis was based on indirect measures of perceived mental fatigue (often used as manipulation checks) as opposed to an analysis of direct manipulations of these perceptions.

What then can be gleaned about the strength of the relationship between perceptions of mental fatigue and self-control through an analysis of the existing body of research that directly tests this relationship? To offer insight into this question, we conducted a meta-analysis of the research looking at the direct effect of perceived mental fatigue on self-control performance (Fig. 10.2).

Method

Inclusion criteria. Studies relevant to the meta-analysis were those that empirically tested the relationship between perceived mental fatigue and self-control performance. Appropriate studies were those that directly manipulated perceived mental fatigue and assessed the associative effects

Paper	Study Number	Self-control Index	Perceived Depletion Manipulation	Study N	High Depletion Correlation	Low Depletion Correlation
Clarkson, Hirt, Jia, and Alexander (2010)	1	Anagram persistence	State feedback	96	0.42	0.42
Clarkson, Hirt, Jia, and Alexander (2010)	2	Anagram persistence	State feedback	66	0.42	0.36
Clarkson, Hirt, Jia, and Alexander (2010)	2	Anagram performance	State feedback	66	0.5	0.39
Clarkson, Hirt, Jia, and Alexander (2010)	3	Response latencies	State feedback	52	0.5	0.41
Clarkson, Hirt, Chapman, and Jia (2011)	1	Working memory capacity	State feedback	91	0.29	0.4
Egan and Hirt (2015)	3	Anagram performance	Power	80	0.55	0.27
Egan, Clarkson, and Hirt (2015)	4	Working memory capacity	Mood	150	0.31	0.26
Egan, Clarkson, and Hirt (2015)	4	Anagram performance	Mood	150	0.5	0.34

FIGURE 10.2 Summary of articles in meta-analysis.

on an index of self-control. Studies that used indirect measures (eg, manipulation checks) of perceived mental fatigue were not included in the meta-analysis (see Hagger et al., 2010).

Data Coding. In total, 16 effects examining the relationship between perceptions of mental fatigue and self-control performance met the inclusion criteria outlined earlier. A review of the studies revealed that correlations were an appropriate metric for the meta-analysis, as the respective data were reported using metrics that could be readily converted to correlations (see Borenstein, Hedges, Higgins, & Rothstein, 2009; Peterson & Brown, 2005). Because multiple effects were reported in single studies, the effects were coded and thus analyzed to assess whether dependency was meaningfully present in the data set for that particular association. Importantly, assessments of dependency are necessary to ensure that the variance within the studies and the variance between the effects are appropriately captured. Finally, all correlations were adjusted for sample size estimates and corrected for attenuation (for further discussion of the rationale for these procedures, see Borenstein et al., 2009).

Descriptive Analysis. The analysis of the perceived mental fatigue correlations began with estimating the weighted Fisher's Z values (Hedges & Pigott, 2001). Analysis of weighted Fisher's Z values and their conversion back to correlations for reporting purposes was done to minimize the bias in the distribution of effects when correlations depart significantly from zero. Weighting Fisher's Z values by its unconditional variance was done to minimize bias from sampling error. To account for the variance between effects, random-effect modeling was used throughout the meta-analysis. A random-effect model is argued as preferable to a fixed-effect model for both bivariate and model-driven meta-analyses (Becker, 2009; Borenstein et al., 2009).

Additional Analyses. As the data included relationships between perceived mental fatigue and self-control performance for both high- and low-resource depletion manipulations, it was important to assess measures of central tendency and its dispersion to develop insights as to whether level of resource depletion should be treated as a meaningful moderator. If the variance of the synthesized effect is judged substantial (based primarily on Cochran's Q statistic for heterogeneity and the I^2 estimate of true heterogeneity; Higgins Thompson, Deeks, & Altman, 2003), the analysis should focus on identifying moderators—here, this would mean parsing the data by level of resource depletion.

Results

Preliminary Analyses. The results of the effect-wise analysis (ie, intraclass correlation, ICC) with study as the grouping variable suggest meaningful dependency among the reported effects is not present in the database (ICC = 0.09). Furthermore, the nonsignificant Q test for heterogeneity

($Q = 16.60$, $p < .34$) and the low percentage of true variance in the perceived depletion-self-control correlations ($I^2 = 6.62\%$) suggests that the perceived mental fatigue—self-control effects are not meaningfully stronger under high- or low-resource depletion conditions. The data were therefore collapsed across all conditions.

Perceived Mental Fatigue and Self-control Analysis. The data support a positive and statistically significant mean correlation between perceptions of mental fatigue and self-control. The mean of the effect size distribution for perceptions and self-control is equal to 0.36 ($p < .001$), an equivalent *Cohen's d* of 0.74. The fail-safe N of 853 (the number of missing, null effects necessary for the mean effect to be nonsignificant) suggests the estimate is likely absent meaningful publication bias.

CONCLUSION

In summary, the mean perceived mental fatigue—self-control effect is relatively large (*Cohen's d* = 0.74) and positively statistically significant. Importantly, this effect is robust, as it was shown to occur above and beyond differences in actual levels of resource depletion and generalizes to a variety of self-control indices. In turn, the results of the meta-analysis only further bolster the importance of perceptions of mental fatigue in predicting self-control behavior.

CONCEPTUAL IMPLICATIONS

This chapter focused on extant research on the consequence of perceptions of mental fatigue. These perceptions, once shown to covary with resource depletion manipulations as manipulation checks, now not only exert an independent influence apart from individuals' actual resource availability but are affected by factors beyond resource depletion manipulations (eg, mood states, lay beliefs of willpower capacity). Furthermore, research details the importance of executive functioning—and working memory capacity in particular—in driving the effects of perceived mental fatigue on self-control performance. Thus, the mounting body of research offers consistent evidence for the importance of perceived mental fatigue for individuals' self-control abilities.

Yet from a limited strength model of self-control (Baumeister et al., 1998; Vohs & Baumeister, 2011; see Chapter 1), should we be surprised that these perceptions of mental fatigue can exert such a significant impact on self-control performance? On one hand, perhaps so. Baumeister and colleagues' model of ego depletion argues that self-control constitutes a single process of resource availability. Here, self-control performance ebbs and flows as a direct function of the amount of resources available to exert

self-control. Yet the findings from the Clarkson et al. (2010, 2011) studies could be construed as in direct opposition to a strict resource availability hypothesis. For instance, in those studies, a limited resource model would predict that only the resource depletion manipulation should impact self-control and that the information about the effects of the paper color should have no impact on individuals' performance. However, not only did the manipulation of resource depletion interact with state feedback to predict self-control performance, but no main effect of the depletion manipulation was observed in any of the studies.

However, in a less dogmatic sense, perhaps not. After all, both actual (Schmeichel, 2007) and perceived (Clarkson et al., 2010; 2011) mental fatigue impact working memory capacity, and working memory capacity has been shown to be central to the cognitive processes underlying self-control (Schmeichel et al., 2008; see also Ilkowska & Engle, 2010). Moreover, research shows that factors can immediately restore a depleted resource capacity (see Chapter 12 on restoration). Thus, perceptions of mental fatigue might offer an important revision to the conceptualization of strength within this model. That is, conceptualizing regulatory strength in terms of perceptions as well as actual abilities still explains the ebb and flow of performance as a function of resource exertion (recall perceptions tend to covary with actual resource depletion) while also accounting for dramatic shifts in resource availability not readily explained by motivational processes.

CONCLUDING REMARKS

This review sought to detail existing research on the impact of individuals' perceptions of mental fatigue for subsequent self-control. As models of self-control continue to evolve, it will be interesting to see what role individuals' subjective assessments of mental fatigue have in elucidating the underlying processes responsible for successful self-control. From our perspective, these perceptions offer potential to exert a significant influence at multiple stages of the self-control process. For instance, the perception of mental fatigue might impact the *agency* (ie, how we use our regulatory resources; Muraven et al., 2006; see also Chapter 7), *allocation* (ie, where we use our regulatory resources; Inzlicht & Schmeichel, 2012), and/or *efficacy* (ie, our confidence in our resources to incite successful regulation; Bandura, 1977) of our self-regulatory resources to maximize the process of goal pursuit. For now, though, it is clear that the role of perceived mental fatigue exerts a significant influence that must be taken into account if we hope to grasp the intricacies of the self-control process.

Now pause again, only this time reflect on how mentally alert, focused, and energized you feel. A silly exercise, perhaps, but—given the extant literature on mental fatigue reviewed in this chapter—one that can hold significant consequence for your ability to successfully engage in self-control.

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