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Six Questions for the Resource Model of Control (and Some Answers)

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Abstract

The resource model of self-control casts self-control as a capacity that relies on some limited resource that exhausts with use. The model captured our imagination and brought much-needed attention on an important yet neglected psychological construct. Despite its success, basic issues with the model remain. Here, we ask six questions: (i) Does self-control really wane over time? (ii) Is ego depletion a form of mental fatigue? (iii) What is the resource that is depleted by ego depletion? (iv) How can changes in motivation, perception, and expectations replenish an exhausted resource? (v) Has the revised resource model unwittingly become a model about motivation? (vi) Do self-control exercises increase self-control? By providing some answers to these questions – including conducting a meta-analysis of the self-control training literature – we highlight how the resource model needs to be revised if not supplanted altogether.

Self-control is at the root of much that is good in people and society. It fosters the ability to stay on task when our minds would rather wander. It allows people to restrain momentary desires to reach cherished long-term goals. It allows people to overcome selfish impulses and for groups of people to work together. It is thus no surprise that it relates to such desirable things as health, happiness, academic achievement, financial stability, and low levels of drug dependence and criminality (Baumeister, Heatherton, & Tice, 1994; Duckworth & Seligman, 2005; Moffitt et al., 2011).

Self-control – known colloquially as willpower and related to self-regulation (Robinson, Schmeichel, & Inzlicht, 2010) – refers to the set of mental processes that allow people to override thoughts, emotions, or behaviors that compete with their central goals. At its heart, self-control is instigated when two competing desires or response tendencies compete for behavioral enactment. This could happen when someone trying to quit smoking enters a bar and sees his old acquaintances lighting up; it could also happen when a mother who legitimately wants to be patient with her children sees them acting out. Such conflict is experienced as subjectively aversive (Saunders, Milyavskaya, & Inzlicht, in press) and can lead people to inhibit or suppress one set of desires or responses and replace them with the

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second set (Inzlicht, Bartholow, & Hirsh, 2015). As such, self-control relies upon core executive functions (Hofmann, Schmeichel, & Baddeley, 2012), specifically inhibitory control (Miyake et al., 2000).

Although studied for quite some time (Ainslie, 1974; Mischel, Ebbesen, & Raskoff Zeiss, 1972), interest in self-control really began to take hold – among scholars and the lay public alike – in the late 1990s and early 2000s. One reason for this spike in interest was the introduction of a new and elegant theory by Roy Baumeister and his colleagues called the resource (or strength) model of self-control (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Baumeister et al., 1994; Muraven & Baumeister, 2000).

The Resource Model of Control

The resource model of self-control casts self-control as an inner capacity that relies on some limited resource or fuel that exhausts with use. The central prediction of the resource model is that effortful control consumes this limited inner capacity, leaving one in a state known as "ego depletion." In this depleted state, further efforts at self-control are prone to failure.

Evidence for the resource model comes mainly from studies using the sequential task paradigm. In this paradigm, participants perform two tasks in sequence, once at Time 1 and then shortly thereafter at Time 2, with results typically showing some loss in performance at Time 2. For instance, regulating one's emotions while watching an emotional movie at Time 1 can reduce performance on subsequent tasks, such as solving a difficult puzzle, squeezing a handgrip exerciser, sustaining mental representations in working memory, or naming the color of words (Inzlicht & Gutsell, 2007; Muraven, Tice, & Baumeister, 1998; Schmeichel, 2007).

The resource model makes a number of other important claims. It claims that self-control relies on a central, domain-general resource (Muraven & Baumeister, 2000). That is, not only is the resource limited, but it is also thought to underlie all manner of controlled behavior, from restraining aggressive impulses to making a good impression, from making effective decisions to acting morally (see Baumeister, Vohs, & Tice, 2007, for a review). Another claim is that the central resource can grow in capacity with sufficient time and practice (Muraven, Baumeister, & Tice, 1999). The idea here is that the resource underlying self-control is like a muscle: exercise and "work-outs" can increase its size. This is a provocative claim but parallels a similar one in cognitive psychology that exercising executive control, or "brain training," can improve both task-specific and general cognitive performance (e.g., Thorell, Lindqvist, Bergman Nutley, Bohlin, & Klingberg, 2009).

The resource model of self-control should be celebrated. By using a powerful metaphor, Baumeister and his colleagues brought much-needed attention to a relatively neglected yet important area in psychology. Despite this deserved acclaim, however, basic questions about the resource model and about self-control remain. The model has been with us for over 20 years (Baumeister et al., 1994), yet its reliance on the resource metaphor has gone mostly unchanged even in the face of disconfirming evidence (Inzlicht & Schmeichel, 2012). Here, we ask six basic questions about the resource model. In answering these, we hope to highlight how the resource model needs to be revised if not supplanted altogether.

Question 1: Does Self-control Really Wane over Time?

This might seem like an odd place to start. After all, a meta-analysis of nearly 200 published effects (Hagger, Wood, Stiff, & Chatzisarantis, 2010) clearly points to the robustness of a medium-sized effect ($d = 0.62$). Study after study from independent labs across the world show the basic ego depletion effect. If there is one thing – and only one thing – we have learned from the resource model, it is that self-control wanes over time. But, how sure are we that this effect is real?

The first doubts were laid by anecdotal evidence. There were whispers at conferences that the basic depletion effect was hard to replicate (Kurzban, 2014). To be sure, the vast majority of these replication attempts were not motivated by notions of discrediting the resource model. Rather, these were good-faith attempts to replicate the effect in order to build on it and discover something new (e.g., Carter & McCullough, 2013). Although there are now a few failures to replicate in the published record (Lange & Eggert, 2014; Xu et al., 2014), these are small in number and hard to reconcile with the much larger record of successful replications (Hagger et al., 2010).

However, the published record in psychology (Ioannidis, Munafò, Fusar-Poli, Nosek, & David, 2014) and indeed much of science (Ioannidis, 2005) tends to produce inflated estimates of the size of effects, even robust ones. What this means is that despite the main ego depletion effect appearing rock-solid, it may have benefitted from publication bias. And, what we need is a way to correct the literature of publication bias.

Such bias-correction methods exist, and recently, three of them have been used to correct the ego depletion literature (Carter & Mccullough, 2014; see also Carter, Kofler, Forster, & Mccullough, in press). A detailed description of the bias-correction procedures is beyond what we can currently write, but we note that two of the three corrections are based on quantifying the relationship between effect size estimates and their standard errors (Egger, Davey Smith, Schneider, & Minder, 1997; Stanley, 2008), assuming that such an association is produced by publication bias. As would be expected in the presence of publication bias, all three of the bias-correction procedures suggest that the true effect is smaller than first advertised, with one estimate suggesting a medium effect ($d = 0.48$), a second suggesting a small effect ($d = 0.25$), and a third – most strikingly – suggesting the effect size is no different from zero. This analysis poses an existential threat to the resource model. At best, it suggests that ego depletion is real yet smaller than originally thought. At worst, it suggests there might not be a real phenomenon at all.

While we appreciate these bias-correction estimates, they are not without their problems. First, two of the three meta-analytic procedures assume the association between effect size and standard error uniquely reflects publication bias and then use the magnitude of this association as a basis for their corrections. However, this association could reflect a number of factors, including some that are rather benign, such as conducting power analyses

(Schimmack, 2015). Second, a recent comparison of five different meta-analytic estimators (including two of three used here) found that they performed poorly in the presence of heterogeneous effects and publication bias (Reed, Florax, & Poot, 2015; see also, Moreno et al., 2009), which was the case here (Carter & Mccullough, 2014). This same comparison also suggested that estimators that correct for publication bias sometimes perform worse than those that do not correct for publication bias (Reed et al., 2015).

Thus, despite confident reports that these bias-correction procedures can reliably detect and estimate meta-analytic effects in the presence of publication bias (Carter & McCullough, 2014; Stanley, 2008), there is lack of consensus among statisticians on this matter, with statements that “a general conclusion remains elusive for now” (Reed et al., 2015, p. 4). As such, one recommendation that comes out of this lack of consensus is to present a variety of meta-analytic estimators, not just one or two, and to consider the range of possible effects these techniques suggest (Reed et al., 2015). Carter and McCullough (2014) presented three such estimators, with only one of them suggesting no effect for depletion; yet, the authors conclude that their “results do not support the claim that the depletion effect is meaningfully different from zero” (p. 7). We suspect that such a conclusion is premature at this time.

Bolstering our view is a recent paper reporting an internal meta-analysis of nine separate ego depletion studies that involved 580 participants and that was free of data selection and publication bias of any kind and returned a small, homogenous, yet real effect ($d = 0.17$) (Tuk, Zhang, & Sweldens, 2015). It is important to note, however, that even here there is some ambiguity, as the meta-analytic effect was only marginally significant (p=.066), with confidence intervals slightly overlapping with zero. Thus, the size of the true effect remains unclear. What is really needed is a high-powered and good-faith attempt to replicate the basic effect and estimate its true magnitude, something we are happy to report is happening right now (Association for Psychological Science, 2014).

The basic question of whether ego depletion is real and replicable is the most important of all our questions. If it turns out that ego depletion is not a replicable phenomenon, then the questions that follow are moot.

Question 2: Is Ego Depletion a Form of Mental Fatigue?

In his authoritative volume on the psychology of fatigue, Robert Hockey (2013) describes mental fatigue as feeling states that arise after prolonged periods of cognitive activity, characterized by low arousal negative mood (e.g., tiredness, weariness, even exhaustion) and an unfocused mental state (e.g., distracted, bored). Fatigue is common in everyday life and is characterized by a reluctance to continue with the present activity, a decrease in the level of commitment to the task at hand, and a decline in cognitive and behavioral performance (Boksem, Meijman, & Lorist, 2006; Boksem & Tops, 2008).

Mental fatigue and ego depletion are so similar that they may refer to identical psychological states (Inzlicht, Schmeichel, & Macrae, 2014). While it is true that mental fatigue is typically evoked after protracted bouts of cognitive labor (e.g., Hockey & Earle, 2006), whereas depletion can emerge after a few minutes (e.g., Halali, Bereby-Meyer, & Meiran, 2014), the phenomena show many parallels. Both depletion and fatigue are characterized by the continuous application of effort that evoke mildly negative feelings, including subjective reports of fatigue (Hagger et al., 2010). Both depletion and fatigue lead to performance decrements that are regarded (by some) as a reluctance to engage further effort rather than an incapacity (Hockey, 2013; Inzlicht & Schmeichel, 2012). Depletion and fatigue can be overcome with sufficient task-motivation (Boksem et al., 2006; Muraven & Slessareva, 2003). What is more, even resource model theorists, on occasion, describe depletion as a form of fatigue: “self-control shows[s] short-term fatigue effects like a muscle”; “[self-control] exertion produces short-term fatigue” (Muraven & Baumeister, 2000, p. 254).

Despite resource theorists occasionally analogizing depletion to being tired or exhausted, they have also pronounced that “ego depletion is not just fatigue” (Vohs, Glass, Maddox, & Markman, 2010, p. 166). In one set of studies, for example, the consequences of depletion appeared distinct from those related to sleep deprivation (Vohs et al., 2010). However, even if sleepiness and fatigue are similar, sleep researchers consider them to be distinct states with different bodily expressions and behavioral consequences (Hossain, Reinish, Kayumov, Bhuiya, & Shapiro, 2003). For instance, unlike mental fatigue, sleepiness never motivates a person to go for a run or to work on a crossword puzzle (Hockey, 2013); sleepiness motivates one thing and one thing only – sleep.

So, is depletion a form of fatigue or not? We suspect that they are essentially the same. Depletion may be produced more readily, and it may not last quite as long as mental fatigue, but we are of the opinion that these two terms describe the same psychological phenomenon. Aligning depletion with fatigue has the potential to offer great insight – fatigue has been studies for over 100 years (Thorndike, 1900), and although there is still much to learn, we know quite a bit already. For example, fatigue is no longer thought to affect task performance through some loss of energy; rather, fatigue is thought to interrupt task performance because it allows other priorities and preferences to be considered more fully (Hockey, 2013; Kurzban, Duckworth, Kable, & Myers, 2013). More and more, the performance effects of mental fatigue – and to some extent, the fatigue produced by physical exertion (Marcora, Staiano, & Manning, 2009; Noakes, 2007) – are seen as the product of changing perceptions of what one is capable of and as a decision to withdraw further effort, rather than some cognitive or mechanical incapacity.

If depletion is a form of mental fatigue, perhaps it too is not caused by a depleted resource but by a shift in perception and priorities (Inzlicht, Schmeichel et al., 2014). Aligning depletion with fatigue would allow the study of self-control to build on a strong base of past findings. It would also allow the field to forego the (perhaps fruitless) search for the nature and identity of the resource being depleted.

Question 3: What Is the Resource that Is Depleted by Ego Schmeichel, Depletion?

The resource model claims that self-control relies on some central resource, and that acts of effortful control exhaust this resource. But, what is the resource?

The short answer is that we do not know. Most experiments do not directly observe resource depletion. Rather, researchers infer the presence of depletion based on patterns of performance on the second of two self-control tasks of the sequential task paradigm (Hagger et al., 2010). While this pattern of effects is consistent with resource dependence, it is also consistent with a number of other alternative formulations that are resource-free and that might have greater theoretical plausibility (Inzlicht & Schmeichel, 2012; Inzlicht, Schmeichel et al., 2014; Kurzban et al., 2013). Thus far, the only direct attempt to measure the putative resource comes from work exploring glucose (Gailliot, Baumeister, et al., 2007).

Glucose is a carbohydrate (or sugar) that is absorbed into the bloodstream during digestion, and it is used by many organisms as a cellular source of energy. According to several initial studies (Gailliot, Baumeister, et al., 2007), one resource that might underlie depletion is glucose: applying effortful control leads to measurable drops in blood glucose, and this glucose drop, in turn, mediates the reductions in self-control attributed to ego depletion. By suggesting that the resource is physiological, these findings appeared to uphold the resource model. But upon scrutiny, the glucose findings have not held up (Kurzban, 2010; Schimmack, 2012).

The idea that short bouts of cognitive effort lead to measurable drops in glucose has proven controversial. The chief problem is that these effects have failed to replicate with more precise measurements of blood glucose (Molden et al., 2012). Further, the idea that a brief cognitive task can meaningfully deplete glucose is biologically implausible; brain glucose is stable and plentiful regardless of mental activity (Beedie & Lane, 2012; Kurzban, 2010). Finally, not only did results of the initial studies (Gailliot, Baumeister, et al., 2007) not hold up upon re-analysis of the original data (Kurzban, 2010), the original studies were excessively significant given their low statistical power, indicating some form of bias (Schimmack, 2012).

Despite assertions that levels of blood glucose predict self-control (Baumeister, 2014), there is actually little evidence that this is the case. For example, there now exist large datasets that cross-sectionally track hourly fluctuations in controlled processing (e.g., Zadra & Proffitt, 2014); however, these datasets provide no evidence that control increases with the typical surge in blood glucose after people have typically eaten lunch and dinner. Yet, glucose supplementation – even a glucose gargle – increases control (Hagger & Chatzisarantis, 2013; Molden et al., 2012); but control also rises after doses of methylphenidate (Sripada, Kessler, & Jonides, 2014) and prayer (Friese & Wänke, 2014). Yet no one claims that Ritalin or God is the resource that underlies control, just as no one should claim that glucose underlies control based on supplementation studies alone.

We do not believe that there is a central and depletable physiological resource underlying the waning of self-control. Rather, it might be that ingesting glucose influences motivation, which then improves self-control (Molden et al., 2012). Such a reconsideration is consistent with a large and growing number of studies showing that motivation and expectations moderate, and perhaps even mediate, depletion (Inzlicht & Schmeichel, 2012).

Question 4: How Can Changes in Motivation and Expectations Replenish a Depleted Resource?

Despite claims that self-control fails due to lack of capacity, a literal depletion of some resource that takes time to replenish (Muraven & Baumeister, 2000), more and more studies are incompatible with the strong version of this claim (Masicampo, Martin, & Anderson, 2014). The first clue that something resource-free was happening was work on motivation: rewarding self-control undoes the depletion effect, apparently canceling self-control's refractory period. For example, Muraven and Slessareva (2003) found that participants could maintain high levels of control if they were offered incentive to do so. Similarly, incentivizing control by re-framing temptations as tests of willpower cancels depletion (Magen & Gross, 2007). Rewarding effort or linking it to a valued aspect of identity, then, undoes the reductions in control due to previous task exertion. Adding an unrelated reward in the period between self-control challenges can also knock out effects of depletion. Thus, smoking cigarettes (Heckman, Ditre, & Brandon, 2012), watching a favorite television program (Derrick, 2012), receiving a surprise gift (Tice, Baumeister, Shmueli, & Muraven, 2007), or affirming some core value (Schmeichel & Vohs, 2009) similarly prevent the reductions in self-control thought to be produced by the depletion of some limited resource.

Changing perceptions and construals can also counteract depletion. When people perceive themselves as being depleted despite not having engaged in previous cognitive work, they exhibit poor self-control; conversely, when people perceive themselves as having lots of stamina, their self-control is intact (Clarkson, Hirt, Jia, & Alexander, 2010). Similarly, lay theories about how self-control works and whether it does or does not have a refractory period influences depletion (Job, Dweck, & Walton, 2010). When people believe that self-control wanes over time, they show typical depletion effects; however, when they believe that self-control is renewable, they show no noticeable drops in self-control over time. Finally, new work suggests that the construal of effort itself can determine whether it leads to depletion. When people construe an effortful activity as work, they tend to show subsequent failures in control; when they construe the same task as fun and enjoyable, they tend not to show these deficits (Werle, Wansink, & Payne, 2014).

These sorts of studies are hard to reconcile with a resource account. If self-control truly relies on some limited and slowly replenishing resource that becomes exhausted after use, it is difficult to understand how simple incentives, perceptions, and construals can reverse this depletion. If a person fails at self-control because of the unavailability of some real physiological resource, no amount of psychological change should make a difference. From these studies, it appears that self-control's refractory period has more to do with motivation and value and less to do with some biologically-mediated incapacity.

Resource theorists concede that motivation matters (Baumeister & Vohs, 2007), although, according to them, it only matters a little, when people are partially or slightly depleted (Vohs, Baumeister, & Schmeichel, 2012). When depletion is extensive or severe, they argue, it cannot be counteracted. Yet these conclusions are at odds with decades of work on fatigue, where even severe fatigue can be defeated with sufficient motivation (e.g., Boksem et al., 2006). We cannot help but wonder if the failure of motivation to prompt control under so-called severe depletion in past work (i.e., Vohs et al., 2012) says more about the weakness of the motivational inducements used rather than the severity of depletion. For example, it is well known that cash and other incentives can help people overcome the effects of fatigue after working on a task for two hours (Boksem et al., 2006; Hockey & Earle, 2006). Cyclists who pedal until the point of exhaustion can be induced to cycle for longer and with greater intensity if the right incentives are offered (Marcora & Staiano, 2010). Both working hard for a two-hour stretch and cycling until the point of physical exhaustion are more severe forms of fatigue than anything we have seen in a depletion study; yet, even these severe states of depletion can be overcome by motivational inducements. And if depletion is caused by resources being spent (Vohs & Faber, 2007), it is difficult to fathom how motivation, perception, or mindsets could change that fact.

Question 5: Has the Resource Model Unwittingly Become a Model About Motivation?

In an important modification of the resource model, resource theorists now suggest that complete resource depletion or exhaustion is rare, with most instances of ego depletion reflecting only partial and temporary depletion (Baumeister, 2014). Unlike the strong version of a resource that was first proposed, self-control failure is no longer attributed to people running out of fuel; instead, the ego depletion effect is now hypothesized to reflect a slight diminishment of a central resource (Baumeister, 2014).

While such a radical alteration allows the resource model to accommodate findings with motivation – motivation is said to induce people to dip into their "ample reserves of energy" (Baumeister, 2014, p. 314) – it begs the question of whether the resource concept is needed at all. If depletion is mostly mild, with people having plenty of energy available to them, why would we look toward flagging energy levels to explain people's failure to exert effortful control? Something other than low energy must explain the findings. That something, we suspect, is people's willingness and desire to exert effort; it is their motivation to exert control.

In our view, this weak version of the resource model is indistinguishable from a model of self-control based on motivation and changing priorities (Inzlicht, Schmeichel et al., 2014). If people have ample energy and depletion is only ever partial, the reason that self-control wanes over time is that people have deemed some tasks are not sufficiently interesting, important, or worthwhile and have chosen not to apply effort. When they estimate that tasks are worthwhile, however, they are perfectly willing to exert themselves. In short, depletion now seems to have turned from a question of inability to a question of unwillingness, suggesting that the resource concept is now superfluous. Like others who have come before us (Navon, 1984), we wonder if the resource concept is a theoretical soup stone, seemingly essential but actually impotent.

Question 6: Do Self-control Exercises Increase Self-control?

Another provocative claim of the resource model is that self-control grows with repeated use (Muraven et al., 1999). That is, just like a muscle that grows with exercise, the resource that underlies self-control is thought to strengthen after repeated exercises. If many of society's problems can be traced to difficulties of self-control (Baumeister et al., 1994), then finding ways to improve it is a worthy endeavor (Inzlicht, Legault, & Teper, 2014). So, does exercising self-control actually increase self-control capacity?

The idea of training control in the hopes of improving it is not unique to the resource model. Training executive functions, for example, by playing computer games that tax working memory and inhibitory control (e.g., Thorell et al., 2009), seems to improve performance on a narrow range of tasks – essentially a practice effect – but does not generalize to conceptually related but novel tasks (Berkman, Kahn, & Merchant, 2014; Shipstead, Redick, & Engle, 2012). This result is pertinent here because self-control is thought to rely on basic executive functions, such as inhibitory control. If executive function training fails to generalize, it follows that self-control training would be similarly unlikely to transfer to unpracticed tasks.

There is now some empirical basis to evaluate this possibility. A handful of studies have tested whether self-control can be trained by having participants practice small acts of self-control throughout the day, usually for two weeks (see Table 1). Despite some success, the effect of self-control training has been inconsistent (Muraven et al., 1999). We thus decided to meta-analyze the small training literature – and to correct this analysis for publication bias –to determine the effectiveness of self-control training. We used a new method to calculate a meta-analytic effect size that corrects for publication bias and undisclosed use of questionable research practices (Simonsohn, Nelson, & Simmons, 2014a). Although the specifics of this new technique are beyond what can be covered here (see Supporting Information), this approach builds upon the idea of a p-curve (Simonsohn, Nelson, & Simmons, 2014b), or the distribution of significant p-values across a set of studies on the same effect, which allows us to estimate the true size of an effect based only on published effects.

We identified 13 studies (Table 1) that tested the hypothesis that training on one kind of self-control would cause improvements on a second kind of self-control but retained only ten of these studies for our meta-analysis.[1] Each of these studies used an active control group and a pre–post design, whereby self-control was examined both before and after training (or active control). We thus tested for a group (training versus control) by time (pre versus post) interaction (or equivalent) on some measure of self-control other than the training task itself. We extracted the relevant *F*- or *t*-value of the interaction test along with the associated degrees of freedom and analyzed these using the procedure and R-code described by Simonsohn and colleagues (2014a). Based on the p-curves derived from these data, we calculated a true effect sizes of $d = 0.17$ (CI = −0.07, 0.41), which is rather small and perhaps no different from zero.

[1]We excluded three studies by Oaten and Cheng (2006a, 2006b, 2007) because (a) they were extreme outliers compared to the other 10 studies (e.g., effect sizes 5 to 70 times as large as the median effect of all other studies), (b) the results section did not contain the key descriptive statistics needed to reproduce the tests in question, (c) it is not clear whether the primary dependent measure they used in fact taps self-control, and (d) the authors were unable to provide the original data, summary descriptive statistics, or further details about the self-control training procedures and the dependent measures (see Supporting Information).

Given recommendations to present a variety of meta-analytic estimators (Reed et al., 2015), we not only meta-analyzed the first reported and relevant test statistic, but we also meta-analyzed the last reported and relevant test statistic (Simonsohn et al., 2014b). Seven studies included more than one relevant statistic, and the p-curve analysis of these returned an effect size of $d = 0.62$ (CI = 0.13, 1.11). Unlike the first estimate, this one reveals an effect that is not only medium in size but also quite unstable.

While these bias-correction attempts cast some doubt about the potential for self-control exercise, suggesting that the effects might be unstable, small, or perhaps negligible, as with the bias-corrected meta-analysis of the depletion effect described above, these results are not conclusive. What is really needed is a statistically powerful and good-faith attempt to replicate the basic exercise effect. Nonetheless, coupled with the lack of a generalized effect for executive control training (Owen et al., 2010), the small effects we calculated here should be seen as a warning sign: self-control training might not generalize.

Even if training is found to be replicable and robust, we note that this possibility does not necessarily support the resource model. Self-control training might improve self-control by enlarging self-control capacity, but it might also increase control by changing people's lay beliefs about willpower (Job et al., 2010), by lowering the aversiveness of effortful control (Botvinick, 2007; Inzlicht et al., 2015), or by making control habitual (Galla & Duckworth, 2014; Gillebaart & De Ridder, 2015) and effortless (Milyavskaya, Inzlicht, Hope, & Koestner, in press). The point here is that even if training increases control, it might do so for any number of reasons, with enlarged self-control resources being only one of many. Nevertheless, before considering the possible mechanisms, we need strong evidence that self-control training actually works.

Conclusions

The resource model has been good for psychology. It captured our imagination and brought much-needed attention on an important yet neglected psychological construct. We learned that self-control underlies many seemingly different behaviors. We also learned that self-control appears limited and does indeed wane over time.

Despite appearances, however, self-control may not actually be limited. In our view, self-control is not based on a limited resource; self-control failure is almost certainly not caused by the depletion of brain glucose; and self-control training might not actually increase global self-control. Instead, we suggest that depletion is no different from mental fatigue. Modern treatments of fatigue indicate that it too is not caused by some loss of energy but instead by psychological changes, in motivations and priorities, as people calculate opportunity costs and the best course of action (Hockey, 2013; Kurzban et al., 2013). In our view (Inzlicht, Schmeichel, et al., 2014), self-control wanes over time not because people have no energy but because people experience a shift in motivation away from "have-to" goals, which are carried out through a sense of obligation and duty, and instead come to prefer "want-to" goals, which are fun, personally enjoyable, and meaningful (Milyavskaya et al., in press; Ryan & Deci, 2000; see also, Milkman, Rogers, & Bazerman, 2008).

Although we are pleased to see the resource model modified, so that resources are now seen as only partially depleted (Baumeister, 2014), we wonder if such a transformation makes the resource concept unnecessary. After all, if people have ample resource at their disposal after initial task exertion, self-control does not fail because of resource unavailability; instead, self-control fails because people choose (consciously or otherwise) to not apply effort. In our opinion, the field would be better served by abandoning the resource concept altogether and focusing on how and why people's choices and preferences change over time and context.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Self-control training studies included in the bias-corrected meta-analysis, with analyses based on first and last reported test statistics.

Study	Self-control training	Training duration	Self-control measure	Total N	t or F (first)	t or F (last)
Bertrams & Schmeichel, 2014	Journaling, attending to logical consistency	1 week	Anagrams after self-controlled typing task	49	$F = 5.05$	–
Bray, Graham, & Saville, 2015	Handgrip practice twice daily	2 weeks	Maximal exertion on a cycling exercise task	41	$F = 28.54$	$F = 3.31$
Denson, Capper, Oaten, Friese, & Schofield, 2011	Non-dominant hand use	2 weeks	Noise blast aggression	90	$t = 2.15$	$F = 9.70$
Finkel, DeWall, Slotter, Oaten, & Foshee, 2009	Speech regulation	2 weeks	Intimate partner violence inclination after attentional control	40	$F = 4.65$	$t = 2.61$
Gailliot, Plant, Butz, & Baumeister, 2007, Study 1	Speech regulation	2 weeks	Solving anagrams after stereotype suppression	38	$F = 7.02$	$t = 3.24$
Gailliot et al., 2007, Study 2	Speech regulation or non-dominant hand use	2 weeks	Solving anagrams after stereotype suppression	98	$F = 2.08$	–
Hui, Wright, Stewart, Simmons, Eaton, & Nolte, 2009	Stroop task	2 weeks	Cold pressor tolerance after a concentration task	55	$F = 3.11$	$F = 2.43$
Muraven, 2010a	Avoiding sweets or handgrip practice	2 weeks	Stop-signal task	92	$F = 5.04$	$F = 7.89$
Muraven, 2010b	Avoiding sweets or handgrip practice	2 weeks	Self-reported cigarette smoking (among smokers trying to quit)	122	$F = 5.93$	–
Muraven et al., 1999	Posture and mood regulation	2 weeks	Handgrip persistence	69	$F = 5.57$	$F = 3.00$
Oaten & Cheng, 2006a[a]	Study skills program	8 weeks	Visual tracking task during distraction	45	$F = 359.98$	$F = 406.64$
Oaten & Cheng, 2006b[a]	Physical exercise (aerobic classes and weights)	8 weeks	Visual tracking task during distraction	24	$F = 23.80$	$F = 315.34$
Oaten & Cheng, 2007[a]	Financial monitoring	4 months	Visual tracking task during distraction	49	$F = 48.13$	$t = 15.29$

[a]These papers were not included in the meta-analysis because of methodological anomalies, missing descriptive statistics, and possible errors in data reporting (see Supporting Information).