

# The Strength Model of Self-Regulation: Conclusions From the Second Decade of Willpower Research

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## Abstract

The strength model of self-regulation uses a muscle analogy to explain patterns of ego depletion, conservation of willpower, and improved performance after frequent exercise. Our 2007 overview of the literature has been well cited, presumably because of the phenomenon's importance to theories of selfhood and a wide assortment of applied contexts, including problem behaviors. Some researchers have put forward rival theoretical accounts, and others have questioned the existence of the phenomenon. The weight of evidence continues to support the usefulness of the strength model, albeit amid continuing updates and revisions.

## Keywords

motivation, goals, reward, intrapersonal processes, self

The idea that self-control resembles a muscle was first proposed as a speculative conclusion based on reviewing diverse literatures by Baumeister, Heatherton, and Tice (1994) and spelled out by Baumeister and Heatherton (1996). Strength meant, first and foremost, that after exerting self-control, subsequent acts of self-control, even in different contexts, would suffer. Early experiments testing the model worked surprisingly well (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Muraven, Tice, & Baumeister, 1988). The phenomenon, resembling muscular tiredness, was dubbed *ego depletion*.

Ego depletion caught on, and soon many researchers were publishing studies on it. The muscle analogy was elaborated with two crucial further points. First, ego depletion does not mean that the self has run out of energy; rather, it reflects the cutting back of exertion to conserve its remaining energy (as it does with physical exertion). Second, and more provocatively, just as muscles become stronger with exercise, self-control could be improved by frequent exertions, as studies found (Baumeister, Gailliot, DeWall, & Oaten, 2006). Meta-analyses by Friese, Frankenbach, Job, and Loschelder (2017) and Beames, Schofield, and Denson (2017) have confirmed that regular exercise of self-control in one domain improves self-control performance in other domains.

After the first decade of research on ego depletion, an update was written by Baumeister, Vohs, and Tice (2007), which found a place (now, after the second decade) among the most-cited articles in APS journals. Indeed, when reading the literature stemming from that article, we are both gratified and overwhelmed to realize that a new article relying on ego depletion gets published almost every day.

## Original Theory and Refinements

Self-regulation is the process by which the self changes its thoughts, feelings, and actions, including impulsive urges and task performance. The first glimmerings of the strength model occurred to Baumeister et al. (1994) during the heyday of cognitivist hegemony, when even motivation was viewed with suspicion by many researchers. The idea that the self's processes could involve energy was not taken seriously. Yet conferences on the self at that time also would typically acknowledge that psychology had not made much progress

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understanding the “agent” aspect of the self, as in executive function. Might the failure to understand executive functioning overlap with the unwillingness to consider energy? Baumeister and Heatherton (1996) noted multiple findings suggesting energy depletion. People with multiple demands on their self-regulatory processes (e.g., dieting while quitting smoking) tended to fare poorly at all of them.

In our view, energy and motivation are different. Energy consists of resources that are consumed in effortful activity. Motivation constitutes the desire to engage in effortful activity. The strength model recognized both motivation and energy, but its focus was on the expenditure of limited resources (energy) in self-regulation. Terms such as ego depletion and willpower invoke energy, not motivation (cf. Inzlicht & Schmeichel, 2012).

The original strength model assumed that the energy operated like a kind of brain fuel, and so after some was expended, there was not enough left to do any more—hence the ego depletion effect, on which performance on the second task suffered. This was soon replaced by the idea of conservation (Muraven, Shmueli, & Burkley, 2006): The body still has energy but, having expended some, seeks to conserve what remains. It can, however, still perform well when sufficiently motivated.

Strength and energy were originally just metaphors, like the folk term *willpower*, which we initially resisted using because of its connotative baggage. Some initial evidence indicated that consuming glucose could counteract ego depletion, which sparked considerable further work (and debate) on the idea that willpower is essentially glucose. Glucose is the human body’s energy supply, and so it was tempting to move from a metaphoric concept of energy to talking about real energy. Abandoning metaphor for physiology is risky for any psychological theory, but initial evidence was quite encouraging, as noted in the 2007 article. Since then, evidence has accumulated in favor of the hypothesis that ingesting glucose can counteract depletion and that states of low glucose cause poor self-regulation. The additional initial finding that laboratory exertions of self-control directly lowered blood glucose has not been consistently replicated, and we now think the glucose processes are much more complicated.

### Citations Increase

The Editor of *Perspectives on Psychological Science*, Robert Sternberg, encouraged authors of the retrospectives in this issue to speculate on why these articles attracted so many citations. Our 2007 article provided a brief overview of research that caught the interest of

many other researchers, and so they often cite this article as a simple way of referencing prior work. Its citation count therefore reflects several features.

First, how the self regulates itself is key to understanding the self. Given widespread research interest in the self, a powerful model of self-regulatory functioning will attract much citation. Second, self-regulation is central to a great many domains that are of prime interest to psychology. Failures of self-control can be seen in emotional difficulties, addiction, crime, violence, underachievement, money problems, unwanted pregnancy, sexually transmitted diseases, obesity, eating disorders, substance abuse, prejudice, relationship problems, and more. Moreover, we think that self-control is a genuine causal factor in many of these problems (much unlike self-esteem; see Baumeister & Vohs, 2018). Indeed, the pattern of citations suggests that a good part of current evidence for the strength model comes in fields of applied research. Self-regulation is centrally important to researchers working on people’s problems in life.

Third, the prominence and novelty of the strength model have attracted the interest of skeptical researchers. Researchers have sought to provide alternative theories or question the empirical database, efforts that have kept the strength model salient and relevant.

### Challenges and Alternative Accounts

As noted, the strength model was a radical departure from the dominant modes of theorizing at the time, which focused on information processing. By coincidence, the idea that psychological processes involve energy has returned to plausibility, thanks in part to the influx of biological perspectives into social psychology. (After all, life itself is an energy process, and the brain depends on energy.) Still, such a departure invites rigorous questioning, and generally the research community finds it appropriate to be extra skeptical when new efforts depart from its dominant way of thinking. The result has been lively theoretical debate about the model, and no doubt this debate has contributed to the impact of our 2007 article.

An alternative theory by Inzlicht and Schmeichel (2012) proposed that ego depletion could be explained by the traditional categories of motivation and attention, dispensing with the idea of depleted energy. Its core idea was that performing the first self-control task reduces motivation to perform well on the second, not because of any loss of energy but because of changes in motivational priorities. However, research has consistently failed to find evidence of change in motivation on the second task (for review, see Baumeister & Vohs, 2016). Other theorists have proposed explanations by focusing on specific findings from the literature, but

these alternate explanations fail to account for the rich assortment of effects (see Baumeister & Vohs, 2016).

Other challenges advanced the theory and led us to revise and improve our thinking. These are sometimes presented as overturning and replacing the strength model, which is probably overreaching—but they have added powerful new dimensions. Beedie and Lane (2012) proposed that ego-depletion effects are not so much about having exhausted one's willpower resource as about whether the body allocates glucose from its reserves, which we think adds a huge new dimension to the conservation findings. Job, Dweck, and Walton (2010) proposed that ego depletion occurs simply because people have a mistaken understanding of self-control. We have replicated their findings but also shown their limitations (Vohs, Baumeister, & Schmeichel, 2012). Implicit theories need to be incorporated into the strength model but are unable to supplant it. In our view, the most creative recent advance was by Evans, Boggero, and Segerstrom (2016), who incorporated the "central governor" notion from physical muscles to explain why subjective and behavioral effects of exertion coexist with genuine resource depletion but are only very loosely linked to each other.

### Adventures in Replication

Although many researchers have sought alternative explanations for ego-depletion phenomena, others have attested that there are no such phenomena. This combination attracts additional citations but puts us in an awkward position. The two lines of critique contradict each other, so at least one of them has to be completely groundless: No alternative explanation can possibly be correct for a nonexistent phenomenon.

Social psychology's much-hyped crisis of replication has led to oddly selective questioning of its knowledge base. The prominence of ego depletion, combined perhaps with the wish to get rid of the troublesome notion of energy, has helped make it a poster child for the crisis. Hagger et al. (2016) conducted a multilab study of ego depletion. In our view, it was hampered by the requirement to administer the procedure entirely via computer programs, resulting in the use of a largely untested set of procedures that unfortunately did not properly operationalize the core constructs. They found null results, leading some to question the reality of ego depletion. It surprises us that many people seem to place so much faith in a single study with a null finding. Nevertheless, Vohs is now spearheading a multisite replication using more suitable procedures.

Another attack on the phenomenon came from a meta-analysis by Carter, Koffler, Forster, and McCullough (2015). They concluded that the true ego-depletion

effect may be no different from zero, but to reach that conclusion they had to discard most of the published literature and resort to statistical techniques of questionable validity (see Cunningham & Baumeister, 2016).

Our view is that denying the reality of ego-depletion phenomena is implausible, given the abundant evidence. There are now hundreds of significant effects in the published literature, and we know of plenty of unpublished ones, too. Like many researchers, we continue to find the effect reliably. We know of no finding in social psychology that is found 100% of the time.

Perhaps one way to salvage some validity to the skepticism about the phenomenon while also leaving room for theoretical debate and alternative explanation is to focus on effect sizes. The thrust of this critique would be that publication bias has inflated the effect sizes of experimental studies, so that what the literature reports is larger than what the true effect size would be. This seems obviously true, not just for ego depletion but for almost every phenomenon: Unpublished studies will have a higher proportion of null findings than published ones and therefore a smaller average effect size than published studies. In this connection, it is instructive to compare the two meta-analyses. Hagger et al. (2016) used only published studies and found an average effect size of .62; the most inclusive analysis of Carter et al. (2015) found an effect size of .43. The drop from .62 to .43 seems a quite reasonable approximation of what one would generally expect to find when adding a slew of unpublished studies.

However, we find the notion of a true effect size of ego depletion to be dubious and misguided. First, ego depletion is studied with a variety of procedures and manipulations, and it is unlikely that all would yield the same effect size. Second, and more important, the concept of ego depletion is essentially a kind of fatigue—and therefore it exists on a continuum, from mild to extreme. Our own work has found significant differences between mild and severe depletion, indeed not only in effect size but also in causal process (Vohs et al., 2012). More extreme depletion should yield more intense effects, and so anyone wishing to argue for a single effect size would have to argue that some such findings are mistaken.

Furthermore, crucially, laboratory effect sizes may bear little resemblance to effects out in the real world. Laboratory effects are both artificially inflated (e.g., by setting up the procedures for optimal demonstration and screening out other factors) and artificially deflated (e.g., because of practical and ethical constraints that make laboratory experiences less persuasive than what can happen in actual life). In our view, the laboratory experiment remains the social scientist's best method for establishing the presence of a causal relationship

but is poor at estimating the power of that relationship outside the laboratory. In that context, the only serious question about the laboratory findings is whether there is any effect, not how large it might be. To assert that there is no effect is to insist that the hundreds of published studies all consist of capitalizing on chance (or perhaps fraud). Again, we find this implausible.

### Some New Directions

Although basic researchers have debated the explanations and, in some cases, even the authenticity of ego depletion effects, researchers in other areas have increasingly recognized the power and utility of these ideas for explaining an immense diversity of human behavior patterns. Over the past decade, we have been repeatedly impressed and gratified by the creativity of these extensions.

For example, a recent study found that schoolchildren's scores on standardized exams are worse when the exams are administered late in the school day, as opposed to earlier or after a break (Sievertsen, Gino, & Piovesan, 2016). School depletes energy because children struggle to behave according to rules and manage their attention. Likewise, test anxiety impairs test performance only when students are depleted and not otherwise (Bertrams, Englert, Dickhäuser, & Baumeister, 2013).

Working at a hospital puts demands on attention, emotion, and behavior and often involves working lengthy shifts. Hence, as hospital workers become depleted, they cut corners on health and safety regulations. Dai, Milkman, Hofmann, and Staats (2015) found that workers skipped the mandatory handwashing more and more often over the course of a 12-hr workday. Another project addressed the problem of overprescribing unnecessary antibiotics, which physicians sometimes do under pressure from patients. Linder et al. (2014) found that physicians do this more often late in the day, when they are presumably more depleted.

Extreme poverty requires many demands on self-regulation, and the resulting ego depletion may explain some of the irrational and self-defeating choices by poor people (Vohs, 2013). Exposure to family violence seems to reduce control over behavior, emotions, and thoughts, which heightens the risk of further violence (Finkenauer et al., 2015).

It is necessary to recognize that research outside the laboratory sacrifices some degree of control. There could potentially be reasons other than ego depletion for why children do worse on tests in the afternoon than in the morning, or physicians prescribe more antibiotics at the end than at the beginning of a 12-hr shift.

In our view, the confluence of rigorous laboratory findings and compelling real-world findings highlights the value of the strength model, although we recognize that field studies' findings can be subject to multiple interpretations.

In an area of research that emerged after our 2007 article was published, decision making was tied to depletion. Making decisions is psychologically taxing (Vohs et al., 2008), which can result in poorer decision making (Pochepstova, Amir, Dhar, & Baumeister, 2009). Multiple investigations have followed up on that work, showing worse decision making and effortful behavior performance among people who recently had used self-control or made a series of decisions. Further work examining the effect of other executive functioning on ego depletion represents a promising new direction because such findings not only inform us about ego depletion but also elucidate our understanding of the components of the self.

Two articles showed depletion effects in potentially life-altering circumstances: parole decisions and elections. Judges deciding on whether an inmate should be paroled face difficult trade-offs. The longer they have been making parole decisions on a given day without a break, the more likely it is that they choose to stick with the status quo and deny prisoners' requests (Danziger, Levav, & Avnaim-Pesso, 2011). Even the act of voting seems to deplete the self. Compared with contests that appear near the top of the ballot, contests further down on the ballot have more abstentions or are decided by simple decision heuristics, such as favoring the first candidate listed or staying with the incumbent (Augenblick & Nicholson, 2016). Voting can result in significant consequences for citizens, but given that the average ballot in that study contained more than 30 races, many important outcomes are determined by impulsive or passive responding.

### Conclusion

The strength model was a radical departure from conventional modes of theorizing, and as a result it would have been surprising if we got it exactly right the first time. Sure enough, the theory has continued to evolve and change, such as in the incorporation of allocation processes, conservation processes, and glucose processes, as well as in the extension to decision making. Future researchers will possibly generate a viable alternative explanation that can dispense entirely with energy, though as the years go by, that seems less and less likely. More plausibly, the theory will continue to evolve and grow while also proving to be an indispensable part of the psychology of self.

## Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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