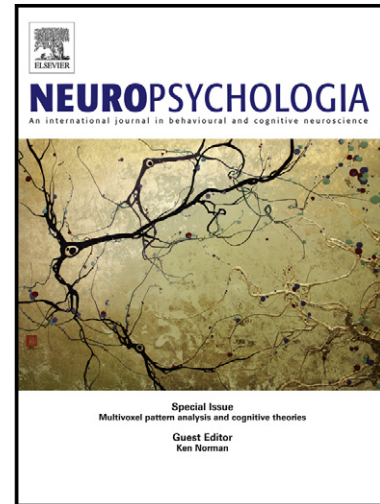


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Self-regulation, Ego Depletion, and Inhibition

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## Abstract

Inhibition is a major form of self-regulation. As such, it depends on self-awareness and comparing oneself to standards and is also susceptible to fluctuations in willpower resources. Ego depletion is the state of reduced willpower caused by prior exertion of self-control. Ego depletion undermines inhibition both because restraints are weaker and because urges are felt more intensely than usual. Conscious inhibition of desires is a pervasive feature of everyday life and may be a requirement of life in civilized, cultural society, and in that sense it goes to the evolved core of human nature. Intentional inhibition not only restrains antisocial impulses but can also facilitate optimal performance, such as during test taking. Self-regulation and ego depletion may also affect less intentional forms of inhibition, even chronic tendencies to inhibit. Broadly stated, inhibition is necessary for human social life and nearly all societies encourage and enforce it.

Inhibition is one form of self-regulation. Self-regulation can be broadly defined as overriding or altering responses, especially as guided by standards of desirable responses (e.g., Baumeister, Heatherton, & Tice, 1994; Carver & Scheier, 1981, 1982). Inhibiting a response (that is, intervening to prevent the response from being felt or acted upon) clearly fits that definition. In fact, after surveying diverse research literatures, Baumeister et al. (1994) estimated that 80-90% of self-regulation in everyday life consists of stopping a response. That includes resisting desires and impulses, shutting unwelcome thoughts out of one's mind, and stifling emotions. In principle, self-regulation can be used to prolong or increase emotions, but in practice the most common form of emotion regulation is trying to reduce bad feelings.

The primacy of inhibition — that is, the fact that the majority of self-regulation acts involve stopping a prepotent response — can be seen in moral rules. Rules restricting and prohibiting various acts are far more common in morality than are rules prescribing and demanding actions. To use one familiar example, the Ten Commandments articulated in the Judeo-Christian Bible mostly specify what “thou shalt not” do. Eight of the ten specify what behaviors are forbidden. Even the other two are not purely prescriptive or promotional requirements. The commandment to keep the Sabbath holy is generally implemented by not performing a wide assortment of activities on that day (though also attending religious services or doing other positive things may also be involved). Likewise, the commandment to honor one's parents is likely a combination of doing and not doing.

### ***Self-regulation, Feedback Loops, and Ego Depletion***

A highly influential model of self-regulation was proposed by Carver and Scheier (1981, 1982) based on cybernetic theory (e.g., Powers, 1973). Their model emphasized the feedback loop on supervisory monitoring. The self-regulator tests the reality against the standard. If the reality falls short, an operation is performed to rectify the difference, the success of which is verified by another test. Testing can be repeated intermittently until the operation reaches success. Once the test indicates that reality matches the standard, the loop is exited, and that self-regulation process is terminated.

To illustrate, one might imagine a person saving money. He has a financial goal of saving a certain amount each month, and he compares his actions against that standard. It is necessary to inhibit other expenditures in order to reach that target. Once he has reached his monthly goal, he does not have to regulate his saving until the next month.

Carver and Scheier's theory grew out of their research on self-awareness, and indeed they theorized that one major purpose of human self-awareness was to facilitate self-regulation. This theoretical approach helped them elucidate the process of monitoring that guides self-regulation, but that emphasis meant that the “operation” phase did not receive much attention by them and other early researchers. The

“operation” phase has been the focus of other research programs, however, including the present author’s.

The initial survey of research literatures on self-regulation led Baumeister, Heatherton, and Tice (1994) to hypothesize that regulating depended on a limited resource, akin to strength or energy. Although the folk notion of willpower contained the idea that some sort of energy is needed for self-control, hardly any psychological theorizing at that time invoked energy models. The proposal that self-regulation required and consumed energy was therefore fairly radical, and it was certainly at odds with the prevailing style of theorizing that featured information processing.

The initial studies were carefully set up to distinguish energy models from two sets of rival theories. An energy model is based on the idea that a limited resource is expended by self-regulation, and so performance on the second self-regulation task will be worse than the first (because some energy is depleted). In contrast, information-processing models suggest that performance should improve on the second self-regulation task, because the first one has primed or otherwise activated the relevant mental programs. A third view from developmental psychology the view of self-regulation as a skill. Skill does not change from one trial to the next but can improve slowly over many trials.

The energy hypothesis received preliminary support in two sets of laboratory experiments by Baumeister, Bratslavsky, and Tice (1998) and Muraven, Tice, and Baumeister (1998). These tested the hypothesis that regulating oneself, such as by inhibiting one incipient response, would use up some energy and thereby cause impairment in performance of a subsequent act of self-regulation. Most of the studies involved intentional inhibition. To deplete willpower, participants in various studies were first instructed to stifle emotional responses to an upsetting film or to block an intrusive thought out of their minds (Muraven et al., 1998). In other studies, they first formed a habit and then had to break it, or they had to resist the temptation to eat chocolate and instead consume unappetizing radishes. Participants who had undergone these procedures subsequently performed worse on other, quite different and seemingly unrelated tests of self-regulation, such as perseverance in the face of failure, or maintaining a poker face despite provocative humor.

The state of reduced self-regulatory capacity stemming from prior exertion of self-control was dubbed *ego depletion* by Baumeister et al. (1998). The term was chosen in homage to Freud, because he may have been the last major theorist to posit that the human self consists partly of energy sources and processes. To be sure, Freud’s ideas about energy and self were underdeveloped and led in many directions that have no resemblance to ego depletion theory and the so-called strength model of self-regulation (Baumeister, Vohs, & Tice, 2007). The use of the Freudian term was meant simply to recognize that Freud had invoked energy — and that after his death, energy largely vanished from self theory for half a century.

The basic ego depletion pattern has been well replicated with many different procedures, as confirmed by a meta-analysis by Hagger, Stiff, Wood, and Chatzisarantis (2010) that integrated over a hundred experiments by many different

laboratories. An informal count suggests that the volume of similar published findings has more than doubled in the few years since then.

Inhibition is impaired during ego depletion. Assorted findings indicate that depleted persons fail to inhibit a broad range of actions and responses that they would otherwise (i.e., if not depleted) inhibit successfully. These include aggression (DeWall, Baumeister, Stillman, & Gailliot, 2007), inappropriate sexual responses (Gailliot & Baumeister, 2007b), prejudice (Muraven, 2008), overeating of unhealthy food (Vohs & Heatherton, 2000), alcohol consumption (Muraven, Collins, & Neinhuis, 2002), and impulsive spending (Vohs & Faber, 2006).

Subsequent findings have added important aspects to the strength model. First, ego depletion does not mean that the brain has run out of fuel, as was first proposed. (Indeed, the word *depletion* has two meanings, referring to partial and total reduction in a resource, and this ambiguity has confused some.) Instead, it appears that most ego depletion findings represent an effort to conserve a resource that is only somewhat diminished (Muraven, Shmueli, & Burkley, 2006). The analogy of a muscle is apt: As muscles get tired, the body naturally seeks to conserve energy, long before the point of exhaustion is reached. Hence people in the state of ego depletion can still self-regulate effectively if an important situation arises and they are accordingly motivated to do so (e.g., Slessareva & Muraven, 2003; see also DeWall, Baumeister, Stillman, & Vohs, 2011).

Because ego depletion is typically a matter of conserving a slightly depleted resource, its effects can be overcome with a variety of cognitive and motivational stimulants. For example, offering a cash incentive, or inducing people to think their willpower is unlimited, can produce good performance despite an initial amount of ego depletion (Job, Dweck, & Walton, 2010; Muraven & Slessareva, 2003). However, as ego depletion becomes increasingly severe, these other procedures become less effective at counteracting the behavioral decrements of ego depletion (Vohs, Baumeister, & Schmeichel, 2012). The reason for these is most likely that the body has ample reserves of energy, which it conserves after some energy has been expended. When motivation (e.g., the chance to win money) is high, however, the person expends more from the reserves. Likewise, the belief that one's willpower is unlimited can cause the person to expend energy more freely — rather like people might spend more money if they came to believe that their bank account was unlimited.

The limited resource is used for more than self-control. Vohs et al. (2008) showed that making choices depletes the same resource, thereby impairing subsequent self-control. Conversely, initial acts of self-control impair subsequent decision-making (Pocheptsova, Amir, Dhar, & Baumeister, 2009). Initiative, as in responding actively rather than taking a passive approach or choosing the default option, also depends on the same resource and suffers when people are depleted (Vohs, Baumeister, Vonasch, Pocheptsova, & Dhar, 2013). There is some evidence that planning is also involved (Webb & Sheeran, 2003).

Taken together, these findings on decision-making, initiative, and planning indicate that the same energy resource is used for far more than intentional inhibition,

though inhibition remains a major category of its applications. Baumeister (2008, 2014) proposed that the philosophical and folk concept of free will is an apt umbrella term for all these interrelated functions. That is, the expenditure of energy in volition may be the psychological reality behind the idea of free will.

### ***Glucose: Fuel for Inhibition?***

Another line of work has explored the idea that glucose is a major part of the resource behind self-control. Glucose is a chemical in the bloodstream that conveys energy to the brain, other organs, and muscles. Initial discussion of the strength model had treated energy and willpower as metaphors, but it was plausible that those processes were linked to the body's actual energy dynamics, through glucose.

Gailliot, Baumeister et al. (2007) provided experimental evidence for three preliminary conclusions. First, they found that blood glucose levels were lower after people engaged in effortful self-regulation (including intentional inhibition), suggesting that the act of inhibiting a response used up glucose in the bloodstream. This finding fit the view that self-regulating consumed energy. However, subsequent work has not consistently replicated the finding that blood glucose levels drop from before to after acts of intentional inhibition or other self-regulation. In retrospect, even the initial evidence might have gotten a boost in significance from a fortuitous control condition. Hence at present it seems unlikely that ego depletion's effects are caused by a shortage of glucose in the bloodstream.

In contrast, the second and third conclusions appear correct (see Baumeister & Vohs, 2014/submitted). The second was that low levels of blood glucose predict poor self-regulation. This was well established long before social psychologists began to study glucose, as nutritionists and other researchers had linked low glucose or problems with glucose metabolizing (e.g., diabetes) to various self-control deficiencies (for review, see Gailliot & Baumeister, 2007a). Experimental manipulations of low glucose have been shown to cause impulsive, uninhibited behavior.

The third conclusion was that receiving a dose of glucose counteracts ego depletion. Self-regulatory performance among non-depleted persons seems not to get any benefit from glucose, but depleted persons who consume glucose perform as well as non-depleted ones. The typical procedure has been to give participants a glass of lemonade, by random assignment sweetened with either sugar or diet sweetener. The drinks taste equally good and indeed most participants cannot tell the difference, but the sugared lemonade counteracts depletion whereas the diet sweetener has no effect (e.g., Gailliot, Baumeister, et al., 2007). This effect has been well replicated in other laboratories and in my own (e.g., Alquist, Tice, & Baumeister, 2013; McMahon & Scheel, 2010; Wang & Dvorak, 2010).

Thus, one way to improve intentional inhibition is to give people more glucose, especially when they have already expended resources. To be sure, this raises something of a conundrum for the millions of dieters, who seek to use their powers of inhibition toward the goal of inhibiting eating. One needs fuel (glucose) to regulate and inhibit eating, but without eating, one does not get that fuel. Fortunately, glucose does

not come solely from sugar but can be made from other foods. A possible implication is therefore that dieters might seek first to fill up on healthy, non-fattening foods such as protein, which will strengthen their glucose reserves so as to enable them to resist fattening temptations.

The failure to find consistent drops in blood glucose helped stimulate Beedie and Lane (2012) to propose that self-regulatory changes are based on allocation of glucose rather than literal depletion. They noted that the human body has ample stores of glucose and certainly in modern life is under no genuine danger of running out. They suggested that the human body decides whether to allocate some of its stored energy (in glucose form) to a particular challenge or not, and that decision is what determines whether self-regulation suffers.

The finding that depleted people can perform and self-regulate quite effectively if sufficiently motivated (e.g., Muraven & Slessareva, 2003) supports the allocation view. Baumeister and Vohs (2014/submitted) have argued, however, that the allocation theory works best in combination with the limited resource view, rather than as a replacement for it. Among other arguments, selective allocation of a resource is itself usually a sign that the resource is limited and can be depleted. After all, there is generally no need for selective allocation if a resource is unlimited.

Hence, the most plausible current view is that there are extensive stores of glucose but the body resists running down its stores, and so it allocates selectively — and as depletion increases, it increasingly resists further allocation. If the person is given a reason to think that it can afford to allocate more without running low, then depletion effects are mitigated. Several findings point to this conclusion. Job, Dweck, and Walton (2010) found that convincing people that willpower is unlimited counteracted depletion effects. This seemingly confirms the view that there is no need to conserve a resource that is unlimited. (In fact, Ainsworth, Baumeister, & Boroshuk, 2014, have found that belief in unlimited willpower causes an increase in blood glucose levels in response to depletion, which fits the view that the body simply retrieves more glucose from its stores when it is convinced that its stores are effectively unlimited.) In a similar vein, Molden et al. (2012) showed that some depletion effects can be eliminated just by having people swish a glucose drink around in their mouths and spit out. Some glucose is metabolized in the mouth, and so that may be sufficient to serve as a cue to the body that more glucose is coming, thereby apparently reducing any need to conserve.

### ***Importance of Intentional Inhibition***

Although it seems clear that some nonhuman animals sometimes inhibit responses (e.g., Miller, DeWall, Pattison, Molet, & Zentall, (2012), deliberate and intentional inhibition is probably far more common among humans. The difference is sufficiently striking as to suggest that a vital aspect of human evolution was a substantial improvement in the neurological and psychological mechanisms for inhibition. Among other factors, the increased volume of the frontal cortex probably facilitated these inhibitory functions.



Why? One long effort to construct a new theory of human nature based on modern psychological laboratory findings led ultimately to the conclusion that distinctively human traits are largely adaptations to facilitate culture (Baumeister, 2005). Briefly, all living things address the problems of survival and reproduction, and humankind developed a highly unusual strategy for dealing with them. Humans use culture, which is understood as an advanced kind of social life that involves organized systems, sharing information and the collective accumulation knowledge, joint task performance based on interlocking and complementary performance of differentiated roles, morality, and exchange. This has proven to be a highly effective strategy, especially when measured by the biological criteria of survival and reproduction, but it requires advanced psychological capabilities (which is why other species, lacking those capabilities, have not embraced culture as their biological strategy).

Inhibition is important for culture. This point, too, was anticipated by Freud (1930), among other writers. Civilized human life is not compatible with expressing every feeling and enacting every impulse. Culture is essentially a system with rules for how to behave. When most people follow most of the rules most of the time, the system can deliver immense benefits, culminating in the improvements in survival and reproduction (not to mention quality of life). But it is vital that people inhibit many impulses to break the rules. These may simply be orthogonal to the event, such as if a desire to eat, fight, or urinate were to arise during a lecture or concert. In other cases, the rules require people to overcome natural impulses, so that (for example) trading partners will give each other fair value rather than selfishly cheating each other so as to maximize one's own benefit. Economic trade is essentially absent in other species, and there are even arguments that the advent of trade was a decisive determinant of success in the competition among hominids. Compared to their contemporary early (Cro-Magnon) humans, for example, Neanderthals had equally large brains and more brawn, but they were far inferior in developing trade and exchange, which proved their undoing once the trade-happy Cro-Magnons entered their territory (Horan, Bulte, & Shogren, 2005).

Thus, the success of humankind owed a great debt to inhibition, in the sense of being able to resist natural impulses and desires so as to follow the rules that make culture possible. As evidence for the importance and prevalence of inhibition in everyday life, an experience sampling study by Hofmann, Baumeister, Förster, and Vohs (2012; also Hofmann, Vohs, & Baumeister, 2012) obtained reports of desire at randomly chosen points as people went about their daily activities. This work uncovered a great deal of inhibition. People reported having a desire about half the time they were awake and reported resisting (i.e., inhibiting) 38% of those desires. Extrapolating from those responses, one can calculate that the average modern citizen spends three to four hours each day inhibiting desires. Most if not all of that resisting was presumably intentional.

Moreover, comparisons among different categories of desire suggested that the most commonly conflicted and resisted desires are the ones most incompatible with workplace activities. Participants reported having to resist desires to sleep, have sex, and play games, all of which are generally frowned upon by employers. Desires

compatible with the workplace (e.g., to have coffee or tea) created much less conflict and were less prone to be inhibited.

Consistent with the strength model, Hofmann, Vohs et al. (2012) showed that people become less effective at inhibiting desires as the day wears on, if they deplete their willpower resisting other desires. The researchers devised a proxy measure of ego depletion by calculating how often and how recently each participant had reported resisting desires previously that same day, and this measure correlated with greater yielding to other desires that one sought to resist. (It had no effect on desires that were *not* resisted, just as the strength model would predict.)

Thus, it appears that intentional inhibition is a regular feature of daily life for most people. Moreover, all that inhibition depends on a limited resource that does become depleted as the day wears on. Broadly, this work fits the view that inhibiting desires is a vital part of what enables human social life to proceed in ways that improve people's chances for survival and reproduction and enable progress to enrich quality of life.

### ***Inhibition that Facilitates***

Intentional inhibition and other forms of self-regulation have applications that extend beyond obeying rules. Participation in human culture often involves performing complex tasks, and effective performance can benefit from inhibiting other responses that might distract, compete, or disturb.

In modern life, one important category of performance involves taking tests. Students know that it is important to do well on tests and that poor performance can cause many setbacks and problems, from disappointing one's family to failing to achieve career goals. Unfortunately, the recognition of the importance of performing well and the motivation to do well on tests causes many students to struggle with fears and worries while taking tests. This so-called test anxiety distracts the mind and impairs the ability to concentrate on the test so as to perform effectively.

Thus, for students who suffer from test anxiety, successful performance may well depend on the ability to inhibit the distracting worries and other thoughts and feelings that interfere with an optimal test focus. Test anxiety can thus offer an opportunity to study the effects of ego depletion and the capacity to inhibit.

The role of ego depletion in test anxiety was studied by Bertrams et al. (in press). They cited numerous studies showing that students with test anxiety perform worse than other students — but also cited numerous studies showing no effect. In their experiments, ego depletion proved a potent moderator of both state and trait test anxiety. Depleted students at progressively higher levels of test anxiety performed progressively worse on the test than those at lower levels of anxiety. But among non-depleted participants, test anxiety had no effect, even seeming to hint at a slight increase, probably because the anxiety heightens arousal and alertness.

The implication is that effective inhibition facilitates positive performance. When willpower is at full strength, students can shut test anxiety out of their thoughts and prevent worries from interfering with focusing on the test. When one is ego depleted, however, worries intrude rather than being shut out, and the person stops focusing on the test. The participants in these studies reported just such struggles with intrusive thoughts, and the measured degree of such intrusions mediated the effects of anxiety and depletion on performance.

### ***Feelings, Inhibition, and the Subjective Side of Ego Depletion***

Given the widespread impact of ego depletion on behavior, it would seemingly be helpful for there to be some subjective signal that one is in that state. However, multiple efforts to identify a specific feeling that indicates ego depletion have failed. The meta-analysis by Hagger et al. (2010) found only two very weak changes in subjective states associated with ego depletion. Neither was significant in most studies that have measured them, but such tiny effects can become significant in meta-analysis thanks to the greatly enhanced statistical power that comes from aggregating large quantities of data from many studies.

The first is fatigue. Altogether, depleted people report being tired or fatigued slightly more often than non-depleted participants. This effect seemingly corroborates the muscle analogy, indicating that energy has been depleted from exertion. However, the significant finding could also arise because many people get inadequate sleep and normally must resist desires to rest and sleep (Hofmann, Baumeister, et al., 2012). So it is possible that ego depletion simply makes some people less able to suppress the feelings they already have, rather than that ego depletion causes fatigue. Thus, it is possible but not conclusively established that intentional inhibition causes fatigue.

The other finding was that depleted people reported a slight increase in overall negative affect. This finding also was too small to be significant in most research samples but emerged from combining many samples. It might suggest that ego depletion causes a slight increase in negative affect. However, that is questionable, because of what use would a signal be that normally cannot be noticed? More likely, the negative affect arises because some procedures for inducing ego depletion are mildly unpleasant. Or, as with fatigue, it may be that many people (even just some people) often suppress negative feelings, and these feelings are slightly more likely to register when willpower is depleted. Hence it seems possible but doubtful that intentional inhibition per se causes negative affect.

A series of studies by Vohs, Baumeister, Ramanan, Mead, Schmeichel, and Hofmann (2014/submitted) came to a quite different conclusion about the subjective marker of depletion. Instead of creating some specific feeling, depletion intensifies all manner of feelings. Their studies confirmed this. A broad assortment of positive and negative feelings was reported more strongly among depleted than non-depleted persons, in response to the same stimuli. Likewise, motivations and desires were reported more strongly by depleted than non-depleted persons. Sad movies were

sadder, puppies were cuter, unfamiliar Chinese or Arabic characters elicited more extreme aesthetic judgments, cold water was more painful, desire for a second and third cookie was stronger, and so forth, to depleted than to non-depleted participants.

An earlier investigation by Schmeichel, Harmon-Jones, and Harmon-Jones (2012) had found that depletion increased approach motivations. They proposed that approach and avoidance/inhibition were interrelated systems and that self-regulation was chiefly about inhibition and avoidance. Hence weakening avoidance motivations would strengthen approach motivations. The work by Vohs, Baumeister, Ramanan et al. (2014) replicated the increase in approach motivations — but found that avoidance manipulations also increased, rather than decreasing. (Schmeichel et al. had not measured effects on avoidance manipulations.) Thus, depletion intensifies a broad range of desires. They even revisited the experience sampling study data and found that people did in fact rate their current desires stronger to the extent that they had previously inhibited other desires that day.

The conclusion that depletion intensifies all manner of feelings has multiple implications for the study of intentional inhibition. One implication is that the effects of depletion on disinhibited behavior may have two causes, not just one. Not only are the restraints weakened, but the impulses are strengthened. The enhanced impulses felt during the depleted state would be extra difficult to inhibit, even if one's inhibitory resources and powers were at full strength.

A second implication invokes the task of explaining the intensification of feelings. The next section will discuss the idea of chronic inhibition and the question of why exactly inhibiting a response is depleting.

### ***Intentional Inhibition, and Other Kinds***

The focus of this special issue is on intentional inhibition. That raises the question of how intentional inhibition differs from other, unintended sorts of inhibition. Indeed, what is the alternative to intentional inhibition?

Unintended inhibition can be thought of in two ways. If we associate intentionality with conscious, deliberate effort, then its alternative would presumably be automatic, unconscious inhibition. Or, if we associate intentional inhibition with specific situations and recognized challenges, then its opposite could be chronic, general inhibition. Perhaps modern civilized adults routinely dampen most of their emotional and motivational responses. These are not wildly different: Most likely, chronic inhibition would overlap substantially with the automatic, unconscious sort. Still, the experience sampling research by Hofmann et al. (2012) found that people report resisting desires quite frequently, indeed probably for a total of several hours every day. Such frequent and routine resistance would qualify as chronic inhibition, but it was undoubtedly conscious — as indicated by the very fact that people were able to report on it. (Reportability is one common methodological sign that something is conscious.) Any unconscious inhibition would be in addition to that already frequent and extensive

inhibition, thus further underscoring the argument (made earlier in this manuscript) that inhibition is a pervasive part of enabling human beings to live together in civilized society.

The findings by Vohs, Baumeister, Ramanan, Mead, Schmeichel, and Hofmann (2014/submitted), indicating that a broad range of emotions and motivations are increased by depletion, are consistent with the notion of chronic inhibition. That is, people may normally learn to keep their urges and feelings in check. Indeed, the socialization process may involve instilling the chronic restraint that is the hallmark of decorum expected of adults. Part of the charm of children is that they express so many feelings clearly and exuberantly, but as they grow up, they learn to be more restrained. A recent study by Chaplin and Norton (2014 /in press) offered children of various ages a choice among various activities, including exuberantly expressive ones such as singing and dancing, and more circumspect ones such as drawing. The younger children favored the expressive activities and enjoyed them. The older children eschewed such public displays for more private activities, which brought less enjoyment.

Adults mostly restrain their emotional displays, and various pressures and contingencies increase the importance of restraint. When negotiating, it is self-defeating to reveal one's wishes and feelings too much. For example, a buyer who gushes that he "absolutely has to have" some item may end up paying more than someone who exudes only mild interest. Most adults must manage their money by restraining impulses to spend and buy. Many adults must restrain their appetites for food. Many pleasures must be limited given the dangers associated with heavy indulgence, such as alcohol, tobacco, sex (especially with multiple partners), and drugs. Selfish impulses are common and natural, but morality and other rules require that people inhibit these to some degree, especially insofar as selfishness is itself often regarded as an undesirable, antisocial trait.

Altogether, then, the accumulated evidence points toward the conclusion that modern human adults chronically inhibit a broad range of responses. Some of this inhibition is automatic and possibly unconscious, while the rest of it may involve explicit intention and conscious effort. Either way, frequent inhibition of one's desires and impulses may be part of the price one pays to be a member of society, and cultures everywhere enforce the importance of inhibiting one's impulses so as to obey the rules that enable the cultural system to function.

What depletes? The program of research summarized here has been guided by the widely accepted view that controlled processes involve effort whereas automatic ones are effortless (e.g., Bargh, 1994). On that basis, one would expect that the more automatic and unconscious forms of inhibition would not consume energy and would therefore not cause depletion. There is, however, a dearth of relevant evidence. To be sure, there has been extensive research on automaticity. However, most work has focused on the relatively straightforward pathway from an unconflicted automatic impulse (such as might be activated by a cue) to behavior or other response. It does seem likely that the automatic activation of behavior by a subtle, implicit, or unconscious cue does not require energy. It is nonetheless plausible, however, that an unconscious

or automatic act of inhibition would require energy. Overriding a prepotent response could be a difficult operation that requires energy.

There is not much relevant evidence. One study has examined whether people are depleted after automatic inhibition. Pu, Schmeichel, and Demaree (2010) showed that spontaneous, automatic suppression of emotional responses caused deficits in working memory, which is closely linked to self-regulation (e.g., Schmeichel, 2007). They concluded that any automatic overriding of a response is indeed depleting. Clearly, more research is needed, but for now that seems the best guess based on available evidence. (The evidence also includes the findings by Vohs, Baumeister, Ramanan, et al., 2014, that a broad range of responses is intensified during the depleted state.)

The implication is that intentional inhibition depletes energy not because it requires conscious effort but rather because of the existence of a prepotent response that must be suppressed. Put another way, inhibiting a prepotent response is inherently depleting. When people are depleted, both conscious and unconscious or automatic inhibition will be impaired.

To be sure, it is possible that consciously effortful inhibition is more depleting than automatic depletion. Automaticity may still conserve energy. Nonetheless, inhibiting may be inherently depleting, if it always or generally requires energy to stifle a prepotent impulse or feeling. Further research is needed, but that is the best guess based on current knowledge.

When the resources are low, even for reasons unrelated to self-regulation and decision-making, a broad variety of feelings and impulses may come to the fore. For example, the immune system consumes a substantial amount of energy when it is highly active, though at other times its needs may be slight. As a result, a person whose system is fighting an incipient illness may feel things more intensely and may act in impulsive or emotional ways that the person would normally resist.

As a revealing instance, a literature review by Gailliot, Hildebrandt, Eckel, and Baumeister (2010) linked premenstrual syndrome (PMS) to a reduction in general inhibition. During the luteal phase of the menstrual cycle, the female body uses more glucose than usual for its reproductive activities. Many women do eat a little more during this phase, but the increase in caloric intake is typically less than the amount the reproductive system takes, so even these women will have less glucose than usual available for other activities such as self-regulation and inhibition. PMS is characterized not by any specific behavior but rather an increased tendency to act on whatever impulses the woman may normally have and restrain. For example, PMS does not typically make women seek out new substances to abuse but rather heighten the women's consumption of what they normally prefer. Alcohol abusers drink more alcohol, cocaine users consume more cocaine, and the like. Alongside the increased impulsiveness is an increased emotionality, which does not seem to indicate that the PMS itself generates negative affect — rather, the PMS sufferer reacts more strongly than usual to a broad range of emotionally evocative behaviors.

The implication is that PMS arises because the reproductive functions take extra glucose, thereby starving regulatory functions of the energy they would normally have and use. The finding that desires and impulses are felt all the more intensely during ego depletion (Vohs, Baumeister, Ramanan, et al., 2014) would also fit into this view and compound the difficulty for the victim of PMS, whose illicit desires thus become stronger than usual. Both intentional and automatic or chronic inhibition may suffer as a result of ego depletion.

## Controversies and Alternative Views

The broad empirical success and widespread applications of the strength model of self-regulation have encouraged many other researchers to conduct relevant work, and some of these have suggested altering or refining the original theory — in some cases discarding it entirely. A detailed survey of these suggestions, complete with responses and theoretical revisions, has been undertaken by Baumeister and Vohs (2014/submitted). A brief summary of the main points is outlined here.

An alternative model of ego depletion was furnished by Beedie and Lane (2012), who proposed that self-regulation depends on allocating resources rather than diminishing them. As already noted, the emphasis on allocation seems largely correct and has been incorporated into the present theory. Selective allocation is however one sign that a precious resource is being depleted.

Inzlicht and Schmeichel (2012) proposed that no resource is depleted and that one can reinterpret findings in terms of psychology's conventional concepts of motivation and attention. In a nutshell, they argue that too much self-regulation is maladaptive and that after a period of self-regulating, the person's attention shifts to gratifying desires. Ego depletion effects result from a decline in motivation to continue self-regulating. Their theory has multiple problems. It fails to account for many of the phenomena of ego depletion, including the glucose findings. Its core assumption (that too much self-regulation can have negative effects) has been repeatedly discredited by previous work and continues to lack any evidence. Only about half a dozens studies have tested their core prediction that ego depletion reduces task motivation, and these have consistently found null results. Baumeister and Vohs (2014) conclude that some motivational and attentional shifts are still likely plausible as part of the ego depletion process, but their theory is woefully inadequate to replace the notion of resource depletion.

A radical attack by Job, Dweck, and Walton (2010) contended that ego depletion is "all in your head," which is to say a matter of false belief in limited willpower. They showed that encouraging participants to believe in unlimited willpower enabled them to perform well despite mild ego depletion. However, their findings fit the view that one can allocate more energy when mildly depleted if one believes the energy to be unlimited. Vohs, Baumeister, and Schmeichel (2013) replicated their findings with mild depletion but showed significant reversals with severe depletion (i.e., believing in unlimited willpower makes things worse in the long run — which presumably explains why most

cultures in the world have not adopted the view that willpower is unlimited.) Ainsworth et al. (2014) even showed that glucose allocations followed this pattern. That is, with mild depletion, belief in unlimited willpower led to an increase in blood glucose, but with severe depletion, it led to a reduction.

At present, then, the best summary is that the strength model requires some updating and overhaul to incorporate new findings, but the core assumption of depleting a limited energy resource cannot be jettisoned. Indeed it indeed remains the best way to account for the myriad findings.

## **Conclusion**

Inhibiting impulses, feelings, cognitions, and perhaps other responses is a pervasive human activity. Quite possibly it is one vital key to the biological success of humankind, given that survival and reproduction are accomplished with the aid of cultural systems, and inhibition is necessary for the optimal functioning of those systems. If humans generally were less adept at inhibition, there would be fewer of them (despite the gain in impulsive sex), because culture would not have produced the technological and other advances that facilitated and enriched human life.

Moreover, it appears that people do a great deal of inhibiting. Conscious restraint of desire happens often every day. There may be plenty of unconscious inhibition too, possibly even chronic patterns by which civilized adults restrain all their desires and emotions (at least public displays of them). The resulting chronic inhibition includes both consciously intentional and automatically unintentional inhibiting.

A person's capacity to inhibit has both state and trait aspects. People with high trait self-control outperform those with low self-control on a broad range of measures, and it seems causal (early self-control leads to later good performance, not the other way around as happened with self-esteem). Meanwhile, despite overall consistencies across time, each person's capacity to inhibit fluctuates over the course of the day, as it depletes its energy resources in responding to demands for intentional inhibition and other acts of self-regulation.

The ability to inhibit one's responses intentionally hardly seems like the sort of thing of which humankind should be exceptionally proud. Yet that capacity has likely been central to its biological success, as indicated by the contrast between the burgeoning human population and the steadily declining populations of most other mammals. As cultural animals, humans must conform their behaviors to system requirements, including moral and legal rules, as well as the guidelines of plans and work roles. Inhibiting feelings and desires that do not fit the program is a vital part of this. Inhibition is thus one meaningful key to understanding human nature.



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## Highlights

Inhibition is crucial for human social life. Both automatic and intentional forms are common.

Self-regulation depends on limited energy. Depleted willpower fosters disinhibited behavior.

Inhibition can facilitate performance, such as among test anxious students.

Desires feel stronger when willpower is depleted, suggesting that chronic inhibition is weakened.

Despite challenges and updates, the limited energy model of self-regulation remains the best fit.

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