

Ego depletion and aggressive behavior: Is the inhibition of aggression a limited resource?

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Abstract

If self-regulation is a limited resource, the capacity to inhibit aggressive behavior should be lower among people who have already exercised self-regulation. In Experiment 1, participants who had to resist the urge to eat tempting food later reacted more aggressively to an insult than other participants who were allowed to eat as much as they wanted. In Experiments 2 and 3, some participants had to self-regulate by making themselves concentrate on a boring film and stifling their physical and facial movements, and afterward they, too, responded more aggressively than controls. Experiment 3 also showed that the results were not due to differential moods and that one act of self-regulation (unrelated to aggression) was sufficient to enhance subsequent aggressive responses toward the experimenter. Copyright © 2006 John Wiley & Sons, Ltd.

Aggression constitutes a substantial social problem, and many people suffer because of the harmful acts of others. Systematic inquiries have revealed many causes of aggression, including frustration (Dollard, Doob, Miller, Mowrer, & Sears, 1939), negative affective states (Berkowitz, 1990), poverty (Hovland & Sears, 1940), alcohol intoxication (Bushman & Cooper, 1990), social rejection (Twenge, Baumeister, Tice, & Stucke, 2001), and media violence (Anderson & Bushman, 2002a; Geen, 1983). Attempts to trace violent, evil actions to their root causes have produced multiple answers, including inter-group hatred, idealism, and threatened egotism (Baumeister, 1997; Staub, 1996). Recently, Anderson and Bushman (2002b) postulated a theoretical framework integrating current approaches to explain several facets of human aggression.

Yet, focusing on the root causes of aggression does not tell the full story. Such inquiries reveal the sources of violent impulses—but it is also clear that many people experience violent impulses without acting on them. As Freud (1933) proposed, the civilized way of life is only made possible on the basis of each person having a set of inner, psychological controls that regulate behavior and prevent aggressive impulses from resulting in interpersonal violence. The proximal cause of aggression is,

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therefore, often a failure or breakdown of these inner restraints. Put another way, the same person might experience an essentially similar impulse to behave aggressively in two different situations; yet, the result may be quite different as a function of whether the inner restraints effectively stifle aggressive behavior. For present purposes, the important point is that human beings are able to live together in a civilized society because they learn generally to stifle most of their aggressive impulses.

Consistent with other patterns of self-regulation failure (Baumeister, Heatherton, & Tice, 1994), the present research was concerned with the release of aggression by means of the breakdown of internal restraints (for a general review about the breakdown of will and a theoretical integration of approaches from psychology, philosophy, microeconomics, and decision science, see Ainslie, 2001). Our studies were based on a model proposed by Muraven, Tice, and Baumeister (1998), and Baumeister, Bratlavsky, Muraven, and Tice (1998) that regards the human capacity for self-regulation as a limited resource, akin to energy or strength, that becomes depleted when it is used (for a review, see Baumeister, 2002; Baumeister & Heatherton, 1996; Heatherton & Baumeister, 1996; Vohs & Heatherton, 2000). Comparable to a tired muscle, a strength model would predict that performance at self-control would deteriorate during consecutive or continuous efforts (Muraven & Baumeister, 2000). In our studies, we exposed people to aggressive provocations after they had or had not already engaged in inhibiting impulses. If the capacity to restrain aggression is reduced following prior exercises in self-control, then people would respond more aggressively to the same provocation than they otherwise would have (i.e., when they had not recently expended resources by engaging in self-control).

The idea that acts of self-control draw upon and deplete a limited resource has emerged from recent studies, which referred to this process involving a person's self as 'ego depletion'. Thus, the term *ego depletion*¹ can be used to describe the condition of reduced resources of self-control following acts of self-regulation or other effortful acts of will. Muraven et al. (1998) and Baumeister et al. (1998) showed that when people had to engage in consecutive acts of self-control, like for example regulating one's emotional response to an upsetting movie, and then worked on unsolvable anagrams, their performance on the second act was impaired (as compared to people who had not done the first act of self-control). Other findings converge to suggest that the self's resources become depleted by acts of control and self-regulation. For example, Schmeichel, Vohs, and Baumeister (2003) found that the participants' intellectual performance had been impaired by preceding ego strength depleting tasks, though only thought processes required active regulation by the self, and thus not on automatic information processes such as rote memory. Finkel and Campbell (2001) applied the notion of ego strength depletion to conflicts in intimate relationships and investigated the influence of ego strength depletion on the response to a romantic partner's potentially destructive behavior. They showed that compared to a control condition without emotion suppression, participants who had to suppress their emotions during a film revealed a decreased willingness to respond constructively to negative partner behavior. Strength depletion has also been shown to lead to increased eating of ice cream by dieters (who normally would seek to avoid such high-calorie foods) but not by non-dieters, consistent with the view that ego strength depletion removes inner restraints.

On the basis of the previous research on ego depletion it can be hypothesized that self-regulatory failure might remove or disable inner restraints that would normally prevent the person from acting on aggressive impulses. We assumed that human beings, like most social animals, will have aggressive impulses stimulated by various conflict and threat situations, but that humans in particular will have been socialized to know that they should refrain from acting on most of these impulses. Self-regulation

¹A reviewer pointed out that the term 'Ego strength depletion' might be more apt, insofar as it is the strength rather than the ego itself that is depleted. We have followed this usage generally here. We do not mean to invoke the separate literature on ego strength nor distance ourselves from the slowly expanding pool of researchers using the term 'ego depletion'. When we first coined the term, it was not clear that strength was the proper metaphor, but in the intervening years evidence has accumulated that the resource does resemble a strength, and so we are now comfortable with the idea of ego strength depletion.

would ordinarily help people refrain from aggressive acts, but when the capacity for self-regulation has been weakened by strength depletion, the aggressive impulses will more easily find expression. We conducted three experiments to address this issue.

THE PRESENT RESEARCH

The present work was designed to test the hypothesis that acts of self-control would lead to subsequent increases in aggressive behavior, presumably because the initial acts deplete the self's capacity for restraining its aggressive impulses. Experiment 1 had people restrain their impulses to eat tempting, delicious snacks. Experiments 2 and 3 required participants to stifle their emotional and physical reactions to an evocative film excerpt. Control participants were exposed to the same stimuli but were not instructed to inhibit their reactions. Both groups of participants were then insulted by the experimenter, and their aggressive responses toward the experimenter were measured. We assumed that insults would stimulate aggressive impulses, as they have throughout the history of laboratory research on aggression, and that people's ability to restrain these impulses would vary as a function of ego strength depletion.

We predicted that participants who resisted the tempting food (Experiment 1) or stifled their physical and emotional reactions (Experiments 2 and 3) would be in a state of ego strength depletion, and therefore they would be less able to overcome their angry reactions toward the experimenter than would people in the control condition. As our measure of aggression, we had people deliver evaluative ratings of the experimenter to his/her academic department.

EXPERIMENT 1

The first experiment investigated the influence of ego strength depletion on aggressive behavior by examining participants' ability to inhibit aggression following an act of provocation. Adapted from Baumeister et al. (1998), and Vohs and Heatherton (2000), ego strength depletion was manipulated by requiring people to resist tempting food, while the experimenter told the participant either to eat as much as desired or to refrain from eating anything. The latter condition would presumably require the inhibition of the impulse to eat, and this act of self-control should deplete the self's resources. Therefore, the capacity to inhibit aggression after a provocation should be limited and result in enhanced aggression. Participants in the control condition were also insulted but did not have to resist the temptation to eat.

We expected participants in the ego strength depletion condition to react more aggressively after the provocation than participants in the control condition. Thus, participants in the ego strength depletion condition should evaluate the experimenter, who had insulted them before, more negatively than participants in the control condition.

Method

Participants and Procedure

Participants were 29 male and 31 female undergraduate psychology students from the University of Giessen (mean age = 21.91 years) who received credit hours in exchange for their voluntary

participation. Thirty participants were randomly assigned to the ego strength depletion condition (19 women, 11 men), and the other 30 participants to the control condition (12 women, 18 men). They participated individually in a 30-minute session. The proportion of males was thus not equal in the two studies, which sometimes happens as a result of random assignment, but insofar as men are normally more aggressive than women, the greater proportion of men in the control condition worked against the hypothesis.

Participants signed up for a study on the effect of hunger on creativity, and were requested not to eat anything for at least 3 hours before the experiment. After the experimenter had provided an overview of the procedures, participants were instructed to work on an alleged creativity task. Participants were asked to read a short, open-ended fable and invent the last sentences for the story which should consist of one to three creative sentences. Before each participant began the task, the experimenter put a big plate with delicious-looking, aromatic cookies, cake and chocolates on the table in front of the participant. Participants in the *ego strength depletion condition* were given the following written instructions:

You were instructed not to eat anything for at least 3 hours before the experiment because this study examines whether hunger enhances creativity. Now you will have to do a creativity task. Former studies have shown that hungry people perform much better on this task than people who have eaten their fill. Thus, if you want to attain good results you should not eat while working on the task. The plate was only put on the table in case you feel sick because of your hunger and you cannot stand it anymore. So, feel free to help yourself to the cookies, but also think of your results on the creativity task!

Participants in the *control condition* were only told that they should feel free to eat as much as they liked while working on the creativity task. To make sure that participants followed the instructions, the experimenter counted the food on the plate before and after the creativity task. While the participants were working on the task, the experimenter left the room. Then, the experimenter re-entered the room, looked at the fable's ending written by the participant and commented on it by saying: 'And it took you so much time to write such a boring ending!' Participants were then asked to complete an evaluation form to judge the experimenter. They enclosed the form in an envelope, brought it to the secretary of the psychology department, and were then fully debriefed and thanked for their participation.

Dependent Measure

Aggression To measure aggression, we relied on a technique that has been widely used in previous work, namely, having the participant make an evaluation of the experimenter. Such evaluations can damage a person's occupational prospects; consequently, they are regarded as just as aggressive as inflicting physical harm (for a review on the external validity of laboratory aggression, see Anderson & Bushman, 1997). Similar job-relevant evaluations have been used to measure aggression in many previous studies (e.g. Berkowitz, 1970; Kulik & Brown, 1979; Ohbuchi, Kameda, & Agarie, 1989; O'Neal & Taylor, 1989; Stucke & Sporer, 2002; Zillmann & Cantor, 1976; for a review, see Baron & Richardson, 1994, pp. 64–66). Each participant judged the experimenter by answering the following items 'The experimenter seemed to be capable and competent', 'The experimenter was friendly and likable', and 'The experimenter is doing a good job within his internship' on a 9-point scale (1 = *completely disagree*, 9 = *completely agree*). Prior to the evaluation, participants were told that their judgment would influence the future funding of the scientific project and the report on the internship of the experimenter. Therefore, a negative judgment could be expected to have negative or even harmful consequences, which corresponds to Baron and Richardson's (1994) widely accepted

Table 1. Analyses of variance for the evaluation of the experimenter in experiments 1–3

	Ego depletion		Control condition		<i>df</i>	<i>F</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Experiment 1	4.06	2.38	5.97	2.37	1,58	9.70**	0.82
Experiment 2	6.02	1.67	6.87	1.19	1,60	5.32*	0.60
Experiment 3	4.16	1.91	5.62	1.29	1,43	15.55***	1.20

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

definition of aggression. The average score for the evaluation of the experimenter was 5.01 ($SD = 2.55$, $\alpha = 0.98$).

Results

All participants followed the instructions, insofar as none of the participants in the ego strength depletion condition ate any of the snacks, whereas participants in the control condition ate between 1 and 2 pieces from the plate ($M = 1.60$, $SD = 0.50$).

Aggression

A one-way ANOVA with the experimental condition (ego depletion *v* control condition) as independent variable and the evaluation of the experimenter as dependent variable revealed a significant difference between the experimental conditions. As can be derived from Table 1, participants in the ego strength depletion condition (food control) judged the experimenter more negatively than participants in the control condition (no food control).

Additional Analyses

Gender Because gender differences in aggressive behavior have often been reported (see Baron & Richardson, 1994), an ANOVA with gender as additional factor was conducted. Female and male participants did not differ in their level of aggression, that is, in their evaluation of the experimenter, $F(1, 56) = 0.00$, $p = 0.953$. More important, no significant interaction emerged between participants' gender and the experimental condition, $F(1, 56) = 0.63$, $p = 0.430$. Also, gender did not change the results when included as a covariate.

Discussion

The results of Experiment 1 provided initial support for the regulation of aggressive feelings as a limited resource. Resisting temptation seems to have reduced the capacity to inhibit aggressive impulses so that, as expected, participants in the ego strength depletion condition expressed more aggression against the experimenter than participants in the control condition. The negative evaluation of the experimenter following a depleting act suggests that the resource for inhibiting aggressive impulses is limited and can be impaired by unrelated acts of self-control like resisting tempting food.

An alternative view, however, might suggest that participants in the ego strength depletion condition were frustrated by the fact that tempting food was placed on their table but they were instructed not to eat anything, and this frustration could have caused the following aggression (see Dollard et al., 1939). However, former studies have shown that creating a state of ego depletion by asking participants to refrain from food did not result in decreased mood (Baumeister et al., 1998; Vohs & Heatherton, 2000). Also, this alternative explanation is somewhat inconsistent with the way the procedure was administered. Similar to the control condition, participants in the ego strength depletion condition were actually told that they should feel free to help themselves to the food, but they received the additional information that their chances of success in the creativity task would be higher if they remained hungry. Thus, they were not frustrated by a prohibition to eat, insofar as they could decide for themselves whether to eat or not, and their restraint reflected their own personal choice, presumably born of their desire to perform well.

Possibly frustration could have emerged in a different way, however. The experimenter did not prohibit participants in the depletion condition from eating, but the experimenter did suggest that refraining from eating would help the participant perform better on the creativity test. Later, of course, the experimenter insulted the participant's performance on that task, possibly thereby suggesting that whatever self-restraint was exercised to refrain from eating had been in vain. The procedures for Experiments 2 and 3 were designed to avoid such interpretive questions.

EXPERIMENT 2

The aim of the second experiment was to replicate the findings of Experiment 1 with a different experimental operationalization of ego strength depletion. Instead of requiring self-control in the form of resisting the temptation to eat, participants in the ego strength depletion condition were instructed to concentrate on controlling their body movements and facial expressions while watching a film (see Gross & Levenson, 1997; Vohs & Heatherton, 2000). As the content of the film was supposed to be extremely boring, we assumed that self-regulation would be needed to concentrate on the film and watch it without any expressions of boredom (e.g. yawning). As in the first study, participants were insulted after the depleting task, and the evaluation of the experimenter was used as dependent measure of aggression. We predicted that participants in the ego strength depletion condition would evaluate the person who insulted them more negatively than participants in the control condition.

Method

Participants and Procedure

Sixteen male and 47 female undergraduate psychology students of the University of Giessen (mean age = 23.18 years) signed up for a study on 'the influence of watching television on creativity' in partial fulfillment of a departmental requirement. They participated individually in a 45-minute session. Thirty-one participants were randomly assigned to the ego strength depletion condition (23 women, nine men), and the other 32 participants were in the control condition (24 women, seven men).

The experimenter explained that they would do a creativity test before and after watching a film sequence: Prior to watching the film, participants were asked to write a story about two people

depicted on a picture. The next task was to find as many alternative uses for a hammer as possible. Participants were then instructed to watch the film. In the *ego strength depletion condition*, participants were instructed to sit still, concentrate on the film, and not show any body movements, emotions, or facial expressions during the film. Participants in the *control condition* were simply asked to watch the film and sit as comfortably as possible. The experimenter explained that all participants would be videotaped while watching the film to verify whether they were following the instructions. Following these instructions, the experimenter left the room and each participant saw a 10-minute videotape showing a very boring lecture about the human brain. In order to control whether the participants really considered the film boring, they were asked to judge the film on the dimensions *aggressive*, *boring*, and *sad* on a 9-point scale ($1 = \text{not at all}$, $9 = \text{very much}$). Participants were then asked to write another short story about two people in a picture, allegedly to measure their creativity after the film. Afterwards, all participants were provoked by receiving negative performance feedback on the first story they had written prior to the film. They were given an evaluation form on which the experimenter had judged their creativity on a 5-point scale ($1 = \text{very bad}$, $5 = \text{very good}$). All participants received negative feedback (2.0 on the 5-point scale). Last, the participants were asked to evaluate the experimenter, and they were then carefully debriefed and dismissed.

Dependent Measures

Aggression Participants' aggression was measured by the same items to evaluate the experimenter, as described in Experiment 1 ($M = 6.45$, $SD = 1.50$, $\alpha = 0.84$).

Results

Prior to data analysis, one score was computed for the evaluation of the experimenter. We conducted an ANOVA with the experimental condition (ego strength depletion v control condition) as the independent variable and the evaluation of the experimenter as dependent variable.

Manipulation Check

Evaluation of the Film As expected, participants judged the film sequence as very boring ($M = 5.84$, $SD = 2.75$) but not aggressive ($M = 1.69$, $SD = 1.83$) or sad ($M = 1.61$, $SD = 1.68$). No differences emerged as a function of experimental condition ($F(1, 63) < 1$, *ns*).

Aggression

In accordance with our expectations, participants in the ego strength depletion condition evaluated the experimenter significantly more negatively than participants in the control condition (Table 1).

Additional Analyses

Gender Female and male participants did not differ in their evaluation of the experimenter, $F(1, 60) = 0.16$, $p = 0.692$. Also, the computed interaction of participants' gender and the experimental condition was non-significant ($F(1, 58) = 2.25$, $p = 0.139$). As in Experiment 1, participants' gender did not change the results when included as a covariate.

Discussion

The results of Experiment 2 replicated the findings of Experiment 1 and supported our assumptions concerning the influence of ego strength depletion on aggressive behavior. An act of self-regulation (concentrating on a boring film while controlling one's body movements and facial expressions) seemed to deplete the capacity to regulate one's aggressive impulses as stimulated by an insult from the experimenter, resulting in a negative evaluation of the experimenter.

EXPERIMENT 3

Experiment 3 sought to provide another replication of the relation between ego strength depletion and aggressive reactions. Thus, we used the same movement control manipulation as in Experiment 2, and then we measured participants' evaluation of the experimenter after having been provoked.

Several features of the procedure were revised from the preceding studies in order to rule out potential confounds and ambiguities. It seemed plausible that the ego strength depletion conditions in Experiments 1 and 2 might have created bad moods that could have contributed to the aggressive responding. Although previous research has shown that different manipulations of ego strength depletion did not have any impact on mood (e.g. Baumeister et al., 1998; Muraven et al., 1998; Vohs & Heatherton, 2000), we wanted to investigate this possibility, and therefore we added a measure of mood prior to the aggression measure.

Additionally, Experiment 3 included an extended manipulation check compared to Experiment 2. Because an act of self-regulation is assumed to be tiresome and effortful, we followed a procedure described by Baumeister et al. (1998) and Muraven et al. (1998) and asked the participants to judge their fatigue and effort after watching the film.

In sum, we predicted that participants in the ego strength depletion condition would evaluate the experimenter more negatively than participants in the control condition. We further predicted that participants in the two experimental conditions would not differ concerning their mood after watching the film. However, the greater requirement of self-regulation while watching the film should cause participants in the ego strength depletion condition to have to expend more effort than participants in the control condition, so that they were expected to report more effort and fatigue.

Method

Participants and Procedure

Thirty-five female and 10 male psychology students from the University of Giessen (mean age = 22.78 years) participated in return for partial fulfillment of a course requirement. Twenty-three participants were randomly assigned to the ego strength depletion condition (16 women, seven men), and 22 were assigned to the control condition (19 women, three men). Participants were individually tested in one 30-minute session and were told that the study would investigate the relationship between watching television and creativity.

The procedure was almost the same as in Experiment 2. Additionally, participants' mood and effort were measured by asking them right after the film whether they felt *sad*, *angry*, *happy*, and *frustrated*, and whether they found it *tiresome* and *effortful* to follow the instructions on a 9-point scale (1 = *not at all*, 9 = *very much*).

Dependent Measures

Participants' aggression was measured by the same items to evaluate the experimenter, as described in Experiments 1 and 2 ($M = 4.87$, $SD = 1.78$, $\alpha = 0.98$).

Results

Manipulation Checks

Evaluation of the Film As expected, most participants judged the film to be boring ($M = 5.27$, $SD = 2.83$) but not aggressive ($M = 1.82$, $SD = 1.47$) or sad ($M = 1.16$, $SD = 0.47$). There was no difference between the two experimental conditions in judging the film as boring, $F(1, 43) = 1.66$, *ns*.

Effort An ANOVA with the experimental condition as the independent variable and effort as dependent variable yielded a significant difference between participants in the ego strength depletion condition and participants in the control condition, $F(1, 43) = 40.41$, $p < 0.001$. Participants in the ego strength depletion condition reported having exerted more effort to watch the film under the given instructions than participants in the control condition, $M = 6.70$ ($SD = 2.68$) *v* $M = 3.55$ ($SD = 1.53$).

Aggression

An ANOVA with the experimental condition as the independent variable and the evaluation of the experimenter as the dependent variable revealed a significant difference between the experimental conditions. As can be seen in Table 1, participants in the ego strength depletion condition judged the experimenter significantly more negatively than did participants in the control condition.

Additional Analyses

Mood The adjectives measuring mood were recoded if necessary, and then summed into one variable representing 'positive mood' ($M = 6.64$, $SD = 1.57$, $\alpha = 0.69$). The adjectives 'effortful' and 'tiresome' were also summed into one variable ($M = 3.70$, $SD = 2.64$, $\alpha = 0.99$).

After conducting a median split for the variable *positive mood*, an ANOVA with experimental condition (ego strength depletion condition *v* control condition) and positive mood (high *v* low) as independent variables, and the evaluation of the experimenter as dependent variable was employed. Participants with high and low positive mood did not differ with respect to their evaluation of the experimenter, $F(1, 43) = 0.23$, $p = 0.631$, and, as expected, the interaction of mood and experimental condition did not reach significance, $F(1, 41) = 1.19$, $p = 0.282$. In a next step, in an ANOVA with experimental condition as independent and the evaluation of the experimenter as dependent variable, *positive mood* was included as a covariate but the results remained significant, $F(2, 42) = 15.95$, $p < 0.001$, $\eta^2 = 0.28$.

We were particularly interested in the possibility that the depletion condition might have given rise to anger or frustration that could have mediated the effect of that manipulation on evaluation of the experimenter (the aggression measure). Analyses using those single items clearly refuted that possibility. First, participants in the depletion condition reported nonsignificantly lower levels of anger and frustration than participants in the control condition (whereas mediation would have assumed significantly higher levels). Second, the correlations between the dependent variable and

anger ($r = 0.00$) and frustration ($r = 0.01$) were not only not significant but so low as to preclude any hint of a relationship.

Gender Female and male participants did not differ in their evaluation of the experimenter, $F(1, 44) = 0.70$, $p = 0.408$. Also, the interaction between gender and experimental condition was not significant, $F(3, 44) = 0.20$, $p = 0.659$. Furthermore, participants' gender did not change the results when included as a covariate.

Discussion

The results of Experiment 3 provide further support for the hypothesized relation between ego strength depletion and the decreased capacity to inhibit aggressive behavior. Again, participants in the ego strength depletion condition judged the experimenter more negatively than participants in the control condition. Again, one single act of self-regulation unrelated to aggression seemed to be sufficient to release an aggressive response following provocation.

In accordance with their strength model of self-regulation, the self-report measure of effort revealed a significant difference between participants in the ego depletion condition and participants in the control condition, suggesting that people found it more tiresome and effortful to control themselves, as opposed to merely watching the film. An additional analysis revealed that when effort was included as a covariate, the differences between the experimental conditions regarding the evaluation of the experimenter were smaller and less significant. In accordance with prior expectations, it can therefore be concluded that the effort caused by the self-regulation task affected the evaluation of the experimenter. This can be interpreted as an indicator for a state of ego strength depletion, which, together with the provocation, could have been responsible for the aggression against the experimenter.

Also, Experiment 3 ruled out the alternative explanation that the negative evaluation of the experimenter was caused by a more negative mood in the ego strength depletion condition because no differences emerged between the two experimental conditions concerning participants' mood after the film. Treating mood as an independent variable did not yield a significant interaction with experimental condition. Using mood as a covariate did not reduce the significance of the depletion manipulation. Further analyses focusing on anger and frustration confirmed that these did not mediate between the depletion manipulation and the evaluation of the experimenter (indeed, the relationships were either near zero or nonsignificantly in the wrong direction to support a mediation hypothesis). Thus, any difference in aggression between the two experimental conditions was not due to differences in emotional state.

In sum, concentrating on a very boring film and controlling one's movements and facial expressions seem to have produced a psychic cost, in the sense that afterwards participants were less able to inhibit their aggressive impulses against the experimenter who had provoked them. In contrast to that, participants who had merely watched the film without any further instructions seemed to have enough resources for self-regulation to control their anger after the experimenter's insult, and consequently did not react as aggressively as participants who experienced ego strength depletion.

GENERAL DISCUSSION

Our experiments are consistent with the hypothesis that the ability to inhibit aggressive behavior is a limited resource that can be depleted by acts of self-regulation. Consistent with other patterns of

self-regulation failure (see Baumeister et al., 1994), at least some acts of aggression or violence might be caused by the depleted capacity to inhibit this socially undesirable behavior. In all three experiments, participants who had performed acts of self-regulation were subsequently more aggressive toward the experimenter in response to an insulting remark.

In Experiment 1, the self-regulating task involved resisting the temptation to eat tasty snack food. In Experiments 2 and 3, it involved making oneself sit motionless and expressionless while watching a boring film. These tasks were designed to deplete the participant's capacity for self-regulation, thereby creating a greater willingness to give in to aggressive impulses. To create these impulses, the experimenter made a critical, insulting comment to the participant. The participant then had the opportunity to retaliate by giving a negative, potentially damaging evaluation of the experimenter to the department office. As predicted, people gave the experimenter more negative evaluations when they were depleted than when they were not.

The main contribution of this work is to extend the pattern of ego depletion to show its relevance to aggression. Previous work has shown that ego depletion can lead to decreased self-control and increased impulsive behavior in a variety of settings (e.g. Baumeister, 2002; Vohs & Heatherton, 2000). Whether aggression is increased among people who have depleted their self-regulatory resources remained a matter of speculation, however. Given the extensive social psychology literature on aggression and the social importance of restraining it, it seemed essential to test directly whether ego depletion would increase aggression, as it has in these studies.

The possibility of mediation by mood was examined explicitly in Experiment 3. We did not find, however, that depleted participants reported a more negative mood than controls, and participants' mood did not interact with experimental conditions with respect to the evaluation of the experimenter. Thus, our depletion manipulation did not apparently have any systematic effect on the often aggression-relevant aspect of mood, and neither mood alone, nor mood in interaction with the experimental condition, did affect the evaluation of the experimenter. Instead, the only differences we found between depleted participants and controls involved feelings of having expended effort and being tired. Comparable results have been reported before (e.g. Baumeister et al., 1998; Muraven et al., 1998) and are most consistent with the depletion hypothesis, for they suggest that what sets the depleted condition apart was the effortful regulation of self and the resulting depletion of inner resources.

Some limiting aspects of our studies should be mentioned. Most important, it is difficult to rule out the alternative explanation that some or all of the aggression toward the experimenter stemmed from resentment or other negative feelings caused directly by the ego strength depletion manipulation, and thus not just from the insult. In the depleting conditions, the experimenter requested the participant not to eat tempting foods (though the experimenter did not actually forbid the participant from eating), or the experimenter put constraints on the participant's behavior during the video. Participants in the control condition may have felt more positively toward the experimenter for permitting them to eat and/or for allowing the participant to watch the movie without the distraction or imposition of further constraints (though they did not feel more positive in general, as indicated by our mood measures). Unfortunately none of the present experiments contained a no-insult, no-provocation control condition, which might have permitted an appraisal of whether the depletion manipulation alone could increase aggression. Future work should include such conditions. A measure of resentment toward the experimenter might have been useful. We did however have measures of anger and frustration in Experiment 3, and these did not mediate the aggressive reactions, which provides some encouragement to the conclusion that the increased aggression in the depletion condition was actually due to lowered self-regulation rather than heightened anger or frustration.

If the increase in aggression was indeed directly caused by the depletion manipulation, this would itself be an interesting extension of previous work. The experimenter did not overtly frustrate the participants by forbidding them to eat tempting foods or forcing them to stifle their responses. Indeed,

in Experiment 1, the experimenter presented the food as an act of kindness, merely requesting the participant to try to refrain from eating for the sake of the experiment (and in the service of performing well in the creativity test). In essence, the experimenter encouraged participants to frustrate themselves, and they complied. It would hardly be news if people behaved aggressively toward an external agent who frustrated them, but it would be striking if aggression can be caused by people frustrating themselves willingly and then blaming their frustration on an outside person who had made the request.

Taken together, our findings suggest that aggressive behavior may often be restrained, but when people's capacity for restraining their impulses has been weakened, aggression may rise. In accordance with our findings, Tice, Bratslavsky, and Baumeister (2001) demonstrated in a series of studies, that in the case of weakened impulse control during emotional distress, people might use immediate impulsive behavior as a means of affect regulation, which in this situation has priority over other (long-term) self-regulatory goals. Criminologists have begun to look at self-control and self-regulation as important defenses against criminal aggression (see Gottfredson & Hirschi, 1990). Although their work has emphasized chronic, dispositional deficits in self-control as central causes of violent, criminal behavior, our findings suggest that temporary, acute deficits may also play a role in releasing aggressive impulses.

There is one important positive implication of this work for society at large. Many of the root causes of aggression, such as poverty, frustration, and genetic predispositions, may be difficult to change, and in that respect the societal goal of reducing aggression seems elusive. The present results suggest, however, that many normal and natural aggressive impulses can be restrained, at least when people are in full possession of their self-regulatory resources. If we can learn to help people maintain or strengthen their capacity for self-regulation, this might enable them to reduce their aggression.

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Tanja Stucke died abruptly and unexpectedly from a lung embolism while this paper was under review. She was 32. The second author and all her friends and colleagues in Germany and in the international scientific community were shocked and saddened by the loss of this bright, promising young woman, both for personal reasons and over the loss to the field of an energetic and talented researcher. Some issues arising in the review process could not be fully addressed because of this tragedy. In others, the second author's efforts were aided by her mentor in Giessen, Siegfried L. Sporer, who with permission of Tanja's parents had access to many of her papers and files and ran some additional analyses. We regret that this article will be the nearly final contribution of Dr Stucke's career, which we all hoped would be long and productive. We will miss you, Tanja.

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