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EGO–DEPLETION AND PREJUDICE: SEPARATING AUTOMATIC AND CONTROLLED COMPONENTS

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This study investigated the effect of ego–depletion on the automatic and controlled components of stereotype–based responses. Participants engaged in a depleting task for either a short or a long period of time. They then performed a weapon identification task, which served as a measure of race stereotyping. Analyses guided by the L.L. Jacoby's (1991) process dissociation procedure indicated that ego–depletion reduced the controlled component of responses, but did not affect the automatic component. Further, ego–depletion increased stereotypical responses only among those participants who showed strong automatic stereotype activation. The discussion focuses on methodologically and theoretically integrating notions of self–control and cognitive control.

Having resisted a mouthwatering chocolate cake, are we more likely to act as if a woman is the secretary rather than the boss? As if an Arabic airplane passenger is a terrorist? Or as if a Black man is a criminal? Recent research on self–control suggests that these counterintuitive possibilities should not be dismissed (e.g., Gordijn, Hindriks, Koomen, Dijksterhuis, & Van Knippenberg, 2004; Richeson & Shelton, 2003). Suppressing an urge to eat and

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controlling the influence of stereotypes might be related because both may rely on a single domain–general, limited–strength resource on which people draw for self–regulation. Thus, having resisted one impulse, a person may be less able to resist the other (Muraven & Baumeister, 2000). The purpose of this article is to explore the link between limited–strength self–control resources and the use versus disuse of social stereotypes. The link between self–control strength and stereotyping is important on theoretical and applied grounds, because stereotypes may be activated automatically, at least for some people, leading to discriminatory behavior (cf. Devine, 1989; Lepore & Brown, 1997). Clarifying the strengths and limitations of control processes involved in inhibiting automatic impulses sheds light on how people regulate (or fail to regulate) important social biases.

LIMITATIONS OF SELF–REGULATION

Research on self–control strength (Muraven & Baumeister, 2000) suggests that diverse acts of self–regulation draw on a single capacity that becomes progressively exhausted with each use. Therefore, after a person has relied on self–control in one domain (such as resisting chocolate, suppressing thoughts or emotions, or sustaining muscular pressure on a hand grip), he or she will be less capable of exerting self–control in a different domain (such as persisting on unsolvable puzzles, forcing oneself to drink an unpleasant beverage, or solving complex problems; Muraven, Tice, & Baumeister, 1998; Schmeichel, Vohs, & Baumeister, 2003). When explaining the concept of limited strength, self–control theorists often invite an analogy with a muscle: similar to a muscle that gets fatigued with each movement and cannot be exercised again until it rests, self–control needs replenishment before it can be dispensed again. The purpose for which that resource is expended may not matter much.

The dynamics of self–control have implications for the important social domain of stereotyping. Will people behave in a more prejudiced manner after having depleted their capacity for self–control? The self–regulation framework of Baumeister and colleagues suggests that depletion will selectively interfere with processes that require intentional control and cognitive resources (Muraven & Baumeister, 2000). We propose that to fully understand the effect of self–control expenditure on stereotyping, it is necessary to distinguish between automatic and controlled components of stereotyping behavior.

A COMPONENT PROCESS APPROACH

Recent work on stereotyping shows that automatic and controlled components of stereotyping behavior can operate independently of each other, both jointly contributing to discriminatory behavior. For example, Payne (2001) used a process dissociation approach, as described below, to separate automatic stereotype activation from the ability to exert control over responses. That research demonstrated that factors reducing processing resources, such as time pressure, affected control over responses without influencing automatic stereotype activation. In contrast, racial primes affected automatic stereotyping without changing control. This model has been validated in a number of studies (e.g., Payne, *in press*; Payne, Lambert, & Jacoby, 2002).

According to the independent–processes hypothesis, a past expenditure of self–control should make it more difficult to block the influence of stereotypes, but it should not affect automatic activation of stereotypes. Therefore, a person for whom stereotypes are not automatically activated is unlikely to behave with prejudice, whether depleted or not. In contrast, a person for whom stereotypes are automatically activated is more likely to display prejudice and engage in discriminatory behavior in a depleted state than in a non–depleted state. This difference should be mediated by reductions in the ability to exert control over responses.

To test this hypothesis, it is critical to empirically distinguish between automatic and controlled components of stereotyping. We used the process dissociation procedure (PDP; Jacoby, 1991) to tease apart the contributions of each. The process dissociation procedure is a technique developed in the context of memory research to separate consciously controlled (i.e., explicit) uses of memory from unconscious (i.e., implicit) uses of memory. Payne

(2001) has adapted the PDP to the study of race bias in judgments, as will be described presently.

PROCESS–DISSOCIATION AND THE WEAPON IDENTIFICATION TASK

In this procedure, participants see images of different hand guns and hand tools and identify each object. The images are preceded by brief but visible presentations of Black or White faces. The typical finding with this task is that participants tend to misidentify harmless objects as weapons when they are paired with Black primes. This stereotyping effect only emerges when participants respond quickly, and hence their processing capacity is somewhat limited. The race bias in weapon identification has proven robust, and has been replicated in several different laboratories using several different methods (Correll, Park, Judd, & Wittenbrink, 2002; Greenwald, Oakes, & Hoffman, 2003; Lambert et al., 2003). The weapon identification bias is of particular interest because of its potential relevance for the weighty split–second decisions that police officers must make. The well–publicized shooting deaths of Amadou Diallo in New York (McFadden & Roane, 1999) and Timothy Thomas in Cincinnati (Clines, 2001) illustrate the high cost of errors in such situations. Moreover, performance on the task correlates with other relevant behaviors, such as forming race–biased impressions of other people (Payne, in press; Lambert, Payne, Ramsey, & Shaffer, 2005).

The weapon identification procedure provides a means of measuring the impact of stereotypes on behavior, as well as a format for using process dissociation to separate automatic and controlled contributions. In this paradigm, White–tool and Black–gun pairings represent stereotype–congruent trials, whereas White–gun and Black–tool pairings represent stereotype–incongruent trials. On congruent trials, responding based on automatic stereotypic associations or responding based on objective information leads to the same answer. For example, participants may correctly identify an object as a gun when it was preceded by a Black face either because they associate Blacks with guns, or because they are able to correctly respond to the object as a gun. On incongruent trials, on the other hand, responses based on automatic and controlled processes oppose each other. For example, when participants see a tool preceded by a Black face, they should respond "tool" but the automatic bias is likely to make them choose "gun."

In the above task, performance in the congruent and incongruent conditions provides a means for estimating the joint influences of intentionally controlled and automatic (unintentional) processes contributing to performance. The control parameter (C) reflects the ability to respond as intended, avoiding the influence of race. The automatic bias parameter (A) reflects an automatic association of Blacks with guns. Correct responses on congruent trials (true "gun" responses with Black primes and true "tool" responses with White primes) can result from either an intentionally controlled response, or from an unintended race bias. Therefore the probability of a correct response on a congruent trial is the sum of the probability of control, C, and the probability of relying on stereotypic associations in the absence of control, A(1–C):

$$P\,(\text{Correct} \mid \text{Congruent}) = C + A\,(1–C).\ (1)$$

The probability of incorrect responses on incongruent trials (false "gun" responses with Black primes and false "tool" responses with White primes) is determined by the automatic bias A when control fails, (1–C):

$$P\,(\text{Incorrect} \mid \text{Incongruent}) = A\,(1–C)\ (2)$$

From these two equations, automatic and controlled components can be estimated separately if one assumes that A and C are independent and represent the same process in congruent and incongruent trials:

$$C = P\,(\text{Correct} \mid \text{Congruent}) – P\,(\text{Incorrect} \mid \text{Incongruent})\ (3)$$

Given this estimate of control, we can then solve for the estimate of automatic bias:

$$A = P\,(\text{Incorrect} \mid \text{Incongruent}) \,/\, (1–C)\ (4)$$

Recent studies provide evidence that the control parameter reflects executive control processes, whereas the automatic bias parameter reflects automatic stereotype activation. For example, the control estimate was reduced when participants were required to respond quickly (Payne, 2001) or when participants felt anxiety about an upcoming interaction (Lambert et al., 2003). In addition, the control estimate was found to correlate with performance on the antisaccade task, a measure of attentional control that is related to executive control abilities (Payne, *in press*). Finally, a recent study found that the control estimate correlated with electrophysiological activity (ERP's) in the anterior cingulate cortex, a brain region important in signaling the need for executive control (Amodio et al., 2004). The automatic bias estimate was affected by the race of the prime, and was positively correlated with explicit racial attitudes for individuals unmotivated to control prejudice (Payne, 2001). This pattern suggests that individuals with more negative racial attitudes may have stronger automatic biases, but that only those low in motivation to avoid prejudice are willing to report their attitudes on an explicit scale (see Fazio et al., 1995, for a similar pattern). Furthermore, the automatic estimate was not reduced by an explicit warning to avoid being influenced by race stereotypes (in fact, it was magnified; Payne, Lambert, & Jacoby, 2002). These studies indicate that the process estimates derived from the process dissociation analysis are valid measures of intentional control processes and automatic stereotype bias, respectively. In the present study we apply this methodology to ask how self–regulation depletion influences the use of stereotypes.

METHOD

Participants first completed a self–control depletion manipulation followed by the weapon identification priming task. The design of the study was thus a 2 (Self–control depletion: yes vs. no) by 2 (Prime race: Black vs. White) by 2 (Target type: gun vs. tool) mixed factorial design, where the first factor was manipulated between participants and the last two within participants.

Participants. Participants were 72 introductory psychology students who received course credit for participation. The sample included 62.5% males and 37.5% females. Participant race / ethnicity was 84.7% European American, 8.3% African American, 4.2% Hispanic, 1.4% Asian, and 1.4% listed as "other." Initial analyses showed that sex and race had no main effects or interactions, and so these variables will not be included in the primary analyses. Participants were randomly assigned to the Depletion or the No Depletion groups.

Self–control Depletion Manipulation. The self–control depletion manipulation was based on the Stroop color–naming task (Stroop, 1935). Recent research has shown that completing the Stroop task does indeed have depleting effects (Webb & Sheeran, 2003). In particular, after completing a Stroop task participants showed less persistence on unsolvable puzzles. Also, when participants first completed a different self–control depleting task, they performed more poorly on the Stroop task.

In our implementation of the Stroop task, participants saw color names and were required to name the "ink" color of the words. On congruent trials, the word's color and meaning were consistent (e.g., the word "green" was presented in a green font). On incongruent trials, the word's color and meaning were inconsistent (e.g., the word "yellow" was presented in green font). Responses were made via key presses; the four target keys were marked with red, yellow, green, and blue stickers.

The typical Stroop effect is that people are slower and less accurate when naming the color of a word when the word meaning conflicts with the ink color. This task is a difficult one, and requires participants to override the well–learned process of word reading in order to carry out their less–practiced intention of color naming. We considered this task depleting because it required participants to override their automatic or dominant tendency to read the words in order to correctly name the ink on incongruent trials, and thus to exercise self–control. Although procedurally the Stroop task was different from the traditional depletion manipulations, it relied on the willful inhibition of automatic responses and thus conceptually resembled tasks such as overriding habits or impulses, initiating action, and making choices.

After a practice round of ten trials, participants in the No Depletion condition completed 30 trials of the Stroop task (which required less than one minute). Participants in the Depletion condition completed 300 trials of the Stroop task (this lasted approximately 15 minutes). Participants in the Depletion condition took two five–second breaks after completing blocks of 100 trials. In both groups, two thirds of the trials were congruent and one third of the trials were not. This proportion was chosen so that overcoming reading on the incongruent trials would be even more difficult, because on two thirds of the trials word reading would provide a valid cue. In this way both groups were exposed to the same task, but the depletion group was required to exert a much more sustained effort. Trials were presented to participants in a random order.

Weapon Identification Task. After completing the Stroop task, participants were asked to participate in an ostensibly unrelated task dealing with how people make simple but quick decisions. Specifically, participants learned that they would classify objects appearing on the screen as guns and tools by pressing the keys labeled accordingly. Participants were also told that before each object was presented, a face would be flashed on the screen as an indication that the next image was about to appear. Participants were instructed to ignore the face, as it was only a warning signal that the trial was about to begin. They were asked to respond as quickly as they could.

After 16 practice trials, participants completed four blocks of experimental trials, where each of the four primes was paired with each of the four targets twice. This yielded 32 trials per block and a total of 128 trials. The pairings were presented in a new randomized order for each participant. The primes included two White and two Black male faces, and the target objects included two handguns and two hand tools (see Figure 1 for examples of prime and target stimuli). The prime appeared for 200 milliseconds, and was instantly followed by the target object. After the target was presented for 100 milliseconds, it was covered by a mask. If participants did not respond within 500 milliseconds, a message saying "*Faster please!*" appeared on the screen for one second. Responses rendered after the deadline were still accepted, so that the time limit would not result in missing data.

After completing the priming task, participants answered a series of manipulation checks, were debriefed and dismissed.

Manipulation Checks. To ensure that the experimental manipulation of self–control depletion was effective, participants were

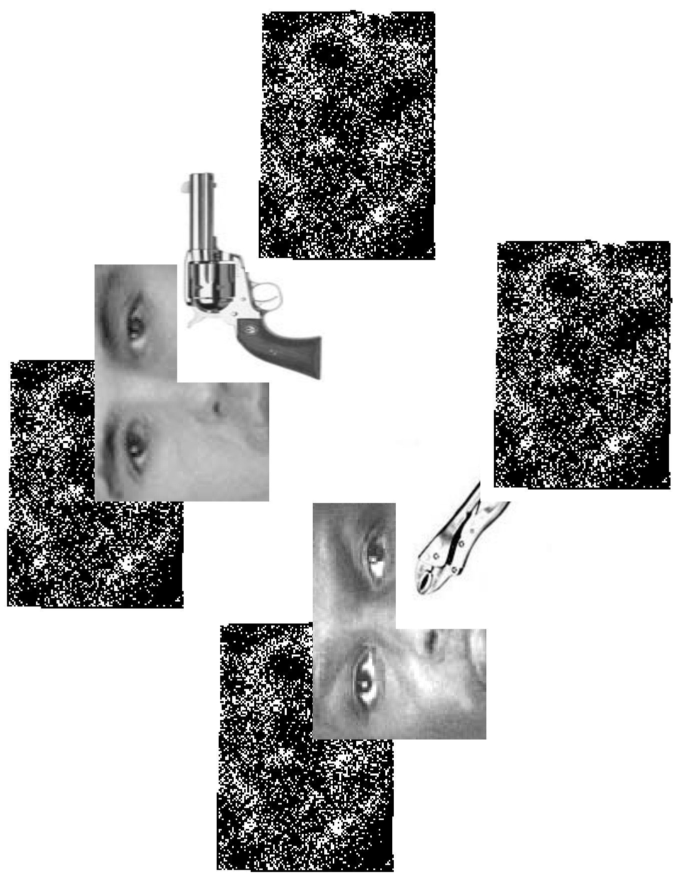

FIGURE 1. Examples of prime and target stimuli.

asked to rate the Stroop task on two questions. The first asked how difficult the task was, and the second asked how mentally exhausting it was. The response scales consisted of five options, where 1 corresponded to "not at all difficult" or "not at all mentally exhausting" and 5 to "extremely difficult" or "extremely mentally exhausting." The midpoint of each scale (3) was labeled as "moderately difficult" or "moderately mentally exhausting." We included these items to measure mental fatigue because previous research has found that ego–depletion is associated with feelings of fatigue (Muraven et al., 1998).

RESULTS

Manipulation Check. If performing the Stroop task was tiring, then participants should report more mental fatigue after 300 trials than after 30 trials. A mental fatigue index was created by averaging the "difficulty" and "mental exhaustion" items, which were correlated, $r = .38$, $p < .001$. As expected, participants reported more mental fatigue after completing 300 trials than after completing 30 trials (M's = 2.49 vs. 1.76), $t\,(70) = 3.94$, $SEM = .19$, $p < .001$. Thus, participants in the depletion condition perceived the task in the "moderately difficult" and "moderately mentally exhausting" range.

Weapon Misidentifications. The effect of race primes and experimental condition was examined by comparing stereotype–consistent errors to stereotype–inconsistent errors. Stereotype–consistent errors included false "gun" responses after a Black prime and false "tool" responses after a White prime. Stereotype–inconsistent errors included false "gun" response after a White prime and false "tool" responses after a Black prime. Analyses of response times are not reported because there was little variability, due to the fact that responses were constrained to be less than 500 ms. An analysis of variance was conducted with Stereotype–consistency and Depletion condition as independent variables. Results are shown in Figure 2. Participants' errors were biased by race, as revealed by a marginally significant main effect of Stereotype consistency, $F\,(1, 70) = 3.74$, $MSE = .02$, $p = .057$. Participants were more likely to make stereotype–consistent errors than stereotype–inconsistent errors. Depletion also produced a

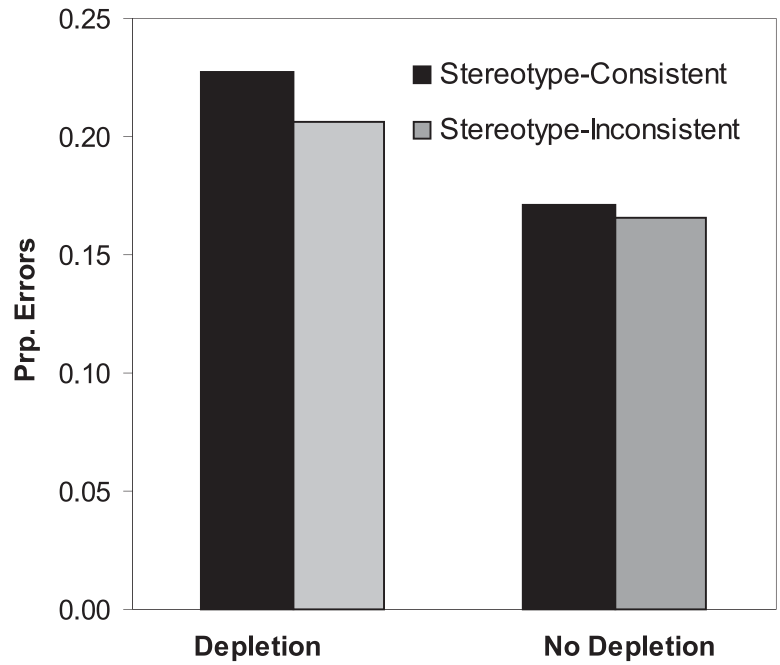

FIGURE 2. Proportion of stereotype-consistent and stereotype-inconsistent errors in depletion and control conditions.

marginally significant main effect, showing that participants in the depletion condition made more errors than participants in the baseline condition, $F(1, 70) = 3.76$, $MSE = .02$, $p = .057$. The effect of stereotype–consistency was not significantly qualified by the depletion condition, $F = 1.31$, $p = .256$. On the basis of this analysis alone, one might conclude that depletion did not moderate the influence of stereotypes. However, it is important to note that this pattern masks a more complex interaction that depends on participants' levels of automatic race bias as well as their cognitive control. This pattern will be explored more fully in the following sections.

Process Estimates. The primary hypothesis was that that ego–depletion would decrease cognitive control but would not affect the automatic bias. We first report the results for process estimates which test the hypothesis most directly, and then report the effects on behavioral errors. To test this prediction, we computed process dissociation estimates of automatic race bias and cognitive control as described earlier. The control estimate can range between 0 and 1, with 1 meaning perfect control of responses. Race bias was calculated by first computing the automatic bias toward responding "gun" for black prime and white prime conditions separately. Next the bias for white primes was subtracted from the bias for black primes, so that higher numbers reflect a more stereotype–consistent bias. Because it is a difference score, the bias estimate could thus range from –1 (complete counter–stereotypical bias) to 1 (complete stereotypical bias).

Consistent with the component process approach, depletion significantly affected estimates of cognitive control, $t\,(70) = 2.06$, $SEM = .01$, $p < .05$. Participants in the depletion condition showed poorer control than participants in the baseline condition (M's = .57 vs. .66). In contrast, there was no effect of depletion on automatic bias estimates (M's = .03 vs. .04), $t\,(70) = -.15$, $SEM = .01$, *ns*.

Mediation by Fatigue. The self–control literature suggests that the depletion reduces cognitive control due to mental fatigue. To test whether mental fatigue could account for the effects of the depletion manipulation on the Control estimate, we conducted a series of regression analyses to test for mediation (Barron & Kenny, 1986). As already described, the depletion manipulation affected reports of mental fatigue. In addition, the depletion manipulation affected estimates of cognitive control. To demonstrate mediation, it is necessary to additionally show that 1) fatigue predicts the reduction in cognitive control, and that 2) statistically controlling for mental fatigue reduces or eliminates the effect of the depletion manipulation on cognitive control.

As shown in Figure 3, there was evidence for mediation by mental fatigue. The depletion manipulation significantly increased mental fatigue. Mental fatigue, in turn, significantly predicted cognitive control on the weapon identification task. As described above, the depletion manipulation significantly reduced cognitive control. Critically, statistically controlling for mental fatigue rendered the effect of the depletion manipulation on cognitive control non–significant. Further, a Sobel test showed that the me-

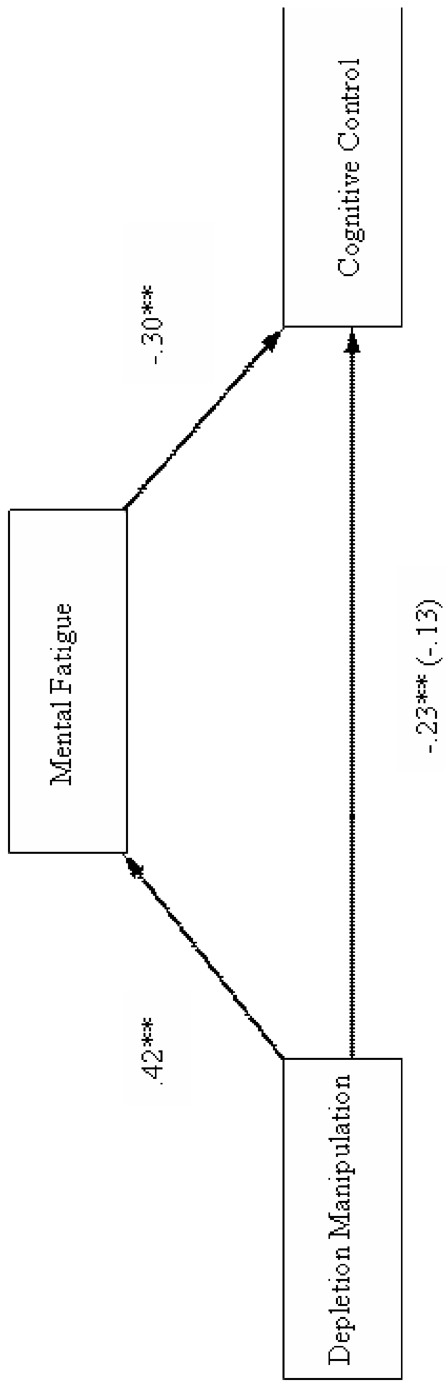

FIGURE 3. Mediation analysis showing that self-rated mental fatigue accounted for the relationship between the depletion manipulation and cognitive control estimates.

diated effect was significant, $z = 2.19$, $p < .05$. the This analysis confirms that the depletion manipulation reduced cognitive control via increased mental fatigue.

From Depletion to Overt Discrimination. The preceding analyses showed that the depletion manipulation reduced control over responses, but did not affect the automatic component of responses. However, the depletion manipulation did not significantly moderate the overall stereotyping effect. In this section we explore the implications for overt errors, showing that depletion did indeed increase behavioral stereotyping for individuals who experienced strong stereotype activation.

There was wide variability in participants' automatic reaction to the race primes (maximum = +.66, minimum = –.42, *SD* = .20). The process dissociation approach to race bias argues that automatic bias drives prejudiced responding to the extent that cognitive control fails. This can be seen most plainly by examining Equation 2, which states that the probability of a stereotypical error equals the degree of automatic bias multiplied by the probability that control fails [$A * (1 - C)$]. This shows that even a strong automatic bias may not be revealed in overt responses if it is opposed by high levels of cognitive control. Because the depletion manipulation selectively affected the controlled component of performance, it is important to examine stereotypical responses as a function of automatic race bias. The process dissociation model predicts that depletion will lead to more stereotypical errors, but only among participants with a strong automatic race bias. In contrast, among participants with little or no automatic bias, depletion should not reveal more stereotypical errors.

A few algebraic manipulations serve to illustrate this relationship. A person who has an automatic bias of .60, and control of .80 produces stereotypical errors at a rate of $.60*.20 = .12$. If the same automatic bias is accompanied by weaker control, say .50, the stereotypical error rate jumps to $.60 * .50 = .30$. At the extremes of perfect control or total absence of control, automatic bias may be completely hidden or revealed in overt errors. At $C = .99$, an automatic bias of .60 leads to a stereotypical error rate of only $.60 * .01 = .006$. Here the automatic bias is almost completely hidden. In contrast, at $C = .01$, the same degree of automatic bias would produce a stereotypical error rate of $.60 * .99 = .59$. Here, the rate of stereotypical errors is very close to the automatic estimate itself (in fact, at C = 0, the rate of stereotypical errors is identical to the automatic bias). These few examples illustrate that the behavioral effect of reducing control depends on the strength of automatic bias. For individuals with strong automatic bias, the reduction of control caused by depletion can be expected to substantially increase the racial disparity in errors. However, for those with little or no bias, the reduction in control will not increase the disparity.

This conceptual analysis can be supported empirically by examining the effect of reduced control at high and low values of automatic bias. We next report the relationship between depletion condition and stereotypical errors, as a function of automatic bias levels. It should be noted that both the automatic estimate and the stereotypical error index represent different transformations based on the same accuracy data, which means that the two variables are necessarily related to each other. This analysis is reported to demonstrate empirically the conceptual analysis reported in the preceding paragraph, although a purely mathematical analysis could be used to reach the same conclusion.

Because the automatic race bias estimate was a continuous variable, these predictions were tested using multiple regression. A contrast score was formed for each participant representing the net stereotypicality of errors. This stereotypical error score was computed by subtracting the proportion of counter–stereotypical errors (false "gun" responses with White primes, false "tool" responses with Black primes) from stereotype–consistent errors (false "gun" responses with Black primes, false "tool" responses with White primes). Thus, higher values represent a more stereotypical pattern of errors. Variables were standardized before entering them in the analysis. The main effects of each variable were entered in the first step, followed by the Depletion condition × Automatic bias interaction on the second step.

Based on our conceptual and algebraic analysis, we predicted that the effect of depletion condition on stereotypical errors would be stronger for individuals high in automatic bias. Results confirmed this prediction. Figure 4 shows the proportion of stereotypical errors as a function of automatic bias and depletion condition. The values are plotted at one standard deviation above and below the mean of the automatic bias estimate (Aiken &

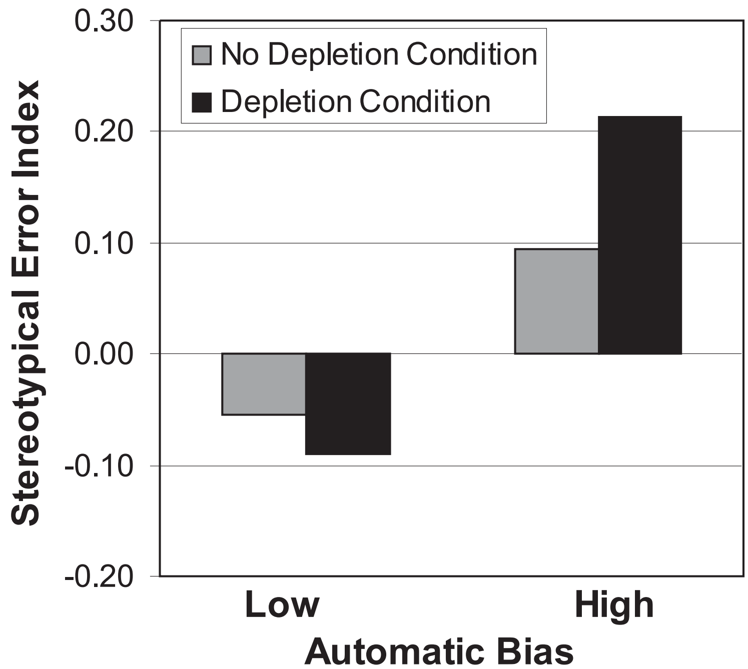

FIGURE 4. Proportion of stereotypical errors as a function of automatic race bias and depletion condition. High and low values of Automatic bias estimates are plotted at one standard deviation above and below the mean.

West, 1991). The main effects of both automatic bias (β = .81) and depletion condition (β = –.15) were significant, $p < .05$. In addition, these main effects were qualified by the Automatic bias × Depletion interaction, β = –.92, $t = 3.68$, $p < .001$.

To test whether the effects of the depletion manipulation depended on participants' level of automatic bias, simple slopes analyses were performed according to the procedures of Aiken and West (1991). These analyses tested the effect of the depletion manipulation at one standard deviation above and below the mean of automatic bias. Results showed that the depletion manipulation led to significantly more stereotypical errors among those high in automatic bias, β = –.41, $p < .001$. In contrast, depletion did not have a significant effect among those low in bias, β = .11, $p = .26$.

An important implication of this pattern is that depletion led to the behavioral expression of whatever automatic impulse participants possessed. For those with a stereotype–consistent automatic bias, depletion led to greater stereotypical errors. However, for those with little or no automatic bias, depletion did not lead to more stereotypical errors.

As a conceptual replication, we ran a similar analysis using self–reported fatigue rather than the depletion condition. This analysis tested whether participants reporting fatigue showed greater racial disparities in their errors, as a function of automatic bias. In this analysis, the Fatigue × Automatic bias interaction was significant, and paralleled the results for depletion conditions, $\beta = -.55$, $t = 2.77$, $p < .001$. Fatigue led to greater racial disparities, but only for participants with a strong automatic bias.

Stroop Performance. The above analyses indicate that the ego–depleting manipulation and the weapon identification task rely on the same domain–general resource. To further demonstrate the link between self–control and executive function, we report the relationship between performance on the Stroop task and estimates of automatic and controlled processing from the weapon identification task. We took advantage of the fact that the process dissociation procedure has been extended to decompose automatic and controlled aspects of Stroop performance (Lindsay & Jacoby, 1994). Although the specific equations of the model differ, the general logic is the same as that described for the weapon identification task (see Lindsay & Jacoby, 1994 for a more detailed treatment of this model). In the Stroop process dissociation model, word reading is the automatic process, which must be overcome in order to execute one's intention of color naming (a controlled process).

When errors on the Stroop task were decomposed into estimates of automatic word reading and controlled color naming, a selective pattern of correlations emerged.[1] The cognitive control estimate from the weapon identification task correlated with the

1. The correlations reported include only the depletion condition because of the small number of Stroop trials in the control condition. Most participants had few errors or none in the control condition, precluding a reliable measure.

controlled color naming estimate, $r = .41$, $p < .01$, but not with the automatic word reading estimate, $r = .24$, *ns*. The automatic race bias estimate was related to neither color naming, $r = -.01$, nor word reading, $r = .24$, both p's $> .15$. This pattern is to be expected, because the automatic estimates from the two tasks represent very different automatic tendencies. In the weapons task, the automatic component reflects stereotype activation, whereas in the Stroop task it represents word reading. We would not expect the two to be related. However, the ability to constrain one's processing to relevant input is a more global capacity. Individuals better able to avoid interference from word reading were also better able to avoid interference from stereotypes. These results add weight to the argument that these two superficially different tasks draw upon similar mental resources, and that this similarity resides specifically in the controlled aspects of performance.

DISCUSSION

Results showed that participants who engaged in a depleting Stroop task for a long time displayed less cognitive control on the weapon identification task than participants who engaged in the task for a short time. Additionally, we demonstrated that the depletion manipulation did not affect automatic stereotyping bias. These findings support the prediction that ego–depletion does not impact automatic stereotype activation, but interferes with processes requiring intentional control and cognitive resources. When control is intact, one can successfully prevent one's associations from biasing behavior; however, automatic associations are more likely to guide behavior when one's resources are depleted. As a result, stereotypical errors result more frequently among participants who have a strong automatic bias *and* are depleted.

This study is the first to demonstrate the effects of ego–depletion on automatic and controlled components of stereotyping. Previous research has suggested that self–control expenditure might lead to greater stereotyping, yet it has not documented the mechanism underlying the effect (e.g., Gordijn et al., 2004; Macrae et al., 1994). For example, Gordijn and colleagues (Study

4) asked participants to either suppress or not suppress the stereotype of skinheads when describing a skinhead target and then to write about a day of an elderly woman. The results showed that suppression of a skinhead stereotype led to an increased reliance on stereotypes about the elderly in the subsequent task. This effect, however, could be due to either greater automatic activation of stereotypes or reduced control following ego–depletion. Our findings suggest that an increase in stereotyping is attributable to a decrease in cognitive control rather than the increased accessibility of stereotypical associations. This conclusion highlights the importance of self–regulation in stereotyping (Monteith, 1993).

RELATIONS BETWEEN SELF–CONTROL AND EXECUTIVE CONTROL

The present research contributes to a more complete understanding of self–control. It has been recently noted that of all of the aspects of the self, the executive aspect has received the least empirical attention (Baumeister, 1998). However, that is probably changing, as social psychologists are increasingly recognizing the importance of executive processes in social behavior (e.g., Cunningham et al., 2004; Barrett, Tugade, & Engle, 2004; Macrae, Bodenhausen, Schloerscheidt, & Milne, 1999; Richeson & Shelton, 2003; von Hippel, Silver, & Lynch, 2000). The definitional similarities between the concepts of control in the self and cognitive literatures are striking. In the former, self–control is seen as the processes by which people direct, regulate, and modify their thoughts and behaviors to achieve their goals (e.g., Baumeister, 1998; Muraven, Tice, & Baumeister, 1998). In the latter, the "central executive" is generally defined as the system(s) responsible for problem–solving, decision–making, planning, adapting to novel situations, or overriding habits or impulses (Baddeley, 1986; Norman & Shallice, 1980).

Nonetheless, theories and experiments focused on the self, and those focused on information processing, have proceeded largely independently. We believe that greater communication between the two will be fruitful both theoretically and methodologically.

For example, self–regulation research has focused on behavioral outcomes (e.g., perseverance and performance), with less emphasis on the mechanism of executive control or interaction between controlled and automatic processes. At the same time, research on the role of the central executive has often neglected the social and personal context in which most planning, decision–making, and self–regulation take place. The present research has demonstrated that the Stroop task, a very non–social manipulation of resource depletion, has consequences of social and personal significance (stereotyping). Other recent research has also shown that decrements in executive control can be instigated by situations that threaten the self (Lambert et al., 2003; Richeson & Shelton, 2003; Baumeister, Twenge, & Nuss, 2003). These lines of research converge on the suggestion that the executive functions of the self and the central executive may share more in common than is commonly recognized.

VARIETIES OF CONTROL

Early research on automatic processes tacitly assumed that automaticity was monolithic. Once a process was shown to have some automatic properties, it was assumed to be automatic in other ways also. Later research showed that this idea was overly simplistic, and that automatic processes may vary in their properties (Bargh, 1989). Evidence is mounting that processes of mental control are not monolithic either. The main contribution of the present research is to show that the domain–general notion of resource depletion can have a selective impact on controlled aspects of behavior, leaving automatic components to drive behavior. However, that does not imply that all mental control is alike.

In some cases, people exert control through *after–the–fact* correction. After a thought or impulse has arisen, people try to adjust or edit its impact on behavior. This type of control has been heavily studied in social psychology, and has been modeled in a number of theories (e.g., Gilbert, 1991; Wegener & Petty, 1997). In other cases, people exert mental control in an *up–front* fashion. For example, they might seek out only relevant information for a decision, form an impression based only on individuating information, or selectively attend only to relevant input (as in a dichotic listening task). In contrast to control–as–correction, this variety of control constrains what thoughts or impulses come to mind in the first place. The first variety of control focuses on mental undoing, whereas the second focuses on how thinking is done to begin with.

The process dissociation model applied here relies on an up–front model of mental control. In the weapons task, participants are presented with a threatening or harmless target item, and with a person who evokes a threatening or harmless stereotype. The model claims that participants attempt to respond based on the relevant target items, but are sometimes unable to do so (especially when in a depleted state). The degree of success at constraining responses to the relevant input is estimated by the Cognitive Control parameter. When control fails responses are not random, but are instead driven by activated stereotypes. The extent that behavior is driven by automatic stereotyping is estimated by the Automatic bias parameter.

This up–front model of control has been applied to understand a range of findings, from misidentifying weapons to memory illusions (Jacoby, 1998). Other models have been developed to represent after–the–fact control. One model more closely aligned with correction theories has been used to model tasks such as the Stroop color naming task (Lindsay & Jacoby, 1994). This model also has two processes, one controlled and one automatic. But their arrangement is reversed. An automatic impulse (such as reading the word in the Stroop task) may capture behavior. However, when that capturing influence is overcome, people can respond in a controlled way. Is the weapon identification phenomenon more like this after–the–fact model or the up–front model of control? In earlier studies, Payne, Jacoby, and Lambert (2005) compared the two models using a multinomial modeling approach, which can test the statistical fit of competing models. They reported that the up–front model provided a better fit for the weapon identification data than the after–the–fact correction model.

As a supplementary analysis, we tested the two models using data from the present study. Again, the up–front model provided a good fit (G^2 [4] = 5.70, G^2 critical = 9.49) but the after–the–fact model did not (G^2 [4] = 21.50, G^2 critical = 9.49).[2] The parameter estimates from the up–front model converged with the process dissociation estimates reported in the results section, showing that self–regulation depletion reduced the Control estimate but did not affect the Automatic estimate. Although after–the–fact models of control may seem more intuitive because they are more commonly used in social psychology, these analyses show that the up–front model of control cannot be rejected, whereas the after–the–fact model can be.

Up–front and after–the–fact varieties of control are not mutually exclusive, but can occur together. To separate different levels of automaticity and control, hybrid models have been developed (see Jacoby et al., 2005). A hybrid model proposed by Conrey and colleagues (in press) has been applied to situations such as the weapon identification task. In this model, stereotypes may automatically capture processing. However, in parallel with that process, people may discriminate the correct response based on the relevant target information (if they cannot discern the correct response, they guess). If an association has been automatically activated and the correct response has also been determined, a second controlled process resolves any discrepancies that result, to determine which process drives responses. Thus, this model represents both up–front and after–the–fact versions of control.

The utility of simpler versus more elaborate models depends on opposing considerations of completeness and parsimony. On one hand, more complex models can potentially generate more complete explanations by teasing apart behaviors into more fine–grained processes. On the other hand, models can in principle be extended *ad infinitum*. Therefore researchers are faced with a decision about how elaborately to design models. The

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These models were first fitted as unconstrained, or saturated models, and then both models were constrained based on equivalent theoretical predictions to derive the model fits. For both models, the automatic estimates were allowed to vary across White vs. Black prime race, but not across depletion conditions. The controlled processes were allowed to vary across depletion conditions, but not across prime races. With eight independent cells of data, and four free parameters, this allowed four degrees of freedom for testing model fits.

principle of parsimony suggests the simplest model that can adequately explain the theoretically important data should be selected. This dictum sets a principled limit on the complexity of models.

In our view, more complex models are appropriate to the extent that a simpler model cannot adequately account for important findings (either because the simpler model produces a poor statistical fit, or because it fails to show theoretically meaningful patterns). In the case of the weapon identification bias, we have found the two–process "up–front" model to produce a consistently good account of the data. As described in Payne et al. (2005) and in the present article, this model provides a good statistical fit. And as described in the introduction section, several experiments have shown that the A and C estimates relate to other variables in theoretically meaningful ways. Based on considerations of parsimony and completeness, we prefer the two process model applied here as the most useful model for the weapon misidentification phenomenon.

CONCLUSION

As we are reminded by cases like that of Amadou Diallo, identifying (or misidentifying) an object in the hands of a suspect may often determine a police officer's decision to shoot. Previous research has documented that this decision can be biased by race (Correll at al., 2002; Greenwald, Oakes, & Hoffman, 2003; Payne, 2001). The present research suggests additional factors that moderate when race biases will affect behavior. A particularly incendiary combination may result when a police officer has an automatic racial bias and is in a state of ego–depletion. Whereas many investigations tend to attribute stereotypic behaviors to automatically activated biases, our findings suggest that low cognitive control may be an additional necessary factor. In fact, one may easily envision the conditions that are depleting for police, such as sustaining attention for prolonged time or forcing oneself into situations in which one does not wish to be involved. On a more positive note, our findings also suggest that when control is high, an officer may successfully block any influence from automatic biases. Just as the automatic activation of race bias is critical for understanding these issues, so too is the potential for self–regulation and cognitive control.

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