



# Self-Control Inhibits Aggression

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## Abstract

Aggression brings tremendous costs to individuals, relationships, and society. Yet, people behave aggressively toward strangers and close others at alarmingly high rates. The current article seeks to unlock part of the mystery of why people behave aggressively. We review evidence that self-control failure plays an integral role in many acts of aggression and violence. We begin by reviewing theoretical models that emphasize the importance of self-control processes in understanding aggressive and other criminal behaviors. We also discuss how a theoretical model that originally neglected self-control processes can be extended to incorporate self-control theorizing. We then discuss recent empirical evidence (a) showing that self-control failure is a crucial predictor of aggression toward strangers and romantic partners and (b) identifying the neural processes relevant to the self-control of aggression. Finally, we review evidence that self-control processes can also explain why people engage in displaced aggression toward bystanders. By appreciating the importance of self-control processes, researchers and laypersons can gain a better understanding of why people behave aggressively – and how aggression can be prevented.

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Violence and aggression have afflicted the world since time immemorial. People kill people they hate, people they love, and people they've never met before. Our brains and our genetic makeup influence whether we will respond to an insult with aggression, but so does our culture. Personality traits increase or decrease our propensity to perpetrate violence, but so can the immediate situational context in which people find themselves. Unlocking the mystery of why people behave violently is a daunting task, one that has puzzled social scientists, philosophers, and laypersons for millennia.

The current article addresses this mystery by reviewing classic and recent research suggesting that self-control failure contributes to most aggressive and violent acts. Self-control, defined as the capacity to override a particular response to align with another, is associated with a variety of positive outcomes including enhanced personal and relationship well-being (e.g., Baumeister, Heatherton, & Tice, 1994; Duckworth & Seligman, 2005; Finkel & Campbell, 2001; Mischel, Shoda, & Peake, 1988; Tangney, Baumeister, & Boone, 2004). Self-control is involved in many different responses, including emotion regulation, thought suppression, and acts of behavioral control, to name a few. Aggression is defined as any behavior carried out intentionally to harm another person who is motivated to avoid the harm (Baron & Richardson, 1994; Bushman & Huesmann, 2010). When aggressive urges become activated, self-control can help one override the desire to behave aggressively, helping one respond in accord with personal or societal standards that admonish aggression. Therefore, factors that undermine self-control should increase aggression. Conversely, factors that strengthen self-control should decrease aggression.

The paper consists of five sections. First, we review theoretical models of aggression and criminality that emphasize the importance of self-control processes. We also suggest how

an existing model that did not originally include a self-control component could be expanded to include self-control theorizing. The second and third sections discuss evidence that self-control failure contributes to aggression between strangers and intimate partners, respectively. Fourth, we discuss the role of self-control failure in explaining displaced aggression and angry rumination. Fifth, we discuss evidence from social neuroscience identifying the neural processes linking self-control to aggression. All five sections point to the integral role of self-control processes in understanding why people behave aggressively.

### **Theoretical Models of Aggression and Criminality that Emphasize the Importance of Self-Control**

There is theoretical precedent that self-control may relate to aggression. This section reviews two theories –  $I^3$  Theory and the General Theory of Crime – that emphasize the importance of self-control processes in understanding aggressive and criminal behavior. It also discusses how a theoretical model that originally neglected self-control processes – the General Aggression Model – can be extended to incorporate self-control theorizing.

#### *I<sup>3</sup> Theory*

$I^3$  Theory is a broad meta-theory of aggression that has a stronger emphasis on self-regulatory processes.  $I^3$  Theory (pronounced ‘I-cubed theory’) seeks to impose theoretical coherence on the massive number of established risk factors for aggression by emphasizing the *process* (or processes) through which each promotes aggression (Finkel, 2008; Finkel, Bushman, & Bodenhausen, in review; Finkel & Eckhardt, forthcoming; Finkel & Slotter, 2009; Slotter & Finkel, 2011).  $I^3$  Theory identifies three processes: Instigation, Impellance, and Inhibition (with the underlined vowels representing the three *I*s in  $I^3$  Theory). Instigating and impelling risk factors combine additively and interactively to determine the strength of the aggressive urge people experience, whereas dis-inhibitory risk factors determine whether this urge results in aggressive behavior or is overridden in favor of non-aggressive behavior.

*Instigators* are discrete social dynamics that normatively trigger an urge to aggress (e.g., insults, rejection); we use the term ‘normative’ to refer the experience of the typical person confronting this particular instigator under these particular circumstances. Such dynamics can trigger hostile cognitive, affective, physiological, and even preliminary behavioral tendencies (Berkowitz, 1993). *Impellers* are dispositional or situational factors that psychologically prepare the individual to experience a strong urge to aggress when encountering this instigator in these circumstances (e.g., dispositional anger, physical pain); these factors collectively determine ‘urge-readiness’ – the individual’s readiness to respond with aggression to this instigator in this situation. Individuals tend to experience especially powerful aggressive urges when impelling forces are strong, particularly when instigating triggers are severe. *Dis-inhibitors* are dispositional or situational factors that decrease the likelihood that people will override this urge to aggress (e.g., depleted self-regulatory resources, low relationship commitment). Dis-inhibitors determine the threshold above which aggressive urges will manifest themselves in aggressive behavior. If the dis-inhibitors are strong, then aggressive urges need not be particularly strong to yield aggressive behavior. If they are weak, then aggressive urges must be strong to yield aggressive behavior.

$I^3$  Theory employs the tools of statistical (and conceptual) moderation to examine how risk factors from each process category – instigation, impellance, and inhibition – combine to aggravate or mitigate the aggression-promoting effects of each. As noted above, aggression is most likely (and most extreme) when instigating and impelling forces are

strong (yielding a strong urge to aggress) and inhibiting forces are weak (yielding weak tendencies to override the aggressive urge). Although dis-inhibiting risk factors can involve regulation from outside the self (e.g., when third parties physically restrain antagonists from escalating violence during a fight; Levine, Taylor, & Best, 2011), most such factors involve the self exerting effort to resist enacting aggressive behavior.

I<sup>3</sup> Theory has enjoyed empirical support from several recent studies. To illustrate, one study used a behavioral analog measure to assess aggressive tendencies toward a romantic partner. In this daily diary study, Slotter et al. (in review) operationalized (a) instigation in terms of daily provocation from the partner, (b) impellance in terms of general tendencies toward retaliation in the relationship (e.g., “I think about how to even the score when my partner wrongs me”; see Fincham & Beach, 2002), and (c) inhibition in terms of daily commitment to the partner. The provocation  $\times$  retaliatory tendencies  $\times$  commitment interaction effect was significant, and the pattern of this effect aligned precisely with I<sup>3</sup> Theory: Participants were the most aggressive against their partner in the crucial ‘cell’ where provocation (instigation) and retaliatory tendencies (impellance) were high and commitment (inhibition) was low. Several additional studies demonstrate that same pattern of results with widely divergent operationalizations of instigation, impellance, and inhibition (e.g., Finkel et al., in review).

### *General Theory of Crime*

In their influential book *A General Theory of Crime*, criminologists Gottfredson and Hirschi (1990) argue that poor self-control is the strongest predictor of crime. A common perception of criminals is that they specialize in certain criminal acts and carefully consider the costs and benefits of the crimes they commit. Yet, most criminal acts represent examples of self-control failure.

This argument has been supported by a number of studies involving juvenile delinquency (self-report and official records), criminal behavior among college students and adults, and aggression toward strangers (e.g., Arneklev, Grasmick, Tittle, & Bursik, 1993; Brownfield & Sorenson, 1993; Gibbs & Giever, 1995; Henry, Caspi, Moffitt, & Silva, 1996; Junger & Tremblay, 1999; LaGrange & Silverman, 1999; Paternoster & Brame, 1998). McGarrell and Flanagan (1985) calculated that most robberies are short-term, limited-benefit activities, with the median loss for robbery (i.e., taking something from someone else using real or threatened force) is less than \$50 and the median loss for burglary (i.e., trespassing and committing theft or other offense) is approximately \$100.

Of particular relevance is the fact that crimes of interpersonal violence (e.g., assault, rape, and robbery) occur primarily late at night (i.e., between 1 and 2 AM), which suggests that violent crimes are committed more when people are in need of sleep than when people are fully rested (Hindelang, 1976; Hindelang, Gottfredson, & Garofalo, 1978; Rand, Klaus, & Taylor, 1983). Sleep deprivation is robustly associated with poor self-control (e.g., Couyoumdjian et al., 2010). Meta-analytic findings have shown that poor self-control has a moderate effect size of  $r = .27$  on criminal behavior, leading researchers to suggest that poor self-control qualifies as ‘one of the strongest known correlates of crime’ (Pratt & Cullen, 2000, p. 952).

### *General Aggression Model*

The General Aggression Model (GAM; Anderson & Bushman, 2002; DeWall & Anderson, 2011; DeWall, Anderson, & Bushman, forthcoming) integrates domain-specific

theories of aggression into a parsimonious, unified framework that incorporates the role of self-control processes in understanding aggression. GAM emphasizes three temporal stages in explaining how aggression occurs within a single cycle of ongoing social interaction: (1) person and situation inputs, (2) internal states (especially affect, cognition, and arousal), and (3) outcomes of appraisal and decision-making processes. In its original formulation, GAM did not emphasize the role of self-control processes in better understanding the causes of aggression. Because of its meta-theoretical structure, GAM is sufficiently flexible to provide researchers an opportunity to include self-control theorizing.

Person inputs refer to enduring traits, values, motivations, and beliefs that predispose people to behave aggressively. For example, trait anger, neuroticism, and normative beliefs about aggression are all associated with higher levels of aggression (Hellmuth & McNulty, 2008; Huesmann & Guerra, 1997; Parrott & Zeichner, 2002), whereas high executive control and gratitude are protective factors (DeWall, Lambert, Pond, Kashdan, and Fincham, unpublished manuscript; Giancola, 2004). Situation inputs represent more transient features of the environment that can increase aggression. Social rejection is one situational factor that reliably increases aggression (Buckley, Winkel, & Leary, 2004; DeWall, Twenge, Bushman, Im, & Williams, 2010; DeWall, Twenge, Gitter, & Baumeister, 2009; Gaertner, Iuzzini, & O'Mara, 2008; see Leary, Twenge, & Quinlivan, 2006; for a review). Hot temperatures also reliably increase aggression inside and outside the laboratory (Anderson, 1989; Anderson, Anderson, Dorr, DeNeve, & Flanagan, 2000; DeWall, Webster, and Bushman, unpublished manuscript; Reifman, Larrick, & Fein, 1991). Merely presenting people with words related to hot temperatures is enough to increase their aggressive thoughts (DeWall & Bushman, 2009).

Person and situation factors start the episodic process in which an aggressive response may occur, but GAM argues that these input variables influence aggression through their effect on affect, cognition, and arousal. That is, person and situation factors supply information regarding 'who' is most likely to aggress and when that aggression is likely to occur, but internal states help explain 'why' people behave aggressively. Angry affect, hostile cognition, and heightened arousal are all associated with higher levels of aggression (Berkowitz, 2001; DeWall et al., 2009; Dodge & Coie, 1987; Geen & O'Neal, 1969).

The General Aggression Model's third stage involves appraisal and decision processes, which can vary along of continuum from automatic to heavily controlled (Strack & Deutsch, 2004). Appraisal and decision processes involve automatic processes referred to as 'immediate appraisal' and controlled processes referred to as 'reappraisal'. Depending on the use of immediate appraisal or reappraisal processes, people behave in impulsive or controlled ways. Once the impulsive or thoughtful action takes place, it enters a feedback loop that becomes part of the input for the next cycle of aggression (i.e., person and situation inputs, then internal states, then appraisal and decision processes).

Recent theoretical work has argued that GAM can provide a useful framework for understanding the role of self-control processes in helping people override aggressive urges (DeWall & Anderson, 2011; DeWall et al., forthcoming). Specifically, individual differences in self-control and situational factors that diminish or bolster self-control strength (person and situation inputs, respectively) produce an internal state characterized by varying levels of self-control depletion. Self-control depletion should not increase aggressive urges; rather, it limits the ability to override an aggressive urge.

The internal state of self-control depletion has direct implications for the appraisal and decision process component of GAM. It deprives people of the needed resources to engage in cognitive reappraisal processes, leading them to engage in an impulsively aggressive action. Crucially, if people conserve their mental energy or if they have

sufficient self-control resources, they should have sufficient resources to engage in cognitive reappraisal processes, which should in turn lead to a non-aggressive action.

### **Self-Control Failure and Aggression toward Strangers**

The previous section provides ample theoretical precedent for predicting that self-control failure is a proximal predictor of aggression. Until recently, however, there was relatively little experimental research to support the hypothesis that self-control failure is a significant predictor of aggression. A recent series of studies filled this gap in this literature by providing causal evidence that self-control failure increases aggression toward strangers (DeWall, Baumeister, Stillman, & Gailliot, 2007; also see Stucke & Baumeister, 2006). These studies were grounded on the premise that self-control relies on a limited resource, akin to energy or strength that becomes depleted after exertion, an effect dubbed ‘ego depletion’ (Baumeister, Gailliot, DeWall, & Oaten, 2006; Hagger, Wood, Stiff, & Chatzisarantis, 2010). When people are depleted of their self-control energy, they should be less likely to override their aggressive urges, leading them to behave aggressively.

In their first experiment, DeWall et al. (2007) exposed participants to a manipulation designed to either deplete them of their self-control energy (ego depletion condition) or to leave their self-control energy intact (control condition). Specifically, participants in the ego depletion condition had to resist the urge to eat a delicious donut, whereas participants in the control condition had to resist the urge to eat a less tempting food – namely a radish (Baumeister, Bratslavsky, Muraven, & Tice, 1998). Next, all participants received an insulting evaluation of their writing from a confederate (“This is one of the worst essays I’ve ever read!”; Bushman & Baumeister, 1998), which was designed to stimulate an aggressive urge that participants had to inhibit. Finally, participants were given the opportunity to make the insulting confederate, who expressed a strong dislike for spicy foods, eat large amounts of hot sauce. Doling out hot sauce to someone who dislikes spicy foods conforms to the aforementioned definition of aggression and, outside of the laboratory, has been used in cases involving aggression toward police officers and children (Associated Press, 1993, 1995).

As expected, depleted participants doled out substantially more hot sauce to the insulting confederate compared to control participants. DeWall et al. (2007) replicated this finding in subsequent studies that measured aggression with the administration of aversive blasts of noise or with the provision of a damagingly negative job candidate evaluation. Crucially, ego depletion did not increase aggression in the absence of provocation. The implication is that self-control energy is needed to override aggressive urges, but it is not needed when the urge to aggress is relatively weak. Finally, DeWall et al. (2007) demonstrated that the link between ego depletion and aggression was especially robust among people low in trait self-control, as assessed with the measure developed by Tangney et al. (2004). Across studies, the results could not be explained by alternative, affective mechanisms, including general positive or negative affect, anger, or frustration.

An additional study demonstrated that bolstering self-control can reduce aggression (Denson, Capper, Oaten, Friese, & Schofield, 2011). In this experiment, undergraduate participants who practiced self-control for 2 weeks by using their non-dominant hand for everyday tasks showed reduced anger when subsequently provoked by a fictitious fellow student. Moreover, practicing self-control also reduced physically aggressive behavior among those high in trait aggression. Taken together, the research reviewed here suggests that self-control failure increases aggression toward strangers and bolstering self-control capacity decreases aggression.

## Self-Control Failure and Intimate Partner Violence

Thus far, we have reviewed evidence that self-control failure is a crucial predictor of aggression toward strangers. In this section, we examine aggression toward intimate (romantic) partners. Intimate partner violence (IPV) is remarkably common, with approximately one U.S. couple in six experiencing at least one violent act *every year* (Schafer, Caetano, & Clark, 1998; Straus & Gelles, 1986). In addition, in one of the most surprising findings in the social sciences over the past few decades, women are at least as likely to perpetrate IPV against their male partners as men are to perpetrate against their female partners, although women are also more likely to be injured as a result of IPV (Archer, 2000).

Self-regulation failure is a crucial predictor of IPV perpetration, and this link is comparably strong for men and women. The program of research that has tackled this issue most directly reported five studies investigating this link from diverse methodological perspectives (Finkel, DeWall, Slotter, Oaten, & Foshee, 2009). The first study sought to demonstrate that individuals are substantially more likely to experience violent urges during fights with intimate partners than they are to enact violent behaviors, which would be consistent with the hypothesis that IPV would be more prevalent if individuals failed to exert self-control during such fights. The subsequent four studies investigated a range of self-regulatory features that can help individuals override aggressive urges toward romantic partners.

In the first study, participants reported on the most serious fight they had ever experienced with a romantic partner and indicated how much they were *tempted* to enact a series of aggressive behaviors during the fight (e.g., slapping, kicking, punching) and how much they *enacted* each of these behaviors. Supporting the hypothesis that people fighting with intimate partners frequently experience aggressive urges that they override in favor of non-violent interaction, participants were almost 2.5 times more likely to experience a violent urge during the fight than to enact a violent behavior (51% versus 21%).

The second study demonstrated, in both cross-sectional and residualized-lagged analyses, that teenagers characterized by low in trait self-control (as assessed with a measure by Grasmick, Tittle, Bursik, & Arneklev, 1993) exhibited substantially higher rates of IPV perpetration. Study 3 examined whether individuals forced to respond quickly to their partner's transgressions – that is, without having the time to move beyond their gut-level urges – would exhibit stronger tendencies toward IPV perpetration than would individuals forced to wait 10 seconds before responding. Rather than asking participants to report on actual acts of IPV they had perpetrated in the past, Study 3 employed a laboratory analog measure of IPV perpetration in which participants (a) immersed themselves in an involving scenario designed to provoke jealousy and anger regarding the partner's behavior and (b) verbalized their thoughts in real time (see Eckhardt, Barbour, & Davison, 1998). Trained coders rated these verbalizations for aggressive content (e.g., “I would beat his ass” and “If she ever talked about me that way, I swear I'd smack her”). Consistent with the hypothesis that gut-level urges in response to provocation tend toward retaliation (see Yovetich & Rusbult, 1994), participants were more than twice as likely to verbalize a tendency toward IPV when they responded immediately than when they responded after a 10-second delay (47% versus 21%).

Study 4 extended the work of DeWall et al. (2007) by examining (a) whether ego depletion causes people to have stronger tendencies toward IPV perpetration and (b) whether these tendencies are limited to situations in which the individual believes that the partner has provoked him or her (or, more generally, to situations in which the

individual experiences an urge to aggress). Participants were assigned to an ego depletion condition or a control condition before being provoked or not provoked by their partner with nasty or supportive false feedback written by the research team but presented as if it came from the partner. As part of an ostensibly unrelated study, participants then had the opportunity to determine for how long their partner would have to hold painful body poses (although the study ended before their partner actually held these body poses). Participants assigned their partner to maintain the painful body poses for substantially longer when they were depleted than when they were not, but only if the partner had provoked them; these effects were robust beyond any effects of positive or negative affect.

Study 5 examined the other half of the strength model, which argues that an extended self-regulation regimen can bolster self-regulatory strength over time (Baumeister et al., 2006; Muraven & Baumeister, 2000). Participants attended two lab sessions 2 weeks apart. At both lab sessions, participants performed a depleting task and then used a self-report measure to indicate how physically aggressive they would be if their partner enacted each of a series of provocations (e.g., “My partner ridicules or makes fun of me”). Between the two lab sessions, participants were assigned to complete one of two self-regulation bolstering regimens (either a verbal regulation task requiring that participants controlled aspects of their speech or a physical regulation task in which participants used their non-dominant hand in everyday tasks) or to a no-intervention control condition. Participants assigned to both of the bolstering regimens exhibited significantly reduced tendencies toward IPV perpetration over time, whereas participants in the no-intervention condition exhibited comparable aggressive tendencies across time.

These findings provide further evidence regarding the importance of self-control processes in understanding why people behave aggressively. When people have deficient self-control resources, they are more likely to lash out at a romantic partner. By contrast, just as strengthening a muscle decreases the negative effects of fatigue, regular self-control exercises reduce the negative consequences of ego depletion on IPV tendencies.

### **Displaced Aggression and Angry Rumination**

Self-control processes may also be implicated in aggression that is directed toward innocent bystanders. People sometimes aggress against others who did not provoke them. For example, after receiving an insulting comment from one's boss, people are more likely to ‘take out’ their aggressive urges on innocent coworkers or family members. This phenomenon is known as *displaced aggression*. Displaced aggression is an especially pernicious form of self-control failure because innocent people are often the targets of harmful venting (Marcus-Newhall, Pedersen, & Miller, 2000). The emotion regulation that occurs in the period following the provocation has important consequences for determining the likelihood and severity of subsequent aggressive behavior. Gross and Thompson (2007) assert that “emotion regulation may dampen, intensify, or simply maintain emotion, depending on an individual's goals” (p. 8). Not all forms of regulating anger reduce angry affect and aggressive behavior. One form of emotion regulation in particular – angry rumination, which consists of reliving the anger-inducing event, focusing on angry thoughts and feelings, and planning revenge – augments both direct and displaced aggression, blood pressure, anger, and aggressive cognition (Bushman, 2002; Bushman, Bonacci, Pedersen, Vasquez, & Miller, 2005; Caprara, 1986; Denson, Pedersen, Friese, Hahm, and Roberts, forthcoming; Denson, Pedersen, & Miller, 2006; Miller, Pedersen, Earleywine, & Pollock, 2003; Pedersen et al., forthcoming).

Denson (2009) proposed that because people are likely aware of the negative consequences of unrestrained anger that might result from continued rumination, and because rumination is aversive and characterized by intrusive thoughts, ruminating people are typically motivated to stop ruminating. To stop ruminating, however, people must (a) down-regulate the intensity of the anger experience, (b) suppress angry thoughts, and (c) refrain from acting on aggressive urges. These three components can be conceptualized as emotion regulation, thought suppression, and acts of behavioral control, respectively. Each of these components consumes self-control energy (see Baumeister & Alquist, 2009; Baumeister, Vohs, & Tice, 2007). These three resource-depleting processes are likely responsible for the many acts of aggression that occur following a period of angry rumination.

The aggression-augmenting effect of rumination is consistent with the two recent social psychological aggression theories reviewed here. I<sup>3</sup> theory suggests that following a provocation (an instigating trigger), rumination can maintain or increase anger (an impelling force), and gaining control over the rumination can deplete self-control energy (an inhibiting force); these processes, in combination, strongly increase the likelihood of aggressive behavior (Slotter & Finkel, 2011). Indeed, a series of four studies found that angry rumination depletes self-control capacity and increases aggression (Denson, Pedersen et al., forthcoming). From the perspective of GAM (Anderson & Bushman, 2002; DeWall & Anderson, 2011; DeWall et al., forthcoming), each time a person thinks about a provoking incident, angry rumination maintains or increases the three internal states that serve as routes to aggression: angry affect, aggressive cognition, and blood pressure (Pedersen et al., forthcoming). Managing this increase in aggressive affect, cognition, and cardiovascular arousal likely reduces self-control resources and therefore the tendency to thoughtfully reappraise a provocation, which can thereby increase the likelihood that people will engage in an impulsively aggressive action.

### Neurobiological Mechanisms of Self-Control and Aggression

The previous sections offer theoretical and empirical support for our argument that self-control failure is a robust predictor of aggression between strangers and intimate relationship partners. This final section reviews evidence regarding the neurobiological mechanisms underlying the relationship between self-control and aggression.

A number of perspectives on aggression informed by neuroscience emphasize the role of specific regions in the prefrontal cortex (PFC) that support top-down control over anger and aggressive urges (Davidson, Putnam, & Larson, 2000; Denson, 2011; MacDonald, 2008; Siever, 2008). These regions include the orbitofrontal cortex, anterior cingulate cortex, medial PFC, and dorsolateral PFC. These regions broadly support self-regulation including emotion regulation (Heatherton, 2011; Ochsner & Gross, 2008). Perhaps not surprisingly, many violent individuals have abnormalities in the structure and function of these regions (Raine, 2008). Furthermore, when provoked, healthy undergraduates show increases in neural activity in regions involved in top down cognitive control and emotion regulation (e.g., the dorsolateral PFC, medial PFC, dorsal anterior cingulate cortex), as well as limbic regions implicated in negative affect (e.g., the insula) (Denson, Pedersen, Ronquillo, & Nandy, 2009). These data converge on the importance of the neural interplay between executive control and impulsive processes in determining aggressive behavior.

One testable implication of hypotheses derived from taking a neurobiological approach to self-control and aggression is that improving functioning in prefrontal regions supporting self-regulation should increase self-control and thereby reduce aggression.

Separate lines of inquiry have examined this notion by manipulating the bioavailability of (a) serotonin and (b) blood glucose. Both serotonin and glucose operate broadly in the brain including regions other than those that support self-regulation. Nonetheless, neuroimaging studies show greater activation in the prefrontal regions mentioned above during tasks that require self-regulation indicating increased glucose metabolism (Ochsner & Gross, 2008). Furthermore, task difficulty increases brain glucose metabolism when exercising executive control (Jonides et al., 1997) and broadly engaging in self-control decreases blood glucose levels (Dvorak & Simons, 2009; Gailliot et al., 2007). Furthermore, Witte et al. (2009) reported that increased density or affinity of postsynaptic 5-HT<sub>1A</sub> receptors in the anterior cingulate, orbitofrontal cortex, and superior frontal gyrus were correlated with trait aggression, suggesting blunted serotonergic neurotransmission in these regions among aggressive individuals. Thus, by boosting the availability of serotonin and glucose to the entire brain, within the context of a situation requiring anger regulation and behavioral control over aggressive impulses, such a boost should be available to the regions that need it most (i.e., regions supporting self-regulation).

Serotonin is a critical neurotransmitter involved in emotion regulation (Siever, 2008), and there is a reliable association between low central nervous system serotonin and increased aggression (Moore, Scarpa, & Raine, 2002). Therefore, increasing the availability of central serotonin should potentially reduce aggression. In a double-blind test of this hypothesis, participants were given 40 mg of Paroxetine, a selective serotonin reuptake inhibitor (SSRI), or a placebo capsule (Berman, McCloskey, Fanning, Schumacher, & Coccaro, 2009). Compared to placebo, for participants who were high in trait aggression, the SSRI reduced the number of intense electric shocks delivered to a fictitious participant.

There is also a reliable association between low blood glucose levels and individual differences in aggressive behavior (DeWall, Deckman, Gailliot, & Bushman, 2011; Gailliot & Baumeister, 2007). Because glucose fuels brain processes, acute decreases in glucose have been implicated in reduced self-control (Gailliot et al., 2007). Conversely, increasing blood glucose improves self-control in a number of diverse domains (DeWall, Baumeister, Gailliot, & Maner, 2008; Gailliot, Peruche, Plant, & Baumeister, 2009; Gailliot et al., 2007). Thus, acute glucose administration should reduce aggression among people who have the most difficulty overriding aggressive urges – people high in trait aggressiveness.

In two studies, participants were led to believe they would consume a glucose beverage (Denson, von Hippel, Kemp, & Teo, 2010). Unbeknownst to participants, they either received a beverage with 40–50 g of sugar or a placebo beverage containing a negligible amount of sugar. In the first experiment, participants underwent an ego depletion manipulation (or not), were insulted by a confederate, and then were given the opportunity to blast aversive noise toward the confederate. Compared to placebo, glucose reduced aggression among participants high in trait aggression even after the prior exertion of self-control. A second experiment replicated and extended this finding by showing that glucose reduced aggression among participants high in trait aggression only under conditions of provocation. The aggression-reducing effects of glucose were independent of mood. Although the entire causal pathway that serotonin and glucose reduce aggression by improving effective emotion regulation and behavioral control has not been shown in a single study, the research reviewed here provides suggestive evidence. Overall, the SSRI and glucose data suggest promising means of boosting self-control among aggressive individuals in response to provocation by increasing the bioavailability of substances necessary for optimal function in prefrontal regions supporting self-regulation.

Additional research outside of the aggression domain has investigated psychophysiological correlates of self-regulatory depletion. For instance, Inzlicht and Gutsell (2007) found

that relative to a control condition, participants who engaged in emotion regulation showed decreased error-related negativity (ERN) signals which in turn predicted worse performance on a measure of cognitive control. The ERN is thought to emanate from the anterior cingulate. Another study found that engaging in self-regulation (i.e., resisting eating tempting cookies) increased heart rate variability, which in turn was correlated with decreased persistence on a difficult anagram task (Segerstrom & Solberg Nes, 2007). Heart rate variability is influenced by the central autonomic network, which includes the anterior cingulate. These two studies provide convergent evidence for the neural regions implicated in self-control, especially the anterior cingulate.

## Conclusion

Daily newspapers are replete with examples of aggression. Although aggression may have evolved to enable early humans to survive and reproduce (MacDonald, 2008), it is a largely maladaptive manner of resolving conflict in modern cultures. Yet people continue to behave aggressively toward strangers and close relationship partners. The current article sought to unlock part of the mystery of why people behave aggressively by identifying a single factor that contributes to most acts of aggression – self-control failure.

The present review summarized several theoretical models to demonstrate the importance of self-control processes in understanding why people behave aggressively and engage in other criminal acts. It reviewed the growing body of research showing (a) that self-control failure promotes aggressive tendencies and (b) that bolstering self-control reduces aggressive tendencies. It reviewed evidence that self-control failure plays a central role in predicting displaced aggression. When people stifle their aggressive urge toward a provocateur, they sap their self-control energy, thereby increasing the likelihood that they will lash out at an innocent bystander. Finally, it discussed neuroscientific evidence pointing to the importance of regions in the PFC, which support self-control processes, in increasing risk for aggression and violence. Aggression was linked to dysfunction in this network, whereas experimentally increasing the availability of substances required for efficient neural functioning decreased aggression.

Although this article emphasized the importance of self-control in reducing aggression, there may be instances in which self-control promotes aggression. Soldiers may use self-control to override their urge not to shoot at the enemy to align themselves with personal and social standards for appropriate behavior in combat settings. Indeed, the dramatic rise in the percentage of U.S. soldiers who shoot to kill the enemy over the past century involved constant exercises designed to strengthen soldiers' capacity to override their urges not to shoot (Grossman, 1995). Other work has shown that neural regions involved in self-control (e.g., dorsolateral prefrontal cortex, anterior cingulate cortex) are used when people make judgments to kill one person to save many people (Greene, Nystrom, Engell, Darley, & Cohen, 2004). Hence, self-control may be needed to override the urge not to kill one innocent person in order for many other people to be saved. Even Shakespeare noted that self-control is sometimes needed to behave aggressively. As Finkel (2007) noted, "Shakespeare's Lady Macbeth...exhorts her husband to conquer his wobbly resolve about committing cold-blooded murder to achieve their goals: 'But screw your courage to the sticking-place/And we'll not fail' (Macbeth, Act 1, Scene 7)" (p. 204). Clearly sometimes people need self-control to behave aggressively.

Our analysis implies that self-control failures are primarily involved in 'reactive' aggression more than 'proactive' aggression (Buss, 1961; Dodge & Coie, 1987; Feshbach, 1964). *Reactive aggression* is 'hot', impulsive, angry behavior that is motivated by a desire

to harm someone. *Proactive aggression* is ‘cold’, premeditated, calculated behavior that is motivated by some other goal (obtaining money, restoring one’s image, restoring justice). Some researchers have argued that it frequently is impossible to distinguish between reactive and proactive aggression because they are highly correlated in real world samples and because aggression motives are often mixed (Bushman & Anderson, 2001). Despite the problems associated with dichotomizing aggression in this way, we would expect that self-control failures would not relate closely to proactive aggression because such behavior does not occur as a result of people failing to override an aggressive urge.

### Summary

Self-control is a costly process. It requires time, demands effort, and consumes metabolic energy. Aggression is also costly. It takes a tremendous mental and physical toll on victims. It bears an economic burden on society too, with each U.S. homicide consuming roughly \$17.25 million of public resources (DeLisi et al., 2010). Despite the costs of exerting self-control, the current article suggests that motivating people to override their aggressive urges could prove useful in reducing the negative consequences of aggression between strangers and close partners. By emphasizing the importance of self-control processes in predicting aggression, researchers and laypersons will have a better understanding regarding why people behave aggressively – and how such aggression can be prevented.

### Short Biographies

C. Nathan DeWall is an Assistant Professor of Psychology at the University of Kentucky. He received a B.A. in psychology from St. Olaf College, an M.A. in Social Sciences from the University of Chicago, an M.S. in experimental social psychology from Florida State University, and a Ph.D. in experimental social psychology from Florida State University. Nathan has three lines of research: social rejection/loneliness, self-regulation, and aggression. He is a recipient of a Young Investigator Award from the International Society for Research on Aggression. His research is currently funded by NIH, NSF, and the John Templeton Foundation. In his spare time, Nathan reads history, drinks coffee, travels with his wife, and conducts self-control experiments on his two golden retrievers.

Eli J. Finkel is an Associate Professor of Psychology at Northwestern University. He received a B.A. in psychology from Northwestern University, an M.A. in social and quantitative Psychology from the University of North Carolina at Chapel Hill, and a Ph.D. in social and quantitative psychology from the University of North Carolina at Chapel Hill. Eli directs the Northwestern Relationships Lab, which conducts research on initial romantic attraction, intimate partner violence, forgiveness, the interface of relationships and self-regulation, and personality and romantic relationships. Eli is a recipient of the SAGE Young Scholars Award, an Early Career Award from the Relationship Researchers Interest Group of the Society for Personality and Social Psychology (SPSP), and the Gerald R. Miller Award for Early Career Achievement from the International Association for Relational Research (IARR).

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## Endnote

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