No pain, no gain: How distress underlies effective self-control (and unites diverse social psychological phenomena)

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Let's dispense with the obvious: Pain is painful. Pain is the unpleasant experience associated with actual or potential tissue damage. In its social form, pain is the unpleasant experience associated with actual or potential damage to social relationships (Macdonald & Leary, 2005). Pain is thus related to physical and social damage and recruits unpleasant feelings and sensations. As such, people go to great lengths to avoid pain, for example, staying away from burning elements, steering clear of mean people, and steering clear of mean people near burning elements. Pain is thus adaptive, motivating people to withdraw from damaging situations and to avoid similar situations in the future.

Just as with pain, distress is painful, albeit adaptive. Distress, or anxiety, describes the unpleasant experience that occurs when things have not gone as planned; or when there is potential for things to not go as planned (Gray & McNaughton, 2000). Because it is unpleasant, people are motivated to avoid distress and to learn from it via the mechanics of negative reinforcement learning. Distress alerts people to the possibility that their goals are at risk of not being met and in so doing arouses shifts in behavior from routine and automatic to deliberate and controlled (Norman & Shallice, 1986; Shackman et al., 2011). The main point of this chapter is to suggest that, just as with pain, distress inspires people to engage self-control to remediate situations where things have actually or potentially gone awry. We further want to suggest that this distress-control dynamic underlies—and potentially unites—a number of seemingly diverse social-psychological phenomena.

Brief Overview

Self-control—known colloquially as willpower (Baumeister & Tierney, 2011) or more formally as executive function (Hofmann, Schmeichel, & Baddeley, 2012)—refers to the mental capacity individuals use to influence their own thoughts, emotions, and behaviors. Self-control is initiated whenever there is a conflict between two or more dominant response tendencies or goals, such as when one's goal of losing weight comes into conflict with one's goal of eating delicious, yet fattening french-fries (Stroebe, Mensink, Aarts, Schut, Kruglanski, 2008). Conflict, however, is not an affectively neutral event; rather, it is distressing, laden with anxiety (Grey & McNaughton, 2000). According to the *affect alarm model of self-control* (Inzlicht, Bartholow, & Hirsh, 2013; Schmeichel & Inzlicht, in press), this anxious distress can be adaptive, acting like a kind of signal that there is a potential for things to go wrong. This distress not only orients people to the kind of conflict that can undermine goal attainment, but, because people are motivated to avoid distress, also motivates people to resolve the conflict effectively. Critically, this distress serves to recruit control *only* to the extent that people are open, curious, and accepting of it; it is only by flexibly accepting their distress that people can hear what the distress is trying to "communicate" and then make necessary behavioral corrections. As with physical and social pain, that is, distress can only recruit effective responses (i.e., self-control) when people are sensitive to and respectful of their own avoidant emotions.

By casting distress in a starring role, the affect alarm model of self-control offers an understanding of self-control that provides novel insights into how it is recruited. Given the centrality of self-control to so many domains of life—from marital fidelity to criminal behavior, from financial stability to academic performance (e.g., Baumeister, Heatherton, & Tice, 1994; Mischel et al., 2011)—it should come as no surprise that a number of different social psychological phenomena seem to affect it. For example, autonomous motivation (Deci & Ryan,

1985), self-affirmation (Steele, 1988), mindfulness meditation (Brown, Ryan, & Creswell, 2007), and incremental theories of intelligence (Dweck, 2006) have all been shown to improve aspects of self-regulation, including self-control. Emerging evidence suggests that these improvements in control occur because these various phenomena evoke the same distress-control dynamic we have outlined above. Specifically, these diverse phenomena may increase control because they amplify the type of short-lived distress response that we suggest is so crucial to self-control. Further, these phenomena may increase control because they also increase an openness to distress, a type of non-judgmental stance that allows people to orient to the source of distress and thus do something about it (Kashdan & Rottenberg, 2010). In other words, these phenomena short-circuit defensive responding to distressing events and instead foster a sort of openness that fosters effective self-control. By suggesting that these diverse phenomena work through the same distress-control dynamic, this may further suggest that these phenomena are not so different after all. We start our chapter by outlining the affect alarm model of control and providing details of the various components of the model.

Affect Alarm Model of Control

Historically, when it has come to understanding the will, emotion has been at the bottom of the list. So, the proposition that negative affective states like distress form an integral part of self-control might seem counterintuitive. This is because emotion has long been considered the antithesis of reason, with reasoned action the master and bestial emotion the slave (Descartes, 1989/1649; Damasio, 1994; Solomon, 2008). Contemporary views, however, suggest that emotion and cognition are fully integrated and only minimally decomposable (e.g., Pessoa, 2008), which opens the door to the idea that emotions play a central, integral role in cognition, including higher cognitive functions like executive function or self-control.

Control is Initiated by Conflict. The affect alarm model suggests that self-control is instigated by conflict, by which we mean any disagreement or discrepancy between competing mental representations, response tendencies, or actual behavior. We have already mentioned how the conflict between the goal of losing weight and the desire to eat french-fries can instigate control, but other examples abound: cognitive conflict is aroused when having to choose between two desirable choices, when having to choose between a large reward now and an even larger reward later, when wanting to write a chapter but also wanting to check email, or when needing to name the color of a word but also having the strong urge to read it. Conflict is a common starting point for the process of self-control, with many other models starting similarly. Indeed, converging evidence from cybernetics, animal models, neuroscience, and social and personality psychology suggests that goal and response conflicts act as the instigator of control.

Conflict plays a critical role in cybernetic or homeostatic models of self-control, which suggest that control hinges on a simple feedback-loop process that checks for disagreements between desired end states (i.e., goals) and current states of the environment (Carver & Scheier, 1981; Wiener, 1948). Cybernetic principles have been widely used to model control in the behavior or humans and machines. They have been successful because they emphasize the decision point when self-control is initiated—specifically, when things deviate from what is ideal. What starts self-control, in other words, is the presence and detection of conflict. This type of conflict is present, for example, when a depressed person sets the goal of not ruminating on their thoughts, but catches themselves doing just that. Indeed, self-control errors or mistakes of this type are paradigmatic, albeit acute (Yeung & Cohen, 2006), forms of conflict in that they signal the potential for goal failure (Gehring, Goss, Coles, Meyer, & Donchin, 1993). The detection of conflict or error is what gets remedial, instrumental action started to bring the

current state of the environment closer to ideal goal states. As we will see below, cybernetic models further suggest that this detection of conflict produces an emotional response that expedites the instrumental actions that contribute to control.

According to revised *reinforcement sensitivity* theory (RST; Gray & McNaughton, 2000; Corr, 2008), goal conflict activates the motivational system that is responsible for the braking or stopping of ongoing behavior, the behavioral inhibition system (BIS). Based on animal models, behavioral neuroscience, and the pharmacological effects of classic and modern pharmacological agents, revised RST suggests that behavior depends on three underlying motivational systems—a system sensitive to reward (the behavioral approach system), another sensitive to punishment (the flight-fight-freeze system), and a third (the BIS) that regulates conflicts that arise within and between the other two systems (Corr, 2008). BIS can be conceptualized as the control system because when it detects goal conflicts, it overrides or inhibits all ongoing behavior while the organism attempts to resolve the conflict to determine the best course of action. Critically, BIS recruits avoidant-motivated, negative affect and is widely considered as the neural substrate of anxiety (Gray & McNaugton, 2000). In short, BIS is sensitive to conflict and reacts to it by recruiting anxious phenomenological states that help put the brakes on ongoing behavior to eliminate goal conflict.

Conflict also plays a large role in a prominent cognitive neuroscience theory of control, *conflict monitoring theory* (Botvinick, Braver, Barch, Carter, & Cohen, 2001; Yeung, Botvinick, & Cohen, 2004). According to this model, control is implemented by two separate neural systems. The first is described as a system that scrutinizes moment-to-moment mental representations for the presence of conflicting response tendencies (Botvinick et al., 2001) or between what is predicted and what actually happens (Holroyd & Coles, 2002). When conflict is

detected, this information is passed to the second, regulatory system, which implements the desired response while suppressing incompatible ones. Neuroimaging studies have suggested that these systems are implemented by the anterior cingulate cortex (ACC) and the dorsolateral prefrontal cortex (DLPFC), respectively (e.g., Kerns et al., 2004). For example, on incongruent trials of the color-naming Stroop task, participants may see the word "red" presented in green font and asked to name the color of the word, but not read it. Because reading is an over-learned response for literate adults, the word "red" in green will activate both the urge to read the word, but also the task-goal of naming the color, which are action tendencies that are in conflict with one another. When these same participants make errors on the Stroop task, their (positively-biased) expectation of success conflicts with the actual outcome they experience. Whether construed as the competition between response tendencies or between expectations and outcomes, conflict is seen as the instigator of subsequent self-control. Thus, upon seeing an incongruent trial or making an error, participants will typically engage in control by slowing down, re-calibrating, and re-engaging with the task so as to maintain accuracy (Rabbitt & Rodgers, 1977). Although not stressed by conflict monitoring theory, increasing evidence suggests that the conflict in conflict monitoring is not affectively neutral, with the neural substrate of conflict detection—the ACC—sensitive to pain, distress, and other negative emotions (Shackman et al., 2011). Much of the evidence we present later in this chapter comes from measures of evoked brain potentials that are widely thought to relate to cognitive conflict, but also to negative affect (e.g., Inzlicht & Al-Khindi, 2012).

Social and personality psychology theories also stress the importance of conflict in instigating control, with some theorists suggesting that the detection of conflict is the "defining feature of self-control phenomena" (Hofmann & Kotabe, 2012; p. 711; also see Myrseth &

Fishbach, 2009). For example, effective thought control is believed to rely critically on a monitoring process that scans for thoughts that are inconsistent or in conflict with an intended state (Wegner, 1994). Conversely, deficient self-control—such as that which occurs when people fail to exert control because they have engaged in a previous, depleting task (Baumeister & Heatherton, 1996)—can occur when people fail to attend and react to the presence of goal and response conflict (Inzlicht & Gutsell, 2007; Inzlicht & Schmeichel, 2012). Finally, a new model of adaptive control (Shackman et al., 2011) suggests that self-control is initiated whenever there is a high need to determine an optimal course of action, such as when people face uncertainty. And, uncertainty can be conceived as a type of conflict between various competing behavioral and perceptual affordances (Hirsh, Mar, & Peterson, 2012). Critically, while uncertainty involves cognitive calculation, it is fundamentally an aversive experience, which people are motivated to avoid.

Conflict Arouses Avoidant Distress. The affect alarm model suggests that mere conflict is insufficient to motivate control; what is also needed is an affective, aversive, and avoidant response to conflict. Without the heat of emotion, conflicts may go undetected— or they may go unresolved even if detected because of a lack of urgency brought about by the desire to reduce the aversive state. Aversive affect is therefore necessary for self-control.

Before presenting evidence linking conflict with aversive arousal, it is important to define and discuss a few terms and issues concerning affective processes. We use the broad term "affect" to describe the emotions that may be triggered by conflict. Affective states are multi-faceted, whole-body response involving changes to subjective experience, physiology, and behavior (Mauss, Levenson, McCarter, & Wilhelm, & Gross, 2005). However, although often assumed, these response systems do not always cohere (Mauss et al., 2005), which suggests, for

example that subjective “feelings” may be dissociated from physiological responses. And, indeed, research suggests that affective states can occur without conscious subjective experience of either the cause of the affect or of the affective state itself (Winkielman & Berridge, 2004; Winkielman, Berridge, & Wilbarger, 2005). What is more, affect can vary on its speed, with some “full-blown emotions” being slow to rise and slow to dissipate, and other affective states being more like quick twinges that may not be conscious, arising very rapidly, possibly within fractions of a second, and maybe dissipating just as quickly (LeDoux, 1989; Zajonc, 1980). Transient, phasic, or unconscious affects are more likely than full-blown emotions to signal the need for control because consciously-experienced emotions are too slow and complex to be useful as self-control signals (Baumeister, Vohs, DeWall, & Zhang, 2007). In fact, full-blown emotions can get in the way of good self-control (Schmeichel & Inzlicht, in press).

Cybernetic models specify that controlled processing is instigated by the detection of some discrepancy from what is ideal. This detection process, however, may be far from affectively neutral, with the detection of fast-changing discrepancies producing positive affect and slow-changing discrepancies, negative affect (Carver & Scheier, 1990). Critically, while positive affect can sometimes lead to the slackening of goal pursuit, for example, through self-licensing (De Witt Huberts, Evers, & De Ridder, 2012), negative affect sometimes hastens goal pursuit and hence discrepancy reduction (Carver & Scheier, 2011). Negative affect, in other words, instigates control by orienting people to the fact that a discrepancy was detected and that discrepancy reduction and hence control are required. It not only orients people to discrepancy, it motivates its reduction because people naturally want to reduce negative affect and maximize positive affect (Freud, 1920/1952). The point here is that feedback-loop models of control posit an important role for negative affect in prompting control. Some animal models do the same.

According to revised RST (Gray & McNaughton, 2000), BIS is not only involved in conflict detection and resolution, but forms the basis of a general anxiety network in the brain. Revised RST suggests that BIS functioning contributes to feelings of anxiety, and may be experienced phenomenologically as worry, caution, and vigilance (Carver & White, 1994). Anxiolytic drugs like Valium, Xanax, or Diazepam act on the neural substrates of BIS, most notably the septo-hippocampal comparator system, but also the ACC and the locus coeruleus-norepinephrine system (Gray & McNaughton, 2000). Norepinephrine is a catecholamine neurotransmitter that is associated with attention (Aston-Jones & Cohen, 2005), but also with alerting, sensory arousal, and anxious distress (Panksepp, 1998). For example, single-cell recording studies suggest that norepinephrine neurons in the locus coeruleus (in the brain stem) are sensitive to emotional stressors (Abercrombie & Jacobs, 1987). The release of norepinephrine thus appears to be one of the key processes in the cascade of neural activity underlying anxiety, and a vital part of the conflict-detecting BIS.

Further evidence for conflict's aversive nature comes from work on the error-related negativity (ERN), a negative voltage deflection in the event-related brain potential that peaks around 100 ms after error and thought to be generated by the ACC (Dehaene, Posner, & Tucker, 1994; Gehring et al., 1993). Although widely assumed to reflect the cold detection of conflict, recent work suggests that the ERN reflects an emotional, distressed response to errors (e.g., Inzlicht & Al-Khindi, 2012; Luu, Collins, & Tucker, 2000). The ERN, as the name implies, is time-locked to errors, and errors are typically distressing. Errors, for example, prompt increased skin conductance, greater heart rate deceleration, increased pupil dilation, and larger startle reflexes compared with correct responses (Critchley et al., 2003; Hajcak & Foti, 2008; Hajcak, McDonald, & Simons, 2003). The ERN may thus reflect not only the detection of an error but

also the avoidant affect that accompanies such detection. This may be why the ERN not only predicts improved cognitive performance (Hirsh & Inzlicht, 2010; Larson & Clayson, 2011), but also individual differences in negative affectivity, including anxiety disorders (Hajcak, McDonald, & Simons, 2004). Findings such as these hint at the possibility that distressed affect plays a key role in linking the detection of conflict and instrumental behaviors to resolve the conflict.

Basic research in social psychology further confirms the distressing nature of cognitive conflict. Cognitive dissonance (Festinger, 1957) is a term used to describe the feelings of discomfort when simultaneously holding in mind two or more conflicting thoughts, or two or more action-tendencies (Harmon-Jones & Harmon-Jones, 2008). Although there was once a dispute as to the nature of dissonance (e.g., Bem, 1967), most researchers now agree that dissonance is fundamentally distressing (e.g., Croyle & Cooper, 1983; Proulx, Inzlicht, & Harmon-Jones, 2012; Zanna & Cooper, 1974) with people actively motivated to reduce its presence and effects. In sum, while conflict prompts control, many lines of evidence suggest that conflict is distressing. The affect alarm model suggests that conflict initiates control via its effects on these avoidant affective states.

Distress Recruits Control. The affect alarm model suggests that control is instigated by the presence of conflict that arouses aversive and avoidant affective states. It further suggests that these states of distress (1) alert people to the presence of conflict and (2) motivate actions to reduce the distress, including resolving the conflict itself.

One reason aversive affect helps recruit control is that affect, both avoidant and appetitive, is especially likely to influence attention and mobilize the organism for action (Bradley, Codispoti, Cuthbert, & Lang, 2001). This is why emotional stimuli are viewed for

longer than neutral pictures (Lang, Bradley, & Cuthbert, 1997), are associated with extremely fast electrocortical responses reflecting visual attention (Smith, Cacioppo, Larsen, & Chartrand, 2003), and can intrude into attention when attentional resources are otherwise occupied (Anderson & Phelps, 2001). Emotional stimuli preferentially capture attention because they typically signify the presence of something motivationally relevant or salient (Hajcak, Weinberg, MacNamara, & Foti, 2012).

Emotions exist to signal states of the world that have to be responded to; they help prepare an organism for effective action (Frijda, 1988; Izard, 2010). Although some have placed boundary conditions on the degree to which emotions prompt actions (Baumeister et al., 2007), emotions are often described as adaptive. That is, they orient people to the motivationally salient aspects of their environments and drive intelligent behaviors (Damasio, 1994). Thus, when the goal conflict faced by a dieter arouses anxious distress, this aversive state not only helps her attend to the presence of conflict, it also helps her prepare for actions to reduce this aversive state. People are typically motivated to avoid pain and distress (Freud, 1920/1952), which may be why people tend to respond to distressing events by taking actions to diminish them.

As we have already mentioned, cybernetic models place great importance on the detection of conflict as the decision point that gets control started. When conflict is detected this feeds forward to the motor of control that labors to reduce conflict. Critically, when the rate of conflict reduction is below some internal criterion, this produces negative affect that acts to hasten the rate of conflict reduction by feeding-back and pumping the motor of self-control (Carver & Scheier, 1990). Similarly, BIS responds to goal conflict by recruiting anxious states of distress that help put the brakes on ongoing behavior so that an organism can quickly determine the optimal course of action. BIS, that is, functions to resolve goal conflict by inhibiting or

overriding movement toward goals, by increasing states of arousal to allow for split-second changes in behavior, and by increasing attention via environmental scanning or other forms of risk assessment (Gray & McNaughton, 2000).

Cognitive neuroscience models of control suggest that the output of the conflict monitoring system is to inform control centers in the brain, especially the DLPFC, when to execute behavior (Botvinick et al., 2001). And there is an abundance of evidence that this conflict system—which is often measured by the ERN and is intricately related to distress (Hajcak & Foti, 2008; Shackman et al., 2011)—reliably predicts self-control. This includes research linking the ERN with low-level indices of control, such as the degree to which participants slow down and recalibrate after making an error on a speeded reaction-time task (Bartholow et al., 2012), or the frequency of errors on a test of executive function (Inzlicht & Al-Khindi, 2012), or overall performance on tests of cognitive control (Larson & Clayson, 2011); but, it also includes research linking the ERN to higher-level indices of control such as better control of racist impulses (Amodio, Devine, & Harmon-Jones, 2008), better grades in college (Hirsh & Inzlicht, 2010), and better emotion-regulation in daily life (Compton et al., 2008).

Finally, a number of models in social and personality psychology suggest that conflict, and the states of anxious distress that accompany conflict, prompt the sorts of approach-motivated states that underlie action, and possibly controlled actions. Specifically, the action-based model of dissonance (Harmon-Jones & Harmon-Jones, 2008) and the model of reactive approach motivation (Nash, McGregor, & Prentice, 2011) suggest that psychological conflicts evoke aversive states that can be overcome by motivational impulses that facilitate effective action. Although the sorts of actions that are invoked by these models are not limited to deliberative and controlled acts, it is interesting to note that both classes of actions are thought to

be implemented by the same DLPFC brain region (Kerns et al., 2004; Pizzagalli, Sherwood, Henriques, & Davidson, 2005), hinting to some deep functional overlap between them. In sum, conflict-related distress prompts control because it recruits attention to the presence of conflict and further motivates a person to act to reduce such conflict.

Moderating the Affect Alarm: Emotion Acceptance. Whether the affect alarm instigates self-control depends critically on questions about whether the signal is heeded. In other words, negative affect is not enough to recruit control. What is also needed is a sensitivity and receptivity to the aversive affective state. When people are sensitive to the emotions they experience and open-minded about those experiences, they not only have the power to make the correct attribution of what instigated the emotion, they can also accept and "hear" the information conveyed by the emotion. This is consistent with work in the area of emotional intelligence, which suggests that affect is only functional to the extent that people can accurately perceive and understand it (Mayer, Caruso, & Salovey, 1999; Salovey & Mayer, 1989). While a number of emotion-related factors may moderate the affect alarm, the one we focus on here is emotion acceptance.

We suggest that the efficiency of the affect alarm is increased when people respond to their emotions with an attitude of openness, curiosity, and acceptance. Thus, simply being aware of one one's emotions is not enough; what is also needed is an accepting, flexible, and non-judgmental stance towards those emotions (Cardaciotto, Herbert, Forman, Moitra, Farrow, 2008; Kashdan & Rottenberg, 2010). People who can experience their affective states—especially aversive ones—without defense, judgment, or a desire to escape them, can "hear" the information the emotion is trying to convey about their current situation. These sorts of people are receptive to their affect, and when the affect signals the presence of goal conflict, they can

then act on them by recruiting instrumental control. In contrast, people who avoid or suppress their negative affect will be unable to use this information to motivate subsequent action.

The affect alarm model suggest that control can only be prompted to the extent that people are receptive to their affective states, especially the aversive states that are hypothesized to alert people to the presence of goal conflicts. What this means is that while a research participant will likely experience a quick surge of anxiety when she is asked to name the color of the word "red" printed in green, instrumental control will only be recruited to the extent that she is receptive and maybe even curious about her transient anxiety. And, as we will see below, new research is now beginning to confirm this idea.

Unifying Diverse Psychological Phenomena

The idea that the acceptance of distress promotes self-control by underscoring and rectifying response conflict is central to the affect alarm model of self-control. In line with this premise, the model predicts that a number of seemingly diverse psychological phenomena should promote emotional agility in the service of optimizing performance. In particular, we suggest that autonomy, self-affirmation, mindfulness meditation, and a growth-oriented mind-set all increase self-control by enhancing openness and responsiveness to errors, conflict, and threat. In other words, the acceptance of negative affect provides a mechanism through which these various phenomena elicit their effects on self-control.

Autonomy Boosts Self-Control Through the Integration of Experience. The experience of autonomy, which involves feelings of self-direction and volition (as opposed to feeling pressured or coerced), is critically linked to self-regulation. For instance, autonomy predicts adherence to weight loss programs (Teixeira et al., 2010; Williams, Grow, Freedman, Ryan, & Deci, 1996), likelihood of quitting smoking (Williams et al., 2006; Williams, Niemiec,

Patrick, Ryan, & Deci, 2009), alcohol abstinence (Ryan, Plant, & O'Malley, 1995), and compliance with pharmacological treatment for disease (Williams et al., 2009). Autonomy also appears to play an important role in long-term persistence (Pelletier, Fortier, Vallerand, & Brière, 2001), as well as problem-solving (Moller, Deci, & Ryan, 2006).

At a lower level of analysis, autonomy has recently been shown to predict better performance on self-control tasks (Legault & Inzlicht, in press). That is, individuals with an autonomous motivational orientation have been shown to commit fewer errors on the Go/No-Go task, compared to their less autonomous counterparts. In a follow-up study where autonomy was manipulated by enhancing task choice and interest, autonomy-supported individuals performed better on a Stroop Task compared to those who were externally coerced or those in a neutral condition (Legault & Inzlicht, in press).

One key finding that can explain the link between autonomy and self-control is that autonomy promotes openness and integration of ongoing experience. One feels autonomously motivated when one is engaged in an activity that is either interesting or personally important. Autonomously functioning individuals are connected to their "core self"; values and behaviors are self-determined (in contrast, externally-coerced individuals' sense of self is socially-defined and their self-worth is contingent upon social standards). Because of this focus on authenticity, those who function autonomously are accuracy-motivated, maintaining openness and responsiveness to reality, whereas externally-coerced individuals are directed by contingencies of self-worth and defensiveness (Hodgins & Liebeskind, 2003).

For instance, research indicates that those high in autonomy do not display self-serving biases (Knee & Zuckerman, 1996). That is, they make fewer self-enhancing attributions for success and fewer defensive attributions for failure compared to coerced individuals, suggesting

low defensiveness. In addition to increasing self-awareness (Deci & Ryan, 1985), autonomous motivation also promotes the acknowledgment and acceptance of negative affect, criticism, personal shortcomings, and threatening self-relevant information (Hodgins et al., 2010; Weinstein, Deci, & Ryan, 2011). More specifically, autonomously motivated people show self-integration of both positive and negative personal characteristics and past behaviors; whereas externally-coerced individuals tend to accept positive personal attributes and behaviors while rejecting and denying negative ones (Weinstein et al., 2011). In line with the affect alarm framework, we suggest that it is precisely because of this openness to experience and feedback, particularly negative experience and feedback, that autonomous motivation promotes self-control. Because an autonomous motivational orientation is task-focused rather than ego-involved, there exists a drive to perceive information accurately and honestly in order to learn and grow.

Self-Affirmation Boosts Self-Control by Reducing Defensiveness. Self-affirmation refers to behavioral or cognitive events that sustain, support, and strengthen the perceived integrity of the self (Steele, 1988; Sherman & Cohen, 2006; see also Alicke & Sedikides, 2009). When integrity is threatened (i.e., when one encounters information that undermines the competence or goodness of the self), people may respond by denying, minimizing, or generally transforming the threatening information through defensive reactions. But, through the process of self-affirmation, threats to integrity can be managed in an adaptive way that preserves self-worth and also promotes accurate responsiveness to threats (Sherman & Cohen, 2006). This process often involves simple reminders of important aspects of the self (e.g., one's deeply held values). Thinking about alternative sources of one’s value or competence – that is, important aspects of the self not tied directly to the threat itself – is thought to help buffer against the

anxiety and stress that comes from failure. By affirming integrity in this way, one's sense of self becomes secured in one's broader view of the self as good, and there is less need to defend against the threat. Like autonomous individuals, self-affirmed people can focus on the demands of the situation, setting aside the need to protect their ego.

We suggest that self-affirmation improves self-control in much the same way as autonomy; that is, self-affirmation enhances self-control by strengthening self-worth, thereby lowering defenses against potential self-threat. Past work has shown that self-affirmation eases the absorption of negative feedback and other threats to the self, such that self-affirmed individuals shed defensiveness in favor of more candid and impartial responses. For instance, whereas people typically tend to resist threatening health-related information, self-affirmation has been shown to increase the acceptance of such information, facilitating awareness of potential health risks and promoting contemplation of the personal implications – leading to higher motivation to engage in corrective responses (Sherman, Nelson, and Steele, 2000). In the same way, self-affirmation encourages openness to counter-attitudinal views (Cohen, Aronson, & Steele, 2000). When self-affirmed, people seem to accept negative information and personal flaws as plausible, which fosters the flexibility to solve future problems. Not only does self-affirmation counteract threats to self-esteem, it also improves self-control, including pain tolerance, task persistence, and delay of gratification (Schmeichel & Vohs, 2009). In line with the affect alarm framework, it appears that self-affirmation promotes openness to threat, and that such openness improves functioning – including task performance – by boosting attention to sources of threat in order to correct future behavior (Legault, Al-Khindi, & Inzlicht, 2012).

Mindfulness Meditation Boosts Self-Control by Increasing Emotional Acceptance. Practitioners of meditation are taught to attend to all thoughts, sensations, and feelings, but also

to receive these experiences in a non-judgmental way. Indeed, both present-moment awareness and mindful acceptance of emotional states are fundamental principles of mindfulness meditation practice (Cardaciotto et al., 2008). Mindfulness is a state of *being* in which receptiveness to internal and external stimuli is paramount. This is quite distinct from common forms of processing, which fall prey to cognitive distortions such as attributions, judgments, appraisals, and rationalizations.

Because meditators invest such effort and focus on openly perceiving as well as attentively monitoring emotional experience, it is not surprising that they also show superior self-control. It has been shown, for instance, that experienced meditators excel at conflict monitoring on the Attention Network Test (Jha, Krompinger, & Baime, 2007). Even short-term meditation practice improves executive function, as measured by performance on the Stroop task (Wenk-Sormaz, 2005), the Internal Switching Task (Chambers, Lo, & Allen, 2008), and the Attention Network Test (Tang, Ma, & Wang, 2007). As a dispositional trait, mindfulness enhances behavior regulation, psychological health, and interpersonal relationships (Brown et al., 2007). In addition, it has been found that trait mindfulness is positively associated with autonomous self-regulation and congruence between implicit and explicit affect (Brown & Ryan, 2003). It also reduces impulsive responding (Wenk-Sormaz, 2005) and promotes tolerance of distressing emotional states, such as anxiety and fear (Eifert & Heffner, 2003). In line with the affect alarm model of control, we suggest that it is because mindfulness facilitates openness to negative emotion and self-threat (e.g., Brown, Ryan, Creswell, & Niemiec, 2008), that it allows people to connect with their mistakes and shortcomings, thus granting them the ability attend to and resolve the sorts of goal conflicts that precede self-control.

Incremental Theorists See Negative Feedback as Opportunity. Dweck's model of implicit theories of intelligence (TOIs; Dweck, 1999; Dweck, 2006) distinguishes between individuals who believe that intelligence is unchangeable and stable (i.e., *entity theorists* or those who have a *fixed mind-set*) and those who believe intelligence is malleable and can be developed incrementally through learning (i.e., *incremental theorists* or those who have a *growth mind-set*). Relative to entity theorists, incremental theorists focus more on learning goals than performance goals (Dweck & Leggett, 1988); tend to make mastery-oriented rather than helplessness attributions for failure (Henderson & Dweck, 1990; Robins & Pals, 2002); and believe in the utility of effort (Hong, Chiu, Dweck, Lin, & Wan, 1999). These two ways of thinking about intelligence are associated with two distinct meaning systems that have important consequences for performance, achievement, and self-control. Various studies have suggested that those with an incremental view of intelligence demonstrate better academic performance than those with an entity view (Henderson & Dweck, 1990; Blackwell, Trzesniewski, & Dweck, 2007; Good, Aronson, & Inzlicht, 2003). Similarly, relative to those with a fixed mind-set, those with an incremental view demonstrate superior executive control, as demonstrated in their performance on a working memory task (Plaks & Chasteen, in press) or on tests of processing fluency (Miele & Molden, 2010). In addition, individuals who believe that self-control is a limited (vs. unlimited) resource tend to set fewer New Year's resolutions, and are also less likely to succeed at those resolutions (Mukhopadhyay & Johar, 2005).

Much like autonomous, self-affirmed, and mindful individuals, incremental theorists display adaptive responses to failure. Whereas entity theorists view failure as an indication of their own immutable lack of ability and tend to abandon tasks when they fail at them, growth-minded incremental theorists see failure as potentially instructive feedback and are more likely to

learn from their mistakes (Dweck, 1999; Utman, 1997). This may be because incremental theorists are likely to interpret their shortcomings and difficulties as signs that their knowledge and abilities are still developing (Blackwell et al., 2007; Miele & Molden, 2010). Instead of shrinking at errors, incremental theorists view them as part of the growth process. Consistent with the affect alarm model of control, then, incremental mindsets may improve performance, including on self-control tasks, because they allow people to adaptively respond to errors in order to learn and grow from them.

A Neural Bottleneck for Diverse Phenomena

An important mechanism underlying each of the aforementioned psychological phenomena is error-related distress. Indeed, recent evidence suggests that brain-based distress responding helps to explain the effects of autonomy, self-affirmation, mindfulness, and learning orientation on self-control. In particular, activity in ACC appears to mediate the effects of each of these psychological states. As previously explained, the ACC is sensitive to response conflict. And, one of the most reliable neural markers of this conflict-related distress is the ERN, an event-related potential representing a neurophysiological response generated by the ACC (Dehaene et al., 1994) and occurring within 100 ms of making an error (Gehring et al., 1993). Since errors are usually associated with some degree of distress, as well as the physiological changes that accompany such distress (e.g. Critchley et al., 2003; Hajcak et al., 2003; Hajcak and Foti, 2008), it is not entirely surprising that the ACC and ERN have been found to be associated with negative affect, uncertainty, anxiety, and psychological pain (Bush, Luu, & Posner, 2000; Gehring et al., 2000; Ridderinkhof, Ulsperger, Crone, & Nieuwenhuis, 2004; Shackman et al., 2011).

Autonomy and the ERN. Recent work has shown that both trait-level and state-induced autonomy are linked to the ERN (Legault & Inzlicht, in press; see also Amodio et al., 2008). When those high and low in autonomy completed a Go/No-Go task while ERN amplitudes were recorded using electroencephalography, those high in autonomy showed greater self-control (i.e. fewer errors) and a higher ERN. A test of mediation further revealed that the ERN accounted for the link between autonomy and self-control. Thus, as autonomous motivational orientation increased, the ERN increased as well, which was related to increases in performance. In a follow-up study, autonomy was manipulated: participants were assigned to a condition in which autonomous motivation toward the task was contextually supported vs. undermined vs. a neutral control condition. Results revealed that the support of autonomy increased Stroop performance, and this effect was mediated by heightened ERN amplitude. Thus, autonomy increased neuroaffective responsiveness to errors, which led to better self-control.

Self-Affirmation and the ERN. Self-affirmation also increases the ERN (Legault, Al-Khindi, & Inzlicht, 2012). Participants in one study were assigned to either a self-affirmation or non-affirmation condition. Those who asserted their core values, that is, those who engaged in self-affirmation, demonstrated larger ERNs on a subsequent Go/No-Go test than did non-affirmed participants. They also performed better on the test, as evidenced by fewer errors. As this study reveals, affirmation of core values appears to anchor self-esteem and lower defensiveness, thereby attuning people to errors so that mistakes can be corrected.

Mindfulness and the ERN. Echoing the above-mentioned findings, Teper and Inzlicht (2013) have recently shown that mindfulness also predicts ERN amplitudes. When mindfulness meditators and community-matched control participants completed a Stroop task (during which their ERN amplitudes were recorded), meditators showed greater self-control (i.e. fewer errors),

as well as higher ERNs. Moreover, mediators showed greater emotional acceptance than did controls. A test of mediation revealed that the link between meditation practice and self-control was explained by both emotional acceptance and increased brain-based performance monitoring (i.e., ERNs). Meditators are typically experts in emotion regulation (Brown, Goodman, & Inzlicht, 2013; Perlman et al., 2010). But, it is also the case that meditators are highly in sync with their emotions (Niemiec et al., 2010; Teasdale et al., 2002). Indeed, mindfulness meditation appears to enhance attention to the emotions associated with making errors, and thereby improve performance (Teper & Inzlicht, 2013).

Learning Orientation and Error Positivity. Finally, recent work has shown that having a growth mind-set is associated with enhanced error positivity (Moser et al., 2011). Error positivity (Pe) is a later occurring event-related-potential component, appearing after the ERN on error trials and is thought to represent awareness and allocation of conscious attention to mistakes (Hughes & Yeung, 2011; Nieuwenhuis, Ridderinkhof, Blom, Band, & Kok, 2001; Steinhauser & Yeung, 2010). Like the ERN, the Pe plays a role in on-line error monitoring, and correlates with adaptive behavioral adjustments following errors (Compton et al., 2008; Frank, D'Lauro, & Curran, 2007; Hajcak, McDonald, & Simons, 2003; Themanson, Pontifex, Hillman, & McAuley, 2011). Moser and colleagues (2011) demonstrated that incremental theorists performed better on a flanker task compared to entity theorists, likely because they interpreted mistakes as "growing pains" rather than evidence of failure. More to the point, the Pe mediated the relationship between mind-set and performance, underlining the idea that error-related awareness and distress increases the ability to rebound from mistakes.

Discussion

Although negative affect is painful and counterproductive in large doses, it serves a vital function in self-control. Without it, people would not know when self-control efforts were lacking and in need of correction. Negative affect is thus an adaptive feedback signal that accompanies deficiencies in goal progress and thereby drives optimal performance. However, it is not simply the presence of distressed affect that instigates this reactive form of self-control. The capacity to detect and accept it is just as important. As we have seen, individuals vary considerably in the extent to which they acknowledge and heed their negative emotions and experiences. Indeed, autonomous motivation, self-affirmation, mindfulness meditation, and an incremental learning orientation all foster the openness and non-defensiveness required to earnestly attend to and accommodate feelings of distress.

While the affect alarm framework casts negative affect in a starring role in self-control, the evidence presented here also points toward the more general salutary effects of negative affect on growth and wellbeing. Autonomously motivated individuals, for instance, are likely to integrate both positive and negative experiences to a similar degree, which contributes to feelings of authenticity, cohesion, and wellbeing (Weinstein et al., 2011). When negative affect is accepted for its accuracy and instructive value, people feel more genuine and self-determined. Although facing negative emotion and experience may be painful and distressing in the short term, the integration of negative affect and experience (rather than the denial thereof) leads to better emotion regulation over time (Hodgins & Knee, 2002). Presumably, one must be able to recognize, experience, and accurately understand emotion in order to regulate it effectively. This may help to explain why the acceptance of negative affect is related increases in wellness. For instance, a recent study revealed, somewhat paradoxically, that accepting negative affect may in fact reduce feelings of depression. Shallcross and colleagues (2011) assessed levels of stress and

depressive symptoms among individuals who had recently been through a stressful experience that had a negative impact on their lives. Then, four months later, symptoms were measured again. The researchers found that those who accepted their negative feelings about their difficult experiences showed reductions in depression and negative affect. In contrast, those who measured low on acceptance of negative affect demonstrated an increase in negative symptoms.

Despite the significant intersection of negative affect and adaptive functioning, we are mindful not to overstate the benefits of distress. Here, we are referring to the functional role of transient negative affect rather than the debilitating effects of prolonged or full blown negative emotions. We certainly do not suggest that negative emotions are conducive to goal regulation or wellness in general, especially if they are chronic (see Inzlicht et al., 2013). Indeed, strong or pervasive negative feedback undermines motivation, self-control, and performance (Seligman, 1975; Gillet, Vallerand, Lafreniere, & Bureau, in press). By the same token, positive emotion and supportive feedback are vital to goal regulation and attainment, as well as to well-being. What we are suggesting is that attention to and acceptance of the phasic changes in affect are integral to the dynamic regulation of feelings and action. And it is negative affect, in particular, that signals when attention is most needed.

Conclusion. The main contribution of the affect alarm model of self-control is to suggest that aversive, avoidant affect plays an instrumental role in recruiting self-control. Affect, according to our model, is not merely an interloper that moderates control from the outside, nor is it merely an object or product of self-control. Rather, it is essential to self-control, signaling when it is needed by amplifying the detection of conflict and giving urgency to conflict resolution (Inzlicht et al., 2013). Thus, the central aim of this chapter was to highlight the integral role of negative affect in instigating and motivating control.

This chapter also highlights the power of neuroscience to unite seemingly diverse phenomena. Since its inception, social neuroscience has been touted as providing many benefits (Cacioppo & Berntson, 2002; Kang, Inzlicht, & Derks, 2010; Harmon-Jones & Winkielman, 2007; Ochsner & Lieberman, 2001). These include the ability to measure implicit processes as they occur, the ability to get at underlying and basic processes that drive our phenomenon of interest, and the ability to integrate across multiple levels of analysis, which allows for the refinement and constraint of psychological theories (Wilson, 1998; however, see Kihlstrom, 2006).

The various studies we have discussed suggest an additional benefit of social neuroscience—it has the potential of unifying psychology. Because social neuroscience reduces social psychological phenomena to a core set of functions and mental modules, it reveals links between otherwise distinct phenomena. The finding that autonomous motivation, self-affirmation, mindfulness meditation, and incremental mindsets all foster better control coupled with the finding that they each foster control because of their respective impact on brain-mediated, conflict-related distress and the non-defensive acceptance of such distress suggests that these phenomena may not be so different after all. Rather, these phenomena fall under the same mechanistic umbrella, namely they each defuse defensive responding to distressing events—including to goal conflict—and instead nurture a sort of acceptance that fosters effective self-control.

By suggesting that these seemingly diverse phenomena work through the same distress-acceptance-control dynamic, it has the potential to unify these phenomena. And it begs the question: at their heart, are self-determined motivations, self-affirmed states, mindful states, and learning orientations all the same thing? Likely, there are many surface differences, but it is our

hope that the kind of work we have presented here will stem the proliferation of “new” mini-theories or phenomena that clutter our field and instead usher in an era of larger, more integrative theories that span sub-disciplinary boundaries (Proulx & Inzlicht, 2012). By offering mechanistic bottlenecks, we believe that neuroscience has the potential to do just that.

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