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Automatic Emotion Regulation

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Abstract

How do people effectively regulate their emotional reactions? Why are some people better at this than others? Most prior research has addressed these questions by focusing on *deliberate* forms of emotion regulation. We argue that this focus has left out an important aspect of emotion regulation, namely, *automatic* emotion regulation (AER). Our review of the behavioral literature suggests that AER is pervasive in everyday life, and has far-reaching consequences for individuals' emotions. However, the behavioral literature has yet to address the mechanisms underlying the observed effects. Because it is difficult to directly measure the processes involved in AER, evidence from neuroscientific studies is particularly helpful in addressing these questions. Our review of the neuroscientific literature suggests distinct neural bases for different types of AER, which provides important clues about the cognitive and behavioral processes that might be involved in AER.

Remember the last time you were in a hurry but had to wait for the driver in front of you to clumsily parallel park his car? Chances are that in this situation (or others like it), you may have felt like honking or yelling out of the car window. But did you actually do either of these things? Probably not. You might have consciously told yourself to calm down, determinedly gripping the steering wheel and clenching your teeth. However, in many such instances – when you resist giving in to emotional impulses – you do not do so consciously, but rather *automatically*. Your habit of not venting your anger at incompetent drivers or your familiarity with the well-learned rule not to shout angrily in public might not even enter your mind.

Our goal in this article is to consider such automatic processes in emotion regulation. We begin by defining emotion and emotion regulation, and distinguishing between deliberate and automatic emotion regulation. We argue that most recent research has focused on deliberate aspects of emotion regulation, paying less attention to automatic aspects. We then explain why we expect *automatic* emotion regulation (AER) to be important for shaping individuals' emotional responses and well-being. Next, we review the empirical evidence on the experiential, behavioral, and physiological correlates of AER. This review suggests heterogeneous correlates of AER, with some studies pointing to less adaptive and others pointing to more adaptive correlates. These seemingly contradictory findings might be explained by different types of AER that involve different processes, and we suggest that neuroscientific methods are particularly useful for understanding these processes. We then review the relevant neuroscientific literature, focusing on the neural bases of different types of AER.

Emotion and Emotion Regulation

Before we can understand emotion *regulation*, we need to define what we mean by *emotion*. We define emotions as multifaceted, whole-body responses that involve coordinated changes in the domains of *subjective experience*, *behavior*, and *peripheral physiology*. Emotions arise when an individual attends to a situation and evaluates it as relevant to his or her goals (Frijda, 1988; Gross & Thompson, 2007). This definition presupposes a chronological sequence of events, involving, first, a real or imaginary situation; second, attention to and evaluation of the situation (appraisal) by the individual; and, third, an emotional response. However, the emotion-generative process cycles rapidly through these situation-evaluation-response steps, and an individual's responses in each cycle powerfully shape subsequent cycles of the emotion-generative process.

Appreciating that individuals are agentic beings rather than passive emitters of their emotions, psychologists have become increasingly interested in the ways individuals attempt to regulate their emotional responses (Gross, 2007). Emotion regulation may be defined as individuals' deliberate or automatic attempts to influence which emotions they have, when they have them, and how these emotions are experienced or expressed. Emotion regulation involves changes to one or more aspects of the emotion, including the eliciting situation, attention, appraisals, subjective experience, behavior, or physiology (e.g., Bargh & Williams, 2007; Gross & Thompson, 2007). Emotion regulation may result in an emotional response that is diminished or augmented either in amplitude or duration. Because decreasing the duration or intensity of *negative* emotion appears to be of particular importance for individuals (Gross, Richards, & John, 2006), and because most research has been done on this type of emotion regulation, this will be our focus here.

The existing research on emotion regulation suggests that individual differences in emotion regulation are associated with a range of important outcomes in individuals' lives (Diefendorff & Gosserand, 2003; Grandey, 2000; Gross et al., 2006; Gross & John, 2003; Mauss, Cook, Cheng, & Gross, forthcoming). However, most research to date has focused on deliberate emotion regulation. This is unfortunate, because AER might have just as pervasive effects as deliberate emotion regulation (cf. Bargh &

Williams, 2007; Berkman & Lieberman, forthcoming; Davidson, MacGregor, Stuhr, Dixon, & MacLean, 2000; Parkinson & Totterdell, 1999). Before we will explore this hypothesis, we need to define AER, and explain why we think it may be important.

Automatic Emotion Regulation

Most contemporary dual-process models contrast automatic (also called nonconscious, implicit, or impulsive) processes with deliberate (also called controlled, conscious, explicit, or reflective) processes (e.g., Chaiken & Trope, 1999; Devine, 1989; Schacter, 1997; Sloman, 1996; Strack & Deutsch, 2004). Deliberate processing requires attentional resources, is volitional, and is driven by explicit goals. In contrast, automatic processing is initiated by the simple registration of sensory inputs, which in turn activates knowledge structures (schemas, scripts, or concepts) that then shape other psychological functions. For many functions such as walking or riding a bike, we do not hesitate to agree that they can be performed automatically after they have been thoroughly learned. However, we hesitate to do so for so-called higher-level functions such as goal pursuit or self-regulation. After all, until recently self-regulation was thought to be squarely located in the realm of the willful, conscious, and deliberate (cf. Bargh, 2004; Wegner, 2002). Thus, at first glance the concept of automatic emotion regulation might seem oxymoronic.

However, research by Bargh and others (e.g., Bargh & Gollwitzer, 1994; Custers & Aarts, 2005; Glaser & Kihlstrom, 2005; Moskowitz, Gollwitzer, Wasel, & Schaal, 1999; Webb & Sheeran, 2003) on automatic goal pursuit has challenged the notion that 'higher-level' processes can only take place in a deliberate fashion. In a series of studies, Bargh and colleagues have shown that goals can indeed be activated and executed without the intervention of conscious awareness. For example, they have primed goals such as the intention to cooperate with others, and found that subsequently participants pursued these goals, without knowing *why* or even *that* they were acting this way (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001). Bargh and colleagues explain these findings by postulating that goals (including self-regulation goals) are mentally represented in the same way as are other cognitive constructs. That is, goals correspond to knowledge structures that contain information such as when and how the goal should be pursued. Thus, the literature on automatic goal pursuit provides theoretical and empirical precedence for AER.

Consistent with these considerations, we define AER as goal-driven change to any aspect of one's emotions without making a conscious decision to do so, without paying attention to the process of regulating one's emotions, and without engaging in deliberate control. In other words, AER is based on the automatic pursuit of the goal to alter the emotion trajectory. We note that automatic and deliberate processes are ends on a continuum. Thus, while we contrast the two types of processes for conceptual clarity, we acknowledge that many instances of emotion regulation fall on a continuum between those two prototypes (e.g., intuitive affect regulation; Koole & Jostmann, 2004).

Why should we care about AER? In our opening example, we described how people might regulate their emotions *without exerting deliberate efforts* to do so. We believe that such instances of AER are pervasive in individuals' lives, because overlearned habits, regulatory strategies learned early in childhood, sociocultural norms, and implicit hedonic goals all engender automatic regulatory processes (e.g., Aarts & Dijksterhuis, 2000; Adams & Markus, 2004; Koole & Jostmann, 2004; Mauss, Bunge, & Gross, forthcoming; Rothbaum, Pott, Azuma, Miyake, & Weisz, 2000; Rudman, 2004). For example, individuals socialized to decrease emotional responses from early childhood on (e.g., 'Anger is destructive' or 'Loud laughter is vulgar') would be likely to automatically decrease their emotions, without this norm even entering their awareness. Because these AER processes are pervasive and because these processes appear to powerfully shape individuals' affective responses, it is of paramount importance to understand what processes underlie them.

How does AER work, and what might be its consequences? We argue that, just like deliberate emotion regulation, AER can involve changes at all levels of the emotion process, including attention deployment (e.g., not paying attention to an emotional situation), appraisal (e.g., altering of the meaning of an emotional situation; engaging in particular beliefs about the situation), cognitively engaging with or disengaging from (e.g., denying) an emotional experience, and regulating emotional behaviors after an emotion has been generated. Importantly, we believe that these processes involve emotion *regulation* rather than simple emotion *reactivity*. This distinction holds important implications for the processes we observe. For example, emotional reactivity may be much less malleable by sociocultural factors than emotion regulation. In addition, this distinction is useful because it helps us understand the affective consequences of different types of AER. In our review, we provide initial evidence for this distinction. However, we believe more research is needed to clarify the distinction between emotion reactivity and emotion regulation (cf. Barrett, 2006; Mesquita & Albert, 2007).

Empirical Findings: Maladaptive Consequences of AER

The concept of defenses and repression (e.g., Freud, 1936; Vaillant, 1977; Weinberger, 1995) represents one of the earliest forms of AER. As formulated by Freud, defensive inhibition of negative emotional experiences is a form of AER that is motivated by the individual's need to keep from awareness emotions that are intolerably painful or incompatible with the ideal self (Freud, 1930/1961). Freud took a negative view of this type of emotion regulation, postulating that this defensive 'work' would come at the cost of expenditure of 'psychic energy'.

Several studies support the concept of defenses (e.g., Vaillant, 1977; Vaillant & McCullough, 1998). For example, Shedler, Mayman, and Manis (1993) identified participants who reported experiencing little negative emotion experience in general but whose early memories were rated as showing signs of psychological disturbance. The investigators categorized these participants as high in defensiveness. While undergoing a mildly stressful task (e.g., reading aloud), defensive participants showed more implicit signs of anxiety (e.g., stammering or avoiding the content of the stimulus) than other participants. Importantly, defensive participants also exhibited greater cardiovascular responding than other participants, indicating that despite their low levels of self-reported negative emotion, at some level they nonetheless exhibited greater reactivity.

The correlates of *repression* have been examined with similar paradigms (e.g., Byrne, Golightly, & Sheffield, 1965; Erdelyi, 2001; Paulhus, Fridhandler, & Hayes, 1997; Weinberger, Schwartz, & Davidson, 1979; Weinberger, 1995). Studies indicate that participants high in repression generally tend not to recognize and label negative emotions (Lane, Sechrest, Riedel, Shapiro, & Kaszniak, 2000), and, when tested in laboratory emotion inductions, they tend to report experiencing less negative emotion. At the same time, however, they exhibit impaired cognitive and social skills, as well as greater physiological reactivity (e.g., Asendorpf & Scherer, 1983; Brosschot & Janssen, 1998; Schwartz, 1995; Weinberger, 1995). These studies suggest that AER is correlated with a relatively maladaptive response profile.

In a similar vein, Shaver and Mikulincer (2007) describe how individuals with avoidant attachment styles (individuals who habitually avoid close emotional relationships) might have learned as children that the expression of negative emotion is ineffective or counterproductive with respect to attachment figures (Cassidy, 1994). By extension, such individuals learn to inhibit negative emotional impulses (cf. Kobak, Cole, Ferenz-Gillies, & Fleming, 1993; Mikulincer & Shaver, 2003), a process that becomes automatized over time. In support of this hypothesis, avoidant individuals show relatively blunted emotional experience in automatic tasks such as affective lexical decision tasks (Mikulincer, Birnbaum, Woddis, & Nachmias, 2000). They thus seem to be able to deny negative emotional impulses automatically. Crucially, this process might not entirely resolve their negative emotional reactions, and might incur some hidden cost. For example, Dozier and Kobak (1992) monitored electrodermal responses while participants recalled memories involving separation or rejection. They found that avoidant individuals had more difficulty generating negative memories. At the same time, they showed increased physiological reactivity during the task, suggesting that there might be an affective cost for cognitive disengagement from emotions.

In addition to these negative effects of cognitive disengagement from emotional impulses, there is evidence that automatic *behavioral* regulation might also have relatively maladaptive consequences for individuals. For example, Egloff, Schmukle, Burns, and Schwerdtfeger (2006) examined the correlates of spontaneous behavioral suppression in a laboratory speech stressor. They did not give participants instructions to regulate their emotions, thus, maximizing automaticity of emotion regulation during the speech. In order to gauge spontaneous behavioral regulation, participants rated after the speech to what extent they had behaviorally inhibited their emotions. Spontaneous behavioral inhibition was found to be unrelated to experience of negative emotions but was associated with greater physiological responding.

Together, the studies on repression and on spontaneous suppression suggest that AER (specifically by way of cognitive disengagement and behavioral regulation) plays an important role in individuals' affective responses, and that overall it is relatively maladaptive. This last conclusion is somewhat surprising for two reasons. First, the recent work on automatic goal pursuit (e.g., Bargh & Gollwitzer, 1994; Jackson et al., 2003; Moon & Lord, 2006; Webb & Sheeran, 2003) suggests that automatic processes are executed relatively effortlessly and efficiently. Second, at least in its unqualified form, the notion that AER is maladaptive is rendered implausible by the existence of at least some individuals who manage to lead quite composed lives without the 'side effects' of AER indicated above.

Empirical Findings: Adaptive Consequences of AER

Might some types of AER be adaptive? Three recent areas of research suggest that the answer to this question may be 'yes'. First, in explaining the positivity effect, which refers to the fact that as individuals grow older, they experience and remember relatively more positive emotions, Carstensen and Mikels (2005) invoke automatic regulatory processes. They argue that since *deliberate* processing deteriorates in older age, it is likely that *automatic* emotion regulatory processing is responsible for the positivity effect. Indeed, the positivity effect has been documented in a number of relatively automatic affective tasks, such as the dot probe task. In these tasks, older relative to younger participants tend to automatically shift their attention away from negative and toward positive emotional stimuli (e.g., Isaacowitz, Wadlinger, Goren, & Wilson, 2006a, 2006b; Mather & Carstensen, 2003). Thus, older individuals might make use of AER to their advantage.

Second, a series of studies suggests that action orientation might be accompanied by relatively automatic emotion regulation ('intuitive affect regulation'), which is flexible and very effective (Koole & Coenen, 2007; Koole & Jostmann, 2004; Kuhl, 1981). Action orientation is the tendency to respond to stress with actions designed to resolve the problem rather than to dwell on the negative affect accompanying those situations. In a series of studies, it was shown that action-oriented individuals are able to quickly decrease negative affect in demanding situations (Koole & Coenen; Koole & Jostmann). The authors argue that because action orientation is a stable individual difference, any regulatory functions associated with it should be well practiced and, thus, relatively automatic. In fact, studies demonstrate that action-oriented individuals are even able to decrease negative affect in subliminal (e.g., Jostmann, Koole, van der Wulp, & Fockenberg, 2005) as well as in affective priming tasks (Koole & Jostmann; Study 2), supporting the view that the type of emotion regulation that accompanies action orientation has automatic components.

Third, Bonanno and his colleagues have provided data suggesting that repressive coping can promote resilience. For example, they have shown that repressive coping, as measured by the discrepancy between affective experience and sympathetic nervous system response, may promote recovery following extremely stressful events such as the death of one's spouse (Bonanno, 2005; Bonanno, Keltner, Holen, & Horowitz, 1995; Bonanno, Znoj, Siddique, & Horowitz, 1999). A study examining the correlates of repressive coping more generally indicates that individuals who habitually use repressive coping as compared to those who do not tend to have fewer symptoms of psychopathology, fewer health problems and somatic complaints, and are rated as better adjusted by close friends (Coifman, Bonanno, Ray, & Gross, 2007). In all these studies, repressive coping was inversely or not related to deliberate measures of avoidant coping, supporting the interpretation that repressive coping is relatively automatic.

These areas of research are intriguing, but they are limited in some ways. Most notably, in many of these studies, AER was inferred rather than directly measured. This consideration led us to conduct a study aimed to provide a more direct measure of individual differences in AER. In developing this measure, we reasoned that the automatic goal of regulating emotion might be associated with an implicit positive evaluation of emotion regulation (cf. Aarts & Dijksterhuis, 2000; Custers & Aarts, 2005). Thus, we developed a variant of the Implicit Association Test (IAT) (cf. Egloff, Wilhelm, Neubauer, Mauss, & Gross, 2002; Fazio & Olson, 2003; Greenwald, McGhee, & Schwartz, 1998) to assess individual differences in implicit evaluation of emotion regulation (emotion regulation IAT; ER-IAT). The ER-IAT assesses participants' implicit evaluations of emotion control versus emotion expression by measuring reaction times to positive (e.g., gold), negative (e.g., gloom), emotion control (e.g., controlled), and emotion expression (e.g., expressive) words. A relatively stronger association between emotion control and positive items implies implicit positive evaluation of emotion control. Because goal states that are associated with positive concepts appear to enhance individuals' pursuit of these goals (e.g., Custers & Aarts), we reasoned that this association might lead to a greater likelihood of *engaging in* automatic emotion control.

In order to put this hypothesis to the test we assessed whether positive implicit evaluation of emotion control would be associated with experiential, behavioral, and cardiovascular responses to a laboratory anger provocation (Mauss, Evers, Wilhelm, & Gross, 2006, Study 2). Anger experience as well as cardiovascular responding, including sympathetic activation, cardiac output, and total peripheral resistance, were assessed. In order to control for the involvement of effortful emotion control, participants were asked after the task to what extent they had tried to control their emotions. While most participants became angry during the provocation, those who had greater ER-IAT scores reported relatively less anger experience. In addition, they exhibited a relatively adaptive challenge cardiovascular activation pattern (as opposed to a threat pattern), characterized by greater sympathetic activation, greater cardiac output, and lower total peripheral resistance (cf. Tomaka, Blascovich, Kelsey, & Leitten, 1993). Apparently, the relative reduction of anger experience happened without conscious effort, because ER-IAT scores were not correlated with self-reported effortful emotion control. In summary, these findings indicate that greater positive implicit evaluation of emotion control is associated with affective responses that are consistent with automatic, successful, and physiologically adaptive emotion regulation.

These correlational results beg the question of what *causal* role AER plays. Because very few studies have addressed this question to date, we devised an experimental manipulation of AER in order to assess its affective consequences (Mauss, Cook, & Gross, forthcoming). We manipulated AER in two studies by priming emotion control versus emotion expression with an adaptation of the sentence unscrambling task (e.g., Bargh et al., 2001; Srull & Wyer, 1979). This task unobtrusively exposed participants to words relating to emotion control (e.g., cool, contain) or expression (e.g., boil, show), thereby implicitly activating (priming)-related concepts and goals. Three domains of affective responding were measured: anger experience, global negative emotion experience (including anxiety and sadness), and cardiovascular responses.

Results revealed that indeed priming different emotion regulation concepts affected subsequent emotional responding, such that participants primed with emotion control reported less anger than did participants primed with emotion expression. Importantly, participants primed with emotion control reported experiencing lesser global negative emotion experience than those primed with emotion expression and did not exhibit more maladaptive cardiovascular responding. Participants primed with emotion expression exhibited emotional responses equal to or greater than during a prior unprimed anger induction, suggesting that the emotion control rather than the emotion expression condition led to the observed group differences. These results imply that, like the individual difference process associated with the ER-IAT, situationally induced AER is not costly.

One important question about the differences in anger observed in these studies is whether emotion regulation rather than mere emotional reactivity is responsible for them. Because the key processes involved here are automatic, it is difficult to come to a conclusive answer to this question. However, two pieces of evidence make it plausible that regulation rather than reactivity is involved in the present findings. First, the words used in the ER-IAT (e.g., controlled, expressive) and in the priming tasks (e.g., contain, show) tap into emotion regulation rather than reactivity. Second, the fact that ER-IAT scores were positively correlated with sympathetic activation makes it more plausible that regulation rather than mere differences in reactivity was involved, because lower anger *reactivity* would have been associated with lower levels of sympathetic activation. Likewise, had there been mere differences in anger *reactivity* between the experimental groups in the priming studies, the group who reported less anger would have likely exhibited less cardiovascular responding as well.

Reconciling Conflicting Findings: Toward a Model of AER

Together, these studies raise the intriguing possibility that people can – without conscious effort – remain calm, cool, and collected in powerfully negative situations. The relative adaptiveness of this type of AER stands in contrast to the maladaptiveness of the AER processes described in the preceding section. How can these conflicting findings be reconciled?

One way to reconcile these findings is to argue that there exist different types of AER, each with a different pattern of affective consequences. More specifically, as summarized in Figure 1, it appears that cognitive disengagement from emotional impulses as well as behavioral regulation are associated with a more maladaptive profile of outcomes. These types of AER appear to be involved in defensiveness, repression, and spontaneous suppression. On the other hand, individual habits, values, or goals such as those tapped into by the ER-IAT or manipulated by priming procedures appear to have generally adaptive affective consequences. These processes appear to involve changes of emotional situations, attention paid to such situations, or appraisals of those situations.

But *what about* these processes make them adaptive or maladaptive? With the existing evidence, we cannot conclusively answer this question. However, the pattern of responses suggests that individuals using cognitive disengagement and behavioral regulation might exhibit an emotional response at some point, which is then decreased. As the right panel in Figure 1 illustrates, these processes could be considered 'response-focused' regulation, in that they occur *after* the emotional response has been triggered (cf. Gross, 1998; Gross & Thompson, 2007). Because some aspects of the emotional response continue to be active in this sequence, they

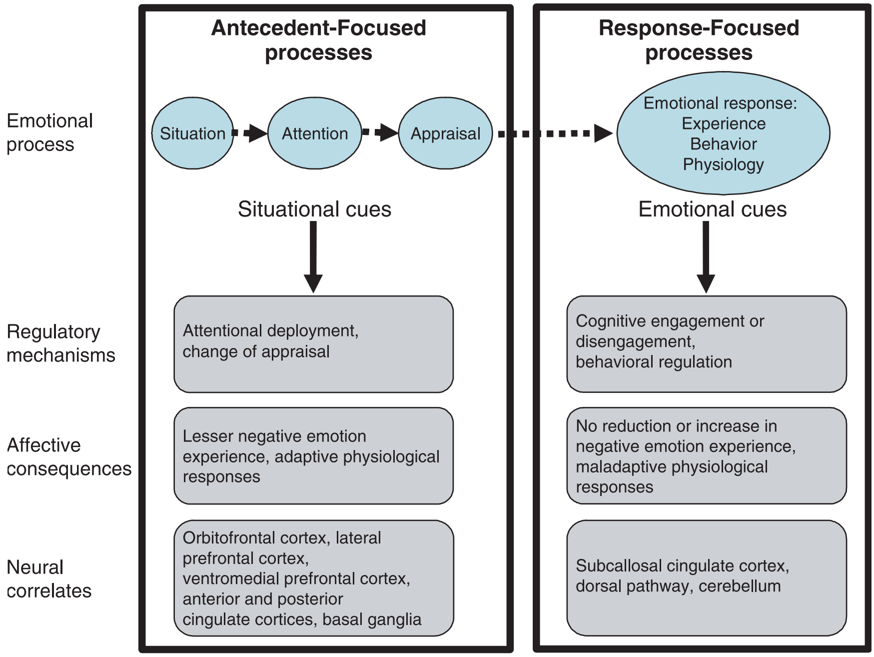

Figure 1 Regulatory mechanisms, affective consequences, and neural correlates of automatic emotion regulation (AER).

might evoke some conflict about the emotion or some continued regulatory effort. On the other hand, implicit positive evaluation of emotion regulation and situationally primed values about emotions might be activated *early* in the emotional response. As the left panel in Figure 1 illustrates, they might thus operate in a more 'antecedent-focused' manner, without ever evoking a conflict about the emotion and effectively decreasing all aspects of the emotional response (cf. Gross; Gross & Thompson). By extension, they are expected to have a relatively adaptive profile of responses. Thus, the distinction of different types of AER might have important implications for individuals' well-being and psychological health.

However, the studies described above are mainly based on self-reported data or relatively nonspecific measures of peripheral physiological responding. Thus, they do not conclusively tell us whether different types of AER engage different processes. Neuroscientific studies, which afford unique insights into the mechanisms underlying different behavioral outcomes, might be better suited to address this question. In the next sections, we review relevant neuroscientific evidence. Guided by the studies reviewed above, we focus on cognitive disengagement and behavioral regulation as instances of response-focused AER, and habit- or value-based regulation as instances of antecedent-focused AER. Because very few neuroscientific studies have directly examined AER, we reference a number of related constructs such as denial or automatic behavior programs. Evidence from these constructs is suggestive and helps generate useful hypotheses. However, more direct neuroscientific assessments will be necessary in the future to develop a more definitive model of AER.

The Neural Correlates of Response-Focused AER

The bottom right row of Figure 1 summarizes brain areas that might be involved in response-focused types of AER. One recent study by Gillath, Bunge, Shaver, Wendelken, and Mikulincer (2005) was aimed at exploring the neural correlates of emotion regulation in individuals with different attachment styles. In this study, participants were first instructed to consider negative scenarios such as an imminent break-up or death of a partner, and then to suppress thoughts about these negative scenarios. Across individuals, attachment avoidance (the tendency to avoid close emotional relationships) was found to be positively correlated with activation of one of the main brain regions implicated in state-dependent mood changes (Liotti, Mayberg, McGinnis, Brannan, & Jerabek, 2002): the subcallosal cingulate cortex (SCC; Brodmann's area 25, part of the subgenual cortex). The SCC projects to subcortical structures including the hypothalamus, and brainstem regions including the periaqueductal gray. These regions are involved in autonomic functions, including heart rate, respiration, skin conductance, as well as in automatic defense reactions, such as escape (Rempel-Clower & Barbas, 1998; Freedman, Insel, & Smith, 2000). The SCC also projects to the dorsal raphe nuclei in the brainstem, and is therefore in a position to influence mood through the regulation of serotonergic neurotransmission throughout the brain (Freedman et al., 2000).

In the study by Gillath et al. (2005), participants low in attachment avoidance exhibited suppression of the SCC during the thought suppression phase relative to the thought phase, whereas participants high in attachment avoidance showed relatively elevated SCC activation. Greater activation of the SCC by the amygdala is also observed in posttraumatic stress disorder (Gilboa et al., 2004). Conversely, Mayberg and colleagues have proposed that sustained suppression of the SCC is necessary for full recovery from unipolar depression (Davidson, 2002; Drevets, 2001; Gotlib et al., 2005; Liotti et al., 2002; Mayberg, 2003; Shin, Kosslyn, McNally, & Alpert, 1997), and fear extinction in healthy participants is associated with progressively greater suppression of the SCC (Phelps, Delgado, Nearing, & LeDoux, 2004). Although the neural mechanisms underlying SCC suppression versus activation are not yet clear, these findings suggest that suppression of the SCC is involved in an adaptive, and perhaps automatic, form of emotion regulation, while relative activation of SCC might be associated with (or indicative of) a more maladaptive form of AER.

Which brain regions might support processes related to the second type of response-focused AER, namely, behavioral regulation of emotional impulses (e.g., keeping one's face still while sad)? No direct evidence exists specifically for the automatic regulation of emotional behaviors in humans, but four different areas appear to be good candidates. First, the animal literature gives us some clues. As noted above, specific hypothalamic and brainstem structures control automatic behaviors. For example, stimulation of the periaqueductal gray and hypothalamus in animals elicits automatic defense reactions like threats, vocalizations, and escape (Freedman et al., 2000). As suggested above, frontally mediated control over these regions would lead to regulation of specific behaviors associated with emotional responses. However, direct evidence for this hypothesis with respect to the regulation of emotional impulses in humans is lacking.

Second, clues relating to response-focused AER may come from the literature on motor control. Knowledge structures such as behavioral scripts come to be associated with specific behaviors (cf. Bunge, 2004; Donohue, Wendelken, Crone, & Bunge, 2005; Engelkamp, 1986; Farah & McClelland, 1991), for example, through acculturation and socialization. In line with this idea, Grafton, Fadiga, Arbib, and Rizzolatti (1997) showed that viewing graspable objects without any intent to use them was associated with activation of the left dorsal premotor cortex, suggesting that motor programs were automatically activated. In addition to the dorsal premotor cortex, studies suggest that parts of the parietal lobe are associated with implicitly activated motor programs (Decety & Grèzes, 1999; Jeannerod, Arbib, Rizzolatti, & Sakata, 1995; Johnson-Frey, 2004; Martin, Haxby, Lalonde, & Wiggs, 1995; Milner & Goodale, 1995; Tettamanti et al., 2005, for a meta-analysis). Thus, through its projections to the dorsal premotor cortex the areas within the parietal cortex might initiate behaviors without conscious intent.

Third, much of the workings of the motor systems seem to be opaque to our introspection because there are simply too many individual muscles and movements to keep track of each one (Prinz, 2003). For example, a review by Picard and Strick (1996) supports this dissociation between knowing and doing, by making the point that the pre-supplementary motor area is associated with the conscious and effortful learning of a skill while the supplementary motor area is associated with automatic actions (Sakai et al., 1999). This finding suggests that some automatic behavioral responses to an emotion may be mediated by the supplementary motor area.

A fourth important structure in the automatic initiation and execution of motor programs is the lateral cerebellum. For example, Thach (1996) speculates that this region may be involved in combining behavioral elements into more complex actions in specific contexts 'such that, through practice, an experiential context can automatically evoke an action plan' (p. 429). The cerebellum may thus link the representations of specific behavioral contexts with the relevant premotor, lower-level movement generators. In this way, complex behavior can be automatically mapped onto, and guided by, specific cues.

The Neural Correlates of Antecedent-Focused AER

What brain areas might support antecedent-focused AER? As summarized in the bottom left row of Figure 1, several recent studies suggest the potential involvement of the orbitofrontal cortex (OFC), especially lateral and medial portions, lateral and ventromedial portions of the prefrontal cortex (lPFC and vmPFC), and the basal ganglia (BG). These regions have been implicated in emotion regulation, cognition–emotion interactions, top-down direction of attention in response to negative emotional stimuli, and encoding affective expectations in relation to conditioned stimuli (Beer, Heerey, Keltner, Scabini, & Knight, 2003; Davidson, 2002; Elliott, Dolan, & Frith, 2000; Gottfried, O'Doherty, & Dolan, 2003; Hamann, Ely, Hoffman, & Kilts, 2002; Lieberman, 2000; Rolls, 2000).

A recent study on agreeableness (Haas, Omura, Constable, & Canli, 2007) suggests that the lPFC, which has been associated with deliberate emotion regulation (Ochsner, Bunge, Gross, & Gabrieli, 2002), might also be associated with AER. Agreeableness is a stable personality trait that is associated with prosocial behaviors and positive affect. These states might plausibly be achieved via antecedent-focused AER. For example, a study by Meier, Robinson, and Wilkowski (2006) showed agreeableness to be associated with automatic activation of prosocial thoughts in response to negative affective cues. In the recent neuroimaging study, agreeableness was positively correlated with right lPFC activation during performance of a task that exposed individuals to negative emotional stimuli without requiring them to regulate their emotions or even pay attention to the emotional nature of the stimuli (Haas et al., 2007). Together, these findings support that the lPFC may be involved in antecedent-focused AER.

The study by Gillath et al. (2005) described above supports the notion that lateral portions of the OFC are additionally involved in antecedent-focused AER. Recall that the researchers instructed participants to consider negative scenarios such as death of a partner (thought trials), and subsequently to suppress thoughts about these negative scenarios (thought-suppression trials). Participants low in attachment anxiety (those who habitually respond with relatively little negative emotion to relationship conflict) as compared to participants high in attachment anxiety exhibited lower activation of the anterior temporal pole, a brain region associated with sadness. Interestingly, these participants exhibited greater activation of the lateral OFC (BA11) during the thought trials as well as the thought-suppression trials, such that anterior temporal pole activation was negatively correlated with lateral OFC activation across participants. These findings suggest that participants low in attachment anxiety might engage in emotion regulatory processes supported by the OFC automatically – whether or not they are instructed to do so – and that these processes are quite effective.

The OFC and portions of the anterior cingulate cortex have also been implicated in AER by a recent study by Westen, Kilts, Blagov, Harenski, and Hamann (2006). They presented political partisans with stimuli regarding either George W. Bush or his challenger John Kerry (the study took place during the months preceding the 2004 presidential election). Participants considered statements that documented contradictions between their candidate's words and deeds (suggesting that the candidate was lying). Next, participants were asked to rate the extent to which the candidate's words and actions were contradictory. Presumably, when examining their own candidate, partisan participants could regulate potential negative affect by denying the presence of a contradiction.

As expected, many participants did just that: they had no difficulty detecting contradictions in the opposing candidate but simply denied contradictions for their own candidate. Because they probably wouldn't say to themselves 'I will deny that there is a contradiction here', and because the dorsolateral prefrontal cortex (dlPFC), which has been associated with explicit and deliberate forms of ER (Hariri, Mattay, Tessitore, Fera, & Weinberger, 2003; Ochsner et al., 2002), was not involved in the processes, it seems plausible to assume that this process is relatively automatic. When first considering the contradictory statements, participants exhibited activation in amygdala and insula, which suggests there was an initial negative affective response. In addition, when they resolved the contradiction, they exhibited activation throughout the OFC (specifically medial and lateral portions) as well as the anterior and posterior cingulate cortices. Together, these results support the notion that these regions are involved in AER.

The OFC is further implicated in AER by studies involving patients with focal brain damage. In a study by Beer, John, Scabini, and Knight (2006), patients with OFC damage were able to state explicitly what they needed to do to accomplish a regulation goal (e.g., inhibit the tendency to share personal information with a stranger). However, when faced with an actual situation that required regulation, they were not able to regulate their behavior to conform to the stated goal. This finding further supports that the OFC is involved in automatic aspects of emotion regulation.

A recent event-related potential study by Carretié, Hinojosa, Mercado, and Tapia (2005) supports the notion that the vmPFC may also be involved in antecedent-focused AER. Their study indicates that the vmPFC is activated in response to *unconsciously* presented fear stimuli. Because the vmPFC is generally related to top-down allocation of attention, this finding suggests that the vmPFC might be involved in regulatory processes even in response to unconsciously presented stimuli, and before an emotional response has become conscious.

An additional neural structure that might plausibly be involved in antecedent-focused AER is the BG. The BG is a promising candidate for a specific central neural correlate of AER because it is associated with implicit learning (Frank, O'Reilly, & Curran, 2006; Grafton, Hazeltine, & Ivry, 1995; Keele, Ivry, Mayr, Hazeltine, & Heuer, 2003), procedural memory (Grafton, Mazziotta, Presty, & Friston, 1992; Grafton, Woods, & Tyszka, 1994), as well as habit learning and automatic execution of motor programs (Graybiel & Saka, 2004; Poldrack & Gabrieli, 2001; Poldrack et al., 2005). Thus, generally, the BG appears to be involved in automatic rather than deliberate processes. The BG might plausibly support motor, cognitive, and affective processes via the motor, the limbic, or the OFC circuits (cf. Lieberman, 2000, 2007). In addition, it appears to be involved in processes that occur in response to predictors of events rather than relevant events themselves (e.g., Lieberman, 2000), which makes it plausible that it is involved in *antecedent* AER. For instance, it might support responses to situational cues that alert an individual to an impending emotional situation, which can then be dealt with before it even arouses strong emotional responses.

While no research has directly assessed the involvement of the BG in AER, patient research supports this hypothesis. For example, patients with Parkinson's disease, especially those with prominent deterioration of the caudate, exhibit disinhibition symptoms (e.g., Brandt & Butters, 1996; Shelton, Shelton, & Knopman, 1991). Similarly, patients with caudate infarcts have been shown to exhibit disinhibition, impulsive behaviors, and heightened anxiety (Mendez, Adams, & Lewandowski, 1989). While no studies are available yet that disentangle automatic activation from regulation of emotions, the available evidence is consistent with the hypothesis that the BG might support AER.

Concluding Comment

Our review of the behavioral literature suggests that AER sometimes is associated with a maladaptive pattern of responses, but at other times is associated with an adaptive pattern of responses. One way to reconcile these divergent findings is to assume that different processes underlie different types of AER. Specifically, we have argued that it may be useful to distinguish response-focused AER, including cognitive disengagement from emotional stimuli and behavioral regulation after the emotion has arisen, from antecedent-focused AER, which occurs early in the emotional sequences. Antecedent-focused AER might involve changing situations, attentional deployment, and appraisals of situations, and might be based more on individuals' habits and values regarding emotional situations. As summarized in Figure 1, neuroimaging studies suggest that these different types of AER may have separable neural correlates. Specifically, response-focused AER might be supported by the SCC (cognitive disengagement) and the dorsal pathway and the cerebellum and/or prefrontal regions operating on subcortical and brainstem structures (behavioral regulation), and antecedent-focused AER might be supported by circuits involving lateral and medial portions of the OFC, the lPFC, and vmPFC, the anterior and posterior cingulate cortices, and portions of the BG. We hope that by providing a conceptual framework for AER and its neural bases, the present overview can help us better understand a pervasive process with important implications for individuals' well-being and health.

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Short Biography

Iris Mauss received her PhD in Psychology from Stanford University, and is now an Assistant Professor of Psychology at the University of Denver. Her research focuses on emotions and emotion regulation, and utilizes a multimethod approach, including experience sampling, behavioral coding, implicit measures, and measures of autonomic physiological responses. Her work addresses questions concerning coherence versus dissociation of emotional response systems, the sociocultural context of emotion regulation, the implications of emotion regulation for psychological and physical health, and automatic processes in emotion regulation.

Silvia Bunge received her PhD in Neuroscience from Stanford University, and went on to do a postdoctoral fellowship in the Department of Brain and Cognitive Sciences at MIT. She then spent over 3 years on the faculty at the University of California, Davis, before moving to a joint faculty position in Psychology and the Helen Wills Neuroscience Institute at the University of California, Berkeley. Dr. Bunge studies the brain mechanisms underlying the control of thoughts, actions, and emotions.

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References

Aarts, H., & Dijksterhuis, A. (2000). Habits as knowledge structures: Automaticity in goal-directed behavior. *Journal of Personality and Social Psychology*, **78**, 53–63.

Adams, G., & Markus, H. R. (2004). Toward a conception of culture suitable for a social psychology of culture. In M. Schaller, & C. S. Crandall (Eds.), *The psychological foundations of culture* (pp. 335–360). Mahwah, NJ: Lawrence Erlbaum Associates.

Asendorpf, J. B., & Scherer, K. R. (1983). The discrepant repressor: Differentiation between low anxiety, high anxiety, and repression of anxiety by autonomic-facial-verbal patterns of behavior. *Journal of Personality and Social Psychology*, **45**, 1334–1346.

Bargh, J. A. (2004). Being here now: Is consciousness necessary for human freedom? In J. Greenberg, S. L. Koole, & T. Pyszczynski (Eds.), *Handbook of Experimental Existential Psychology* (pp. 385–397). New York: Guilford Press.

Bargh, J. A., & Gollwitzer, P. M. (1994). Environmental control of goal-directed action: automatic and strategic contingencies between situations and behavior. *Nebraska Symposium of Motivation*, **41**, 71–124.

Bargh, J. A., & Williams, L. E. (2007). The case for nonconscious emotion regulation. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 429–445). New York: Guilford Press.

Bargh, J. A., Gollwitzer, P. M., Lee-Chai, A., Barndollar, K., & Trötschel, R. (2001). The automated will: Nonconscious activation and pursuit of behavioral goals. *Journal of Personality and Social Psychology*, **81**, 1014–1027.

Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science*, **1**, 28–58.

Beer, J. S., Heerey, E. A., Keltner, D., Scabini, D., & Knight, R. T. (2003). The regulatory function of self-conscious emotion: insights from patients with orbitofrontal damage. *Journal of Personality and Social Psychology*, **85**, 594–604.

Beer, J. S., John, O. P., Scabini, D., & Knight, R. T. (2006). Orbitofrontal cortex and social behavior: Integrating self-monitoring and emotion-cognition interactions. *Journal of Cognitive Neuroscience*, **18**, 871–879.

Berkman, E., & Lieberman, M. D. (forthcoming). The neuroscience of goal pursuit: Bridging gaps between theory and data. In G. Moskowitz (Ed.), *Goals*. New York: Guilford Press.

Bonanno, G. A. (2005). Resilience in the face of potential trauma. *Current Directions in Psychological Science*, **14**, 135–138.

Bonanno, G. A., Keltner, D., Holen, A., & Horowitz, M. J. (1995). When avoiding unpleasant emotions might not be such a bad thing: Verbal autonomic response dissociation and midlife conjugal bereavement. *Journal of Personality and Social Psychology*, **69**, 975–989.

Bonanno, G. A., Znoj, H., Siddique, H. I., & Horowitz, M. J. (1999). Verbal-autonomic dissociation and adaptation to midlife conjugal loss: A follow-up at 25 months. *Cognitive Therapy and Research*, **23**, 605–624.

Brandt, J., & Butters, N. (1996). Neuropsychological characteristics of Huntington's disease. In I. Grant, & K. M. Adams (Eds.), *Neuropsychological Assessment of Neuropsychiatric Disorders* (2nd edn, pp. 312–341). New York: Oxford University Press.

Brosschot, J. F., & Janssen, E. (1998). Continuous monitoring of affective-autonomic response dissociation in repressors during negative emotional stimulation. *Personality and Individual Differences*, **25**, 69–84.

Bunge, S. A. (2004). How we use rules to select actions: A review of evidence from cognitive neuroscience. *Cognitive, Affective, and Behavioral Neuroscience*, **4**, 564–579.

Byrne, D., Golightly, C., & Sheffield, J. (1965). The Repression-Sensitization scale as a measure of adjustment: Relationship with the CPI. *Journal of Consulting Psychology*, **29**, 586–589.

Carretié, L., Hinojosa, J. A., Mercado, F., & Tapia, M. (2005). Cortical response to subjectively unconscious danger. *Neuroimage*, **24**, 615–623.

Carstensen, L. L., & Mikels, J. A. (2005). At the intersection of emotion and cognition: Aging and the positivity effect. *Current Directions in Psychological Science*, **14**, 117–121.

Cassidy, J. (1994). Emotion regulation: Influences of attachment relationships. *Monographs of the Society for Research in Child Development*, **59**, 228–283.

Chaiken, S., & Trope, Y. (1999). *Dual-Process Theories in Social Psychology*. New York: Guilford Press.

Coifman, K. G., Bonanno, G. A., Ray, R. D., & Gross, J. J. (2007). Does repressive coping promote resilience? Affective-autonomic response discrepancy during bereavement. *Journal of Personality and Social Psychology*, **92**, 745–758.

Custers, R., & Aarts, H. (2005). Positive affect as implicit motivator: On the nonconscious operation of behavioral goals. *Journal of Personality and Social Psychology*, **89**, 129−142.

Davidson, K., MacGregor, M. W., Stuhr, J., Dixon, K., & MacLean, D. (2000). Constructive anger verbal behavior predicts blood pressure in a population-based sample. *Health Psychology*, **19**, 55−64.

Davidson, R. J. (2002). Anxiety and affective style: Role of prefrontal cortex and amygdala. *Biological Psychiatry*, **51**, 68−80.

Decety, J., & Grèzes, J. (1999). Neural mechanisms subserving the perception of human actions. *Trends in Cognitive Science*, **3**, 172–178.

Devine, P. G. (1989). Stereotypes and prejudice: Their automatic and controlled components. *Journal of Personality and Social Psychology*, **56**, 5−18.

Diefendorff, J. M., & Gosserand, R. H. (2003). Understanding the emotional labor process: A control theory perspective. *Journal of Organizational Behavior*, **24**, 945−959.

Donohue, S. E., Wendelken, C., Crone, E. A., & Bunge, S. A. (2005). Retrieving rules for behavior from long-term memory. *Neuroimage*, **26**, 1140−1149.

Dozier, M., & Kobak, R. R. (1992). Psychophysiology in attachment interviews: converging evidence for deactivating strategies. *Child Development*, **63**, 1473−1480.

Drevets, W. C. (2001). Neuroimaging and neuropathological studies of depression: Implications for the cognitive-emotional features of mood disorders. *Current Opinion in Neurobiology*, **11**, 240−249.

Egloff, B., Schmukle, S. C., Burns, L. R., & Schwerdtfeger, A. (2006). Spontaneous emotion regulation during evaluated speech tasks: Associations with negative affect, anxiety expression, memory, and physiological responding. *Emotion*, **6**, 356–366.

Egloff, B., Wilhelm, F. H., Neubauer, D. H., Mauss, I. B., & Gross, J. J. (2002). Implicit anxiety measure predicts cardiovascular reactivity to an evaluated speaking task. *Emotion*, **2**, 3–11.

Elliott, R., Dolan, R. J., & Frith, C. D. (2000). Dissociable functions in the medial and lateral orbitofrontal cortex: Evidence from human neuroimaging studies. *Cerebral Cortex*, **10**, 308−317.

Engelkamp, J. (1986). Motor programs as part of the meaning of verbal items. In I. Kurcz, G. W. Shugar, & J. H. Danks (Eds.), *Knowledge and Language* (pp. 115−138). Amsterdam, The Netherlands: Elsevier.

Erdelyi, M. H. (2001). Defense processes can be conscious or unconscious. *American Psychologist*, **56**, 761–762.

Farah, M. J., & McClelland, J. L. (1991). A computational model of semantic memory impairment: Modality specificity and emergent category specificity. *Journal of Experimental Psychology General*, **120**, 339−357.

Fazio, R. H., & Olson, M. A. (2003). Implicit measures in social cognition research: Their meaning and uses. *Annual Review of Psychology*, **54**, 297–327.

Frank, M. J., O'Reilly, R. C., & Curran, T. (2006). When memory fails, intuition reigns: Midazolam enhances implicit inference in humans. *Psychological Science*, **17**, 700−707.

Freedman, L. J., Insel, T. R., & Smith, Y. (2000). Subcortical projections of area 25 (subgenual cortex) of the macaque monkey. *Journal of Comparative Neurology*, **421**, 172–188.

Freud, A. (1936). *The Ego and the Mechanisms of Defense*. New York: International Universities Press.

Freud, S. (1930/1961). Civilization and its discontents. In J. Strachey (Ed. and Trans.), *The Standard Edition of the Complete Psychological Works of Sigmund Freud* (Vol. 31). New York: Norton.

Frijda, N. H. (1988). The laws of emotion. *American Psychologist*, **43**, 349–358.

Gilboa, A., Shalev, A. Y., Laor, L., Lester, H., Louzoun, Y., Chisin, R., et al. (2004). Functional connectivity of the prefrontal cortex and the amygdala in posttraumatic stress disorder. *Biological Psychiatry*, **55**, 263–272.

Gillath, O., Bunge, S. A., Shaver, P. R., Wendelken, C., & Mikulincer, M. (2005). Attachment-style differences and ability to suppress negative thoughts: Exploring the neural correlates. *NeuroImage*, **28**, 835−847.

Glaser, J., & Kihlstrom, J. F. (2005). Compensatory automaticity: Unconscious volition is not an oxymoron. In R. Hassin, J. S. Uleman, & J. A. Bargh (Eds.), *The New Unconscious* (pp. 171–195). Oxford, UK: Oxford University Press.

Gotlib, I. H., Sivers, H., Gabrieli, J. D., Whitfield-Gabrieli, S., Goldin, P., Minor, K. L., et al. (2005). Subgenual anterior cingulate activation to valenced emotional stimuli in major depression. *Neuroreport*, **16**, 1731–1734.

Gottfried, J. A., O'Doherty, J., & Dolan, R. J. (2003). Encoding predictive reward value in human amygdala and orbitofrontal cortex. *Science*, **301**, 1104–1107.

Grafton, S. T., Woods, R. P., & Tyszka, M. (1994). Functional imaging of procedural motor learning: Relating cerebral blood flow with individual subject performance. *Human Brain Mapping*, **1**, 221–234.

Grafton, S. T., Fadiga, L., Arbib, M. A., & Rizzolatti, G. (1997). Premotor cortex activation during observation and naming of familiar tools. *Neuroimage*, **6**, 231–236.

Grafton, S. T., Hazeltine, E., & Ivry, R. (1995). Functional mapping of sequence learning in normal humans. *Journal of Cognitive Neuroscience*, **7**, 497–510.

Grafton, S. T., Mazziotta, J. C., Presty, S., & Friston, K. J. (1992). Functional anatomy of human procedural learning determined with regional cerebral blood flow and PET. *Journal of Neuroscience*, **12**, 2542–2548.

Grandey, A. A. (2000). Emotional regulation in the workplace: A new way to conceptualize emotional labor. *Journal of Occupational Health Psychology*, **5**, 95–110.

Graybiel, A. M., & Saka, E. (2004). The basal ganglia and the control of action. In M. S. Gazzaniga (Ed.), *The Cognitive Neurosciences* (3rd edn, pp. 495–510). Cambridge, MA: MIT Press.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology*, **74**, 1464–1480.

Gross, J. J. (1998). Antecedent-and response-focused emotion regulation: Divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology*, **74**, 224–237.

Gross, J. J. (2007). *Handbook of Emotion Regulation*. New York: Guilford Press.

Gross, J. J., & John, O. (2003). Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*, **85**, 348–362.

Gross, J. J., & Thompson, R. (2007). Emotion regulation: Conceptual foundations. In J. J. Gross (Ed.), *Handbook of Emotion Regulation* (pp. 3–24). New York: Guilford Press.

Gross, J. J., Richards, J. M., & John, O. P. (2006). Emotion regulation in everyday life. In D. K. Snyder, J. Simpson, & J. N. Hughes (Eds.), *Emotion Regulation in Couples and Families: Pathways to Dysfunction and Health* (pp. 13–35). Washington, DC: American Psychological Association.

Haas, B. W., Omura, K., Constable, R. T., Canli, T. (2007). Is automatic emotion regulation associated with agreeableness? A perspective using a social neuroscience approach. *Psychological Science*, **18**, 130–132.

Hamann, S. B., Ely, T. D., Hoffman, J. M., & Kilts, C. D. (2002). Ecstasy and agony: Activation of human amygdala in positive and negative emotion. *Psychological Science*, **13** (2), 135–141.

Hariri, A. R., Mattay, V. S., Tessitore, A., Fera, F., & Weinberger, D. R. (2003). Neocortical modulation of the amygdala response to fearful stimuli. *Biological Psychiatry*, **53**, 494–501.

Isaacowitz, D. M., Wadlinger, H. A., Goren, D., & Wilson, H. R. (2006a). Is there an age-related positivity effect in visual attention? A Comparison of two methodologies. *Emotion*, **6** (3), 511–516.

Isaacowitz, D. M., Wadlinger, H. A., Goren, D., & Wilson, H. R. (2006b). Selective preference in visual fixation away from negative images in old age? An eye-tracking study. *Psychology and Aging*, **21**, 40–48.

Jackson, D. C., Mueller, C. J., Dolski, I., Dalton, K. M., Nitschke, J. B., Urry, H. L., et al. (2003). Now you feel it, now you don't: Frontal brain electrical asymmetry and individual differences in emotion regulation. *Psychological Science*, **14**, 612–617.

Jeannerod, M., Arbib, M. A., Rizzolatti, G., & Sakata, H. (1995). Grasping objects: The cortical mechanisms of visuomotor transformation. *Trends in Neuroscience*, **18**, 314–320.

Johnson-Frey, S. H. (2004). The neural bases of complex tool use in humans. *Trends in Cognitive Science*, **8**, 71–78.
Jostmann, N. B., Koole, S. L., van der Wulp, N. Y., & Fockenberg, D. A. (2005). Subliminal affect regulation: The moderating role of action vs. state orientation. *European Psychologist*, **10**, 209–217.
Keele, S. W., Ivry, R., Mayr, U., Hazeltine, E., & Heuer, H. (2003). The cognitive and neural architecture of sequence representation. *Psychological Review*, **110**, 316–339.
Kobak, R. R., Cole, H. E., Ferenz-Gillies, R., & Fleming, W. S. (1993). Attachment and emotion regulation during mother-teen problem solving: A control theory analysis. *Child Development*, **64**, 231–245.
Koole, S. L., & Coenen, L. H. M. (2007). Implicit self and affect regulation: Effects of action orientation and subliminal self priming in an affective priming task. *Self and Identity*, **6**, 118–136.
Koole, S. L., & Jostmann, N. B. (2004). Getting a grip on your feelings: Effects of action orientation and external demands on intuitive affect regulation. *Journal of Personality and Social Psychology*, **87**, 974–990.
Kuhl, J. (1981). Motivational and functional helplessness: The moderating effect of state versus action orientation. *Journal of Personality and Social Psychology*, **40**, 155–170.
Lane, R. D., Sechrest, L., Riedel, R., Shapiro, D. E., & Kaszniak, A. W. (2000). Pervasive emotion recognition deficit common to alexithymia and the repressive coping style. *Psychosomatic Medicine*, **62**, 492–501.
Lieberman, M. D. (2000). Intuition: A social cognitive neuroscience approach. *Psychological Bulletin*, **126**, 109–137.
Lieberman, M. D. (2007). Social cognitive neuroscience: A review of core processes. *Annual Review of Psychology*, **58**, 259–289.
Liotti, M., Mayberg, H. S., McGinnis, S., Brannan, S. L., & Jerabek, P. (2002). Unmasking disease-specific cerebral blood flow abnormalities: Mood challenge in patients with remitted unipolar depression. *American Journal of Psychiatry*, **159**, 1830–1840.
Martin, A., Haxby, J. V., Lalonde, F. M., & Wiggs, C. L. (1995). Discrete cortical regions associated with knowledge of color and knowledge of action. *Science*, **270**, 102–105.
Mather, M., & Carstensen, L. L. (2003). Aging and attentional biases for emotional faces. *Psychological Science*, **14**, 409–415.
Mauss, I. B., Bunge, S. A., & Gross, J. J. (forthcoming). Culture and automatic emotion regulation. In S. Ismer, S. Jung, S. Kronast, C. van Scheve, & M. Vanderkerckhove (Eds.), *Regulating Emotions: Culture, Social Necessity and Biological Inheritance*. London: Blackwell Publishing.
Mauss, I. B., Cook, C. L., & Gross, J. J. (2007). Automatic emotion regulation during an anger provocation. *Journal of Experimental Social Psychology*, **43**, 698–711.
Mauss, I. B., Cook, C. L., Cheng, J. Y. J., & Gross, J. J. (forthcoming). Individual differences in cognitive reappraisal: Experiential and physiological responses to an anger provocation. *International Journal of Psychophysiology*.
Mauss, I. B., Evers, C., Wilhelm, F. H., & Gross, J. J. (2006). How to bite your tongue without blowing your top: Implicit evaluation of emotion regulation predicts affective responding to anger provocation. *Personality and Social Psychology Bulletin*, **32**, 589–602.
Mayberg, H. S. (2003). Modulating dysfunctional limbic-cortical circuits in depression: Towards development of brain-based algorithms for diagnosis and optimised treatment. *British Medical Bulletin*, **65**, 193–207.
Meier, B. P., Robinson, M. D., & Wilkowski, B. M. (2006). Turning the other cheek: Agreeableness and the regulation of aggression-related primes. *Psychological Science*, **17**, 136–142.
Mendez, M. F., Adams, N. L., & Lewandowski, K. S. (1989). Neurobehavioral changes associated with caudate lesions. *Neurology*, **39**, 349–354.
Mesquita, B., & Albert, D. (2007). The cultural regulation of emotions. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 486–503). New York: Guilford Press.
Mikulincer, M., & Shaver, P. R. (2003). The attachment behavioral system in adulthood: Activation, psychodynamics, and interpersonal processes. In M. P. Zanna (Ed.), *Advances in Experimental Social Psychology* (Vol. 35, pp. 53–152). San Diego, CA: Elsevier Academic Press.
Mikulincer, M., Birnbaum, G., Woddis, D., & Nachmias, O. (2000). Stress and accessibility of proximity-related thoughts: Exploring the normative and intraindividual components of attachment theory. *Journal of Personality and Social Psychology*, **78**, 509–523.

Milner, A. D., & Goodale, M. A. (1995). *The Visual Brain in Action*. New York: Oxford University Press.

Moon, S. M. & Lord, R. G. (2006). Individual differences in automatic and controlled regulation of emotion and task performance. *Human Performance*, **19**, 327–356.

Moskowitz, G. B., Gollwitzer, P. M., Wasel, W., & Schaal, B. (1999). Preconscious control of stereotype activation through chronic egalitarian goals. *Journal of Personality and Social Psychology*, **77**, 167–184.

Ochsner, K. N., Bunge, S. A., Gross, J. J., & Gabrieli, J. D. E. (2002). Rethinking feelings: An fMRI study of the cognitive regulation of emotion. *Journal of Cognitive Neuroscience*, **14**, 1215–1229.

Parkinson, B., & Totterdell, P. (1999). Classifying affect-regulation strategies. *Cognition and Emotion*, **13**, 277–303.

Paulhus, D. L., Fridhandler, B., & Hayes, S. (1997). Psychological defense: Contemporary theory and research. In R. Hogan, J. A. Johnson, & S. R. Briggs (Eds.), *Handbook of Personality Psychology* (pp. 543–579). San Diego, CA: Academic Press.

Phelps, E. A., Delgado, M. R., Nearing, K. I., & LeDoux, J. E. (2004). Extinction learning in humans: Role of the amygdala and vmPFC. *Neuron*, **43**, 897–905.

Picard, N., & Strick, P. L. (1996). Motor areas of the medial wall: A review of their location and functional activation. *Cerebral Cortex*, **6**, 342–353.

Poldrack, R. A., & Gabrieli, J. D. E. (2001). Characterizing the neural mechanisms of skill learning and repetition priming. Evidence from mirror-reading. *Brain: A Journal of Neurology*, **124**, 67–82.

Poldrack, R. A., Sabb, F. W., Foerde, K., Tom, S. M., Asarnow, R. F., Bookheimer, S.Y., et al. (2005). The neural correlates of motor skill automaticity. *Journal of Neuroscience*, **25**, 5356–5364.

Prinz, W. (2003). How do we know about our own actions? In S. Maasen, W. Prinz, & G. Roth (Eds.), *Voluntary Action: Brains, Minds, and Sociality* (pp. 21–33). New York: Oxford University Press.

Rempel-Clower, R. L., Barbas, H. (1998). Topographic organizations of connections between the hypothalamus and the prefrontal cortex in the rhesus monkey. *Journal of Comparative Neurology*, **398**, 393–419.

Rolls, E. T. (2000). The orbitofrontal cortex and reward. *Cerebral Cortex*, **10**, 284–294.

Rothbaum, F., Pott, M., Azuma, H., Miyake, K., & Weisz, J. (2000). The development of close relationships in Japan and the United States: Paths of symbiotic harmony and generative tension. *Child Development*, **71**, 1121–1142.

Rudman, L. A. (2004). Sources of implicit attitudes. *Current Directions in Psychological Science*, **13**, 79–82.

Sakai, K., Hikosaka, O., Miyauchi, S., Takino, R., Tamada, T., Iwata, N. K., et al. (1999). Neural representation of a rhythm depends on its interval ratio. *Journal of Neuroscience*, **19**, 10074–10081.

Schacter, D. L. (1997). The cognitive neuroscience of memory: Perspectives from neuroimaging research. *Philosophical Transactions of the Royal Society*, **352**, 1689–1695.

Schwartz, G. E. (1995). Psychobiology of repression and health: A systems approach. In J. L. Singer (Ed.), *Repression and Dissociation: Implications for Personality Theory, Psychopathology, and Health* (pp. 405–434). Chicago, IL: University of Chicago Press.

Shaver, P. R., & Mikulincer, M. (2007). Adult attachment strategies and the regulation of emotion. In J. J. Gross (Ed.), *Handbook of Emotion Regulation* (pp. 446–465). New York: Guilford Press.

Shedler, J., Mayman, M., & Manis, M. (1993). The illusion of mental health. *American Psychology*, **48**, 1117–1131.

Shelton, P. A., Shelton, P. A., & Knopman, D. S. (1991). Ideomotor apraxia in Huntington's disease. *Archives of Neurology*, **48** (1), 35–41.

Shin, L. M., Kosslyn, S. M., McNally, R. J., & Alpert, N. M. (1997). Visual imagery and perception in posttraumatic stress disorder: A positron emission tomographic investigation. *Archives of General Psychiatry*, **54**, 233–241.

Sloman, S. A. (1996). The empirical case for two systems of reasoning. *Psychological Bulletin*, **119**, 3–22.

Srull, T. K., & Wyer, R. S. (1979). The role of category accessibility in the interpretation of information about persons: Some determinants and implications. *Journal of Personality and Social Psychology*, **37**, 1660–1672.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review*, **8**, 220–247.

Tettamanti, M., Buccino, G., Saccuman, M. C., Gallese, V., Danna, M., Scifo, P., et al. (2005). Listening to action-related sentences activates fronto-parietal motor circuits. *Journal of Cognitive Neuroscience*, **17**, 273–281.

Thach, W. T. (1996). On the specific role of the cerebellum in motor learning and cognition: Clues from PET activation and lesion studies in man. *Behavioral and Brain Sciences*, **19**, 411–431, 503–527.

Tomaka, J., Blascovich, J., Kelsey, R. M., & Leitten, C. L. (1993). Subjective, physiological, and behavioral effects of threat and challenge appraisal. *Journal of Personality and Social Psychology*, **65**, 248–260.

Vaillant, G. (1977). *Adaptation to Life*. Boston, MA: Little, Brown and Co.

Vaillant, G., & McCullough, L. (1998). The role of ego mechanisms of defense in the diagnosis of personality disorders. In J. W. Barron (Ed.), *Making Diagnosis Meaningful: Enhancing Evaluation and Treatment of Psychological Disorders* (pp. 139–158). Washington, DC: American Psychological Association.

Webb, T. L., & Sheeran, P. (2003). Can implementation intentions help to overcome ego-depletion? *Journal of Experimental Social Psychology*, **39**, 279–286.

Wegner, D. M. (2002). *The Illusion of Conscious Will*. Cambridge, MA: MIT Press.

Weinberger, D. A. (1995). The construct validity of the repressive coping style. In J. L. Singer (Ed.), *Repression and Dissociation: Implications for Personality Theory, Psychopathology, and Health* (pp. 337–386). Chicago, IL: University of Chicago Press.

Weinberger, D. A., Schwartz, G. E., & Davidson, R. J. (1979). Low-anxious, high-anxious, and repressive coping styles: Psychometric patterns and behavioral and physiological responses to stress. *Journal of Abnormal Psychology*, **88** (4), 369–380.

Westen, D., Kilts, C., Blagov, P., Harenski, K., & Hamann, S. (2006). Neural cases of motivated reasoning: An fMRI study of emotional constraints on partisan political judgment in the 2004 U.S. Presidential Election. *Journal of Cognitive Neuroscience*, **18**, 1947–1958.