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by

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Abstract

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Securing social acceptance and avoiding social rejection are basic human needs. When faced with rejection, individuals low in self-esteem show elevated defensive psychological reactions. However, an emerging literature indicates that individual differences in attentional-control – the ability to direct and maintain attentional focus – might attenuate these reactions. In three studies, the present research further investigated the role attentional-control plays in attenuating reactivity to rejection among low self-esteem individuals. Self-esteem and attentional-control were measured with questionnaires. In Study 1 we found that low self-esteem high attentional-control individuals perceived and construed social rejection in less threatening ways. In Study 2 we found that that low self-esteem high attentional-control individuals showed enhanced BOLD response in brain regions related to emotion regulation (rostral anterior cingulate cortex) when judging the valence of artwork that depicts social rejection. In Study 3, we found that following a real-life rejection experience, rumination is significantly reduced by the second day among low self-esteem high attentional-control people, but not in their low attentional-control counterparts. Consistent with prior research demonstrating the buffering role of attentional-control in self-esteem (Gyurak & Ayduk, 2007), these studies indicate that individuals low in self-esteem but high in attentional-control responded less negatively to social rejection than low self-esteem low attentional-control individuals. Finally, in Study 4, we explored the correlates of attentional-control measured by the Attentional Control Scale (Derryberry & Reed, 2002) used in the first three studies by examining its relationship to self-report measures of emotion and self-regulatory scores, and performance on executive function measures. These results showed that higher scores on the Attentional Control Scale were related to emotion reappraisal ability and conscientiousness. Furthermore, there was a significant relationship between higher scores on the Attentional Control Scale and complex executive function measure of Verbal Fluency. Taken together, these studies demonstrate that attentional-control attenuates defensive reactions to social rejection among otherwise vulnerable low self-esteem individuals, possibly via the engagement of behavioral and emotion regulatory mechanisms.

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Attenuating reactivity among low self-esteem individuals: The role of attentional-control

Self-esteem, a basic human need (Branden, 1969), has been proposed to motivate people to strengthen social ties and secure acceptance in the service of survival (Hart, Shaver, & Goldenberg, 2005; Leary & Baumeister, 2000; Leary, Tambor, Terdal, & Downs, 1995). A person's enduring sense of self-worth – or trait self-esteem – is the cumulative result of repeated experiences of acceptance and rejection (MacDonald, Saltzman, & Leary, 2003; Rosenberg, 1989). Even though trait self-esteem is believed to function in the service of acceptance, research shows that individuals with chronically low levels of self-worth react to social rejection in such negative ways that they ultimately beget social rejection from relationship partners (Joiner, Katz, & Lew, 1999; Murray, Holmes, Griffin, Bellavia, & Rose, 2001; Murray, Holmes, MacDonald, & Ellsworth, 1998). Collectively, negative reactions to rejection contribute to the maintenance of chronic low self-esteem. Furthermore, a large-scale longitudinal study showed that low levels of self-esteem predict development of clinical depression, suggesting that low self-worth may play a causal role in the onset of mood disorders (Orth, Robins, & Roberts, 2008).

Emerging evidence suggests that attentional-control (Derryberry & Reed, 2002) – the ability to direct and maintain attentional focus – might attenuate some of the negative reactions that characterize low self-esteem individuals. High attentional-control, in general, has been documented to promote disengagement from threat related stimuli (Mathews, Yiend, & Lawrence, 2004) and buffer from emotional over-reactions (Derryberry & Reed, 2002). Likewise, previous research has documented that high attentional-control buffers defensive physiological reactivity in the face of social rejection among low self-esteem individuals (Gyurak & Ayduk, 2007).

Through a series of four studies, the goal of the present research was to extend and elaborate on these findings. Specifically, we aimed to investigate the buffering role of attentional-control in low self-esteem on (a) construal of social rejection, (b) neural responses to rejection and (c) rumination about real-life rejection. Finally, in Study 4, we aimed to (d) refine and better characterize the construct of attentional-control and examine its relationship to self-report measures of emotion and behavioral regulation, and to performance based executive functions measures. Collectively, the studies intend to pinpoint critical junctures in the processing of social rejection on which attentional-control acts as a buffer – protecting otherwise vulnerable low self-esteem individuals.

Defensive psychological reactions to rejection in low self-esteem

The sociometer theory of self-esteem (Leary et al., 1995) posits that people's enduring feelings about their self-worth are affected by how they believe they are regarded by others. Supportive empirical studies show that transient feelings of self-worth are a function of immediate threats to social inclusion (Leary, Haupt, Strausser, & Chokel, 1998; Leary et al., 1995; Nezlek, Kowalski, Leary, Blevins, & Holgate, 1997), and chronic feelings of self-esteem are a result of how people think they are generally viewed by others (Harter, 1993; Leary & Baumeister, 2000; Leary et al., 1995; Rosenberg, 1989).

Reduced self-esteem following social rejection is believed to function to motivate people to reaffirm their social ties and forestall rejection (Leary et al., 1995). However, low self-esteem individuals react to rejection such that they become locked into a self-reinforcing cycle of intra- and inter-personal processes that ultimately undermines social acceptance aspirations. It has been hypothesized that selective attention to exclusion related threat cues in low trait self-esteem acts as a gating mechanism that creates a process of hypervigilance and attentional bias to rejection.

These attentional biases to threat have been identified to be the perpetuating mechanism in clinical disorders characterized by low self-esteem, such as social anxiety, social phobia and generalized anxiety disorder (Williams, Mathews, & MacLeod, 1996). Specifically, research shows that rejection powerfully captures low self-esteem people's attention at early stages of processing (e.g., Dandeneau & Baldwin, 2004; Leary et al., 1995). When faced with rejection, low self-esteem people exhibit greater negative reactivity emotionally (Nezlek et al., 1997), physiologically (Gyurak & Ayduk, 2007), and hormonally (Pruessner, Hellhammer, & Kirschbaum, 1999) than people with high self-esteem. Furthermore, a recent prospective longitudinal study found that among adolescents and young adults, low self-esteem predicted subsequent levels of depression and social isolation, but that depression did not predict low self-esteem later in life (Orth et al., 2008).

Several theories have been proposed to account for the association between low self-esteem and these negative outcomes. Interestingly, all of these theories note a common process about deteriorating social relationships and loss of acceptance in low self-esteem. One theory posits that individuals with low self-esteem seek reassurance excessively about their personal worth from friends and relationship partners, increasing the risk of being rejected by their support partners and thereby increasing the risk of depression and alienation (Joiner, Alfano, & Metalsky, 1992). A second theory proposed by Swann and colleagues (e.g., Giesler, Josephs, & Swann, 1996; Swann, Wenzlaff, & Tafarodi, 1992) proposes that individuals with low self-esteem seek negative feedback from their relationship partners to verify their already negative self-concept, which may further degrade their sense of self-worth. Finally, Murray and colleagues (Murray et al., 2001; Murray et al., 1998) argue that individuals with low self-esteem are more sensitive to rejection and tend to perceive their relationship partner's behavior more negatively, and act in hostile manners in the face of perceived rejection. These behaviors ultimately undermine attachment and satisfaction that their relationship could otherwise provide (e.g., Murray, Rose, Bellavia, Holmes, & Kusche, 2002). Related research found that individuals with low self-esteem are prone to engage in antisocial behaviors, such as aggression and substance abuse, that might contribute to their feeling excluded and alienated from others (Trzesniewski et al., 2006). All of these studies suggest that even though low self-esteem individuals strive to secure social acceptance, when faced with rejection they react in negative ways that ultimately undermine their social ties and beget rejection from significant others.

Attentional control as a moderator of negative responses to social rejection

Given the pervasive nature and negative consequences of the responses that characterize low self-esteem individuals, it is important to identify protective factors that can alter the dynamics associated with low self-esteem. One potential candidate system is attentional-control (Posner, Sheese, Odludaş, & Tang, 2006; Rothbart & Bates, 1998), the ability to direct and maintain attentional focus in the service of behavioral goals.

Attentional-control plays a moderating role in how highly anxious individuals process threatening information. For example, among highly trait anxious individuals, higher attentional-control has been linked to faster disengagement from threat related information (Derryberry & Reed, 2002). Among healthy individuals, higher attentional-control leads to lower levels of negative affect after a laboratory induction of negative mood (Compton, 2000). Attentional-control is believed to be a part of temperament and it is believed to underlie effortful behavioral control. Thus, it has been proposed that attentional-control influences threat processing relatively early on in the course of development (Rothbart & Bates, 1998). Consistent with this, research finds that among children prone to negative emotionality, externalizing behaviors (e.g., lying,

arguing) are less common and teacher-reported social competence is higher when children are better in regulating their attention (e.g., Eisenberg et al., 1997). Longitudinal research studies corroborate this correlational finding, and show that greater attentional-control, indexed by higher scores on the Attentional Control Scale (Derryberry & Reed, 2002) and better performance on related measures in childhood, predict better adjustment in adulthood (e.g., Eisenberg, Fabes, Guthrie, & Reiser, 2000; Kochanska & Knaack, 2003). Furthermore, among individuals prone to borderline personality disorder higher attentional-control scores were related to less likelihood of exhibiting borderline symptomatology (Ayduk et al., 2008).

Most importantly, however, there is evidence that high attentional-control can buffer defensive responses that characterize low self-esteem individuals in the face of rejection. In a previous study we found that physiological reactivity to rejection was attenuated among those low self-esteem individuals with high attentional-control (Gyurak & Ayduk, 2007). We used the emotion modulated startle[1] paradigm (Lang, Bradley, & Cuthbert, 1990) to assess modulation of threat reactivity in the presence of social rejection related stimuli. In this paradigm participants are typically presented with images that are neutral (e.g., household object), positive (e.g., babies, erotica) or strongly negative (e.g., mutilated bodies) in valence. During presentation some of these images are paired with a loud noise burst. When an individual is in a heightened state of threat, the magnitude of eye-blink that is reflexively elicited by the loud noise burst is larger than when the individual's defensive physiological state is not elevated. We used artwork as stimuli to capture modulation of the startle eye-blink response by social rejection. Paintings that were either neutral, negative in valence or depicted interpersonal rejection were pre-selected and were presented electronically on a monitor. The paintings were then paired with a loud noise-burst and the magnitude of the eyeblink response to the noise was measured. In line with the argument that rejection predisposes individuals low in self-esteem to exhibit defensive physiological reactions, we found that the magnitude of the startle eye-blink responses to loud noises that accompanied rejection pictures was higher in low self-esteem individuals. However, we also observed that the magnitude of the startle eye-blink response was lower among low self-esteem high attentional-control individuals, than low self-esteem low attentional-control individuals. In fact, due to the buffering role of attentional-control, the magnitude of startle eye-blink responses of low self-esteem high attentional-control individuals was equivalent to the low reactivity response exhibited by high self-esteem individuals.

Collectively these studies suggest that the extent of negative reactions to rejection among low self-esteem individuals might depend on individual differences in the ability to control one's attention. Thus, in the current work we sought to extend and elaborate on our previous findings. Through three studies, we examined the attenuating role attentional-control plays among low self-esteem individuals in construal of ambiguous social information (Study 1), neural responses in evaluating social rejection related information (Study 2) and rumination after real life rejection from a romantic partner (Study 3). Finally, we explored the construct validity of the Attentional Control Scale and examined the relationship between Attentional Control Scale scores, self-report measures of emotion and self-regulatory scores and performance on executive function measures (Study 4).

Study 1

Threat construals in self-esteem and the buffering role of attentional-control

Attentional and interpretation biases are believed to contribute to the maintenance of emotional vulnerabilities, such as anxiety disorders and low self-esteem (e.g., Bögels & Mansell, 2004; Matthews & MacLeod, 2005). Research evidence shows that rejection cues capture low

self-esteem individuals' attention at early stages of processing (e.g., Dandeneau & Baldwin, 2004; Leary et al., 1995), however, no study to date has examined interpretation biases in the construal of rejection in low self-esteem. Past research shows that in naturally occurring interactions individuals with low self-esteem tend to perceive their relationship partner's behavior more negatively than high self-esteem individuals (Murray, Holmes, & Griffin, 2000; Murray et al., 2002). This suggests that low self-esteem individuals are more likely to construe stimuli as rejecting and threatening than high self-esteem individuals. Evidence from studies using related emotional vulnerabilities also suggests that low self-esteem predisposes individuals to construe potentially ambiguous information as highly socially rejecting. For example, studies with rejection sensitivity (*RS*, Downey & Feldman, 1996) report that high RS people (who also tend to be low in self-esteem) readily perceive and appraise ambiguous or potentially rejecting cues as threatening (e.g., Buckley, Winkel, & Leary, 2004; Downey & Feldman, 1996). Additionally, studies on social anxiety show that socially anxious people exhibit a similar tendency to imbue threat into ambiguous information. For example, individuals high on social anxiety attend to, and perceive negatively valenced (Mathews & MacLeod, 1985) stimuli as more threatening than low anxious individuals.

Thus, in Study 1, we examined the association between self-esteem and construal of ambiguous social and physical threat related information using an established measure of threat perception (Zadro, Boland, & Richardson, 2006). This questionnaire measure considers construal of social as well as physical threat. We hypothesized that low self-esteem will be specifically related to higher likelihood of threat construal for social threat. However, because low self-esteem develops from repeated experiences of social rejection, we did not expect that low self-esteem individuals would be more prone to imbue ambiguous situations with physical threat construal. This research constitutes an extension of previous research that documented interpretation biases in low self-esteem and related conditions (e.g., Matthews & MacLeod, 2005; Murray et al., 2000; Murray et al., 2002). Additionally, as our central question of interest in this study, we examined the moderating role of attentional-control on social threat construal. Consistent with the buffering role of attentional-control we documented in prior research, we hypothesized that high attentional-control would be successful in attenuating social threat construal in low self-esteem individuals.

Method

Participants and procedures

Undergraduate participants ($N = 149$, 55 males) were invited to participate in a two-session study in exchange for course credit. Thirty-eight percent were Asian, 39% White, 3% Black/African-American, 7% indicated race as "other" and 11% marked "mixed" as their racial identification. Ethnically 10% percent of the participants indicated that they were Hispanic. First, participants read and signed the consent form on a customized website. They were then emailed a link to an online survey that consisted of a computerized version of the self-esteem questionnaire (Rosenberg, 1989), an abbreviated measure of the Attentional Control Scale (Ayduk et al., 2008; Derryberry & Reed, 2002) among other surveys. After completing the online surveys, participants were scheduled for a lab session where they completed the threat perception scale (Zadro et al., 2006) on paper, and a mental imagery exercise that was not the focus of this study. At the end of the laboratory session, participants were debriefed, thanked and compensated for their time.

Self-esteem. Rosenberg's (1989) 10-item questionnaire (e.g., ''On the whole, I am satisfied with myself'') was used to measure self-esteem. Ratings were made on a scale from 1

(does not describe me at all) to 6 (describes me very well). Items were reverse-scored when appropriate and then averaged (M = 4.43, SD = .84) across the 10 items.

Attentional Control. Participants completed a 12-item short version (Ayduk et al., 2008) of the Attentional Control Scale (Derryberry & Reed, 2002). This scale assesses the ability to voluntarily focus and switch attention on a four-point scale (1: rarely/never to 4: almost always/always). Typical items include: "I can quickly switch from one task to another;" "When trying to focus my attention on something, I have difficulty blocking out distracting thoughts" (reverse coded); "When I need to concentrate and solve a problem, I have trouble focusing my attention" (reverse coded); "It's very hard for me to concentrate on a difficult task when there are noises around" (reverse coded). We computed each participant's average rating out of 12 items (M = 2.64, SD =.42).

Threat perception. The Threat Perception questionnaire (Zadro et al., 2006) asks participants to identify the most likely explanation for five situations that potentially involve physical threat (e.g., "On the way to school, you feel a strange churning in your stomach.") and five that potentially involve social threat (e.g., "Your good friend says she will give you a call over the weekend to make plans to go to the movies the following week. It is Sunday night and she still hasn't called"). Each scenario is then followed by three explanations, with one reflecting a threat appraisal (e.g., example of social threat: "Your good friend doesn't really want to go to the movies with you and is avoiding the call") and two reflecting benign appraisals (e.g., example of social threat; "She has lost or forgotten your number"). After identifying the most likely explanation for each ambiguous situation, participants also rate the likelihood of the explanation on a scale from 1-100.

To index threat construals, separate threat construal scores were calculated for social and physical threat by counting the number of times participant selected the threatening explanation over the two non-threatening explanations (social threat M = 1.92, SD = 1.25; physical threat M = .74, SD = .83). To index threat likelihood, scores were also calculated by summing the percent likelihood selected on the threatening explanation (social threat M = 200.70, SD = 99.00; physical threat M = 200.14, SD = 82.63).

Results

First, bivariate correlations between self-esteem and social threat construal and social threat likelihood were conducted in the SAS statistical package (Version 9.1). We then examined the relationship between social and physical threat construal, threat likelihood scores and self-esteem, attentional-control and their interaction term using separate multiple regression analyses. Gender and ethnicity did not moderate any of the results. For the interaction analyses, predictors were centered on their means and used as continuous variables (Aiken & West, 1990).

Does low self-esteem relate to higher threat construal of social threat?

Consistent with our hypothesis, self-esteem was negatively related to social threat construal and social threat likelihood. Additionally, self-esteem was not related to physical threat construal, but it was negatively related to physical threat likelihood. Bivariate correlations and corresponding significance levels are displayed in Table 1.

Does attentional-control moderate the relationship between self-esteem and social threat construal and social threat likelihood?

As can be seen in Table 2, the interaction term of self-esteem and attentional-control was significantly related to social threat construal, $t(149) = 3.06$, $p = .002$ and social threat likelihood, $t(149) = 2.24$, $p = .03$, but not to physical threat construal, $t(149) < 1$ and likelihood, $t(149) = 1.07$, $p = .23$. Significant interactions were decomposed using simple slopes analyses (Aiken &

West, 1990) conducted one SD below and above the centered means of the predictor variables. The results for social threat construal (Figure 1) indicated that, consistent with our prediction, among low self-esteem participants, higher attentional-control was related to lower levels of threat construal, $\beta = -.53$, $t(149) = -4.04$, $p < .001$, whereas among high self-esteem participants the slope of attentional-control was not significant, $\beta = .04$, $t < 1$. Among low attentional-control participants, the slope of self-esteem was significant such that higher self-esteem was related to lower social threat construal, $\beta = -.48$, $t(149) = -3.94$, $p < .001$, whereas among high attentional-control the slope of self-esteem was not significant, $\beta = .08$, $t < 1$.

For social threat likelihood (not graphed) the results were parallel such that among low self-esteem participants, higher attentional-control was related to lower levels of threat likelihood, $\beta = -.32$, $t(149) = -2.50$, $p = .01$, whereas among high self-esteem participants the slope of attentional-control was not significant, $\beta = .09$, $t < 1$. Among low attentional-control participants, the slope of self-esteem was significant such that higher self-esteem was related to lower social threat likelihood, $\beta = -.58$, $t(149) = -4.83$, $p < .001$, and among high attentional-control the slope of self-esteem was again at trend level such that higher self-esteem was related to lower likelihood estimation of social threat, $\beta = -.17$, $t(149) = -1.46$, $p = .1$.

Discussion of Study 1

Results of Study 1 showed that low self-esteem was related to higher threat construal of ambiguous social scenarios, but not of ambiguous physical threat scenarios. Importantly, the relationship between self-esteem and social threat construal was moderated by attentional-control, such that low self-esteem individuals with high attentional-control showed lower levels of threat construal than their low self-esteem low attentional-control counterparts.

These results demonstrate that when evaluating ambiguous social situations, low self-esteem individuals are more likely to imbue threatening, rejection-related explanations, potentially paving the way for behavioral over-reactions. Furthermore, low self-esteem individuals showed interpretation biases to social situation, and not to physical threat, implying that it is not a general emotional vulnerability that underlies this heightened threat construal of social threat. These results are consistent with previous evidence that low self-esteem attunes individuals toward social threat and not to negative valence in general (e.g., Gyurak & Ayduk, 2007).

Importantly, our results show that high attentional-control can buffer interpretation biases among low self-esteem individuals. Low self-esteem individuals characterized by high attentional-control construed ambiguous social situations in benign, non-threatening ways – similar to high self-esteem individuals. These results indicate that high attentional-control acts as a protective mechanism against interpretational biases among particularly vulnerable low self-esteem individuals.

In sum, evidence suggests that low self-esteem predisposes individuals to imbue social threat and rejection into otherwise neutral scenarios, but that high attentional-control can buffer these interpretational biases. One way to rein in these potentially negative biases is to engage in effortful regulation while evaluating rejection-related information. In other words, it is possible that the reason why low self-esteem low attentional-control individuals show physiological threat reactions (Gyurak & Ayduk, 2007) and attentional biases is because they fail to engage in regulation in the face of rejection. In order to address this question, Study 2 examined the neural correlates of evaluating rejection-related stimuli as a function of self-esteem and attentional-control, with a focus on emotion regulation related brain regions as our primary areas of interest.

Study 2

In Study 2, we hypothesized that individuals who are vulnerable to over-react to social rejection (low self-esteem), but are able to control these responses (high attentional-control) would show neural activation consistent with regulation when processing social rejection stimuli. Conversely, we hypothesized that vulnerable (low self-esteem) individuals who are low in regulation (attentional-control) would not rely on emotion regulation when processing social rejection related stimuli. More specifically, a growing body of imaging studies indicates that attentional-control is associated with the recruitment of higher order brain areas that enact control over behavior and emotions (rostral ACC, rACC and dorsal ACC, dACC) (Carter & van Veen, 2007; Egner, Etkin, Gale, & Hirsch, 2008; Mathews et al., 2004). In one study, better attentional-control – measured as an individual difference using the Attentional Control Scale (Derryberry & Reed, 2002) – was found to be related to stronger blood oxygenation level dependent (BOLD) signal in the left rACC while participants passively viewed facial expressions of fear versus neutral faces (Mathews et al., 2004). These authors concluded that individual differences in the recruitment of the left rACC index engagement of cognitive control processes over emotional threat and the ability to maintain attention in the face of threatening stimuli. Another study by Bishop and colleagues (Bishop, Jenkins, & Lawrence, 2007) corroborated these findings and found higher activation in the left dACC as a function of attentional-control in a task where participants had to disregard threatening negative faces to complete a digit-recognition task. Collectively, these studies link activation in the ACC to individual differences in attentional-control.

Thus, based on these findings (Bishop et al., 2007; Mathews et al., 2004), we defined the left ACC as our region of interest (ROI). To further narrow our ROI definition within the ACC, we drew on the meta-analysis conducted by Bush and colleagues (Bush, Luu, & Posner, 2000) and evidence from Mathews and colleagues (Mathews et al., 2004) who found that activation in the rACC is related to regulatory control over emotional information. We thus defined the left rACC as our as our *a priori* ROI.

We used previously validated stimuli in the form of evocative paintings proven to elicit feeling of social rejection (Downey, Mougios, Ayduk, London, & Shoda, 2004; Gyurak & Ayduk, 2007; Kross, Tobias Egner, Ochsner, Hirsch, & Downey, 2007). We controlled for neural activation associated with processing negative paintings by creating activation contrasts between rejection and negative control trials – and thus isolated rejection related processing.

We hypothesized that individuals who are vulnerable to over-react to social rejection (low self-esteem), but able to control these responses (high attentional-control) would show spontaneous engagement in rACC when processing social rejection stimuli but low self-esteem individuals low in attentional-control would not. We expected high self-esteem individuals to engage rACC in the presence of social rejection cues regardless of their attentional-control levels. This expectation is based on previous findings showing that people who are not sensitive to social rejection, such as those high in self-esteem, automatically engage regulation related brain areas when processing social rejection information (Kross, et al., 2007).

Method

Participants and procedures

English speaking, right handed undergraduate students were recruited as participants for a larger study ($N = 106$) on emotional processing in ongoing dating relationships on the UC Berkeley campus (see Ayduk, Gyurak, & Luerssen, 2009 for details on the larger study). All participants were in a dating relationship at the time of the study. A subset of these participants took part in the imaging study ($N = 25$, 12 males, 11 couples, 1 individual). All participants (in

the larger study) had a laboratory session in which they completed self-report questionnaires and other tasks unrelated to the present study. At that time an invitation to participate in the fMRI scan was extended. Interested participants were then screened for fMRI procedure contradictions (e.g., metal in the body, claustrophobia) and history or current diagnosis of neurological or psychiatric illness. Eligible participants were scheduled and scanned. The mean age of the participants in the current study was 20.92 years (*SD* = 2.25). Couples had been in relationships for an average of 22.4 (*SD* = 20.1) months. Thirty two percent of the sample was Asian, 40% Caucasian, 28% another race. Ethnically, 12% of the sample indicated being Hispanic. Participants were scheduled for the fMRI session individually. During the fMRI session participants completed the painting task (described below) and two other tasks that are not pertinent to the current study. Participants were compensated $50 for the fMRI scan.

fMRI Painting task

Participants were asked to appraise how artwork depicting negative, positive, social rejection, social acceptance, and neutral themes made them feel. The current study focused on the rejection and negative paintings to isolate the neural networks associated with processing of social rejection.

Artwork used in this task was identical to the set used in our previous work (Gyurak & Ayduk, 2007) and similar to other imaging studies (e.g., Kross et al., 2007). Paintings were pilot tested to be negative, positive or neutral or to elicit social rejection, or acceptance. As reported in Gyurak and Ayduk (2007) a group of undergraduate participants rated these paintings on the dimensions of acceptance/rejection, valence (positive/negative), and arousal (low/high). Rejection and acceptance paintings were matched on arousal to negative and positive paintings, respectively. Rejection paintings were more rejecting, and acceptance paintings were more accepting, than neutral, negative, and positive paintings. The final set included eight paintings in each category, and can be viewed on the web at http://www.ocf.berkeley.edu/~agyurak/startle/index.htm. The paintings were scanned from high-quality slides and digitally presented on a computer screen using E-prime software (Psychology Software Tools, Pittsburgh, PA, U.S.A.).

The fMRI task (Figure 2) consisted of two, eight-minute runs. Presentation of the painting stimuli was blocked by condition type (negative, positive, social rejection, social acceptance, neutral). Four paintings of the same category were presented within a condition block. Each painting was presented for 2750 milliseconds, followed by a 1250 millisecond blank screen creating 16 second condition blocks. Following a block of trials, participants rated how negative the block of paintings made them feel using a four-button box. Each condition block was followed by 12 seconds of "rest" to ensure that hemodynamic response returned to baseline. Figure 2 shows a schematic depiction of the task design.

Across the two runs, there were 30 category blocks total; thus each condition block was presented six times. Participants saw each individual painting three times during the task. Within each condition block the paintings were pseudo-randomized such that no two blocks were composed of the same four paintings. The category blocks were presented in a fixed random order. The order of presentation remained the same across participants.

Subjective appraisals during the fMRI task

During the fMRI scan participants rated the how *"negative/positive the previous pictures made you feel*" on a 1 to 4 scale (1: very negative to 4: very positive). Instructions were designed to draw attention to internal feelings and focus on subjective appraisals. Findings (Table 3) confirm that negative and rejection paintings on the one hand and positive and acceptance

paintings on the other are not different on valence, thus any observed differences as a function of self-esteem and attentional-control are likely to be due to individual differences in appraisals of social rejection.

fMRI image acquisition

All images were acquired at four Tesla using a Varian INOVA MR scanner (Palo Alto, CA, U.S.A.) that was equipped with echo-planar imaging. A standard radiofrequency head coil was used, and a memory foam pillow restricted head motion. E-Prime software (PST, Pittsburgh, PA, U.S.A.) controlled the stimulus display and recorded participant responses via a 4-button fiber-optic keypad. An LCD projector (Epson, Long Beach, CA, U.S.A.) projected stimuli onto a backlit projection screen (Stewart, Torrance, CA, U.S.A.) within the magnet bore, which the participant viewed via a mirror mounted on the head coil. Functional images were acquired during two runs. Each run included five dummy scans (with no data acquisition) and four scans at the beginning of the run which were subsequently dropped from analysis to insure steady state magnetization for all analyzed data. This resulted in 242 whole brain volumes per run (total of 484 volumes). Images were acquired with a set of parameters used to optimize signal in regions susceptible to drop-out due to magnetic field inhomogenities (i.e., frontal cortices). Each volume acquisition included 40, 3.5 mm thick coronal slices with a .5 mm inter-slice gap, with a phase encode direction oriented in the superior-inferior direction. A one-shot T2* weighted echo-planar image (EPI) sequence (TR = 2000 ms, TE = 28 ms, FOV = 22.4 cm^2, matrix size = 64 x 64) was used to acquire blood-oxygenation dependent (BOLD) signal. EPI voxel size at acquisition is 3.5 x 3.5 x 4 mm. A high resolution 3D T1-weighted structural scan (MPFLASH sequence) and an in-plane low resolution T2-weighted structural scan (GEMS) were acquired for anatomical localization.

Questionnaire measures

Self-esteem. Participants completed Rosenberg's (Rosenberg, 1989) 10-item questionnaire to assess self-esteem. Ratings were made on a scale from 1 (does not describe me at all) to 7 (describes me very well). Items were reverse-scored when appropriate and then averaged (M = 5.30, SD = .80) across the 10 items.

Attentional Control. Participants completed a 12-item short version (Ayduk et al., 2008) of the Attentional Control Scale (Derryberry & Reed, 2002) on a four-point scale. We computed each participant's average rating out of 12 items (M = 2.77, SD =.29).

MRI data processing

MRI data was processed and analyzed using SPM2 (Wellcome Department of Cognitive Neurology, London, U.K.) software. Each EPI volume was realigned in space to the first scan, using a six parameter, rigid body, least-squares transformation algorithm. None of the participants had more than 3 mm of movement across the two runs. After realignment, we re-sliced the coronal EPI data to the axial plane, and smoothed the data using an 8 mm (FWHM) smoothing kernel. We then created and estimated a general linear model (GLM), and created contrast images of the difference between neural activity for rejection versus negative paintings. For theoretical reasons we focused on the rejection versus negative contrast to isolate neural mechanism associated with processing of social rejection related information. Additionally, past research indicated that rejection-related (but not negative) stimuli to be important in the low self-esteem high attentional-control dynamics (Gyurak & Ayduk, 2007). In the creation of the GLM, the BOLD response for each painting category block was modeled with a boxcar function from the onset of the block. We defined each painting category block as a covariate of interest. We then convolved the canonical hemodynamic response function (hrf) with brain activity at the

onset of the block with duration of 16 seconds. Brain activity was high-pass filtered at 200s, scaled by the global mean, and corrected for serial autocorrelation. Finally, contrast images were coregistered to the individual participant's co-planar (GEMS) and high resolution (MPFLASH) anatomical images, re-sliced to 2 x 2 x 2 mm isotropic voxels and then normalized to the Montreal Neurological Institute (MNI) atlas space.

fMRI data analysis

Contrast images comparing rejection to negative paintings were submitted to a group level voxel-wise multiple-regression analysis in SPM2 (Wellcome Department of Cognitive Neurology, London, U.K.). Participants' grand mean centered self-esteem, attentional-control and self-esteem x attentional-control scores were entered as simultaneous predictors. Areas of BOLD activation associated with the main effect of each predictor (i.e., self-esteem and attentional-control separately) were modeled in a t-contrast by setting the weight of the predictor at 1 and the other two predictors at 0 (e.g., for modeling self-esteem, we set the weight of self-esteem at 1, and the weight of attentional-control and the self-esteem x attentional-control interaction term at 0). Areas of BOLD activation associated with the interaction term (i.e., self-esteem x attentional-control) in the rejection versus negative contrast were modeled in a t-contrast by setting the weight of self-esteem and attentional-control at 0 and thus holding them constant and setting weight of the self-esteem x attentional-control interaction at -1. We used -1 as the weight to isolate areas of significant BOLD activation associated with *interference* interactions (J. Cohen, P. Cohen, West, & Aiken, 2003) where the value of the outcome variable (i.e., areas of BOLD activation) is significant when the predictors are of opposite signs (e.g., low self-esteem and high attentional-control). Even though we defined the rACC as our region of interest, we conducted a whole brain analysis to explore other areas that might show significant activation. Thus the whole-brain random-effects analysis was thresholded at $t(21) = 3.53$, $p < .001$ (uncorrected), with an extent threshold of 10. After identifying areas of BOLD activation that covaried with the predictor, small volume correction was used to correct for multiple comparisons (False Discovery Rate, FDR $p < .05$) within the left rACC, our a priori region of interest anatomical region and indentify areas of functional activation that survived multiple comparisons. The left rACC was anatomically defined using the Automated Anatomical Labeling (AAL) program in MRICron. In order to decompose the pattern of the interaction, we used *MarsBaR* (Brett, Anton, Valabregue, & Poline, 2002; http://marsbar.sourceforge.net/) to extract the mean contrast values of each participant from the cluster of voxels showing a significant interaction effect in the group-level analysis. These effects were decomposed in the SAS statistical package (Version 9.1) and the pattern of interaction was graphed for visualization purposes. We used a mixed linear model to account for the fact that observations came from dating couples and thus were non-independent. For the mixed model, individuals were nested within couples and partners' centered scores on self-esteem and attentional-control were entered as covariates (Kenny, Kashy, & Cook, 2006). Mean contrast value scores from the functional ROI were entered as dependent variables, and grand mean centered self-esteem and attentional-control scores and their interaction served as predictors. Following the omnibus analysis, we conducted simple slopes analyses (Aiken & West, 1991) one SD above and below the respective means of the predictor variables.

Results

Brain areas associated with the main effects of self-esteem and attentional-control

There were no areas of significant activation associated with the main effects of self-esteem or attentional-control. Next, we examined the effect of the interaction term.

Brain areas associated with the self-esteem x attentional-control interaction

Areas of BOLD activation associated with the interaction term are displayed in Table 4. Consistent with our predictions, one of the areas of activation associated with the interaction term of self-esteem x attentional-control was a cluster in the rACC on the left side, *x, y, z* = -4, 44, 2, $t = 4.50$ small volume corrected (FDR $p < .05$) (see Figure 3 Panel A). Mean contrast values were extracted using *MarsBaR*. Outlier analysis indicated that one participants' contrast value was more extreme than the rest, Grubb's $z = 2.82$, $p < .05$, and because extreme values can unduly influence results, we excluded this participant from further analyses. The pattern of the results with this outlier were similar to the results reported here, only more robust. Figure 3 Panel A depicts the pattern of the interaction where contrast values from the rACC (Figure 3 Panel B) region were significantly predicted from self-esteem x attentional-control interaction term, $F(1,11) = 8.06$, $p = .01$. First, we examined the association between attentional-control and BOLD activation separately for participants low and high in self-esteem. These analyses showed that consistent with our prediction, among vulnerable low self-esteem participants, those higher in attentional-control showed significantly more BOLD activation in the rACC in response to the rejection than to the negative paintings, $b = 2.94$, $t(11) = 2.69$, $p = .02$, whereas among high self-esteem participants, the slope of attentional-control did not reach significance, $b = -1.37$, $t(11) = 1.49$, $p = .20$. Next, we examined the slope of self-esteem separately for low and high attentional-control groups. Among low attentional-control participants, the slope of self-esteem was significant such that higher self-esteem was related to more rACC activation, $b = 1.07$, $t(11) = 2.46$, $p = .03$, whereas among high attentional-control, the slopes of self-esteem was not significant, $b = -.45$, $t(11) = -1.46$, $p = .20$. These results demonstrate that low self-esteem high attentional-control individuals and high self-esteem individuals as a group (regardless of their level of attentional-control) engage the rACC to a greater degree than low self-esteem low attentional-control individuals in the face of rejection threat.

Discussion of Study 2

Social rejection, a ubiquitous source of threat in human life, poses an emotion regulatory challenge to most people. Managing social rejection effectively is likely to depend on top-down control processes that enable regulation of immediate responses and better anticipation of future outcomes (Wager et al., 2009). Results of the current study demonstrate that individual differences in self-esteem and regulatory abilities can alter the nature of these top-down neurobiological responses to social rejection. Our results show that those low self-esteem individuals who are also low in attentional-control capacity show a less advantageous pattern of neural responses to rejection than their low self-esteem high regulatory capacity counterparts. Specifically, we found that low self-esteem individuals who are also low in attentional-control show less activity in emotion control related regions in the rACC while appraising their personal feelings about social rejection. On the flip side, our results show that high attentional-control alters the neural signature among low self-esteem individuals resulting in higher engagement of the rACC – a neural response indicative of more adaptive responding to threat (Etkin, Egner, Peraza, Kandel, & Hirsch, 2006; Mathews et al., 2004).

These results are consistent with our earlier findings and hypotheses on the buffering role of attentional-control among low self-esteem individuals (Gyurak & Ayduk, 2007). The current results showed that those who showed the strongest physiological reactivity to rejection (i.e., low self-esteem low attentional-control group) in our prior work (Gyurak & Ayduk, 2007), demonstrated the lowest levels of rACC activation. Lack of activation in the rACC might pave the way for heightened physiological reactions down the road (Gianaros et al., 2005).

Study 3

Rumination, defined as persistent repetitive thoughts about negative life events, is a central feature of mood disorders (Nolen-Hoeksema, Parker, & Larson, 1994). Low self-esteem individuals ruminate more after laboratory induced failure (Di Paula & Campbell, 2002) and are also characterized by persistently high levels of trait rumination (Trapnell & Campbell, 1999). Conflicts with partners have been shown to be potent elicitors of perceived rejection, negative affect and rumination among vulnerable individuals (Downey, Freitas, Michaelis, & Khouri, 1998). Thus, in Study 3, our goals were twofold. First, we aimed to conceptually replicate our previous findings on the attenuating role of attentional-control on negative defensive reactions associated with low self-esteem. Specifically, we investigated post-rejection rumination that is hypothesized to be a maintaining mechanism in psychological disorders characterized by pervasive low self-esteem (Nolen-Hoeksema, 2000). Secondly, we wanted to increase the ecological validity of our findings and extend our previous results by examining the moderating role of attentional-control following real life interpersonal rejection. Thus, in the current study rejection was operationalized as occurrence of relationship conflicts with romantic partners. We examined the moderating role of attentional-control between self-esteem and post-conflict rumination in a longitudinal diary study. The longitudinal design afforded by a diary design allowed us to assess two questions. First, we examined whether the within-subjects changes in rumination that occur in response to relationship conflicts were different for low and high self-esteem individuals and second, we investigated whether the relationship of self-esteem to rumination was different as a function of attentional-control.

We hypothesized that following conflict, low self-esteem people would show elevated levels of rumination indicating an inability to move on and disengage from the rejecting experience. We expected that, consistent with the cyclic, prolonged nature that characterizes ruminative thinking, these effects would persist long after the conflict (one-day and two-day). Furthermore, we hypothesized that rumination would be lower among individuals better equipped to counter the negative effects of their low self-esteem disposition (low self-esteem high attentional-control people). Specifically we hypothesized that high attentional-control would attenuate rumination immediately after relationship conflict and also two days after.

Method

Participants and procedure

English speaking, right handed undergraduate student participants were recruited for a study (N = 106, 53 couples) on emotional processing in ongoing dating relationships. This larger group of participants encompasses the subset of participants included in Study 2. The mean age of the participants was 20.58 years (SD = 2.43 years). Couples had been in relationships for an average of 16.52 months (SD = 14. 37). Two participants did not provide racial or ethnic information. In the rest of the sample, 46.15% of the participants were Asian, 35.58% Caucasian, 17.31% another race. Ethnically 9.71% indicated being Hispanic. Same-race relationships accounted for 63.46% of the sample (33.33% Caucasian, 57.58% Asian, 9.09 % Hispanic).

The study consisted of an online questionnaire session, a one and a half hour-long laboratory session, and a 21-day long daily-diary. For the purposes of the current study, we focused on the self-report measures and the daily-diary. Couples completed background questionnaires online before the laboratory session. During the lab session couples talked about their relationship and completed various other measures that were not the focus of the current study. Members of the couple were paid $30 each for the completion of the background questionnaires and the laboratory session.

At the end of the lab assessment, participants received the web address to the daily-diary questionnaires that they were to complete at the end of each day for 21 days. Participants were asked to complete the diary questionnaires alone in a setting that minimized distraction. Daily electronic mail was sent to participants in the evening to remind them to complete the online questionnaires. Participants logged their diary responses online between 6 PM and 3 AM the following day. Submissions were time stamped electronically. Participants could not go back and modify their responses. Upon completion of the 21 diaries, each member of the couple received payment of $55 or a prorated amount proportional to the number of submissions. The diary response rate was high, on average 91.70 % of daily diaries were completed, with no significant sex differences ($t < 1$). Additionally, diary submissions were on time, less than .5% of the daily diaries had to be eliminated because responses were submitted outside of the time window specified.

Questionnaire measures

Self-esteem. Same as previous studies, participants completed Rosenberg's (1989) 10-item questionnaire to assess self-esteem. Ratings were made on a scale from 1: does not describe me at all to 7: describes me very well. Items were reverse-scored when appropriate and then averaged across the 10 items ($M = 5.24$, $SD = .90$).

Attentional Control. Same as in the previous two studies, participants completed a 12-item short version (Ayduk et al., 2008) of the Attentional Control Scale (Derryberry & Reed, 2002). We computed each participant's average rating out of 12 items ($M = 2.69$, $SD = .41$).

Daily-diary measures

The structured daily-diary included questions about the couple's daily interactions, occurrence of conflict and conflict behavior, reports on partner's behavior, daily mood, and other stressors and goals. The specific focus of the current study was on the following variables:

Perceived occurrence of conflicts with partners. Each diary day participants indicated whether they experienced a conflict with their partners (1: yes 1, 0: no). Of the 53 couples, 45 reported having at least one conflict with their partner during the diary period. Conflicts occurred on 11.39% of the diary days. Partners agreed about whether a conflict had occurred on 91.1% of the days, with a kappa coefficient of .58.

Rate of relationship conflict over the diary period was not significantly related to self-esteem or attentional-control (Fs < 1). This result is consistent with previous research (Ayduk, May, Downey, & Higgins, 2003; Downey et al., 1998).

Conflict related daily rumination. Each diary day, participants indicated their daily level of rumination by rating themselves (1: not at all, 5: extremely) on the item "I replayed an argument I had with my partner in the past over and over in my head" ($M = 1.30$, $SD = .70$).

Daily-diary data analyses

The diary data involved a hierarchical structure where participants were nested within couples, and days of assessment were nested within participants. For each couple, this structure represented a two-level model and required the simultaneous analysis of within-person and between-person levels that are hierarchically organized. Therefore, the analyses were conducted using the mixed procedure in the SAS statistical package (SAS Institute, Cary, NC, USA), which is based on a hierarchical linear modeling approach, and permits the simultaneous analysis of within- and between-person variation (Kenny et al., 2006).

In the current study, for each member of a couple the higher-level between-person analyses were used to examine whether within-person processes were a function of between subjects variables. For example, we examined whether the relationship between variables

measured at the daily level (i.e., association between having a relationship conflict and rumination) differed as a function of individual differences in self-esteem and attentional-control. Additionally, to make use of the longitudinal nature of the data and more directly explore causal direction of effects with respect to this question, we focused on associations with lag analyses. Specifically, we used a one-day lag (e.g., today's rumination following yesterday's conflict) and two-day lag (today's rumination two days after a relationship conflict) in our primary analyses. Thus, we assessed whether the effect of the *previous* day's conflict on *change* in the level of rumination from yesterday to today was contingent on self-esteem and attentional-control and their interaction by including the lagged value of rumination in the model and therefore controlling for any effect of previous day's rumination on today's rumination.

In the mixed models we assumed an error structure allowing for contemporaneous (same-day) dependence between the errors within a couple and a first order autoregressive structure within a person in a couple. In addition, variances were allowed to differ between males and females. In preliminary analyses we found no differences in the pattern of the results with gender, therefore, this variable will not be discussed further. For all analyses reported, continuous variables were centered on their grand means and simple slopes for high and low groups were tested at one SD above and below the grand mean centered mean. Partners' self-esteem and attentional-control scores were controlled for in all analyses because individual differences on these variables might influence relationship dynamics (Kenny & Cook, 1999; Kenny, et al., 2006).

Results

Relationship between self-esteem and rumination

Average levels of rumination and relationship conflict. First, we examined the relationship between self-esteem and rumination across the diary period. Rumination served as the dependent variable, and self-esteem as the predictor variable. As expected, there was a negative relationship between self-esteem and rumination, such that low self-esteem people on average ruminated more over the course of the 21 days, $b = -.08$, $F(1,53) = 8.98$, $p = .004$. Next, we examined the relationship between relationship conflict as the dependent variable, and self-esteem as the predictor variable. These results indicated a lack of association between self-esteem and the frequency of relationship conflicts across the diary period, $F < 1$. Thus, the relationship between self-esteem and elevated level of rumination was not due to more frequent experiences of interpersonal rejection, rather it likely reflected an enduring trait level association.

Rumination following rejection experience

Rumination one day after a conflict. Next, we examined the association between self-esteem and rumination as a function of previous day's relationship conflict. Rumination served as the dependent variable. Previous day's rumination (lagged rumination) was controlled for in addition to partner's self-esteem and attentional-control. Main effects of self-esteem and previous day's relationship conflict (lagged conflict) were entered into the model as main effects and jointly as an interaction term. We tested the association between the interaction term of lagged relationship conflict x self-esteem and rumination and found a significant association, $b = -.11$, $F(1,53) = 3.70$, $p = .05$. Simple slopes analyses indicated that following conflict days, low self-esteem people reported more rumination than high self-esteem people, $b = -.16$, $t(53) = -2.88$, $p = .005$. Self-esteem was also significantly related to rumination on days where no relationship conflict occurred on the previous day, $b = -.05$, $t(53) = -2.17$, $p = .03$.

Rumination two days after a conflict. Next, we tested the relationship between self-esteem and rumination two days after a conflict. Rumination served as the dependent variable.

Rumination two days prior (two day lagged rumination) was controlled for in addition to partner's self-esteem and attentional-control. Main effects of self-esteem and relationship conflict two days prior (two day lagged conflict) were entered into the model as main effects and as an interaction term. The interaction term between two day lagged conflict and self-esteem was significant, $b = -.11$, $F(1,53) = 3.77$, $p = .05$. We examined the hypothesized relationship between self-esteem and rumination on days that were preceded by a relationship conflict two days prior. These simple slopes analyses indicated that similar to rumination one day after a conflict, two days after a conflict, low self-esteem people reported more rumination than high self-esteem people, $b = -.17$, $t(53) = -2.92$, $p = .005$. Self-esteem was also significantly related to rumination on days that were not preceded by a conflict two days prior, $b = -.05$, $t(53) = -2.28$, $p = .03$.

Moderation of rumination by attentional-control

Average levels of rumination. First, we examined the relationship between self-esteem, attentional-control and rumination across the diary period. Rumination served as the dependent variable. Partner's self-esteem and attentional-control were held constant. Main effects of self-esteem and attentional-control were entered into the model and their interaction terms served as the main predictor variable. These results revealed that attentional-control did not significantly moderate the relationship between self-esteem and rumination across the diary period, $F < 1$.

Our central question of interest was the moderating role of attentional-control on the association between self-esteem and relationship conflict. Rumination served as the dependent variable. Partner's self-esteem, partner's attentional-control and previous day's rumination were held constant. Predictors were self-esteem, attentional-control and lagged value of conflict. Main-effects, lower order interaction terms and the 3-way self-esteem x attentional-control x lag of conflict term were used in the model. We considered rumination at one day and two days after a relationship conflict in separate analyses.

One day after conflict. The three-way interaction between lag value of conflict on the previous day, self-esteem and attentional-control was not significant, $b = .05$, $F < 1$ suggesting that attentional-control did not moderate the relationship between self-esteem and rumination on the day after a relationship conflict. We elaborate on these somewhat unexpected findings in more detail in the discussion section.

Two days after conflict. Using the same analysis strategy, results indicated that two days after a relationship conflict the three-way interaction term between lag value of conflict, self-esteem and attentional-control was significant, $b = .38$, $F(1,53) = 4.10$, $p = .04$. As seen in Figure 4, simple slopes analyses indicated that two days after a conflict, among low attentional-control people, there was a negative relationship between self-esteem and rumination such that people low in self-esteem ruminated more, $b = -.29$, $t(53) = -3.11$, $p = .003$, whereas among high attentional-control people, self-esteem had no effect, $b = .001$, $t < 1$. Consistent with our hypothesis, it appears that among low self-esteem people, high attentional-control acts as a protective factor and buffers them from conflict related rumination.

Discussion of Study 3

Results of Study 3 show that low self-esteem predisposes individuals to show prolonged rumination after a relationship conflict. However, high attentional-control attenuated these responses and reduced conflict-related rumination. Collectively, these results argue that individuals high on attentional-control are able to disengage from potentially threatening interpersonal events in their relationships, whereas low self-esteem individuals low on attentional-control cannot.

The moderating effects of attentional-control on rumination were only detectable on the second day following a relationship conflict. Several reasons might explain this pattern. One possibility is that in order for attentional-control to reduce rumination, there is a certain level of temporal distance required (Liberman & Trope, 2008). Temporal distance reduces the intensity of emotional experiences and paves the way for more abstract, higher level construal, thus allowing for attentional-control to reduce rumination. Another possibility is that some form of rumination and concern is adaptive following a relationship conflict. In line with this, research on rumination distinguishes between functional (e.g., reflection) and dysfunctional (e.g., brooding) forms of rumination (Nolen-Hoeksema & Morrow, 1991). Thus, it is possible that low self-esteem high attentional-control individuals could have been engaging in adaptive reflection one the day following a relationship conflict, whereas their low attentional-control counterparts were engaging in brooding. We speculate that our measure was not sensitive enough to distinguish between these different forms of ruminative responses on day one after a relationship conflict. Thus, it is possible that the effects of attentional-control on rumination were only detectable at day two when reflection dropped among low self-esteem high attentional-control individuals and when low self-esteem low attentional-control individuals were still engaged in ruminative brooding.

Study 4

Studies 1-3 provided evidence for the buffering effects of high attentional-control among low self-esteem individuals against negative responses to social rejection. Given the importance of attentional-control as an individual difference, the goal of Study 4 was to better understand the conceptual and psychometric underpinnings of the Attentional Control Scale (Derryberry & Reed, 2002). Thus, we sought to examine the relationship between Attentional Control Scale scores and related constructs at the behavioral level (e.g., with performance based attention network efficiency test, and executive functioning tests) and self-report level (e.g., with questionnaire measure of personality, mood, emotion and self-regulation).

The Attentional Control Scale is designed to tap into subjective self-reports of attentional and concentration difficulties that are believed to be biological in their origins (Derryberry & Reed, 2002; Fan, McCandliss, Sommer, Raz, & Posner, 2002). The Attentional Control Scale is a unique self-report questionnaire in that it tries to capture biologically based individual differences in effortful control at the self-report level. To the extent that biological differences in the efficiency of effortful control provide the foundation for personality and other more complex skills related to self and emotion regulation (Derryberry & Rothbart, 1997), there is reason to believe that Attentional Control Scale scores would have correlates on these domains. Thus, the first goal of the current study was to assess correlates of Attentional Control Scale at the behavioral level using performance based reaction time and executive function tests. Furthermore, given that early developmental differences in attentional-control skills are believed to provide the foundation and scaffolding for later developing personality differences (Derryberry & Rothbart, 1997) such as conscientiousness, impulsivity, emotion and mood regulation, we assessed correlates of Attentional Control Scale on these self-report domains.

Performance-based behavioral measures

Attention network efficiency. Evidence from previous studies (Bishop et al., 2007; Mathews et al., 2004) as well as from Study 2 indicates that higher Attentional Control Scale scores are related to brain activation in rostral-midline (ACC) regions during emotional tasks. Neuroscientific accounts of attentional-control (Posner et al., 2006; Posner, Petersen, Fox, & Raichle, 1988; Posner & Raichle, 1994) argue that rostral-midline brain regions (among other

more lateral and ventral brain regions) support the functioning of the *anterior (or executive) attention system*. Recently, Fan and colleagues (Fan et al., 2002) developed a computerized behavioral test to measure individual differences in the efficiency of the anterior attention system and its two facets, the alerting and executive attention systems (Posner & Petersen, 1990). Specifically, Fan and colleagues created a test, the Attention Network Task (ANT) that is a combination of the Cued Reaction Time (Posner, 1980) and the Eriksen flanker task (Eriksen & Eriksen, 1974). The ANT purportedly indexes global efficiency of the anterior attention network by measuring performance on (a) the alerting network, related to maintenance of attention; and (b) the executive control network, involved in resolving conflict among possible actions. In addition to the alerting and the executive attention networks the ANT provides a performance score that indexes the *posterior attention system* that is responsible for orienting, or selecting the region of space or the channel to be attended. Thus, to assess the relationship between the Attentional Control Scale, a questionnaire measure of attentional-control, and a computerized reaction time measure of individual differences in attention network efficiency, we administered the ANT to a group of participants along with the Attentional Control Scale.

We expected scores on the Attentional Control Scale to be related to the indexes of the anterior attention system and show a positive relationship to alerting and executive control of attention. We did not expect the Attentional Control Scale to be related to scores that index the efficiency of the posterior network.

Executive function tests. To map correlates of Attentional Control Scale on the executive function domain, we selected two relevant measures. First, a well-established test of *inhibitory control* the Go/No-Go task was administered on the computer. The test requires quick execution of a behavior (pressing the spacebar when a green circle appears) intermixed with occasional and unpredictable signals (red circle) to inhibit the behavior. The task assesses individual differences in inhibition, the ability to stop a pre-potent response from being executed. It is a measure of one of the main executive functions (Miyake et al., 2000).

We also selected a "complex" executive function measure, the test of Verbal Fluency to assess executive functioning in general. In the Verbal Fluency test, participants are instructed to say words that start with a given letter within 60 seconds while observing a set of predetermined rules (e.g., do not repeat the same word or use the same root). Fluency measures are considered to be complex, multi-factorial executive function measures in the sense that they draw on several more basic executive functions skills, such as working memory, planning and inhibition (Miyake et al., 2000).

Given that self-report Attentional Control Scale scores are most likely be reflective of behaviors that are multiply determined by a wide array of behavioral, biological and situational factors, inhibitory control as indexed by the Go/No-Go task might show a modest correlation or no correlation with the measure. However, to the extent that Attentional Control Scale scores reflect behavioral experiences that are multiply determined by several complex functions, and thus depend on several basic executive functions, we speculated that scores on the measure might be positively related to performance on the Verbal Fluency task, a "complex" executive function measure.

Self-reported personality

To assess correlates of the Attentional Control Scale on broad, dispositional personality traits, individual differences were assessed by using a well established measure of personality, the Big Five Inventory (John & Srivastava, 1999). The measure taps into enduring dispositions on Conscientiousness, Openness, Neuroticism, Extraversion, and Agreeableness. Because of the

close association between self-control and Conscientiousness (John & Srivastava, 1999), we expected that higher scores on the Attentional Control Scale would be related to higher scores on the Conscientiousness scale. We did not make specific predictions for the relationship between Extraversion, Agreeableness, Neuroticism and Openness. However, to the extent that better attentional-control skills enable better functioning and serve as protective factor against interpersonal vulnerabilities (Derryberry & Rothbart, 1997), we might expect that higher scores on the Attentional Control Scale to be related to lower self-reported Neuroticsm.

Trait impulsivity

The Barratt Impulsiveness Scale (*BIS*, Patton, Stanford, & Barratt, 1995) is the most widely used self-report measure of impulsive personality traits. The scale samples from six conceptually and psychometrically separate manifestations of impulsivity: attentional impulsiveness, motor impulsiveness, low self-control, low cognitive complexity, low perseverance, and cognitive instability (see description and sample items under *Measures*). The scale's subfactors have been repeatedly revisited since its conception, and researchers typically report the overall scores on the BIS. However, our goal in this study was to better characterize the nature of Attentional Control Scale at a more fine grained level. Thus, we report BIS scores at the factor level and examined their correlations with Attentional Control Scale. We hypothesized that attentional impulsiveness, low self-control, and low perseverance would be related to lower Attentional Control Scale scores.

Emotion regulation

To measure enduring trait differences in using cognitive reappraisal and expressive suppression as emotion regulation strategies, the 20-item Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) was administered. The measure taps into differences in habitual use of cognitive reformulation (e.g., attempting to change the way one feels about an emotional incident) as an emotion regulatory strategy and behavioral suppression (not showing an emotion) as an emotion regulation strategy. Functional neuroimaging studies (e.g., Goldin, McRae, Ramel, & Gross, 2008) show that when participants are instructed to reappraise or suppress emotional stimuli, medial and frontal areas are recruited indicating the role of effortful control in engaging these strategies on demand. These results would link attentional-control to both reappraisal and suppression at the trait level. However, questionnaire studies using the ERQ indicate that trait reappraisal is associated with higher well-being, positive affect (Gross & John, 2003), whereas trait suppression is related to lower well-being and social difficulties. Based on these latter correlational studies using self-report measures, we speculated that Attentional Control Scale scores would be related to reappraisal, but not expressive suppression.

Ruminative mood regulation

The Response Styles Questionnaire (RSQ; Nolen-Hoeksema & Morrow, 1991) was administered to assess participants' tendencies to ruminate in response to their symptoms of negative emotion. Questions probe participants about how often they use brooding or reflective pondering when they are "sad, blue, or depressed." Brooding is believed to play a causal role in the etiology and maintenance of depression (Nolen-Hoeksema & Morrow, 1991). Thus we expected that Attentional Control Scale scores would show a negative relationship to brooding.

Method

Participants and procedure

Native English speaker undergraduate students from the UC Berkeley campus participated in a study of cognition and emotions ($N = 77$, 36 males) either for pay ($20) or

course credit. Fifty one point forty three percent of the participants were Asian, 28.57% Caucasian, 10% another race and 10% Mixed. Ethnically 10% indicated being Hispanic.

As part of a two-study protocol, participants participated in two laboratory sessions. The first session, conducted one to two weeks before the second session, consisted of a series of tasks that assessed physiology and emotional functioning. The data from this initial session are not reported here because they are not relevant to the goals of the present study. Upon arrival for the second session, participants were seated in a sound attenuated experimental room approximately 65 centimeters from a computer monitor. A research assistant explained the purpose of the study and had participants sign the consent form. Following this, participants completed the Attention Network Test, the Go/No-Go Task and the Verbal Fluency tests (described below) on the computer in a counterbalanced order. Questionnaire measures (described below) were completed on the computer at the end of the session. The entire session lasted about two hours. Upon completion participants were debriefed, thanked and compensated.

Attention Network Test – ANT. The Attention Network Test, a well-established reaction time measure that assess the efficiency of the attentional networks (Fan et al., 2002) was administered to participants using E-Prime (PST, Pittsburgh, PA, U.S.A.). In the ANT, participants are told to determine whether a central arrow points left or right and indicate their response by pressing the appropriate button (left or right) of the computer mouse. The flanker arrow appears above or below a fixation cross and is accompanied by congruent or incongruent flanker arrows or by neutral non-distracting lines. The flanker screens are preceded by one of four cue conditions, (1) the no-cue screen where there is no cue presented above or below the fixation cross, (2) the center-cue where the cue replaces the fixation cross, (3) double-cue where two cues appear above and below the fixation cross, and (4) spatial-cue where the cue appears either below or above the fixation cross to correctly indicate where the central arrow is to appear. Efficiency of the three attentional networks is assessed by measuring how response times to the central arrow are influenced by alerting cues, spatial cues, and flankers. Only correct trials are included in the analyses.

Following previous research (Fan et al., 2002) individual differences in alerting, the ability to detect a signal when there is no warning, was calculated by subtracting the mean RT of the double-cue condition from the mean RT of the no-cue conditions (where no cue is presented). The rational for this was that neither the double cue nor the no-cue condition provided information about the location of the central arrow, and when no warning cue is presented, attention tends to remain diffused across the two potential target locations. Orienting scores were calculated by subtracting the mean RT of the spatial-cue condition from the mean RT score on the central-cue condition. Both center and spatial cues served as a form of alerting cue, but only the spatial cue provided predictive spatial information that allows subjects to begin orienting attention to the appropriate location before the target arrives. Finally, the executive attention scores were calculated by subtracting the mean RT of all congruent flanking conditions, summed across cue types, from the mean RT of all incongruent flanking conditions. Descriptive statistics are presented in Table 5.

Executive function measures

Inhibitory control: Go/No-Go Task. Participants completed a standard Go/No-Go task (Durston, Thomas, Worden, Yang, & Casey, 2002) on the computer using Direct RT software (Empirisoft, New York, NY, USA). Participants' task was to press the space bar to the "go" signal (green circle) and withhold a response to the "no-go" signal (red octagon). There were more "go" then "no-go" trials (73% vs. 27%) and context of the "no-go" signal was manipulated

such that each "no-go" trial was preceded by 1, 3, or 5 "go" trials. As the number of preceding "go" trials increases, more cognitive control is needed to inhibit response to the "no-go" signal. Each trial started with a fixation cross (2000 ms), then the go/no-go signal (i.e., the green circle or red octagon) was presented for 350 ms with an additional 25 ms of response window. Each trial was preceded by an inter-stimulus interval of 1000 ms (total trial length = 1350 ms or 1375 if no response was made). Instructions emphasized both speed and accuracy. Participants received a message ("Wrong") if they erroneously pressed the space bar in response to a "no-go" trial or failed to respond to a "go" trial. Failure to press the space bar to a "go" signal resulted in a message "Please try to respond faster." Both messages remained on the screen for 1500 ms.

As an index of inhibitory executive control (Durston et al., 2002; Eigsti et al., 2006) RT on correct "go" trials and the number of false alarms on "no-go" trials were calculate for each participants. Additionally, research shows that false alarms on trials preceded by 3 and 5 "go" trials provides a particularly sensitive probe of inhibitory executive control (Durston et al., 2002). Thus, we derived separate false alarm scores across all trial types, and separately for "no-go" trials preceded by 3 or 5 "go" trials. Descriptive statistics are presented in Table 5.

Verbal Fluency. A computerized form of Verbal Fluency, a widely used neuropsychological test (Benton & Hamsher, 1994; Fu et al., 2002; Lezak, 1995) was used. Participants were seated in front of a computer and were instructed to speak into a microphone and generate words that began with the letter A, E, F, N, S, or T (excluding proper nouns and not repeating the same word with different suffixes) on six, separate, counterbalanced one-minute trials. Instructions were presented using Direct RT software (Empirisoft, New York, NY, USA). One of the traditional neuropsychological indexes of Verbal Fluency is the number of correct words generated on F, A, and S trials. Previous research (Fu et al., 2002) suggest that S and T trials are easier and participants tend to generate more correct words, whereas the A, E, F, N, and S trials produce more interference and are more difficult. We thus calculated the average number of correct words across the traditional F, A, and S trials, as well as across all trials. Descriptive statistics are presented in Table 5.

Questionnaire measures

Big Five Personality Inventory. The Big Five Personality Inventory was administered to measure broad indexes of personality (John & Srivastava, 1999). Participants indicated the extent to which they agreed or disagreed with statements about their personality on a five-point Likert-type scale (1: Strongly disagree; 2: Somewhat disagree, 3: Neither agree nor disagree, 4: Somewhat agree, 5: Strongly agree). Following John and Srivastava (1999), appropriate items were first reverse scored and responses were then averaged to create mean scores for the five facets. These facets are Openness to experiences (e.g., I see myself as someone who values artistic, aesthetic experiences), Conscientiousness (e.g., I see myself as someone who makes plans and follows through with them), Extraversion (e.g., I see myself as someone who is talkative), Agreeableness (e.g., I see myself as someone who has a forgiving nature) and Neuroticism (e.g., I see myself as someone who worries a lot). Descriptive statistics are presented in Table 6.

Barratt Impulsivity Scale- BIS – 11. The Barratt Impulsivity Scale version 11 (BIS-11) is a 30 item self-report measure of Impulsivity (Patton et al., 1995). Participants rate the extent to which items accurately describe them on a four-point Likert-type scale (1: rarely/never to 4: almost always/always). Higher scores indicate more impulsive behavior. The scale consists of six conceptually and psychometrically separate factors. Attentional impulsiveness (e.g., I don't pay attention); motor impulsiveness (e.g., I buy things on impulse); low self-control (e.g., I say things

without thinking); low cognitive complexity (e.g., I get easily bored when solving thought problems); low perseverance (e.g., I change jobs); cognitive instability (e.g., I have "racing" thoughts). Means and standard deviations are presented in Table 6.

Emotion regulation questionnaire – ERQ. To measure enduring trait differences in using cognitive reappraisal and expressive suppression the 20-item ERQ (Gross & John, 2003) was administered. Participants answered questions about the ways they regulate their emotions in everyday life by indicating their agreement or disagreement with statements on a seven-point Likert-type scale (1: Strongly disagree, 2: Disagree, 3: Somewhat disagree, 4: Neither agree nor Disagree, 5: Somewhat agree, 6: Agree, 7: Strongly agree). Appropriate items were reverse scored and averaged to create separate reappraisal scores (e.g., I control my emotions by changing the way I think about the situation I am in) and expressive suppression (e.g., I control my emotions by not expressing them). Descriptive statistics are provided in Table 6.

Mood regulation – brooding and reflection. The 22-item Response Styles Questionnaire (Nolen-Hoeksema & Morrow, 1991) was administered to participants on the computer. Participants were asked to select how often they respond in a particular way to depressing events or depressed mood in their lives on a four-point Likert-type scale (1: Almost never, 2: Sometimes, 3: Often, 4: Almost always). Following Treynor, Gonzalez, & Nolen-Hoeksema's (2003) recommendation, separate scores were calculated to index constructive reflective pondering (e.g., Analyze recent events to try to understand why you are depressed) and brooding (e.g., Think "Why can't I handle things better?"). Descriptive statistics are presented in Table 6.

Attentional Control. Participants completed the full, 20-item version of the Attentional Control Scale (Derryberry & Reed, 2002). Scale type was the same as in studies 1-3. Appropriate items were reverse scored and averaged to create an overall index of attentional-control. Means and standard deviations are presented in Table 6.

Results

Correlation between behavioral performance measures and Attentional Control Scale scores

A series of bivariate correlations were conducted using the SAS statistical package (Version 9.1) between indexes of executive control and Attentional Control Scale scores. As can be seen in Table 7, contrary to our predictions, none of the ANT scores were related to Attentional Control Scale scores. Furthermore, none of the Go/No-go performance indexes showed a relationship with Attentional Control Scale scores. Consistent with our predictions, Verbal Fluency performance scores on FAS trials across all six trials were positively related to scores on the Attentional Control Scale.

Correlation between individual differences measures and Attentional Control Scale

A series of bivariate correlations were conducted using the SAS statistical package (Version 9.1) between individual differences measures and Attentional Control Scale scores. Data for four participants were lost due to computer failure on the BIS-11. Analyses were thus conducted on a subset of the sample ($N = 73$). As can been seen in Table 8 the correlations with BFI factors indicate that higher Attentional Control Scale scores were positively related to extraversion, conscientiousness, and openness. Attentional Control Scale scores were related to lower neuroticism, and they showed no relationship to agreeableness. On the BIS-11, Attentional Control Scale scores were significantly related to the following factors in the theoretically expected direction: low self-control, low perseverance low cognitive complexity, and attentional impulsiveness but showed no relationship to motor impulsiveness and cognitive instability. Additionally, higher Attentional Control Scale was related to higher cognitive reappraisal on the ERQ, but showed no relationship to suppression. Furthermore, higher Attentional Control Scale

scores were related to less self-focused rumination (brooding), but were not related to reflective pondering (reflection). These results are presented in Table 8.

Discussion of Study 4

Results of Study 4 showed a robust association between Attentional Control Scale, beneficial emotion and mood regulation strategies, personality dispositions, impulsivity, and a complex measure of executive control. However, contrary to our predictions, results revealed little or no relationship between scores on behavioral performance-based reaction time measures and Attentional Control Scale scores. Specifically, despite strong theoretical overlap between ANT and Attentional Control Scale scores, none of the ANT indexes were related to Attentional Control Scale scores. While surprising, the lack of association observed between ANT indexes and attentional-control is consistent with previous observations that found little or no correspondence between performance based reaction time or implicit measures of a construct and self-report measures of the construct. Specifically, implicit and explicit measures of the same construct tend to be unrelated or only weakly associated; low or no correlations have been reported in the field of stereotypes (Banaji & Hardin, 1996), motives (McClelland, Koestner, & Weinberger, 1989), attitudes (Greenwald et al., 2002), and self-esteem (Spalding & Hardin, 1999). Thus, we speculate that the lack of association between ANT indexes and attentional-control are due to these implicit-explicit distinctions.

Importantly, in line with our predictions Go/No-Go performance was not related to Attentional Control Scale scores. However, a "complex" executive measure, Verbal Fluency showed strong and consistent relationship to scores on the Attentional Control Scale. These results indicate that explicit evaluation of one's attentional capacities reflects performance on a complex executive control measure, and thus likely emerges from self-knowledge derived from tasks determined by several executive functions. Despite a lack of convergence between Attentional Control Scale scores and simpler executive function measures that we speculate were due to implicit-explicit distinctions, performance on complex executive function measures might have a more direct link to explicit evaluations of one's own attentional abilities.

Results with self-report measures revealed a strong relationship between broad personality dispositions on the BFI and on the BIS-11. Strong correlations were observed with conscientiousness on the BFI, and attentional impulsiveness and low cognitive complexity on the BIS. These results validate and confirm the construct of Attentional Control Scale as a measure of attentional and concentration ability. Smaller, but significant negative correlations were observed with neuroticism, a broad index of negative affect. Furthermore, significant correlates emerged with emotion and mood regulation. Specifically, Attentional Control Scale scores were related to reappraisal as an emotion regulatory strategy, and lower rumination as mood regulation strategy. We believe that these results highlight the role of attentional-control in developing a healthy regulatory repertoire.

General Discussion

Social rejection, an inevitable source of threat in human life poses an emotion regulatory challenge to most people, but particularly those low in self-esteem. Managing social rejection effectively is likely to depend on top-down control processes that enable regulation of immediate responses. Results of the current study demonstrate that individual differences in regulatory abilities can alter the cascade of negative responses to rejection among low self-esteem individuals. Across three studies, we demonstrated that among vulnerable low self-esteem individuals, having high attentional-control resulted in less threat construal of social rejection, at the neural level more recruitment of emotion regulation related rACC region, and less rumination

following a real-life relationship conflict. The data presented here span laboratory based self-report measures, neurobiological responses and ecologically valid diary data. Collectively, they argue that high attentional-control as a personality disposition serves as a protective factor against the negative cascade of responses that low self-esteem individuals often experience in the face of social rejection.

These results replicate and extend previous research (Gyurak & Ayduk, 2007) that demonstrated that the personality disposition of low self-esteem and high attentional-control buffers individuals from the negative physiological consequences of social rejection. Here, we showed that those low self-esteem individuals who have high attentional-control abilities construe social rejection as less threatening, possibly paving the way for less reactive responses later. In our previous work, we speculated that the buffering effect that can manifest in lower physiological reactivity might occur via the engagement of the rACC given the rACC's extensive connections to emotional centers in the brain (Devinsky, Morrell, & Vogt, 1995; Lewis & Todd, 2007). In line with these earlier findings and hypotheses, results of Study 2 showed that those with the strongest physiological reactivity to rejection (i.e., low self-esteem low attentional-control group) deactivated the rACC most, possibly paving the way for heightened physiological reactions down the road. The results of this study are consistent with findings that implicate the rACC in situations when the organism needs to meet the demands of a heightened emotion regulatory challenge (Bishop et al., 2007; Bush et al., 2000; Mathews et al., 2004; Wager et al., 2009). Results of Study 3 further elucidate the role attentional-control plays in attenuating reactivity to rejection among low self-esteem individuals and shows that high attentional-control results in reduced rumination following a real-life rejection experience. These suggest that high attentional-control buffers low self-esteem individuals from a negative cycle of repetitive brooding and helps them disengage from the dysfunctional process of ruminative thinking in the long-run. Collectively these three studies indentify critical junctures in the construal, evaluation and post-processing of social rejection where interventions that boost attentional-control abilities might successfully interject and lessen the negative impact of otherwise painful social rejection experiences.

Finally, in Study 4, we evaluated the construct of attentional-control and found a robust, statistically significant and meaningful pattern of relationships between attentional-control and relevant performance-based behavioral and self-report measures. Especially noteworthy are the relationships found between higher attentional-control and better performance on a complex executive function measure, higher scores on a trait measure of conscientiousness, lower levels of behavioral impulsivity, and higher emotion regulation and mood regulation scores. Consistent with our argument that attentional-control enables top-down regulation of emotional responses, these results indicate that attentional-control shares common variance with executive functioning – processes thought to contribute to top-down behavioral regulation. Furthermore, these results show that attentional-control has broad correlates in mood and emotion regulatory competencies.

In sum, these results support recent advances in clinical science that characterize psychological disorders as an interaction of underlying dispositional vulnerability exacerbated by poor effortful control (Beevers, 2005; Carver, Johnson, & Joormann, 2008). Even though our sample was recruited to be psychologically healthy, we found that not all low self-esteem individuals are equally reactive in the face of rejection. When those characterized by high attentional-control construe rejection, they recruit regulatory resources and dwell less on the rejection, whereas those low in effortful control do not. This interaction between dispositional

vulnerability and effortful control might serve as a precursor of future resilience or mental health problems.

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Footnotes

1. This paradigm is different from the traditional startle paradigm used in animal research (Davis, Gendelman, Tischler, & Gendelman, 1982) and in some human research (Ekman, Friesen, & Simons, 1985; Hagemann, Levenson, & Gross, 2006) as the threat state of the participants is experimentally manipulated in the former and not in the latter. Furthermore, other researchers assess whole body freezing in response to a noxious stimuli, while in the emotion modulated startle paradigm the eye-blink component of the response to a loud noise paired with a valenced foreground is measured. It is argued that the blink response (muscle contraction) is amplified as a function of the individuals' momentary threat state thus resulting in larger amplitude.

Table 1
Bivariate correlations between self-esteem, attentional-control, social and physical threat construal and likelihood ratings.

	1	2	3	4	5
1. Self-esteem	-				
2. Attentional-control	.32**	-			
3. Social threat construal	-.26**	-.27**	-		
4. Social threat likelihood	-.40**	-.21**	.71**	-	
5. Physical threat construal	-.05	-.24**	.32**	.26**	-
6. Physical threat likelihood	-.21**	-.13	.31**	.52**	.42**

Note. * $p < .05$, ** $p < .01$, *** $p < .0001$

Table 2

Regression coefficients from the multiple regression predicting social threat and physical threat from self-esteem, attentional-control and their interaction term.

	Self-esteem	Attentional-control	Self-esteem x Attentional-control
Social threat construal	-.19**	-.24**	.23**
Social threat likelihood	-.38**	-.11	.17*
Physical threat construal	.01	-.25**	.004
Physical threat likelihood	-.19*	-.09	.09

Note. * $p < .05$, ** $p < .01$, *** $p < .0001$

Table 3
Valence ratings of different painting category blocks in the fMRI task.

	Category				
Scale	Neutral *M (SD)*	Negative *M (SD)*	Positive *M (SD)*	Rejection *M (SD)*	Acceptance *M (SD)*
Valence	2.50_b (.45)	1.49_a (.42)	3.46_c (.42)	1.46_a (.50)	3.54_c (.40)

Note. Ratings were made on a four-point scale. Higher ratings on valence indicate greater positivity. Means with different subscripts differ from each other at $p < .05$.

Table 4
Areas of significant BOLD response associated with the self-esteem x attentional-control interaction term in the rejection versus negative contrast.

Brain Region	R/L	BA	Voxels	MNI coordinates *x,y,z*	t value
rACC	**L**	**10**	**20**	**-4,44,2**	**4.50***
Inferior Frontal Gyrus	L	45	17	-44,32,2	3.99
Superior Temporal gyrus	L	48	16	-42,-28,12	4.51

*Note: * We corrected for multiple comparisons within the anatomically defined rACC region FDR < .05.*

Table 5
Descriptive statistics for the Attention Network Task and the executive control measures (Go/No-Go and Verbal Fluency)

		M	*SD*
Attention Network Task	RT of alerting	43.48	22.84
	RT of orienting	47.60	24.03
	RT of executive attention	101.71	34.38
Inhibitory control - Go/No-Go	Mean RT on correct Go trials	315.80	20.91
	Mean correct inhibition	10.30	.60
	Mean correct inhibition on difficult trials	9.43	.69
Flexibility - Verbal Fluency	Average number of words generated on FAS trials	13.74	3.70
	Average number of words generated across all trials	12.57	3.27

Table 6
Descriptive statistics of questionnaire measures of emotion regulation, rumination, impulsiveness and personality

Scale	*Subscale*	*Mean*	*SD*
Big Five Personality Inventory	Extraversion	3.89	.88
	Agreeableness	4.49	.63
	Conscientiousness	4.25	.66
	Neuroticism	3.57	.80
	Openness	4.13	.64
Barratt Impulsiveness Scale	Attentional impulsiveness	2.24	.56
	Motor impulsiveness	2.13	.50
	Low self-control	2.28	.49
	Low cognitive complexity	2.25	.46
	Low perseverance	1.93	.39
	Cognitive instability	2.22	.45
Emotion Regulation Questionnaire	Cognitive reappraisal	4.93	1.05
	Expressive suppression	3.82	1.40
Response Styles Questionnaire	Ruminative self-focus	2.05	.64
	Reflective pondering	2.04	.74
Attentional Control Scale	Attentional-control	2.56	.43

Table 7
Correlation coefficients between Attentional Control Scale scores and measures of executive control

		Correlation with Attentional Control Scale r(75)
Flexibility - Verbal Fluency	Average number of words generated on FAS trials	.28**
	Average number of words generated across all trials	.26*
Inhibitory control - Go/No-Go	Mean RT on correct Go trials	-.11
	Mean correct inhibition	-.05
	Mean correct inhibition on difficult trials	-.03
Attention Network Task	Alerting	-.13
	Orienting	.14
	Executive attention	-.08

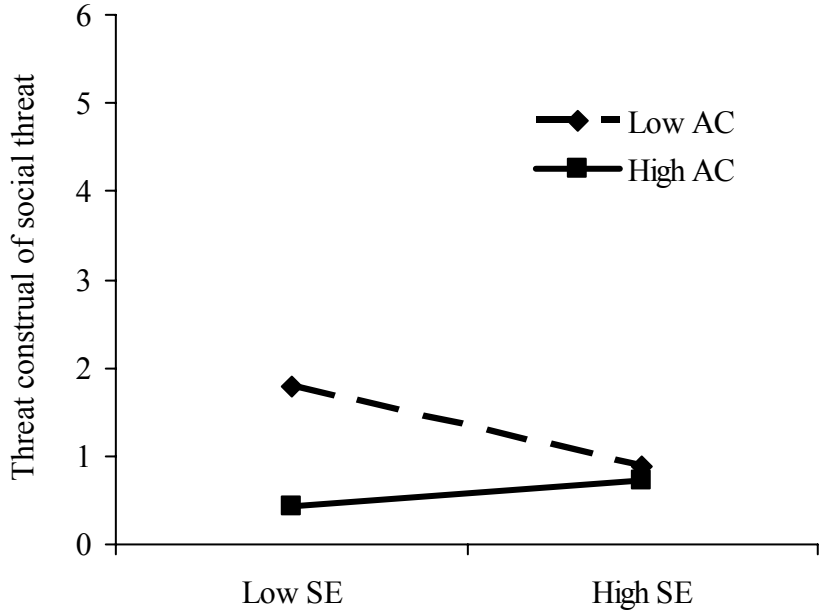
Note. * $p < .05$, ** $p < .01$, *** $p < .0001$

Table 8
Correlation coefficients between Attentional Control Scale and individual differences measures of emotion regulation, rumination, impulsiveness and personality

Scale	*Subscale*	*Correlation with Attentional Control Scale r(71)*
Big Five Personality Inventory	Extraversion	.25*
	Agreeableness	.13
	Conscientiousness	.41**
	Neuroticism	-.36**
	Openness	.32*
Barratt Impulsiveness Scale	Attentional impulsiveness	-.63***
	Motor impulsiveness	-.02
	Low self-control	-.38**
	Low cognitive complexity	-.58***
	Low perseverance	-.26*
	Cognitive instability	-.14
Emotion Regulation Questionnaire	Cognitive reappraisal	.27*
	Expressive suppression	.09
Response Styles Questionnaire	Ruminative brooding	-.26*
	Reflective pondering	-.05

Note. * $p < .05$, ** $p < .01$, *** $p < .0001$

Figure 1. Attentional-control buffers the relationship between heightened threat construal among low self-esteem individuals.



Notes: AC: attentional-control; SE: self-esteem

Figure 2. Schematic depiction of the fMRI task

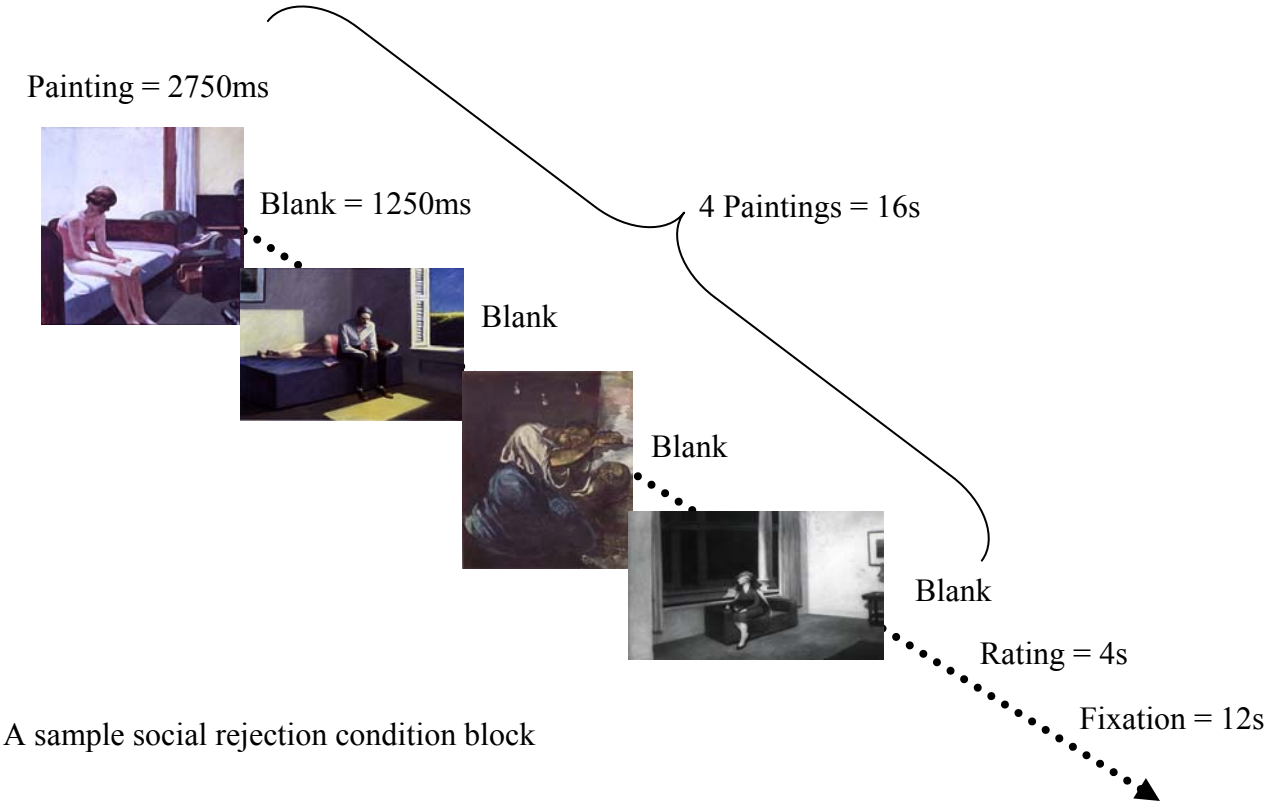
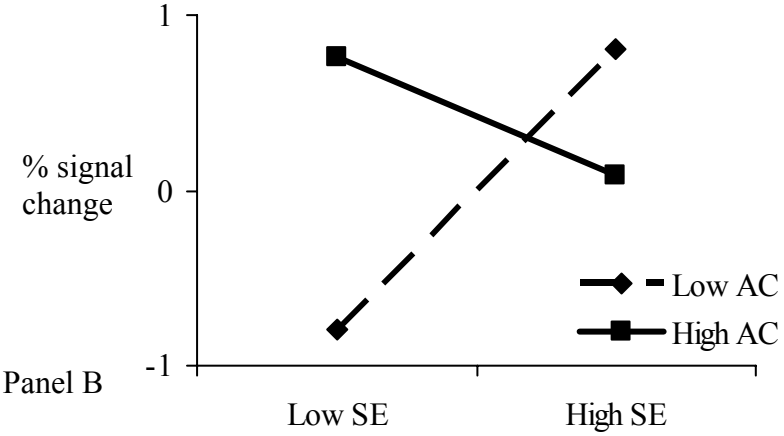


Figure 3.
Panel A



Panel B

BOLD activation significantly related to the interaction term of self-esteem and attentional-control in the left rACC area (x,y,z = -4,44,2). Contrast values were derived from the left rACC area and the pattern of the interaction was graphed.

Notes: Images were thresholded at $t(21) = 3.78$, $p < .001$, extent threshold 10 voxels. AC: attentional-control; SE: self-esteem

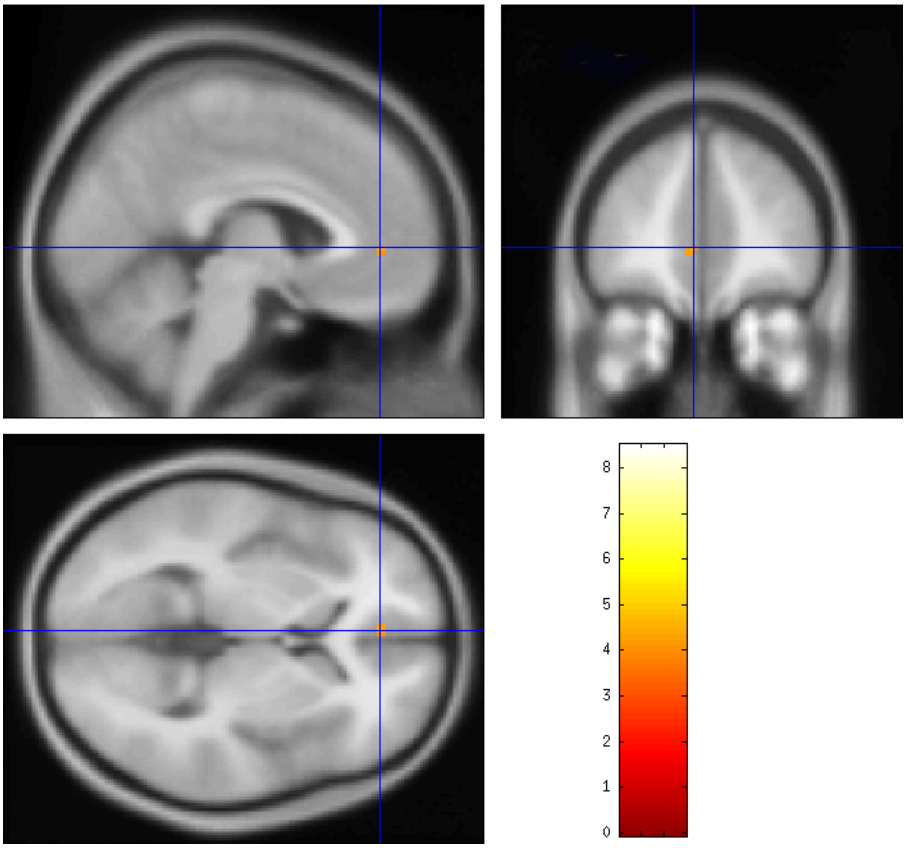
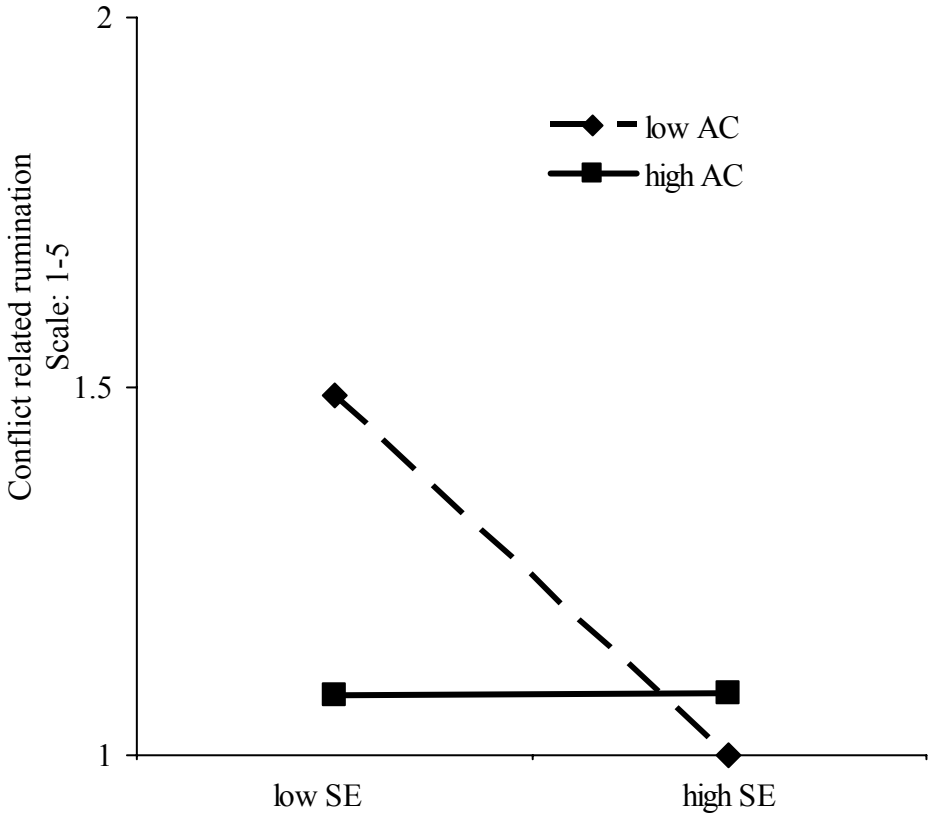


Figure 4. Moderation of conflict related rumination among low self-esteem by attentional-control two days after conflict.



Notes: AC: attentional-control; SE: self-esteem