Cutting Stress Off at the Pass: Reducing Vigilance and Responsiveness to Social Threat by Manipulating Attention

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Personality processes relating to social perception have been shown to play a significant role in the experience of stress. In 5 studies, the authors demonstrate that early stage attentional processes influence the perception of social threat and modify the human stress response. The authors first show that cortisol release in response to a stressful situation correlates with selective attention toward social threat. Second, the authors show in 2 laboratory studies that this attentional pattern, most evident among individuals with low self-esteem, can be modified with a repetitive training task. Next, in a field study, students trained to modify their attentional pattern to reduce vigilance for social threat showed lower self-reported stress related to their final exam. In a final field study with telemarketers, the attentional training task led to increased self-esteem, decreased cortisol and perceived stress responses, higher confidence, and greater work performance. Taken together, these results demonstrate the impact of antecedent-focused strategies on the late-stage consequences of social stress.

Keywords: selective attention, rejection, social stress, self-esteem, cortisol

Psychological stress is experienced when a situation is considered to be threatening, with the threat exceeding the individual's available resources for coping (Folkman & Lazarus, 1988). In particular, recent evidence demonstrates that social-evaluative threats, such as rejection, criticism, and exclusion, are especially powerful stressors (Dickerson & Kemeny, 2004; Stroud, Tanofsky-Kraff, Wilfley, & Salovey, 2000), as they pose a threat to the "social self" (Gruenewald, Kemeny, Aziz, & Fahey, 2004). Stress perception sets in motion a cascade of psychological and neuroendocrinological responses, leading to the activation of the hypothalamic-pituitary-adrenal (HPA) axis with the subsequent release of cortisol, a critical stress hormone and an endocrine marker of the stress response.

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We argue that fundamental, early stage attentional processes producing the initial perception of social threat play a critical role in the stress response. Prior research examining psychological factors involved in the stress response has examined various late-stage cognitive appraisal processes, such as attributional judgments, self-evaluations, and mechanisms through which a person appraises a situation as exceeding his or her coping resources (Gross, 2002; Lazarus & Folkman, 1984). Less investigated is the role of early stage attentional processes through which the individual brings potentially threatening aspects of the social situation to focus and processes them, versus ignoring or disengaging from them (Compton, 2003; Gross, 2002; Koster, Crombez, Verschuere, & De Houwer, 2004; Robinson, 1998). We examined the role of attention in stress perception both as a general personality process and as a function of individual differences.

Bolger and Zuckerman (1995) proposed a general framework for studying personality and stress by separating the stress process into two fundamental stages: exposure and reactivity to a stressor. Personality factors are suggested to directly influence one's potential exposure and/or reactivity to a stressor in various ways. For example, optimism, a sense of psychological control, and high self-esteem have been shown to be valuable personality resources for facing and coping with stress because they promote active coping and social support seeking (Aspinwall & Taylor, 1992; Taylor & Brown, 1988). In attachment research, individuals with an anxious-ambivalent attachment style have been found to exaggerate the appraisal of hardships as irreversible and uncontrollable, and to experience more interfering thoughts after failure than avoidant or secure individuals (Mikulincer & Florian, 1998). Sev-

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eral cognitive mechanisms, then, associated with a range of personality characteristics play an important role in the exposure and reactivity to stress. In particular, thought processes related to uncontrollable negative social evaluation appear especially important in determining the stressfulness of social situations (Dickerson & Kemeney, 2004).

Of interest to us in this research was the cognitive mechanism of attention to rejection, which appears to be a key personality process related to the experience of social stress and individual differences in self-esteem. Low self-esteem is associated with an elevated experience of daily hassles and chronic stressors (DeLongis, Folkman, & Lazarus, 1988). In laboratory research with standardized stress paradigms, individuals with low self-esteem show greater cortisol release after failure and criticism (Pruessner, Hellhammer, & Kirschbaum, 1999b). Low self-esteem is theorized to derive in part from repeated experiences of social rejection and criticism, conditioning an individual to be particularly attuned and sensitive to negative social evaluations (Baccus, Baldwin, & Packer, 2004; Dandeneau & Baldwin, 2004; Gilbert, 1992; Leary, Tambor, Terdal, & Downs, 1995). Selective attention to social-evaluative threats is thought to act as an initial filter or gate on information processing, engendering a view of the environment as hostile and unsupportive and further undermining self-confidence (Dandeneau & Baldwin, 2004; Williams, Mathews, & MacLeod, 1996). Indeed, in one study using a reaction time (RT) task that assessed responses to interpersonal and noninterpersonal words, individuals with low self-esteem were found to exhibit a greater attentional vigilance for rejection-related words relative to acceptance-related words (Dandeneau & Baldwin, 2004). This cognitive process of hypervigilance or attentional bias for threat relating to one's current concerns is also found in clinical syndromes such as social anxiety, social phobia, and generalized anxiety disorder (Williams et al., 1996).

Hypervigilance is theorized to be produced by a limbic system sensitized to threat (Compton, 2003) and has been shown across a range of stimuli, including visual images and threat-relevant words (Bradley, Mogg, Falla, & Hamilton, 1998; Ellenbogen, Schwartzman, Stewart, & Walker, 2006; MacLeod, Mathews, & Tata, 1986). Vigilance to threat has been suggested to be specialized in the right hemisphere, where brain structures, including the amygdala, may play an important role in the processing and interpretation of threat (M. X. Cohen & Shaver, 2004; Compton, 2003; Compton et al., 2003; Mogg & Bradley, 1999; Rhodes, 1985; Wittling, 1997). Such a "threat surveillance" function of the right hemisphere has been supported by results of studies using different methodologies, ranging from dichotic listening to event-related brain potentials to functional magnetic resonance (Asbjörnsen, Hugdahl, & Bryden, 1992; Compton et al., 2003; Compton, Wilson, & Wolf, 2004; Fox, 2002; Gruzelier & Phelan, 1991; Nitschke, Heller, & Miller, 2000; Van Strien & Heijt, 1995). Hemispheric localization was not a primary focus of the present research, but we did examine it in two studies to build on these previous findings.

Examining the causal role of selective attention requires experimentally manipulating the putative cause, and recent findings have indicated that attentional biases are subject to experimental modification. In one study, low-self-esteem participants who performed a repetitive task involving finding a single smiling face in a crowd of frowning faces later showed reduced attentional bias toward rejection words (Dandeneau & Baldwin, 2004). More important, in another set of studies, a causal link has been shown between experimentally manipulated processing biases and emotional vulnerability (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002; see also Mathews & MacLeod, 2002; Wilson, MacLeod, Mathews, & Rutherford, 2006).

In two of these studies, MacLeod et al. (2002) used a modified visual probe task (VPT) to induce an attentional bias away from threatening information (toward neutral information), or else toward threat. In their word-based VPT, participants were briefly shown two words, one neutral (e.g., *thereby*) and one threatening (e.g., *violent*). The participant's task was to quickly identify the probe that immediately replaced one of the words. In the attend-neutral training condition, participants were given hundreds of trials in sequence in which the probe was always behind the neutral word and never behind the threatening word. The researchers confirmed that the attend-neutral and attend-threat training produced differential biases, by measuring posttraining attentional patterns using a set of standard VPT trials (in which the participants' RTs are compared on trials in which the probe randomly replaces either the threatening stimulus or the neutral stimulus to determine which kind of stimuli captures attention). They then showed that the induced attentional bias modified participants' subsequent emotional reactions to a very difficult anagrams task. Participants in the attend-neutral condition reported significantly lower levels of negative mood after completing the stressful anagrams task, compared with those trained in the attend-threat condition, and there was a significant correlation between VPT changes and emotional reactivity to stress. Thus, attentional patterns can be modified and have shown causal effects on emotional outcomes—demonstrating the potential of attentional modification to yield psychological benefits.

However, previous research has not examined whether the manipulation of attention to social rejection affects self-esteem, behavioral, or physiological outcomes to stress reactions in the context of social-evaluative threat. We sought to examine these three types of outcomes in terms of perceived stress and state self-esteem, work performance, and cortisol release in response to psychosocial threat. We also sought to examine the influence of attentional training in more complex, real-world stress situations by supplementing our laboratory studies with field research involving people immersed in their challenging day-to-day lives.

We had three major research goals. First, we wished to examine the association between attentional processes and physiological reactivity. Second, we wished to clarify and extend previous work suggesting that attentional processes can be modified via a repetitive training task. Third, we wished to examine the real-world consequences of this training task on people's perceived stress, self-esteem, and physiological reactivity in stressful situations.

Early Stage Exposure and Late-Stage Reactivity

Study 1

Our first major research question involved the hypothesized link between early stage attentional processes and late-stage physiological reactions, particularly cortisol reactivity, a reliable biomarker of social stress. Given the mutual interaction between attentional processes and physiological reactions, the terms *early stage*

and *late stage* are somewhat arbitrary. However, initial attention to a given stimulus is logically the first step in the perception of a particular situation or event (e.g., Gross, 2002), and this characterization fits well with Bolger and Zuckerman's (1995) stages of exposure and reactivity in their stress framework. In any case, our first question involved simply exploring the association between attention and physiological reactions.

Potentially stressful situations can be experienced as merely challenging when situational demands are seen as manageable, but when situational demands outweigh available resources, this leads to the experience of threat (Tomaka, Blascovich, Kelsey, & Leitten, 1993). When a situation is perceived as a threat to the self, a cascade of neuroendocrine responses is triggered in the HPA axis, involving the hypothalamus, pituitary and adrenal glands, and including the release of cortisol into the bloodstream (Dickerson & Kemeny, 2004). Cortisol is involved in the maintenance of physiological homeostasis via adaptive processes across a number of physiological systems. Although the activation of the HPA axis under acute threat is regarded as an adaptive mechanism in response to alterations in demand, prolonged (chronic) activation, which may be due in part to individual differences in threat perception, can increase the risk of serious conditions ranging from hypertension to diabetes (McEwen, 2002).

To assess attentional bias for rejection and acceptance information, we used the VPT, which measured reactions to rejecting, accepting, and neutral faces. Across a series of trials, participants were briefly shown two adjacent faces on a computer screen and required to quickly identify a probe that replaced one of the faces. An attentional bias for rejection was indicated by faster response times for identifying probes that replaced rejecting faces relative to those that replaced neutral faces. Stress was induced using a standard social-evaluative stress paradigm, and cortisol was sampled to measure stress reactivity.

Some previous research has documented a hemispheric difference in the VPT, reflecting the role of the right hemisphere in the processing and interpretation of emotionally threatening information (Davidson & Irwin, 1999; Ellenbogen et al., 2006; Heller, Nitschke, & Miller, 1998; Mogg & Bradley, 2002). Potential hemispheric differences can be examined by analyzing RTs to rejection and acceptance targets in right- and left hemivisual fields separately. As a secondary analysis, therefore, we investigated the possibility of hemispheric differences in the link between vigilance for rejection and stress reactivity.

Method

Procedure. Participants were 20 healthy young men, from 20 to 26 years of age, participating in a larger functional magnetic resonance imaging (fMRI) study investigating brain activation changes under stress (Pruessner et al., 2005). (Note that the restriction of the sample to male participants was not based on our present theoretical concerns, but rather the goals of the larger fMRI study.) Data from 1 participant, whose rejection bias score was more than 3 standard deviations greater than the group mean, were excluded as an outlier. Variables of interest assessed for the present study included cortisol reactivity to an acute stressor as well as attentional bias to rejection information measured by the VPT.

Participants underwent the Montreal imaging stress task (MIST), a standard stress paradigm in which they performed computerized mental arithmetic under time pressure while in the fMRI scanner. The MIST, which is derived from the Trier Mental Challenge Test (Kirschbaum, Pirke, & Hellhammer, 1993), consists of several conditions; however, the critical stressor condition consists of presenting difficult arithmetic tasks with a time limit calibrated just beyond participants' capacity. The social threat component is implemented by having the experimenter periodically criticize the participant for making errors (see Dedovic et al., 2005, for a more detailed description of the task). Participants later completed the VPT. Salivary cortisol was sampled seven times during the procedure using cotton salivettes, beginning before the stress task started to establish a baseline and then at 20-min intervals until 30 min after the task was completed.

The VPT. The procedure was based on the method well established in anxiety and social anxiety research (Bradley et al., 1998). The stimuli consisted of 64 grayscale pictures of faces with a resolution of 72 dpi, measuring 45 × 70 mm on the computer screen, with a distance of 115 mm between their centers. The pictures were shown on a white background. The 64 stimulus faces consisted of 32 different people, with 16 providing neutral and rejecting poses and 16 providing neutral and accepting poses. Each neutral picture was matched with the rejecting or accepting pose of the same person, thereby making 16 rejecting–neutral pairs and 16 accepting–neutral pairs for the critical trials. Independent rating of the pictures ($n = 27$ raters) confirmed that the smiling pictures were perceived as significantly more accepting, and the frowning pictures were judged as significantly more rejecting, than a neutral point on a 9-point scale ranging from −4 (*rejecting*) to +4 (*accepting*). A separate set of 16 pairs, 8 rejecting–neutral and 8 accepting–neutral, was used for the practice trials.

The VPT consisted of 16 practice and 64 experimental trials that were presented in a random order for each participant. Each of the 32 pairs of experimental stimuli faces was presented twice, once with the emotional face on the right and once on the left, making for 32 rejecting-neutral trials and 32 accepting-neutral trials. Each trial started with the fixation symbol the "*plus*" sign in the center of the screen for 500 ms. Following the fixation, a picture pair was shown for 500 ms, followed by a probe (either as two dots arranged vertically or two dots arranged horizontally) replacing the picture on either the left or the right of the screen. The probe remained on the screen until the participant made a response by pressing the appropriate labeled key on the keyboard (*q* for two dots arranged vertically and *z* for two dots arranged horizontally). Each probe type replaced an equal number of emotional and nonemotional pictures on each side of the screen. The participants were instructed to indicate, as quickly and accurately as possible, which probe appeared on the screen after the presentation of picture pairs. The intertrial interval varied randomly between 500 ms and 1,250 ms. The VPT was programmed using E-Prime psychology software (Psychology Software Tools, Inc., Pittsburgh, PA) and presented on Dell Pentium III 200 MHz

PC computers with a 15-in. (38-cm) monitor set at 60 Hz refresh rate.

Results and Discussion

On the VPT, trials with errors were discarded (2.7% of data), and based on Ratcliffe's (1993) recommendations for dealing with outliers, RTs less than 200 ms or greater than 2 standard deviations above each participant's overall mean RT were discarded (3.7% of data). Rejection bias scores were calculated by subtracting the mean RT when the rejection faces and probes were in the same location (valid trials) from mean RT when rejection faces and probes were at different locations (invalid trials) (MacLeod et al., 1986). An acceptance bias score was calculated by subtracting the mean of valid acceptance trials from the mean of invalid acceptance trials. A high positive rejection bias score indicates an attentional bias toward rejecting faces, whereas a negative rejection bias score demonstrates inhibition or disengagement from rejecting faces. Similarly, a positive acceptance bias score signifies an attentional bias toward accepting faces and inhibition of these faces in the case of a negative score. The two bias scores were then used as outcome variables in subsequent analyses.

Cortisol was analyzed using a time-resolved fluorescence immunoassay (Dressendörfer, Kirschbaum, Rohde, Stahl, & Strasburger, 1992). Cortisol reactivity to the stressful situation was indexed by the area under the curve (AUC), which is calculated to measure increases above the individual's baseline in response to an acute stressor (Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003).

Rejection bias scores and AUC cortisol indices were correlated and showed that individuals with the most pronounced rejection bias also showed the highest cortisol release in response to the stressful situation, $r(17) = .59$, $p = .007$ (see Figure 1A). Cortisol release was not significantly related to acceptance bias, $r(17) = -.007$, *ns*, demonstrating that the rejection correlation was not simply due to the emotionality of the faces.

In order to test hemispheric lateralization of emotional processing, we computed four bias scores representing left-rejection bias score (i.e., involving trials when the frown was on the left), right-rejection bias score, and left- and right-acceptance bias scores. These scores were then correlated with the AUC cortisol indices. The correlation with cortisol release was strongest for rejection bias calculated from trials in which frowns were presented in the left visual field, $r(17) = .59$, $p = .008$, versus, $r(17) = .10$, $r(17) = -.05$, $r(17) = .04$, for right-rejection, left-acceptance, and right-acceptance biases, respectively (*ns*). This pronounced correlation in the left visual field mirrors results in past studies, with socially anxious participants showing greater vigilance for threat in the left visual field, which the authors indicate is suggestive of contralateral right-hemispheric involvement (Heller et al., 1998; Mogg & Bradley, 1999, 2002; see Figure 1B).[1]

These findings provide evidence that the early stage process of vigilance for social rejection is linked to the late-stage physiological process of increased production of cortisol in response to psychosocial stress. These findings extend those of other studies showing that prolonged attention to angry faces produced increases in HPA axis activation (van Honk et al., 2000). In any situation, there may be socially threatening as well as nonthreatening qualities. Personality processes that increase the person's attentional focus on the socially threatening

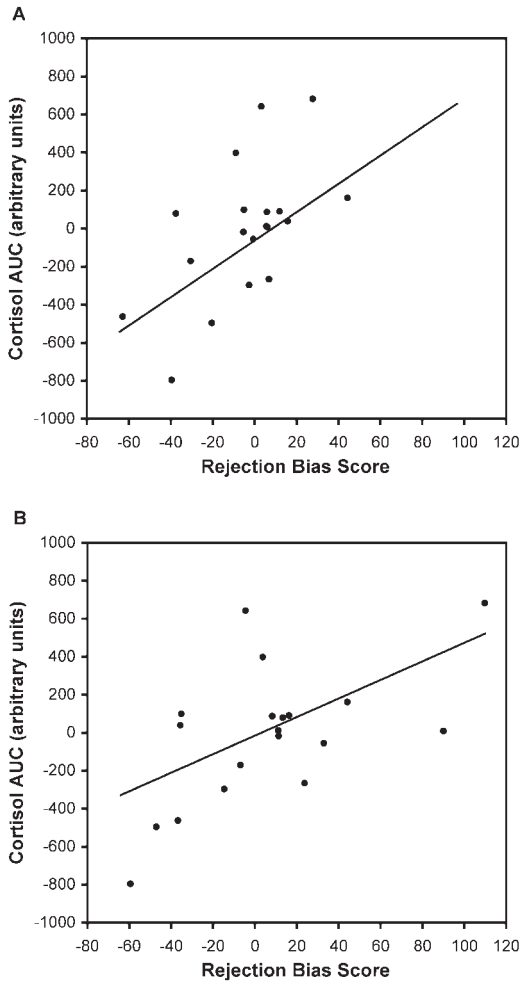

Figure 1. A: Scatterplots of participants' cortisol level (area under the curve [AUC] indexed to baseline) versus overall rejection bias scores and B: versus rejection bias scores in the left hemivisual field.

[1] It is plausible that the difference between left and right presentation of the threatening stimulus could be explained by an automatic tendency of our participants to scan from left to right, due to ingrained reading habits (Spalek & Hammad, 2005), meaning that stimuli situated on the left were likely to be processed before stimuli on the right (we thank an anonymous reviewer for bringing this possibility to our attention). We cannot rule out this possibility with our data, although we note that other research using physiological approaches (e.g., fMRI, dichotic listening) has shown the specificity of the right hemisphere in processing negative emotions and perception of social threat (Compton, 2003; Davidson & Irwin, 1999; Wittling, 1997).

aspects of a situation are likely to set in motion a more powerful physiological stress response.[2]

Modifying Vigilance to Social Threat

Our second major research question concerned the possibility of modifying people's attentional patterns to social threat. We adopted a training task that had shown positive results in initial tests (Dandeneau & Baldwin, 2004). In this task, participants practice a response of seeking one accepting face in a matrix of 15 rejecting faces. Results of earlier research showed that this task modified Stroop color-naming responses to verbal stimuli. Individuals with low self-esteem, for whom rejection is an important concern, who completed the experimental training task displayed significantly less Stroop interference on rejection-related words than their counterparts in a control condition (Dandeneau & Baldwin, 2004). At least on this rejection Stroop task, therefore, it seems that attentional training can modify automatic reactions to threat-related stimuli.

We examined further the impact of attentional training on individuals with low self-esteem. As already noted, previous research has documented relationships between the perception of rejection, stress, and individual differences in self-esteem. Individuals with low self-esteem appear especially sensitive to signs of social rejection. Thoughts of rejection lead individuals with low self-esteem to criticize themselves, to perform poorly at tasks, and to give up more easily (Sommer & Baumeister, 2002). In the workplace, low self-esteem has been shown to be associated with cortisol dysregulation, somatic complaints, and occupational burnout (Pruessner, Hellhammer, & Kirschbaum, 1999a), possibly reflecting social difficulties. Preliminary evidence suggests that the stress associated with low self-esteem is likely worsened by hypervigilance to rejection (Dandeneau & Baldwin, 2004, Study 1), and so attentional training could be expected to help such individuals reduce the extent to which they are vigilant for threats even in relatively neutral contexts (Dandeneau & Baldwin, 2004, Study 2).

The initial research on attentional training left some important questions unanswered, however. Rather then being trained to inhibit attention to social threat, were participants in the experimental training condition perhaps simply being desensitized to threat via the repeated exposure to rejecting faces? Second, are these results replicable with other, more ecologically valid, measures of attentional bias, or are they limited to Stroop responses? These questions were addressed in two studies that included an exposure condition for comparison (see Study 2a) and used the VPT as a measure of attentional bias (see Study 2b). Our goal with these studies was to further test the hypothesis that attention to social threat could be modified via repetitive practice.

Study 2a

The rationale behind the attentional training task is that in the find-the-smile condition, the participant must repeatedly inhibit attention to the frowning distractors, disengaging from them to continue the search for the desired target. An alternative account of the mechanism might be simple desensitization; that is, perhaps the participant is exposed to frowns so many times that social threats cease to provoke any response or to attract attention. Desensitization has been shown to effectively reduce people's sensitivity and fear of threatening objects and situations like spiders, heights, flying, and public speaking among other things (Rothbaum, 2006; Watts, McKenna, Sharrock, & Trezise, 1986). Watts et al. (1986), for example, showed reduced color-naming interference for spider-related words in participants treated with desensitization therapy compared with those receiving no treatment. The Stroop task has also been shown to reveal the effects of in virtuo (virtual reality) exposure (Côté & Bouchard, 2005). Therefore, the main purpose of this follow-up study was to investigate whether the Stroop effect found in our previous attentional training study was due to the modification of attentional patterns, as we hypothesize, or due to desensitization to rejecting stimuli.

We created an exposure condition in which the participant looked at matrices of frowning faces but did not perform any search. If the desensitization explanation is correct, then this exposure condition should show the same pattern of findings as the find-the-smile condition. This seemed unlikely to us, given the relatively small number of trials, the low impact of the stimuli (e.g., compared with real tarantulas and high-impact graphics as in previous desensitization findings), and the fact that it seemed just as likely that the degree of exposure in the present task might increase, rather than decrease, vigilance. We hypothesized that the Stroop response patterns would be different in the find-the-smile and exposure conditions. Specifically, we hypothesized that participants with low self-esteem in the find-the-smile condition would exhibit less rejection interference compared with those in the exposure condition.

Method

Procedure. Participants were 88 (17 men) undergraduate students, fluent in English, who participated either for $10 CDN (about $9.38 U. S.) or for course credit. Twelve participants were excluded due to technical difficulties (specifically, a malfunctioning MP3 recorder), which left a total of 76.[3] Participants first completed the Rosenberg Self-Esteem Scale (Rosenberg, 1965) online the day preceding their appointment for the lab session. At the lab session, participants completed the rejection Stroop task (see Dandeneau and Baldwin, 2004, for details) to establish a baseline. Participants were then randomly assigned either to the find-the-smile, the find-the-flower, or the exposure condition by the computer (the experimenters were blind to the participants'

[2] It is worth noting that although previous research has usually documented an attentional bias toward threat (e.g., Bradley et al., 1998; Williams et al., 1996), some studies have instead shown avoidance of threat. For example, bias away from faces has occasionally been shown among highly anxious individuals (Mansell, Clark, Ehlers, & Chen, 1999), among social phobics (Chen, Ehlers, Clark, & Mansell, 2002), and when using very mildly threatening stimuli (Wilson & MacLeod, 2003). The results of the present study, with a nonclinical sample and moderately threatening stimuli, are consistent with the more common pattern whereby heightened attention toward threat is associated with other problematic outcomes. This congruence with the literature adds support to the soundness of our particular version of the VPT, and of the images that were selected for this task.

[3] We felt it prudent to discard data from the 12 participants for whom we could not determine the accuracy of their responses due to a malfunctioning MP3 player. When their data were included in the analyses, the results were virtually identical and remained statistically significant.

Figure 2. Picture grid with 15 rejecting and one accepting face. Participants in the experimental condition are instructed to identify the smiling person as quickly as possible.

condition). After completing the training task, participants next completed a postmanipulation administration of the rejection Stroop task, which was identical to the first administration. Next, participants completed postexperimental questionnaires, which included, for participants in the find-the-smile and the exposure conditions, a face memory task. The latter showed a matrix of 16 faces, 8 of which were shown in their training and 8 that were not, and participants were asked to cross out the faces they had not seen in the training. Accuracy was scored as the total of hits and correct rejections out of 16 possible correct answers. Finally, participants were fully debriefed, compensated for their time, and thanked for their participation.

Rejection Stroop. The rejection Stroop task administered in this study used the same stimuli, procedure, and equipment as that used in Dandeneau and Baldwin's (2004) initial study. Stimuli were 36 words divided into three categories: 12 rejection words (e.g., *unwanted*, *ignored*), 12 acceptance words (e.g., *welcomed*, *wanted*), and 12 noninterpersonal words of mixed valence (e.g., *pain*, *rainbow*, *spoon*). These words were randomly presented in one of four colors, red, blue, green, or yellow, with the constraint that the same color would not be shown in sequential trials. A total of 144 trials were presented in four blocks of 36 trials with breaks in between blocks. Participants were instructed to name the color of each word as quickly as possible. Participants completed the rejection Stroop task alone, therefore their verbal responses were recorded with an MP3 recorder in order to later check for errors or superfluous noise that may have tripped the microphone.

Attentional training tasks. A smiling/accepting pose and a frowning pose of 16 different people were used as stimuli for the experimental training task. Independent raters ($n = 5$ raters) confirmed that the smiling pictures were perceived as significantly more accepting, and the frowning pictures were perceived as significantly more rejecting, than a neutral point on a 7-point scale. The grayscale stimuli were presented on a computer screen in the following manner: a 4 square $\times$ 4 square matrix, measuring 17 cm $\times$ 17 cm on the computer screen, appeared in the middle of the screen wherein there was 1 smiling face and 15 frowning faces (see Figure 2). Using a touch screen panel, participants were instructed to tap on the accepting face with their index finger as quickly as possible. Each of the 16 accepting faces was randomly presented seven times, each time in a different square of the matrix, making for a total of 112 training trials. The 112 trials were divided into four blocks of 28 trials with breaks between blocks.[4]

In the control condition, the stimuli consisted of black-and-white drawings of five- and seven-petaled flowers. The procedure was identical to that in the experimental condition except the instructions asked participants to identify the five-petaled flower as quickly as possible in the matrix of seven-petaled flowers. In neither the find-the-smile or find-the-flower conditions were the

[4] A demonstration of the training task can be tried online at http://www.selfesteemgames.mcgill.ca/games/sematrix.htm

participants given any positive or negative feedback regarding their performance at finding the target.

In the exposure condition, the stimuli consisted of the same frowning faces presented in the find-the-smile condition, except that participants were simply asked to look at the grid of 16 frowning faces. The same 112 grids from the find-the-smile condition were randomly presented in 4 blocks of 28 trials, with the smiling pose in each trial replaced by the person's frowning pose making a full grid of frowns. The grids were presented for 3.4 s, the mean response time for people in the find-the-smile condition in Dandeneau and Baldwin's (2004) study. Participants were simply instructed to look at the faces, as they may be asked questions later in the session. No feedback was given at any point during any of the tasks.

Results and Discussion

Using the recorded audio session of each participant, trials in the rejection Stroop task were individually coded for errors as well as for hesitation and sounds emitted before naming the color. In addition, trials less than 300 ms and greater than 1,500 ms were treated as outliers and excluded from the analyses. In the first (baseline) administration of the Stroop, errors constituted .79% of the data, and excluded trials constituted 5.5%. In the second administration of the Stroop, error trials constituted .58%, and excluded trials 5.6% of the data.

Four key interference scores were calculated to represent rejection and acceptance bias at both administrations. Rejection bias scores were calculated by subtracting the mean RT for noninterpersonal neutral words from the mean RT for *rejection* words. Acceptance bias scores were calculated by subtracting the mean reaction for noninterpersonal neutral words from the mean RT for *acceptance* words. Rejection and acceptance bias scores were calculated for both Stroop administrations. High interference scores indicate a bias for that respective valence, whereas negative scores indicate inhibition of that information.

Participants were designated as high or low in self-esteem on the basis of a median split using scores on the Rosenberg Self-Esteem Scale. A 3 (condition: find the smile, exposure, or find the flower) $\times$ 2 (self-esteem: high or low) $\times$ 2 (bias: rejection and acceptance) $\times$ 2 (administration: baseline and postmanipulation) mixed model ANOVA, with bias and administration as within-subject factors, was conducted on the rejection and acceptance interference scores of both administrations. The four-way interaction term was significant, $F(2, 70) = 3.36$, $p = .040$; however, no other interaction terms or main effects approached significance. Analyses conducted on the baseline premanipulation scores showed no significant effects; therefore, to clarify the four-way interaction, change scores between Stroop administrations were computed for each bias by subtracting baseline interference scores from their respective postmanipulation scores.

To clarify the four-way interaction, we conducted a 3 (condition) $\times$ 2 (bias: rejection change and acceptance change) ANOVA for both self-esteem groups. Results revealed a two-way interaction between condition and bias for participants with low self-esteem, $F(2, 70) = 3.09$, $p = .052$, but not for those with high self-esteem, $F(2, 70) = .05$, *ns*. Inspection of the change scores showed a very different pattern in the find-the-smile and exposure conditions. In order to test whether the exposure condition had a similar attentional training effect as the find-the-smile condition, we tested the change in rejection and acceptance interference for participants in those two key conditions. The 2 (condition: find the smile or exposure) $\times$ 2 (bias: rejection change and acceptance change) mixed model ANOVA was significant for individuals with low self-esteem, $F(1, 15) = 4.81$, $p = .044$ (see Table 1 for means and standard deviations of rejection and acceptance change scores in all three conditions). As can be seen in Figure 3, individuals with low self-esteem in the exposure condition experienced a relative increase from baseline in rejection interference and a decrease in acceptance interference, suggesting a worsening of selective attention toward rejection. In comparison, individuals with low self-esteem in the find-the-smile condition experienced a *decrease* in rejection interference and an *increase* in acceptance interference, indicating that participants were better at inhibiting rejection and paying more attention to acceptance after training. Participants in the find-the-flower control condition showed little change from baseline.

To confirm that participants in the exposure condition were indeed looking at the faces, we administered a postquestionnaire face memory test approximately 10-15 min after the training. Results confirmed that participants in the exposure and

Table 1
Means and Standard Deviations for Rejection and Acceptance Interference Changes From Baseline Administration to Posttraining Administration of the Stroop Task

	Find the flower		Find the smile		Exposure	
Interference	LSE	HSE	LSE	HSE	LSE	HSE
Rejection change						
M	1.28	2.73	−16.07	−8.67	8.45	−0.70
SD	48.10	29.19	51.61	47.16	31.15	39.55
Acceptance change						
M	−6.02	10.90	3.67	−11.09	−18.18	10.64
SD	48.23	33.08	58.92	50.67	16.65	32.82

Note. LSE = low self-esteem; HSE = high self-esteem.

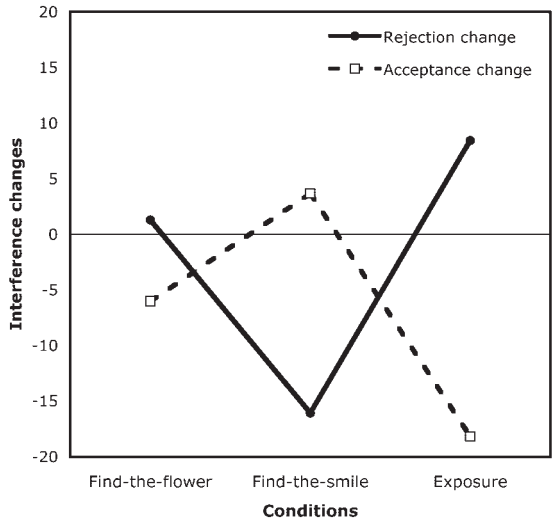

Figure 3. Rejection and acceptance interference changes from Session 1 to Session 2 in individuals with low self-esteem in all the attentional training conditions.

find-the-smile conditions remembered the rejection faces very accurately, even though they were not explicitly told to memorize the faces. There was no significant difference between conditions on their memory score (out of a score of 16, exposure $M = 14.12$, $SD = 1.85$; find-the smile $M = 13.78$, $SD = 1.76$), $F(1, 43) = 0.62$, *ns*.

The results from this study demonstrate that the attentional training procedure, involving searching for a smiling face among frowning distractors, does not simply operate by desensitizing low self-esteem individuals to rejection information. A more active engagement is evidently necessary to train people's selective attention toward acceptance and away from rejection. If simply exposed to frowning faces, then individuals with low self-esteem show, if anything, an exacerbation of their rejection bias rather than a reduction. We cannot rule out the possibility that a more intense exposure treatment, with perhaps more trials and more threatening stimuli, might yield a desensitizing effect as in previous research. The present findings do indicate, however, that desensitization is not the mechanism underlying the effects of the attentional training task.

Study 2b

In a second laboratory test of the attentional training task, we sought to replicate the effect using a different outcome measure using more ecologically valid stimuli, namely faces rather than words. Here, we wished to test the effects of our attentional training task on reactions to pictorial stimuli representing rejection and acceptance, using the VPT measure of attentional bias to build on results from Study 1. This also allowed us to examine the possible hemispheric specificity of the training effect, which is not possible with the Stroop task.

We hypothesized that individuals with low self-esteem would show a bias toward social threat but that the attentional training would reduce this bias for individuals in the find-the-smile condition compared with their counterparts in the find-the-flower condition. Also, expanding on the suggested hemispheric dominance of the effects found in Study 1 and others' results on the VPT (e.g., Ellenbogen et al., 2006; Mogg & Bradley, 1999, 2002), we hypothesized that the find-the-smile training condition, which might be operating more strongly in the right hemisphere, would have a greater impact on the left visual field than the right visual field rejection bias.

Method

Participants were 147 (48 men) undergraduate students who completed the study either for $8 CDN (about $7.50 U. S.) or course credit. Participants completed the Rosenberg Self-Esteem Scale (Rosenberg, 1965), either online before the study or at the beginning of the laboratory session. Participants were seated approximately 50 cm from the computer monitor and then randomly assigned by the computer program to one of the two training task conditions: either the find-the-smile experimental condition or the find-the-flower control condition. These two conditions were identical to those used in Study 2a. Participants were taken through a set of instruction screens and practice trials before completing the 112 experimental trials of the training task. Following the training task, participants completed the same VPT as in Study 1. The VPT was followed by a final set of questionnaires that included the Profile of Mood States (McNair, Lorr, & Droppleman, 1971) to assess situational mood, and finally participants were compensated for their time and fully debriefed.

Results and Discussion

The VPT data were prepared as in Study 1, with error trials constituting 2.7% of the data and outlier RTs constituting 4% of the data. Rejection and acceptance bias scores were also computed using the same computations as in Study 1. RT data on the VPT were submitted to regression analyses after centering all continuous variables and dummy coding conditions with the find-the-flower condition as a reference. Regression analyses, capitalizing on the full range of predictor scores, were feasible in this study because we were not examining repeated measures taken at different times.

The multiple regression analyses showed that rejection bias scores were significantly predicted by self-esteem scores ($\beta = -.245$), $t(144) = -2.36$, $p = .020$, indicating that low self-esteem was related to a high rejection bias. More important, rejection bias was also significantly predicted by the Self-Esteem × Condition interaction term ($\beta = .253$), $t(144) = 2.43$, $p = .016$. Tests of simple slopes (Aiken & West, 1991) showed that participants with low self-esteem (at –1 standard deviation below mean self-esteem) in the experimental condition experienced significantly less rejection bias than those in the control condition ($\beta = -.283$), $t(144) =$

-2.43, $p = .016$ (see Figure 4A).[5] The simple slope analysis for participants with high self-esteem (at +1 standard deviation above mean self-esteem) was not significant ($\beta = .123$), $t(144) = 1.06$, *ns*. Participants' acceptance bias was not predicted by either the self-esteem scores or the Self-Esteem × Condition interaction term. Thus, bias on the VPT was only evident on the rejection targets, revealing the predicted hypervigilance for rejection.

As in Study 1, left- and right-rejection and acceptance bias scores were calculated. These scores were then used as outcome variables in multiple regressions. Results indicated that the experimental training had the clearest effect in the left hemivisual field (see Figure 4B). The left- and right-rejection bias scores were not correlated ($r = -.03$, *ns*); therefore, the two biases were used as outcome measures in the following regression analyses. The regression predicting left-rejection bias showed a marginal effect of self-esteem ($\beta = -.187$), $t(144) = -1.80$, $p = .074$, but a significant Self-Esteem × Condition interaction ($\beta = .277$), $t(144) = 2.66$, $p = .009$. Simple slopes analyses showed that participants with low self-esteem showed less rejection bias in the experimental than in the control condition ($\beta = -.287$), $t(144) = -2.46$, $p = .015$, and that there was no difference between conditions for participants with high self-esteem ($\beta = .157$), $t(144) = 1.35$, *ns*. Similar analyses conducted predicting right-rejection bias and both lateral acceptance biases, calculated from trials involving smiling versus neutral faces, yielded nonsignificant results. There was no training effect for individuals with high self-esteem, who, on average, showed no rejection bias in either condition. In summary, the experimental training effect was significantly exhibited by low self-esteem individuals responding to rejection targets presented to their left hemifield but not their right, suggesting a contralateral right-hemispheric specificity of the find-the-smile training task.

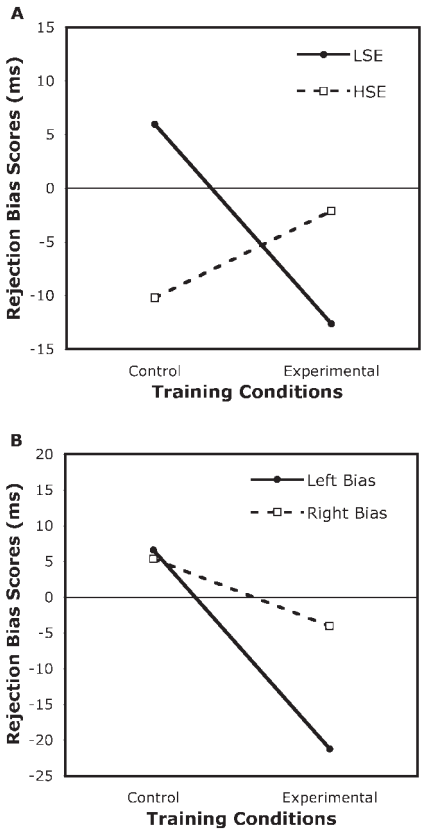

Figure 4. A: Rejection bias for individuals at one standard deviation below mean self-esteem ratings (low self-esteem; LSE) and at one standard deviation above mean self-esteem ratings (high self-esteem; HSE) in both training conditions. Positive rejection bias scores indicate vigilance for, whereas negative scores indicate vigilance away from, rejection. B: Left- and right-rejection bias scores for participants with LSE in both conditions suggesting the lateralized training effect of the experimental condition in the left hemivisual field.

These findings document the capacity of the attentional training to modify people's vigilance for threatening social information. Individuals with low self-esteem who practiced a repetitive exercise of directing attention away from rejection stimuli exhibited significantly less hypervigilance to rejection compared with their counterparts in the control condition. In addition, there is evidence that this cognitive training affects the processing of stimuli in the left hemivisual field, which supports previous research showing the right hemisphere to be involved in the processing of negative emotions and with avoidance or withdrawal behaviors (M. X. Cohen & Shaver, 2004; Davidson, Jackson, & Kalin, 2000).

The working models and social cognitive processes known to be at the core of many individual differences are notoriously difficult to modify. By identifying specific cognitive patterns and designing repetitive training tasks to address them, it appears possible to produce at least short-term modifications of cognitive responses. The intervention examined here was focused on modifying the early stage process of attention to social threat, which is known to be associated with individual differences in initial evaluation of anxiety and stress. Our assumption is that by modifying automatic vigilance for socially threatening information, this may have later stage benefits by limiting the perception of social threat, and thereby "cutting stress off at the pass." We next tested this hypothesis in the field.

The Impact of Attentional Training on Stress Reactivity

In the final two studies, we explored the effects of the attentional training task on people's reactions to naturally occurring stressors. Here, rather than focusing on individual

[5] Recent research has shown that RT responses can be shifted as a function of powerful mood inductions (Smith et al., 2006), and we wished to rule out the possibility that the training task was having its effects due to a simple manipulation of mood state. The attentional training task did not produce significant mood effects, compared with control. There was no significant condition or Condition × Self-Esteem interaction effect on mood $|\beta s| < .022$, $|ts| < .304$, $ps > .762$. Moreover, when the VPT analyses were conducted, including mood in the regression as a control variable, mood did not predict VPT responses, and the other findings were unchanged $|\beta s| > .256$, $|ts| > 2.48$, $ps < .015$.

differences in hypervigilance, we examined the potential benefits of attentional training to a broad range of individuals when under significant stress. In Study 3a, we examined students' reactions to exam stress, and in Study 3b, we examined telemarketers' experience of stress during the workday.

Study 3a

A recent poll of Canadian university students found that 40% of undergraduate students reported feeling "high stress" regarding their final exams, with related feelings of nervousness and anxiety, difficulty sleeping, and fatigue or exhaustion (Ipsos-Reid & Kumon Math, 2005). The same poll found that 68% of undergraduate university students started studying for their exams no earlier than a week in advance. Thus, it appears that the week leading up to a final exam is perceived as a highly stressful time for undergraduate students.

Indeed, exams have been shown to increase people's self-reported perceived levels of stress and to impair cognitive functioning (Jemmott & Magloire, 1988; Vedhara, Hyde, Gilchrist, Tytherleigh, & Plummer, 2000). Test anxiety causes poor performance, is inversely related to self-esteem, and is positively related to fear of negative evaluation (Hembree, 1988). Exam stress has been shown to increase self-reported stress and cause cortisol dysregulation, which was associated with impaired divided attention and decreased levels of secretory immunoglobulin A, an important antibody for upper respiratory infections (Jemmott & Magloire, 1988; Vedhara et al., 2000). Recent interpersonal research on self-esteem has suggested that failure is an implicit social-evaluative threat, automatically activating an anticipation of criticism and rejection from others (Baldwin, Baccus, & Fitzsimons, 2004; Baldwin & Sinclair, 1996; Leary et al., 1995). Thus, the preparation period leading up to an exam is a context of heightened social-evaluative stress.

We tested whether the repeated use of the attentional training task might reduce the experience of exam stress. In Study 3a, students used either the experimental or control version of the attentional training task for 5 consecutive days leading up to one of their final exams. We predicted that participants trained to direct attention away from rejection-related information would report less perceived stress about the exam.

Method

Participants were 25 undergraduate students (3 men) taking an undergraduate course in social psychology at McGill University. They were recruited 1 week prior to the final exam in the course. Participants received two movie passes as compensation for their participation in the study.

Participants were randomly assigned to either the control or experimental training condition. Online versions of the training tasks were programmed in Macromedia Flash and required slight modification. In the find-the-smile condition, 15 frowns from a group of 18 were randomly allocated to a square in the 4×4 grid, and 1 smile from a group of 18 filled the last square. Participants were asked to "Click on the smiling/approving face" using their computer mouse as quickly as possible. In the find-the-flower condition, 15 seven-petaled flowers were randomly allocated to squares on the grid, with a five-petaled flower filling the last square. There were a total of 80 trials with no practice trials.

Five days before their final exam took place, participants were e-mailed a link to a Web site where they read a consent form before continuing with the study. Participants then completed a set of prequestionnaires, which included the Rosenberg Self-Esteem Scale (Rosenberg, 1965) and the Perceived Stress Scale (S. Cohen, Kamarck, & Mermelstein, 1983). Participants were randomly allocated to the experimental or control condition and directed to a Web site where they completed an online version of their attentional training task. Afterwards, they were asked to answer, using a 7-point Likert scale ranging from 1 (*I strongly disagree*) to 6 (*I strongly agree*), the following three posttraining statements: (a) "I am stressed about the exam"; (b) "I am anxious about the exam"; (c) "Today I feel that I will be able to work effectively towards my goals."

For each of the next 4 days, participants were e-mailed a link during the day that directed them to a Web site where they answered a short daily questionnaire that included the four-item Rosenberg Self-Esteem Scale (Major, Richards, Cooper, Cozzarelli, & Zubek, 1998) and the four-item Perceived Stress Scale (S. Cohen et al., 1983). Next, participants completed their respective attentional training tasks online and answered the three posttraining statements, including the critical statement about exam stress. The last day of the study coincided with the day participants wrote their exam. After writing their exam, participants were asked to complete a final set of online postquestionnaires, including the Rosenberg Self-Esteem Scale, the Perceived Stress Scale, the State Anxiety Inventory (Spielberger, 1983), and the School Abilities subscale of the Feelings of Inadequacy Scale (Fleming & Courtney, 1984). Upon completion of the postquestionnaires, participants were directed to a Web page where they read about the purpose of the experiment and were later mailed their movie passes.

Results and Discussion

As anticipated, the attentional training affected participants' specific feelings of stress about their final exam. Figure 5 displays the daily means of the most targeted statement: "I am stressed about the exam." A 2 (self-esteem: high or low based on the median split of premeasured self-esteem) $\times$ 2 (condition: experimental or control) $\times$ 2 (time: Day 1 and Day 5) mixed model analysis of covariance (ANCOVA), with time as a within-subjects factor, covarying participants' cumulative grade point average (CGPA) to control for students' overall academic abilities, revealed a significant interaction between condition and time, $F(1, 13) = 5.77$, $p = .032$. The three-way interaction term with self-esteem was not significant, indicating that the experimental condition had its effects regardless of level of self-esteem; therefore, self-esteem was excluded in the following analyses. At the beginning of the study, participants did not significantly differ in terms of their stress about the exam, $F(1, 15) = 0.11$, *ns*. However, on the morning of the exam, participants who had completed the experimental version of the attentional training reported that they were significantly less stressed about the upcoming exam compared with partici-

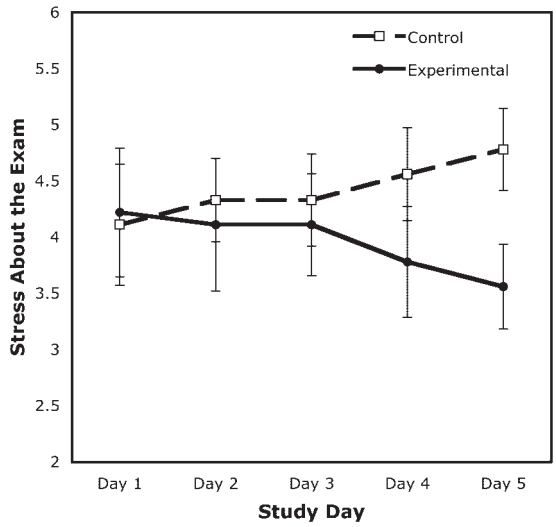

Figure 5. Graph of self-reported stress ratings about the exam. Error bars represent standard error of the mean.

pants in the control condition, $F(1, 15) = 4.88$, $p = .043$ (see Figure 5).[6]

Whereas the attentional training affected students' specific stress toward the primary social-evaluative stressor (i.e., their final exam), it did not affect participants' overall and daily levels of self-esteem, stress, and anxiety. That is, repeated measures ANCOVAs conducted on daily measures from all 5 days of the week and pre- and postmeasures of self-esteem, overall perceived stress, and anxiety about the exam, controlling for participants' CGPA, revealed nonsignificant Time × Condition interactions ($Fs < 2.27$, $ps > .074$). The effects of attentional training, therefore, were evident only on the most targeted measures relating to the social-evaluative stressor.

To test the effects the experimental training task had on the reactivity to stress during the exam itself, analyses were conducted on other measures of stress taken after the exam. An ANCOVA (covarying CGPA) on State Anxiety scores taken after participants completed their exam showed that participants in the experimental condition reported significantly less state anxiety than their counterparts in the control condition ($M = 1.92$, $SD = .40$ vs. $M = 2.40$, $SD = 0.48$ for experimental and control, respectively), $F(1, 20) = 7.14$, $p = .015$. Finally, participants in the experimental training condition also reported marginally significantly higher School Abilities self-esteem on the Feelings of Inadequacy Scale (covarying CGPA) than those in the control condition ($M = 4.51$, $SD = 1.28$ vs. $M = 3.62$, $SD = 0.85$ for experimental and control respectively), $F(1, 20) = 3.74$, $p = .068$. The experimental training, however, did not have any influence on the outcome of the actual exam performance. Therefore, not only did the experimental training make students less stressed about their exam, but it also made them feel less anxious and more competent about their school abilities, suggesting it had a buffering effect against the negative late-stage affective and cognitive aspects of exam stress.

Our findings indicate that if individuals learn to direct attention away from rejection-related information during a stressful exam study period, then this can have beneficial outcomes on their self-reported levels of stress about the exam. Various lines of research on evaluation anxiety have found that individuals who consistently experience anxiety in stressful situations tend to anticipate and expect failure and negative evaluation, which, in turn, become significant threats to their self-esteem (Schlenker & Leary, 1982). Along the same lines, Baldwin and Sinclair (1996) have shown that people with low self-esteem hold contingent failure–rejection links that lead them to automatically anticipate rejection after thoughts of failure are activated. The present findings demonstrate the possibility of training individuals to inhibit thoughts of rejection, thereby limiting their anticipation of failure and negative evaluation, which evidently reduces their feelings of stress vis-à-vis an upcoming socially evaluative situation.

The effect of the attentional manipulation did not interact with premeasured levels of self-esteem, as might have been anticipated based on the findings of Studies 2a and 2b. As Mischel (1977) pointed out, however, the influence of individual-difference variables tends to be most pronounced when situational pressures are relatively weak. Indeed, Wilson and MacLeod (2003) found that individual vulnerabilities to threat perception were evident with moderately threatening stimuli but tended to play less of a role in response to highly threatening stimuli. In Studies 2a and 2b, when participants were assessed for their attentional patterns in the absence of any external stressor, individual differences played a major role, and only low self-esteem individuals showed hypervigilant responses. In the case of students preparing for final exams, however, the realities of heightened social evaluation may simply have been strong enough that all students, regardless of self-esteem, were in the position to benefit from the reduction in attention to threat. This study was not designed to specifically address this question, however, and we acknowledge that it may simply be a lack of statistical power that resulted in the null effect.

The findings were limited to particular questions about the stressfulness of academic work, and the participants' final exam specifically. We had anticipated that given the pressures of exam week, any effects of the training might generalize to influence overall levels of stress, but this was not the case. This may have been because the stressor—exam performance—was only implicitly a social threat, or it may be because the students' daily lives at that time were much more multifaceted than we had anticipated. Whatever the reason, we elected in our final study to examine what we perceived as a more highly stressful and consuming social environment.

Study 3b

In our final study, we examined the psychological, behavioral, and neuroendocrinological impact of attentional modification among a sample of telemarketers to determine whether our paradigm would modify the experience of social stress in the workplace. The social stressors in the daily life of a telemarketer are palpable. Call center operators face frequent rejection from poten-

[6] Alternative ANCOVA analyses were conducted to compare both conditions on Day 5 covarying for Day 1 and CGPA. Results revealed a significant condition effect, $F(1, 14) = 9.02$, $p = .009$, mirroring the results from the repeated measures analyses. (Differences in degrees of freedom are due to instances of missing data.)

tial clients, and they are subject to constant performance evaluation from their superiors as well as overt social comparison via weekly office advertisement of their sales ranking. Moreover, their success in their job is closely linked to their capacity to deal with this constant and often negative feedback. The telemarketing call center seemed the ideal setting to examine the impact of attentional training. Telemarketers completed either the experimental or control version of the task each workday morning for 1 week. They filled out daily stress and self-esteem measures, and on the final day, their cortisol reactivity was assessed.

Method

Twenty-three (14 men) telemarketing representatives were recruited from Media Express, a Montreal-based call center, to complete either the experimental training task or the control version for 5 consecutive workdays. At the beginning of the week, participants completed premeasures of the four-item Rosenberg Self-Esteem Scale (Major et al., 1998), and the four-item Perceived Stress Scale (S. Cohen et al., 1983) and were randomly assigned to either the find-the-smile or find-the-flower training condition. Participants completed their version of the task before the beginning of each work shift for 1 week. At the end of each day's work shift, participants completed a daily paper-and-pencil questionnaire containing the four-item Self-Esteem Scale and the four-item Perceived Stress Scale. The scale instructions for the daily questionnaires were slightly modified to ask participants to rate how they felt "TODAY." On the final day of the study, Friday, participants were asked to provide five cotton swab saliva samples to be self-administered at scheduled times (10:30 a. m., 12:00 p. m., 14:00 p. m., 15:00 p. m., 17:00 p. m.). Most complied with this request. At the end of this final shift, they also filled out a set of personality questionnaires, which included a brief measure of the Big-Five personality traits (Gosling, Rentfrow, & Swann, 2003).

Daily sales data were gathered for each participant for the 2 weeks prior to testing (as a baseline) and for the testing week. Finally, during the testing week, quality control personnel at the telemarketing firm, who were blind to the experimental hypotheses and participants' condition, were asked during their routine monitoring of calls to rate "How self-confident" participating representatives were during greeting, after the potential client's first objection, and at the end of the phone conversation on a scale from 1 (*not at all*) to 7 (*very much*).

Results and Discussion

Overall, results indicated that the attentional training had beneficial psychological and behavioral effects. Participants in the experimental condition experienced a significant increase in self-esteem, decrease in self-reported stress, lower levels of cortisol release, greater self-confidence, and improved sales performance, compared with the control condition.

Self-esteem. A 2 (time: premeasured self-esteem vs. self-esteem measured on the last day) × 2 (condition: experimental or control) mixed model ANOVA, with time as a within-subjects factor, revealed a significant two-way interaction, $F(1, 21) = 5.07$, $p = .035$. Participants in the training condition exhibited a significant increase in self-esteem above baseline, $t(10) = 2.61$, $p = .026$, whereas their control counterparts showed no significant change (see Figure 6A).

Perceived stress. A 2 (time: pre- vs. postmeasured perceived stress) × 2 (condition: experimental or control) mixed model ANOVA, with time as a within-subjects factor, also revealed a significant two-way interaction, $F(1, 21) = 7.05$, $p = .015$. Participants in the training condition had a significant decrease in self-reported stress by the end of the week, $t(10) = -4.25$, $p = .002$, whereas those in the control condition showed no significant change (see Figure 6B).[7]

Cortisol. Cortisol was processed as in Study 1. Cortisol release was calculated in two ways (Pruessner et al., 2003). First, an AUC score was calculated with respect to ground, to represent total cortisol release during the workday. Second, a delta or difference score was calculated between the participant's highest and lowest cortisol reading, to reflect their peak reactivity. Diurnal patterns in cortisol show sizable individual differences, which might obscure effects of any experimental manipulation. There was no premeasure of cortisol to use as a statistical control, but preliminary analyses revealed a moderate correlation between cortisol levels and the personality trait Agreeableness. Therefore, to control for the possible effects Agreeableness might have on cortisol level, it was included as a control variable in the cortisol analyses. Additional analyses in which participants' gender, smoking status, and medication status, which are known to affect cortisol release, were included as statistical controls and did not alter the findings.

The attentional training influenced neuroendocrine responses. Participants who completed the experimental task showed significantly lower levels of cortisol compared with those in the control condition (see Figure 6C). The area under the curve of the total amount of circulating cortisol during the workday showed a 16.8% lower cortisol index for participants completing the experimental condition compared with controls ($M = 2{,}760$, $SD = 1{,}074$ vs. $M = 3{,}317$, $SD = 1{,}492$ for controls), $F(1, 13) = 4.78$, $p = .048$. On the second measure of cortisol reactivity, the delta score, indicative of the individual's peak reactivity of cortisol release, experimental participants were 35.5% lower than control participants ($M = 7.20$, $SD = 3.82$ vs. $M = 11.17$, $SD = 8.20$ for controls), $F(1, 15) = 5.60$, $p = .032$. Therefore, participants in the experimental condition experienced significantly less overall cortisol release and a significantly lower peak reactivity to social stress.

Quality control ratings. The effect of the intervention also became apparent in the ratings made by the quality control personnel. Participants in the experimental condition were rated as significantly more self-confident after a client's first objection than those in the control group ($M = 6.16$, $SD = 1.06$ vs. $M = 4.91$, $SD = 0.87$ for controls), $F(1, 13) = 6.03$, $p = .029$. Therefore, not only did participants report an increase in self-esteem and a reduction in stress but also objective raters evaluated them as more self-confident in the face of negative social feedback.

Sales performance. Finally, the experimental training task also had an impact on sales performance. Sales performance was indexed by a sales-per-contact *conversion* ratio, a standard indicator in the industry that expresses the individual's performance as a

[7] Analyses conducted to investigate moderating effects of self-esteem on perceived stress and subsequent dependent measures revealed no significant moderating effects ($Fs < 2.00$, $ps > .17$), as in Study 3a. To avoid repetition and for the sake of brevity, we chose not to report these null findings in the text.

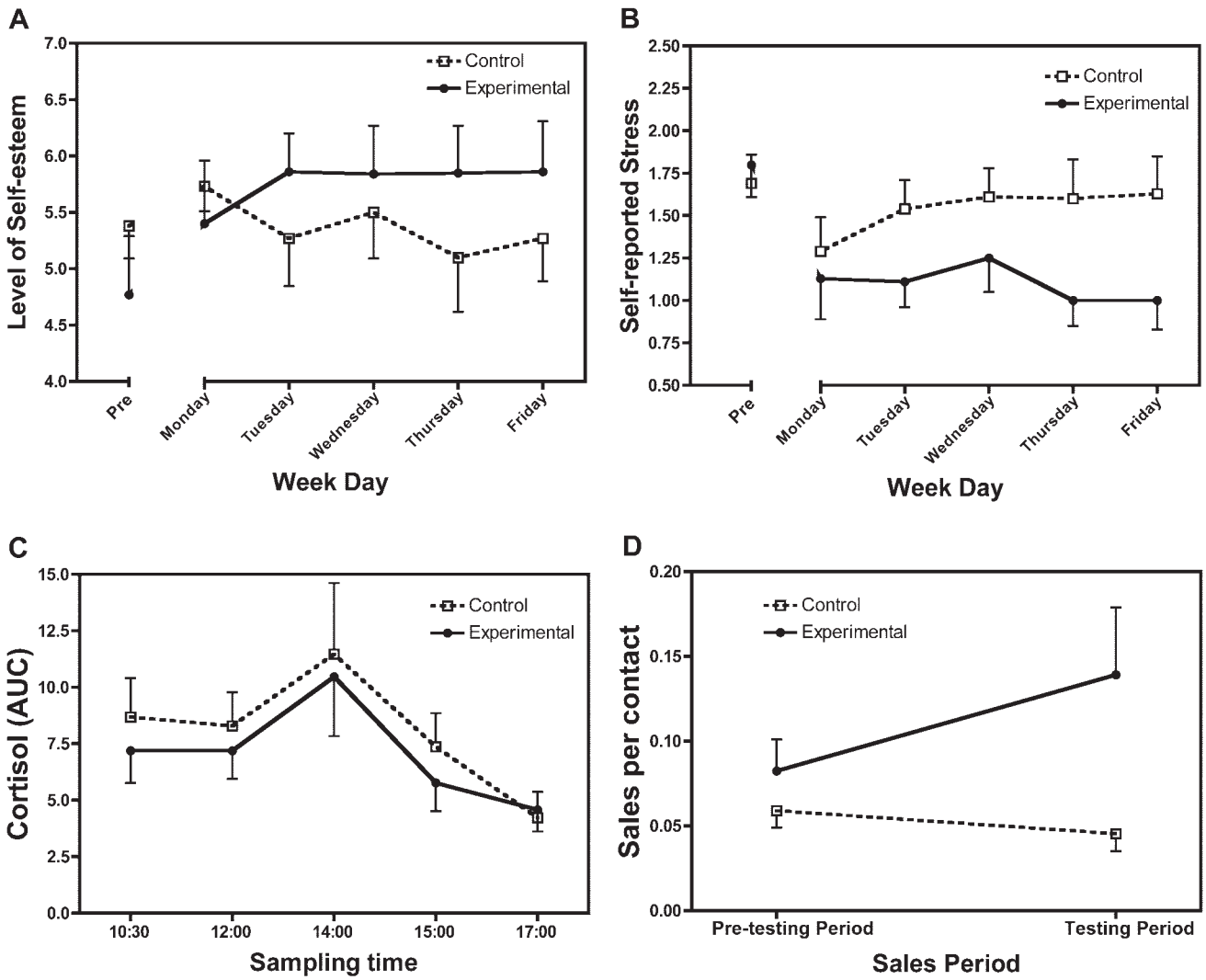

Figure 6. A: Graph of mean group ratings for self-esteem and B: self-reported stress over the test week. C: Mean cortisol levels for each group at each sampling time on the last testing day. D: Pretesting and testing period mean sales per contact for each group. Error bars represent standard error of mean. AUC = area under the curve.

ratio of sales to their total number of telephone contacts with customers. A 2 (sales period: pretesting period vs. testing period sales ratio) × 2 (condition: experimental or control) mixed model ANOVA, with sales period as a within-subjects factor, revealed a significant two-way interaction, $F(1, 21) = 5.10$, $p = .035$. Whereas participants in the control condition did not show improved sales during the training week, $F(1, 21) = 0.376$, *ns*, participants in the training condition showed a 68.9% increase in sales success from the pretesting period to the test period, $F(1, 21) = 6.45$, $p = .019$ (see Figure 6D).[8]

These combined results show the potential for attentional training interventions designed to manipulate the perception of threatening environmental information, in terms of their behavioral and physiological benefits. Even in this environment, there can be pleasant interactions with customers from time to time, and the satisfaction of the occasional sale. Workers who underwent attentional training were able to maintain their self-confidence even in the face of rejection, to maintain a manageable level of stress, and to convert their confidence into tangible outcomes.

General Discussion

Our findings from five studies highlight the pivotal role of early stage attentional allocation in the human stress response. Attentional bias toward negative social information was associated with

[8] As was done in Study 3a, alternative ANCOVA analyses for the self-esteem, perceived stress, and sales performance dependent measures can also be conducted on the postmeasures of these dependent variables, covarying the premeasures of the respective measures. The ANCOVA results mirror those of the repeated measures analyses reported in the text, although, some cases only approached significance: self-esteem, $F(1, 20) = 3.61$, $p = .072$; perceived stress, $F(1, 20) = 6.95$, $p = .016$; and sales performance, $F(1, 20) = 4.22$, $p = .053$.

heightened cortisol reactivity to threat. A simple task that involves repeatedly ignoring social threat and searching for acceptance was effective in reducing this attentional bias, and when tested in an academic context, this attentional training resulted in students feeling less stressed about their final exam and less anxious and more competent in their school abilities after having experienced their exam. Finally, in the workplace context, this attentional training resulted in higher self-esteem, lower self-reported stress, lower levels of cortisol, higher self-confidence, and improved work performance.

Prior research has documented the stressful effects of social-evaluative threats (Dickerson & Kemeny, 2004), including the critical evaluation, interpersonal conflict, and dominance hierarchies often found to deflate employee morale in the modern workplace. People experience such social threats in different ways, and present psychological models of stress and coping focus on cognitive appraisals of the social situation. For example, primary appraisal involves weighing what is at stake in the specific encounter, whereas secondary appraisal involves assessing what can be done to manage and cope with the encounter (Lazarus & Folkman, 1984). Many of these appraisal and coping processes deal with how best to respond to a threat. However, the emotional relevance of stimuli is implicitly encoded in the first 100–300 ms of perception (Compton, 2003). Thus, late-stage, *response-focused* coping strategies (Gross, 2002) may therefore be akin to closing the proverbial barn door after the horse has bolted. Instead, *antecedent-focused* cognitive strategies, such as situation selection, situation modification, or, as in the present research, automatic attention deployment, are thought to tune the cognitive system to alter the perception of threat early in the primary appraisal stage, before the stress response is triggered (Gross, 2002). More important, these strategies differ from late-stage, response-focused strategies, such as emotional suppression or escape, which often require a dysfunctional distortion of reality and can lead to negative psychological and physiological outcomes. Several studies have demonstrated that antecedent-focused strategies, which moderate the perception of threat before an emotional response is triggered in the limbic system, are instead associated with positive outcomes ranging from increased well-being to improved interpersonal functioning (Folkman & Lazarus, 1988; Gross, 2002).

As indicated earlier, stress reactivity is not a simple linear process. Several theorists have proposed a kind of feedback loop whereby the exaggerated perception of threat leads to a stress response, which may then reinforce the individual to be more attentive and cautious about rejection in his or her environment in the future, thereby amplifying the rejection-vigilant habit. In the case of anxious attachment, for example, hyperactivating strategies are characterized by constant vigilance for attachment figures, early detection of threat cues, and exaggeration of the potential negative effects of threats, which together influence the primary appraisal of future threats and produce a self-amplifying cycle of distress (Mikulincer, Shaver, & Pereg, 2003). Our findings suggest that it may be possible to interrupt this cycle by modifying the stage of initial attention to threat.

We acknowledge limitations in the present research as well as important conceptual issues to consider in future research. We have argued that our find-the-smile task modifies attention away from rejection. It is possible that the task instead modifies people's emotional reactivity to frowns, perhaps via an exposure mechanism, and that this yields the reduced stress response observed in our field studies. In Study 2a, we did not find that the exposure condition modified participants' attentional bias in the same manner as the find-the-smile condition, but there remains the possibility that both conditions could reduce emotional reactivity independently of their effects on attention. This possibility highlights important considerations regarding the design of the control condition. We used two control conditions: the find-the-flower condition that controlled for the search process and the exposure condition that controlled for the exposure to frowning faces. Although one might wish to control for both processes simultaneously, this is not as straightforward as one might think. For example, a control condition in which the participant would be asked to identify the female face in a grid of frowning male faces might, at first glance, appear to expose participants to frowning faces while incorporating a search component. However, in searching for the female face, participants would still need to repeatedly disengage from frowning distractors. In fact, any search that entails looking for a discrepant target in a grid of frowns might be expected to have an attentional impact similar to the find-the-smile experimental manipulation because of this disengagement practice. It is therefore important to consider both processes involved in the training when designing the control condition.

An alternative route to demonstrating that attentional changes mediate the stress effects would be to assess individuals' changes in attentional bias and then link them to their changes in stress reactivity, which we did not do in our studies. This is precisely the approach taken in earlier laboratory research documenting the causal effects of attentional training on emotional vulnerability (MacLeod et al., 2002). Our focus was instead on exploring these processes in the context of real-world social stress. Still, in future research, we advocate testing the entire early–late-stage cycle, ideally in the context of naturalistic stressors, assessing mutual causality among attentional processes, physiological stress reactions, and personality variables. Additional research is also needed to further clarify the role of self-esteem in the perception of moderate social threat (as in Studies 2a and 2b), and in the beneficial effects of attentional training in highly stressful contexts (see Studies 3a and 3b). Relating to the possibility of hemispheric dominance in stress-related attentional processes, thorough neuropsychological investigation (e.g., using fMRI) is called for to clarify the mechanisms underlying the phenomena we observed, although our findings are broadly consistent with the previous literature.

These limitations notwithstanding, the present results clearly demonstrate a role for attention in the perception of social stress. With appropriate cognitive training, which targets the problematic vigilance for threat that can be engendered by stressful situations or individual vulnerabilities, early stage processes can be modified to circumvent the psychological and physiological consequences of stress. A seemingly innocuous task, specifically directed toward tuning the attentional filter to reduce automatic selective attention to threat, can help "cut stress off at the pass" and reduce the later stage aspects of the stress response.

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