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UNIVERSITY OF MIAMI

ATTENTIONAL BIASES AND EMOTIONAL REACTIVITY: ELUCIDATING CAUSAL MECHANISMS AND UNDERSTANDING INDIVIDUAL DIFFERENCES

By

Kimberly A. Arditte

A THESIS

Submitted to the Faculty
of the University of Miami
in partial fulfillment of the requirements for
the degree of Master of Science

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ATTENTIONAL BIASES AND EMOTIONAL REACTIVITY: ELUCIDATING CAUSAL MECHANISMS AND UNDERSTANDING INDIVIDUAL DIFFERENCES

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Previous studies have proposed that biased attention for emotional stimuli is related to subsequent emotional responsivity and research has found that the preference, or bias, to attend to specific emotional stimuli is often associated with heightened, or attenuated, emotional reactivity. Yet, it remains unclear whether attention causally contributes to emotional responding. As such, recent research has begun to examine these relations by manipulating attentional biases with the use of attention training tasks. The current investigation looked to add to the extant body of literature by systematically examining the impact of two attention training paradigms (train towards negative stimuli and train towards positive stimuli) on subsequent patterns of attention, emotional responsivity, and biased interpretation of ambiguous stimuli within an unselected sample of undergraduates. Additionally, the project explored the moderating role of individual difference variables, including psychological symptoms and emotion regulation strategies, in the relation between the attention training tasks and participants' subsequent emotional responding. With the exception of an induced interpretation bias among participants trained to attend to positive stimuli, results revealed few effects of the attention training tasks. Potential theoretical explanations are discussed alongside methodological points of interest to promote further understanding of the relations among attention training, cognition, and emotion.

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Chapter 1: Introduction

Recall a time in the past when you have been feeling sad or down. Have you ever noticed that, when you are in such a mood, the world around you seems dull and gray to match? When you are feeling sad you may be more inclined to notice an overcast sky, an unreturned phone call from a friend, or the lonely person sitting at a bus stop. The preference to attend to mood-congruent environmental stimuli is known as an *attentional bias*. Attentional biases can be directed towards both negative and positive stimuli and have been documented within specific populations, such as individuals with anxiety or mood disorders and optimists (Mogg, Bradley, Miles, & Dixon, 2004; Segerstrom, 2001).

Theory on the role of attention in relation to emotional experience posits that what you pay attention to has an important effect on your mood and emotions (e.g., Beck & Clark, 1997; Beck, Rush, Shaw, & Emery, 1979). At any given moment, individuals are limited in their ability to allocate attention to environmental stimuli and attentional resources are often spent on things perceived to be self-relevant. For example, individuals experiencing symptoms of anxiety or depression may be more likely to selectively attend to emotion-congruent stimuli. Yet, this selective attention towards negative emotional content may actually serve to exacerbate symptoms. In this way, attention is theorized to play a causal role in the development of emotional problems. Similarly, a person in a positive mood state may be more inclined to attend to positive self-relevant stimuli, which may work to sustain the positive mood state or buffer against negative mood states (e.g., Carstensen & Mikels, 2005).

Furthermore, some researchers have conceptualized selective attention to specific environmental stimuli as a form of emotion regulation (ER). Emotion regulation has been defined as the ability to alter how and when a particular emotion is experienced (Gross, 2007). Individual differences in emotion regulation (ER), including the types of ER strategies that are used, how effectively strategies are implemented, and the context in which strategies are employed are all thought to influence subsequent emotional responding (Campbell-Sills & Barlow, 2007). For example, deploying attention towards emotional stimuli may contribute to the up-regulation of emotional responding, whereas the deployment of attention away from emotional stimuli may aide in the down-regulation of the emotional experience (Gross & Thompson, 2007; Wadlinger & Isaacowitz, 2011).

Research has supported theory on attention and emotion by demonstrating an association between biased attention for emotional material and emotional reactivity. Specifically, research has found that an attentional preference for negative stimuli (*negative attentional bias*; NAB) is related to heightened emotional responding, while an attentional preference for positive stimuli (*positive attentional bias*; PAB) is related to attenuated emotional responding. For example, NABs are found to relate to greater stress reactivity as measured by subjective negative affect and elevated cortisol levels (Ellenbogen, Schwartzman, Stewart, and Walker, 2002). Conversely, PABs appear to be associated with enhanced ability to repair mood states and regulate emotions in response to interpersonal conflict (Mather & Carstensen, 2005).

Yet, research lags behind theory in documenting the causal effect of attentional biases on emotional reactivity. The majority of research to date has relied on correlational data, documenting only that individual differences in biased attention are associated with individual differences in emotional vulnerability or psychological resilience. Elucidating the causal nature of this relation is an important next step in providing empirical support for widely applied theories. Beyond the theoretical implications, however, understanding the effects of attention on emotional reactivity may have important clinical implications, as this research may help to determine risk and resilience factors for the development and maintenance of emotional disorders and could provide a possible point of entry from a treatment perspective.

The primary aim of the current investigation was to identify the effects of negative and positive attentional biases on subsequent emotional reactivity in response to stress. Additionally, the study examined the effects of attentional biases on other cognitive processes (i.e., interpretation of ambiguous stimuli), which have been shown to be closely associated with attention (Mathews, Mackintosh, & Fulcher, 1997). Finally, the study attempted to identify individual differences in psychological symptoms and trait-level emotion regulation strategies that moderated these relations.

Attentional Biases to Emotional Stimuli.

As interest in the relation between attentional biases and emotional reactivity has grown, researchers have worked to identify existing attentional biases within specific populations vulnerable to emotional distress, including individuals with anxiety and depression (see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg & Ijzendoorn, 2007 and Mogg and Bradley, 2005 for reviews). This work has relied heavily on experimental paradigms such as the emotional Stroop and dot-probe tasks. In the emotional Stroop task, participants are given a list of words and asked to say aloud the color of the ink the word is printed in. Attentional biases can be identified when individuals take longer to correctly identify the color of the ink for emotionally-relevant, as compared to neutral, words. Dot-probe paradigms typically involve the simultaneous presentation of two stimuli (e.g., words or pictures), one valenced and the other neutral. Following stimulus presentation, a probe appears in the same spatial location as one of the previously presented stimuli and participants are asked to respond to the probe as quickly as possible. Dot-probe tasks will have both valid (probe appearing in the position of the valenced stimulus) and invalid (probe appearing in the position of the neutral stimulus) trials. Decreased reaction times (RTs) on valid trials and increased RTs on invalid trials are indicative of biased attention towards emotional stimuli.

As summarized by Bar-Haim et al. (2007), results from these tasks indicate that, compared to healthy controls, anxious individuals demonstrate a significant attentional bias towards threat-related cues. This NAB appears to be most pronounced in early stages of attentional deployment, indicating that individuals with anxiety may be hypervigilent in their perception of threat-relevant stimuli. For example, when presented with threatening and non-threatening picture pairs, participants with high levels of trait anxiety demonstrate increased attentional preference to threat images presented for short (500ms) durations (Mogg et al., 2004). Research on late-stage attentional biases in anxiety has been mixed, with some evidence for maintained attention towards threat (Weierich, Treat, & Hollingworth, 2008) and other evidence suggesting that anxious individuals demonstrate attentional avoidance of threat-related cues (Mogg et al., 2004).

In contrast, depression does not seem to be related to an initial orienting to mood-congruent stimuli (MacLeod, Mathews, & Tata, 1986; Mogg, Millar, and Bradley, 2000).

This has, thus, called the existence of a depression-related NAB into question. In their review of experimental research on attentional biases in depressive disorders, Mogg and Bradley (2005) concluded that only about half of studies had found evidence for a depression-related attentional bias. Additionally, the authors suggested that depression-related NABs were only present under specific experimental conditions, such as when stimuli were presented for longer durations (i.e., 2s or more). The authors hypothesized that longer stimulus presentation led to biased attention because it allowed for more elaborative processing of emotional material.

Others have proposed that attentional biases seen under longer presentation durations reflect a depression-related dysfunction in attentional maintenance and may be indicative of difficulty disengaging from negative material (Bradley, Mogg, & Lee, 1997). In support of this hypothesis, Joormann and Gotlib (2007) examined NABs in a sample of currently depressed, remitted-depressed, and never-depressed control participants. To examine biased attentional patterns, a dot-probe task that included images of happy, sad, and neutral facial expressions was employed. Face stimuli were chosen over self-relevant words in order to increase emotional salience. Additionally, each stimulus was displayed for 1,000ms so as to target the hypothesized late-stage attentional bias. Results from this study found that, compared to never-depressed controls, currently-depressed and remitted-depressed participants both demonstrated significant attentional preference for dysphoric stimuli. That, like depressed participants, depression-vulnerable participants did not disengage from dysphoric facial expressions may indicate that NABs play a causal role in the onset of depressive episodes. Still, the correlational nature of the study design means that the directionality of this relation remains undetermined.

Importantly, attentional biases need not be directed towards negative stimuli and researchers have begun to examine the existence of PABs within specific populations as well. Understanding the association between PABs and emotional reactivity may have implications for both clinical and non-clinical populations, as identifying attentional preferences for happy or positive stimuli may help to explain why certain populations demonstrate psychological resilience, while others demonstrate vulnerability in the face of stress or negative emotions. Research using the dot-probe has found that non-psychiatric controls demonstrate a natural PAB towards happy faces that is not seen in individuals with current or remitted depression (Joormann & Gotlib, 2007). However, particular groups may be even more apt to display a PAB than the population-at-large. For example, individuals high in trait-level optimism, a personality characteristic associated with increased positive affect, decreased negative affect, and better ability to cope with stress, have demonstrated attentional preferences for positive words within an emotional Stroop paradigm (Segerstrom, 2001).

As seen from the above review, the literature on attentional biases has relied heavily on the Stroop and dot-probe paradigms. It should be noted, though, that neither task is without its methodological weaknesses. Some researchers have been critical of the emotional Stroop task, arguing that it is unclear whether color-naming latencies are truly reflective of interference due to attention allocation (e.g., MacLeod, Rutherford, Campbell, Ebsworthy, and Holker, 2002). Likewise, critics of the dot-probe task argue that this paradigm provides only cross-sectional data on attention allocation, missing potentially important information on how attention to emotional stimuli changes over time (e.g., Caseras, Garner, Bradley, & Mogg, 2007). Further elucidation of the time course of attentional biases may have important implications. For example, specific NABs occurring along the time course may be differentially related to psychological symptoms and/or diagnoses and identifying different anxiety- or depression-related NABs may aide in conceptualization of treatment. Furthermore, there have been no studies to date that have looked at the time course of PABs, despite the fact that this information could inform theory on attention and emotion in the context of psychological resilience.

Given this, recent research has examined attentional biases with the tracking of natural gaze patterns. Eye tracking can provide a more ecologically valid understanding of biased attention than either the Stroop or the dot-probe tasks have been able to do because it allows for the continuous evaluation of focal attention (Caseras et al., 2007). The tracking of eye movement also provides a richer understanding of how specific components of attention relate to emotion. Eye tracking allows one to assess early-stage attentional biases by examining where an individual initially orients his or her attention. Additionally, late-stage biases can be assessed by looking at the number of visual fixations within a trial or by a global assessment of attention which calculates total time spent looking at emotionally-valenced images over the course of a trial.

Preliminary results of eye tracking studies have yielded further evidence for early orienting towards threat among anxious individuals, but again demonstrate inconsistencies with regard to late-stage anxiety-related attentional biases. For instance, in a study conducted by Rinck and Becker (2006), spider phobic participants were more likely than non-phobic controls to orient their gaze towards images of spiders during the first 500ms of a trial. However, they then displayed increased attentional avoidance of spider images over the remainder of the 60s stimulus presentation. In contrast, individuals with high levels of contamination fear were found to demonstrate initial attentional preference for fearful facial expressions, as well as maintained attentional preference for both fearful and disgusted facial expressions (Armstrong, Olatunji, Sarawgi, & Simmons, 2010). Still, there exist numerous explanations for such discrepancies, including differences in methodology and study samples or the presence of individual difference factors not assessed. As such, further research in this area is warranted before conclusions may be confidently drawn.

Results from eye tracking studies on depressed samples replicate the findings of Joormann and Gotlib (2007) using the dot-probe task. Individuals with depression demonstrate a bias, not in the initial orientation of their gaze, but in the maintenance of attention towards negatively-valenced stimuli over time (Caseras et al., 2007). In fact, when Mogg et al. (2000) only measured initial eye movement toward threat-neutral picture pairs, depressed participants did not differ from controls and both groups showed significantly less bias toward threat images than participants with GAD. However, when eye movement is tracked over a period of time, depressed participants have been found to fixate on dysphoric images for longer (Eizenman et al., 2003) and at a higher frequency (Kellough, Beevers, Ellis, & Wells, 2008) than control participants.

Eye tracking has also been used to assess for the presence of PABs. The socioemotional selectivity theory posits that older adults (and others who may perceive their lifespan to be time-limited) may be motivated to attend to positive and/or emotionally meaningful stimuli in their environment, a phenomenon termed the *positivity effect* (Carstensen & Mikels, 2005). Using eye tracking methodology, research has supported the socioemotional selectivity theory, finding that older adults demonstrate a PAB for happy faces that is not seen in younger adults (Isaacowitz, Wadlinger, Goren, & Wilson, 2006).

Despite all that is known about attentional biases, much of the extant research has been limited by its correlational nature. It remains unclear, for example, whether NABs represent a causal mechanism leading to the etiology and maintenance of clinical disorders or merely a state-dependent symptom of such disorders. Moreover, the link between PABs and emotional reactivity has not yet been well-established. Relatively few studies have examined PABs and those that have have rarely looked to establish an association between attention to positive stimuli and emotional responding. Research with older adults has found that they demonstrate better ability to regulate negative emotional responses than their younger counterparts, yet it is unclear that this finding is causally-related to their preference to attend to positive stimuli. As with NABs, PABs may be either causes or consequences of healthy emotional functioning in older adults. Elucidating the causal nature of these relations is an important next step in translating basic cognitive findings into clinically-relevant treatment research. However, to date, few studies have investigated whether attentional processes are causally related to negative or positive emotional responding.

Cognitive Bias Modification: Attention Training Tasks.

Attempting to address the issue of causality, research has begun to experimentally manipulate NABs and PABs through the use of attention training tasks. Training tasks have been shown to effectively alter attention and to impact participants' ensuing emotional responsivity (for reviews, see Browning, Holmes, & Harmer, 2010 and Hallion & Ruscio, 2011). In one of the first studies of its kind, MacLeod and colleagues (2002) examined the effects of a training task on attentional preference for negative or neutral words in a sample of non-clinical, undergraduate students. The training consisted of a dot-probe task in which participants were presented with a series of 576 trials. For half of participants, the probe always appeared in the spatial location of the negative word, thus training a NAB over time (attend negative condition). The other half completed a training in which the probe appeared in the spatial location of the neutral word, thus shifting attention away from negative stimuli over time (attend neutral condition). The effects of training condition on attentional biases were assessed by examining reaction times on test trials in which the probe was equally as likely to appear behind either the negative or neutral word.

Findings from this study revealed a two-way interaction of training condition by probe location. Participants in the attend-negative condition demonstrated faster responding to probes replacing the negative versus neutral test trial stimuli, whereas participants in the attend-neutral condition were faster to respond to probes replacing the neutral rather than negative stimuli. Additionally, while no group differences were found in subjective mood ratings made during the training, participants in the attend-negative condition reported significantly more negative affect than those in the attend neutral condition in response to an anagram stressor that followed the training. From these results, it was concluded that both training conditions effectively elicited attentional biases towards or away from negative material and that the induction of a NAB produced increased levels of stress reactivity.

Procedures similar to those described above have been used repeatedly to alter attentional biases. For example, a dot-probe training task was used to successfully modify attention away from words associated with a stressful life event (i.e., moving overseas for college) amongst high school seniors (See, MacLeod & Bridle, 2009). Moreover, modification of attention toward threat-related words (e.g., evil, pain) was found to differentially predict lateral prefrontal cortex activity in a sample of healthy volunteers (Browning, Holmes, Murphy, Goodwin & Harmer, 2010). Finally, Wadlinger and Isaacowitz (2008) adapted the task procedures by using positive-neutral word pairs in order to induce a PAB. In this study, change in attentional preference was assessed by tracking eye gaze in response to negative images before and after the attention training. Results revealed that inducing a PAB caused participants to spend a smaller percentage of time looking at the negative components of each image.

Attention modification paradigms have also been found to effectively alter attentional biases associated with clinical disorders. For example, Amir, Weber, Beard, Bomyea, and Taylor (2008) examined the effects of a single-session training away from threatening stimuli within a sample of individuals reporting symptoms of social anxiety. Participants were randomly assigned to either a training (Attention Modification Program; AMP) or no-training control condition (Attention Control Condition; ACC). Results indicated that participants receiving the AMP, but not the ACC, demonstrated improved ability to disengage from threatening words (e.g., *embarrassed*). Also, when asked to make a post-training speech, those in the AMP demonstrated lower levels of social anxiety assessed by both self-report and observer ratings. Likewise, in a sample of participants diagnosed with generalized anxiety disorder (GAD), an eight-session attention training away from threat-relevant words (e.g., *disease*) elicited a change in attention bias, such that those participants who received the training, as compared to controls, showed decreased NABs at a post-training assessment (Amir, Beard, Burns, & Bomyea, 2009). Researchers also found that reducing NABs via training led to decreased symptoms of anxiety, depression, and worry and that significantly more participants in the training condition (50%) no longer met criteria for GAD at post-assessment than those in the control condition (13%).

The effects of attention training tasks on depression-related attentional biases have been somewhat less clear. In one study, undergraduates with mild to moderate levels of depression symptoms were randomly assigned to either a four-session attention training (AT) or control condition (Wells & Beevers, 2010). Those in the AT condition were trained to attend to neutral, rather than dysphoric images. Bias scores were then calculated by examining change in attentional preference for dysphoric stimuli across sessions. Participants receiving the AT demonstrated decreased bias scores and self-reported depression symptoms from session one to session four, while those in the control condition showed no change in attention or emotional responding over time. However, in another study conducted by Baert, de Raedt, Schacht, and Koster, 2010, dysphoric and clinically depressed individuals participated in a 10-session training protocol. Here, participants in the training condition practiced directing attention away from dysphoric words (e.g., *sad*), as well as towards positive words (e.g., *happy*). Again, bias scores were calculated by examining changes in response latencies across training sessions. Results showed that the training did not effectively alter attentional biases among either the dysphoric or depressed participants, and surprisingly, it was participants assigned to the control condition that reported decreased psychological symptoms at a post-training assessment.

One possible explanation for the discrepancy in findings between these two studies may be the methodological differences that exist between them. For example, the first study utilized dysphoric images, while the second utilized dysphoric words. In addition, Wells and Beevers (2010) only trained attention away from negative stimuli, while Baert et al. (2010) simultaneously trained attention away from negative and towards positive stimuli. However, to date, these are the only two studies examining attention modification tasks with dysphoric content and among dysphoric or depressed participants. As such, it is evident that further research is needed to elucidate existing findings and to address outstanding research questions.

For instance, it remains unknown how attention training tasks impact different components of attention (e.g., initial visual orientation, number of visual fixations, global assessment of attention). Using eye tracking to assess altered attentional biases would allow researchers to tease apart the effects of training on specific aspects of attention. Gaining an understanding of the ways in which training paradigms target particular aspects of attention, may then allow us to determine for whom training may be most effective. Nevertheless, to date, change in attentional biases has almost exclusively been assessed by examining response time latencies to dot-probe paradigms. Only one known study has used eye tracking to assess the effects of retraining on attentional processes (Wadlinger & Isaacowitz, 2008).

Secondly, inducing attentional biases through training tasks has been found to produce altered affective responses to stress (e.g., MacLeod et al., 2002), but further investigation is needed to fully elucidate this finding. Studies have, at times, produced inconsistent findings (Wells & Beevers, 2010 versus Baert et al., 2010) and the relation between PABs and subsequent stress responding has not been well established. Furthermore, extant research has relied heavily on self-report measures, while behavioral measures of affect (e.g., electromyography) and physiological measures of arousal (e.g., heart rate, respiratory sinus arrhythmia) have been largely ignored. Considering the discrepancies that often exist between subjective, behavioral, and physiological indicators of emotion (e.g., Mauss & Robinson, 2009), this is an essential component to understanding the impact of NABs/PABs on stress responding.

Lastly, it remains unknown how the alteration of one cognitive bias may impact biases within other cognitive domains. In addition to attention, cognitive biases have been demonstrated in domains such as memory, cognitive control, and in the interpretation of ambiguous stimuli (for a review of cognitive biases in emotional disorders, see Mathews & MacLeod, 2005). Yet attentional and interpretation biases appear to be most closely related and it has been proposed that they are derived from a common mechanism. For example, cognitive accounts of anxiety suggest that a dysfunctional affective evaluation system may enhance the perceptual representation, and therefore the salience, of threatening stimuli in the environment, just as it may make the threatening interpretation of an ambiguous situation more salient than a neutral, or benign, alternative (Mathews et al., 1997). Similarly, populations that have demonstrated PABs, such as optimists, also appear to interpret ambiguous stimuli more positively, hence the expression “rose colored glasses” (see Isaacowitz, 2005). Segerstrom (2001) proposed that the development of both PABs and positive interpretation biases may arise from a more readily accessible schema of success within this population.

Given that attention and interpretation biases are closely related, it seems likely that manipulation of one bias will affect the consequent presentation of the other and researchers have called for further investigation into this hypothesis (e.g., Amir et al., 2009). However, when effects of attention retraining have been examined, focus has been predominantly on the impact of training on stress reactivity, while the effects of induced attention biases on interpretation biases remain untested.

The Role of Individual Differences in Emotional Responding.

Of final note is the role individual differences may play in the retraining of attention. Much research has been done to document the existence of NABs within clinically anxious and depressed samples (Mogg et al., 2004; Joormann & Gotlib, 2007), yet even within non-clinical samples the effects of an attention training may be moderated by individuals’ self-reported psychological symptoms. It may be expected that increased levels of anxiety, depression, or worry symptoms would exacerbate the effects of a NAB training and attenuate the effects of a PAB training on subsequent stress reactivity. However, none of the previous attention training studies using non-clinical samples have looked to examine the empirical support for this prediction.

It is also possible that trait-level differences in the ability to regulate emotional responses contribute to this variability. Training an attentional preference for either negative or positive material has been conceptualized as a form of emotion regulation (ER). In fact, attentional deployment is a commonly used ER strategy (Gross & Thompson, 2007; Wadlinger & Isaacowitz, 2010), which has been found to relate to the use of other ER strategies. For example, van Reekum et al. (2007) examined the effects of instructing participants to use cognitive reappraisal, an ER strategy that involves changing the way you think about a situation in order to up- or down-regulate your emotional response to it, on attention towards emotional stimuli. They found that reappraising to up-regulate emotional responses led to increased time fixating gaze on emotional images, while reappraising to down-regulate led to decreased time spent fixating gaze on emotional images. Along the same lines, it has been proposed that individuals who are better able to direct attention away from negative stimuli may also be better able to use cognitive reappraisal to redirect attention away from negative cognitions (Johnson, 2009). Conversely, the author of this study suggests that participants who are worse at deploying attention away from negative stimuli may also demonstrate difficulty in disengaging from negative thoughts, perhaps because they are relying on rumination, an ER strategy involving perseverative, introspective focus on thoughts or feelings. However, this hypothesis has yet to be tested empirically.

In addition, there is some evidence to suggest the relation between attention training and subsequent emotional reactivity is moderated by the habitual use of ER strategies (Ellenbogen, Pilgrim, & Paquin, 2010). Yet no work has been done to systematically examine the moderating role of ER strategies in the development of attention biases and subsequent outcomes. Along with the strategies of cognitive reappraisal and rumination, two other ER strategies, expressive suppression and emotional acceptance, may be of particular interest. Expressive suppression is a response-focused strategy in which the individual attempts to prevent the expression of a particular emotional response. Paradoxically, research on the use of suppression suggests that it is actually related to increased emotional responsivity (Gross & John, 2003). Emotional acceptance has been defined as a willingness to experience a negative emotion freely, without trying to alter or judge it (Bond et al., in press). This strategy has been linked with a number of positive quality of life outcomes, but may be associated with an initial increase in emotional reactivity following a stressor (Liverant, Brown, Barlow, & Roemer, 2008). To date, no studies exist that have examined the moderating role of expressive suppression or emotional acceptance in the relation between attentional biases and emotional responding.

The Current Study.

It has been well documented that selective attention towards emotionally-valenced stimuli in one's environment is related to altered emotional responding. For example, NABs associated with psychological disorders such as anxiety and depression appear to relate to increased negative affect in response to stress. Conversely, biased attention towards positive stimuli have been found to be associated with decreased negative affect and better ability to regulate emotional responding. Yet, despite all that is known, a number of important questions remain unanswered.

The assessment of attentional biases has usually relied on tasks such as the dot-probe or Stroop. However, recent technological advances, including the ability to continuously track eye movements, can provide a richer understanding of attentional gaze patterns, allowing us to tease apart biases related to specific components of attention. Understanding how specific components of attention relate to emotional responding may have important theoretical and clinical applications. Furthermore, research assessing emotional responding has often relied on subjective reports of positive and negative affect. Few studies have examined behavioral (e.g., electromyography) or psychophysiological indicators of emotional reactivity. Using a multi-modal method to assess change in emotional responding can, again, allow for a more complete understanding of these relations and is an important next step in this field of inquiry. Finally, despite what is known about the relations between attentional biases and subsequent emotional reactivity, much of the extant research has been limited by its correlational nature. As such, recent research has begun to experimentally manipulate attentional biases to examine the causal effects attention on subsequent emotional responding. As an extension of this work elucidating the causal role between attention and emotion, it may be necessary to also examine the role of individual differences in emotion, emotion regulation, and other aspects of cognition. Yet, to date, no work has been done to systematically examine the moderating role of such variables.

The current investigation looked to add to the literature in a number of critical ways. The study utilized a previously-validated dot-probe attention training paradigm to alter attention towards positive or negative stimuli. These conditions were compared to a no-training control condition in order to assess the causal impact of attentional biases on natural gaze patterns and subsequent stress reactivity measured by subjective, behavioral, and psychophysiological indicators. As a secondary aim of the project, I looked to see if altered attentional biases affected change in other cognitive biases, such as those associated with the interpretation of ambiguous stimuli. Finally, I sought to understand how individual differences in psychological symptoms and habitual use of specific emotion regulation strategies moderated the effects of the training on altered emotional responding.

Hypotheses.

The hypotheses for the current study were as follows:

I. *Effects on Attention*. Completion of the attention training would alter attentional patterns assessed via eye tracking using a pre- and post-training design.

   i. Following the attention training, participants in the NAB condition, as compared to both the PAB and control conditions, would demonstrate increased attention to dysphoric stimuli. Given the literature on depression-related attentional biases, it was predicted that this shift in attention would not appear in participants' initial orientation to dysphoric stimuli (an indicator of early-stage bias), but rather in a global assessment of their attention (an indicator of late-stage bias). No change was predicted in attention to positive or neutral stimuli for participants in the NAB condition.

   ii. Participants in the PAB condition, as compared to both the NAB and control conditions, would demonstrate increased attention to positive stimuli following the attention training. As no research has been done to investigate the relation between PAB and specific components of attention to positive stimuli, no prediction on how training would alter specific components was made. No change was expected in attention to negative or neutral stimuli for those participants in the PAB condition.

iii. No change in attentional patterns from pre- to post-attention training was expected for participants in the control condition.

II. *Effects on Subsequent Emotional Reactivity*. Completion of the attention training would alter patterns of emotional reactivity in response to the speech task.

i. Compared to the control group, participants completing the NAB training would show increased emotional reactivity in response to the speech task. Specifically, it was predicted that they would show increased subjective negative affect, heightened autonomic reactivity, and more frequent behavioral expressions of emotional responsivity during and immediately following the speech preparation period.

ii. Compared to the control group, participants completing the PAB training would show decreased emotional reactivity in response to the speech task. Specifically, it was predicted that they would show decreased subjective negative affect, reduced autonomic arousal, and less frequent behavioral expressions of emotional responsivity during and immediately following the speech preparation period.

III. *Effects on Other Cognitive Biases*. The attention training would affect subsequent performance on a task assessing for negative interpretation biases of ambiguous stimuli.

i. Compared to controls and participants in the PAB condition, participants in the NAB condition would demonstrate a more pronounced negative interpretation bias. Specifically, it was expected that they would spell significantly more homophones (e.g., die/dye) using the negative interpretation.

ii. Participants in the PAB condition were not predicted to demonstrate a negative interpretation bias. It was expected that they would spell significantly fewer homophones with the negative interpretation than either the participants in the NAB or control conditions.

IV. *The Role of Individual Differences in Emotional Responding*. Individual differences in psychological symptoms and habitual use of specific emotion regulation strategies would moderate the effects of the attention training on subsequent emotional reactivity.

i. Within all three study conditions, it was predicted that participants endorsing high levels of psychological symptoms (i.e., depression, anxiety, worry) would demonstrate greater stress reactivity in response to the speech task than participants endorsing low levels of such symptoms.

ii. It was expected that individual differences in the habitual use of ER strategies, including rumination, expressive suppression, cognitive reappraisal, and acceptance, would moderate the relation between attentional biases and emotional reactivity. However, as no previous research has been done to examine these relations, no specific predictions are made about the direction of the predicted effects.

Chapter 2: Method

The current study examined the effects of a training task on attention for positive, negative, and neutral images in a sample of undergraduates. The training consisted of three conditions: a NAB, a PAB, and a control condition. Altered attention was assessed by examining natural gaze patterns via eye tracking in a pre- and post-training design. In addition, the study examined the causal relation between attention training and subsequent stress reactivity, as measured by subjective, behavioral, and physiological indicators of emotion. Effects of the attention training were also assessed using an interpretation bias task. This task was included to explore the impact of attention training on other cognitive processes and to provide insight into how single-session training effects are maintained over time. Finally, the current study investigated the moderating role of psychological symptoms and specific ER strategies on outcome measures.

Participants.

Ninety-two ($N = 92$) participants were recruited for the current study. Eligible participants were required to be at least 18 years of age or to have parental consent to participate and to be currently enrolled as a student at the University of Miami. Participants were recruited using the Psych 110 research pool. Sessions were posted on the Psychology Department's online system (i.e., rEpr) and participants received four research credits for their participation.

Of the total sample recruited, three participants were excluded from analyses owing to lack of adherence to study procedures. Thus, presented results were obtained from a reduced sample of $N = 89$. Average age of participants was 19.90 ($SD = 2.34$)

years. The sample was 53% (*n* = 47) female and 47% (*n* = 42) male. With regard to participants' reported race/ethnicity, the sample was diverse, with 51% (*n* = 45) identifying as White/Caucasian, 18% (*n* = 16) identifying as Hispanic/Latino, 12% (*n* = 11) identifying as Black/African American, 9% (*n* = 8) identifying as Asian, 1% (*n* = 1) identifying as American Indian/Alaskan Native, and 9% (*n* = 8) identifying as "Other." In contrast, the large majority of the sample reported they were currently single (*n* = 86, 97%). Two participants (2%) endorsed being married, and one (1%) reported that they were currently separated. Finally, about half of the sample reported that they were freshman at the university (*n* = 47, 53%). Of the remaining participants, 21% (*n* = 19) were sophomores, 12% (*n* = 11) were juniors, 9% (*n* = 8) were seniors, and 5% (*n* = 4) reported being some other academic standing (e.g., in their fifth year).

In addition to demographic variables of interest, symptoms of depression and anxiety were assessed using the Beck Depression Inventory, Second Edition (BDI-II), Beck Anxiety Inventory (BAI), and Penn State Worry Questionnaire (PSWQ). On the BDI-II, participants reported a mean score of 8.75 (*SD* = 6.77), which falls within the minimal range and suggests that, on average, participants were not experiencing significant symptoms of depression at the time of participation. Similarly, participants reported mild symptoms of somatic anxiety on the BAI (*M* = 10.35, *SD* = 8.73) and minimal symptoms of worry on the PSWQ (*M* = 45.56, *SD* = 8.58). Again, results suggest that, on average, participants were not experiencing significant symptoms of anxiety at the time of participation.

Assessment of Attentional Biases.

IAPS Picture Processing Task. This task was used pre- and post-attention training to assess change in attention to positive and negative stimuli. During this task, participants viewed a series of 60 trials, each of which included an IAPS picture pair (dysphoric-neutral, positive-neutral, or neutral-neutral). Trials were presented in six blocks of ten, categorized by valence. Block order and image location was randomized to control for order effects. Each trial began with the presentation of a black fixation cross in the middle of the screen (500ms). After, a number from one to five took its place (500ms) and participants were instructed to say this number aloud. This was done to ensure that participants began each trial with eye gaze directed at the center of the screen. Trials ended with the presentation of a picture pair. The images remained on the screen for 6000ms, during which, participants were instructed to look at whatever they like, while keeping their eyes on the screen. A sample trial from this task can be seen in Figure 2.1.

The 60 image pairs (20 dysphoric-neutral, 20 positive-neutral, and 20 neutral-neutral) included in this task were selected from the International Affective Picture System (IAPS; NIMH Center for the Study of Emotion and Attention, 1999). IAPS images were displayed using E-Prime 2.0 Professional software on a 40-inch television screen located 60 inches away from the participant, on the opposite wall of a sound isolation enclosure. When displayed on the screen, each image (1024 x 768 pixels) measured 8.25 x 13.00 inches with their centers 17.50 inches apart. Images were chosen based on normed valence and arousal ratings (Lang, Bradley, & Cuthbert, 2005). The three categories of images differed significantly in their valence ratings, F (2, 116) =

1013.97, *p* = .001. Negative images (*M* = 2.44, *SD* = .43) were significantly less pleasurable than neutral images (*M* = 4.99, *SD* = .34), *t* (97) = 28.28, *p* < .001, and neutral images were significantly less pleasurable than positive images (*M* = 7.45, *SD* = .31), *t* (97) = 29.37, *p* < .001. The categories also differed significantly in their arousal ratings, *F* (2, 116) = 103.02, *p* = .00. Negative (*M* = 4.94, *SD* = .45) and positive (*M* = 4.87, *SD* = .69) images were significantly more arousing than the neutral images (*M* = 3.17, *SD* = .64), *t* (97) = 11.58, *p* < .001 and *t* (97) = 10.44, *p* < .001 for negative-neutral and positive-neutral comparisons, respectively, but not significantly different from each other, *t* (38) = .34, *p* = .74. In addition, image pairs were selected based on previous research using dysphoric, neutral, and positive IAPS images or image pairs (Caseras et al., 2007; Kellough et al., 2008; Urry, 2010). A complete list of images used in the study can be found in Table 1 of Appendix A.

Eye Tracking. To assess for altered attention as a function of the attention training task, bilateral eye movements were unobtrusively tracked using a Tobii X120 Eye Tracker and Tobii Studio Analysis Software (Tobii Technology, Danderyd, Sweden) pre- and post-training, during the IAPS picture processing task. Eye tracking data were recorded at a rate of 60 times per second (60 Hz). Data on initial orientation, number of fixations, and total gaze duration will be recorded for each of the prescribed areas-of-interest (i.e., each of the two images within a given trial).

Attention Training Task.

Participants were randomly assigned to one of three attention training conditions: NAB, PAB, or control. Across conditions, trainings consisted of 10 practice trials and 160 experiment trials. Participants were asked to begin each trial by fixating their gaze on a black cross presented in the middle of the screen (500ms). Then, two faces appeared simultaneously on either side of the screen (500ms). Following the presentation of the face stimuli, a probe (the letter “E” or the letter “F”) appeared on either the left or right side of the screen, in the spatial location of one of the two faces. Participants were instructed to identify which letter appeared by pressing a key on the computer keyboard if the “E” appeared and a different key if the letter “F” appeared. A sample trial from this task can be seen in Figure 2.2. Probe detection accuracy and response latencies were recorded.

Participants assigned to the NAB condition were presented with 128 (80%) dysphoric-neutral trials, in which one facial expression was sad and the other was neutral, and 32 (20%) neutral-neutral trials, in which both expressions were neutral. Similarly, participants assigned to the PAB condition were presented with 128 (80%) positive-neutral trials, containing one happy and one neutral expression, and 32 (20%) neutral-neutral trials. Image location (i.e., valenced image located on the left or right side of the screen) and probe type (E or F) were counterbalanced across trials. In both the NAB and the PAB conditions, the probe appeared behind the valenced image in each of the 128 dysphoric-neutral or positive-neutral trials. Thus, as participants completed the training it was expected that they would learn to shift their attention towards the valenced image. Previous research has found similar paradigms to effectively induce negative and positive attentional biases (Amir et al., 2009; Wadlinger & Isaacowitz, 2008).

In the control condition, participants were presented with 64 (40%) negative-neutral, 64 (40%) positive-neutral, and 32 (20%) neutral-neutral images. As with the NAB and PAB conditions, image location and probe type were counterbalanced.

Additionally, within the control condition, probe location was counterbalanced, such that the probe was equally as likely to appear behind the valenced or the neutral image. Participants in the control condition did not learn to shift attention towards either negative or positive stimuli and, thus, should not have developed an attentional bias.

Images used during the attention training were selected from the NimStim Face Stimulus Set (MacArthur Foundation Research Network on Early Experience and Brain Development), a battery of facial expression stimuli. Participants were presented with 10 expression pairs (i.e., neutral-neutral expressions from the same model) during the practice phase of the task and 16 expression pairs (i.e., sad-neutral, happy-neutral, or neutral-neutral expressions from the same model) during the training phase of the task. Valence (i.e., happy or sad) and the ratio of valenced to neutral photos varied depending on training condition. Face stimuli were selected to control for the gender and race of the model, as well as the model's mouth position (open mouth or closed mouth). In addition, the original NimStim Face Stimuli were edited so that only the facial features of each model were visible to the participant. A complete list of facial stimuli used in the training tasks can be found in Table 2 of Appendix A. Digital color photographs (213 x 273 pixels) were displayed using E-Prime 2.0 Professional software (Psychology Software Tools, Inc.; Sharpsburg, PA) on a 40-inch television screen located 60 inches from participants, on the opposite wall of a sound isolation enclosure. When displayed on the screen, each image measured 8.00 x 7.50 inches with their centers 18.50 inches apart.

Assessment of the Effects of the Attention Training Task.

Stressor Task. In order to examine the effects of the attention training on emotional reactivity, participants underwent a speech preparation task designed to elicit stress and anxiety. Participants were instructed by the experimenter that they would have to prepare and deliver a five-minute speech on the topic “Why am I a good friend.” They were told that they would have five minutes to prepare the speech and would be given paper and a pen to make notes. In order to increase the stressfulness of the task, participants were informed that the speech they gave would be video recorded and judged by three independent evaluators (one undergraduate student, one graduate student, and a member of the department faculty) based on factors such as clarity, cohesiveness, and persuasiveness. In addition, they were informed that their speech may be used by the university at some point in the future for training purposes. More specifically, the experimenter explained that the top 10% and the bottom 10% of speeches given, based on the independent evaluators’ ratings, would be used as examples of strong and weak public speaking skills. See Appendix B for a complete version of the script used for this portion of the protocol. Behavioral (i.e., corrugator and zygomatic electromyography) and physiological indicators (i.e., electrocardiography, respiration, and galvanic skin response) of affect and arousal were recorded using a BioNex 8 Slot Chassis (Model 50-3711-08) and BioLab Acquisition Software (Version 3.0.5; MindWare Technologies Ltd., Gahanna, OH).

Electrocardiography (ECG). ECG data were collected using two Adult Multipurpose Silver EKG/ECG electrodes (Model 93-0100-00; MindWare Technologies) attached to participants’ right collar bones and lower left rib. This electrode placement, referred to as the modified Lead II placement, is ideal in psychophysiological laboratory settings. Sensors are placed on areas of the body that are relatively free of fatty tissue and muscle, reducing movement and associated artifacts during data collection (Stern, Ray, & Quigley, 2001).

Respiration. Respiratory rate was measured using the girth method, in which a strain gauge (i.e., Respiration Belt with Pulse Lock [BioNex pl500]; Model 50-4504-00; MindWare Technologies) is wrapped around the chest and positioned over the clothing at the base of the sternum. The degree of strain placed on the belt clasp is, then, measured as participants inhale and exhale. The girth method is one of the most commonly used and cost-effective methods for measuring respiration within research settings, as it is non-invasive and easy to collect (Stern et al., 2001).

Galvanic Skin Response (GSR). GSR data were transduced using two disposable Ag/AgCl electrodes (Model 93-0102-00; MindWare Technologies) affixed to the thenar and hypothenar eminances of the non-dominant palm as is recommended by Dawson, Schell, and Filion (2007).

Electromyography (EMG). Facial EMG data were collected using four 4mm sensors filled with multipurpose electrolyte gel (Model 93-0600-00; MindWare Technologies). Corrugator EMG, a measure of facial expressive behavior associated with increased negative affect, was measured using two sensors attached in the bipolar configuration, just above participants' left eyebrows, resting on top of the corrugator supercilii muscle. Zygomatic EMG, a measure of facial expressive behavior associated with increased positive affect, was measured using the second set of sensors. These sensors were affixed, one centimeter apart, to the center of the cheek over the zygomaticus major muscle. Facial EMG sensor placement was guided by the recommendations of Fridlund and Cacioppo (1986).

EMG data is exceptionally prone to artifacts, thus, it is important that sensor attachment is done carefully (Stern et al., 2001). Prior to attaching the four EMG sensors, the experimenter prepared the skin by cleansing it with water and abrading the area to remove the high-impedance dead surface layer of skin. EMG impedence values were recorded before and after the experimental procedures. Only data with a mean impedence value of 50 or less were considered valid.

Interpretation Bias Task. Negative interpretation biases were assessed using a homophone task adapted from Mathews, Richards, and Eysenck (1989). In the original version of this task, participants were asked to write out a series of aurally presented words. The task consisted of 10 practice trials, 28 neutral trials, 14 threat-related trials, and 14 ambiguous trials. Ambiguous trials included homophones (e.g., dye/die) in which one spelling was neutral and the other was negative. In the current version of this task, the 14 threat-related trials and 14 of the neutral trials were removed to alleviate participant burden. In addition, six ambiguous trials were added after pilot testing revealed that for six of the original ambiguous trials one spelling was heavily favored over the other. The final set of word stimuli used in this task can be found in Table 3 of Appendix A.

To complete this task, participants were provided with a computer keyboard and asked to spell out a series of pre-recorded words presented over the speaker system within the sound isolation room. Participants completed 10 practice trials before completing the task, which consisted of 14 neutral and 20 ambiguous trials. For each trial, the word was presented and followed by an inter-stimulus interval of 500ms. Finally, participants were presented with a blank screen where they were asked to type the word they just heard before moving on to the next trial.

Self-Report Measures.

Demographics Questionnaire. Data were collected on participants' age, gender, racial/ethnic background, marital status, and college standing (i.e., freshman, sophomore, junior, senior, etc.).

Beck Depression Inventory, Second Edition (BDI-II; Beck, Steer, & Brown, 1996). The BDI-II is a 21-item measure of depression symptoms experienced within the past two weeks. Responses range from 0 (e.g., "*I do not feel sad*") to 3 (e.g., "*I'm so sad or unhappy that I can't stand it*"). When administered to undergraduates, the BDI-II has demonstrated high levels of internal consistency (α = .91; Dozois, Dobson, & Ahnberg, 1998) and test-retest reliability (*r* = .91; Sprinkle et al., 2002). In addition, Dozois et al. (1998) found that the following cutoff scores accurately classified 91% of participants: 0-12, non-depressed; 13-19, dysphoric; 20-63 dysphoric or depressed.

Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988). The BAI is a 21-item measure of state anxiety and was originally developed in order to differentiate between depression and anxiety symptoms. Participants are asked to report how much they have been bothered by each symptom (e.g., "*Unable to relax*" or "*Difficulty breathing*") in the past two weeks. Responses are made using a four-point Likert scale with anchors *Not at all* to *Severely – I could barely stand it*. Higher scores on the BAI indicate more severe anxiety symptoms. Psychometric analyses within a sample of non-clinical undergraduates indicate that the BAI has strong internal consistency (α = .91) and moderate test-retest reliability over a seven week period (*r* = .62). It has been found to be moderately correlated with other measures of state anxiety (i.e., STAI-S; *r* = .56; Creamer, Foran, Bell, 1995).

Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990). This is a 16-item measure of trait-level worry (e.g., "*Once I start worrying, I can't stop*"). Participants are asked to rate how typical or characteristic each item is for them using a Likert scale with anchors 1 (*Not typical at all*) to 5 (*Very typical*). Among college students the PSWQ has demonstrated high internal consistency (α = .94) and test-retest reliability (*r* = .69), and is found to be moderately correlated with other measures of trait anxiety, such as the STAI-T (*r* = .64; Meyer et al., 1990).

Ruminative Responses Scale (RRS; Treynor, Gonzalez, & Nolen-Hoeksema, 2003). This 22-item questionnaire assesses use of rumination in response to dysphoric mood. Specifically, the RRS examines responses that are focused on the self, on symptoms, or on possible consequences and causes of moods using a 4-point scale (*Almost never* to *Almost always*). Factor analysis has identified two subscales within the measure, brooding (e.g., "*I think 'what am I doing to deserve this'*") and reflection (e.g., "*Analyze recent events to try to understand why you are depressed*"). Internal consistency (α = .79 and α = .72) and test-retest reliability (*r* = .62 and *r* = .60) were previously determined within a community sample for the brooding and reflection subscales, respectively (Treynor et al., 2003).

Emotion Regulation Questionnaire (ERQ; Gross & John, 2003). The ERQ is a 10-item measure of trait-level use of ER strategies in response to both positive and negative emotions. The measure has two subscales, expressive suppression (e.g., "*When I'm feeling negative emotions I make sure not to express them*") and cognitive reappraisal ("*When I want to feel less negative emotion, I change the way I'm thinking about the situation*"). Items have anchors 1 (*Strongly disagree*) to 7 (*Strongly agree*). The measure has been shown to be a valid and reliable measure of these strategies with good internal consistency (α = .77), test-retest reliability (r = .69), and convergent and divergent validity (Gross & John, 2003).

Acceptance and Action Questionnaire, Second Edition (AAQ-II; Bond et al., in press). The AAQ-II is a 10-item measure of trait-level emotional acceptance, psychological flexibility, and experiential avoidance. Items (e.g., "*It's OK if I remember something unpleasant*") are rated on a scale of 1 (*never true*) to 7 (*always true*). Preliminary results indicate that the measure has high internal consistency (α = .88), test-retest correlations of .81 at three months and .79 at twelve months, and appropriate convergent and divergent validity (Bond et al., in press).

Positive Affect Negative Affect Scales (PANAS; Watson, Clark, and Tellegen, 1988). The PANAS consists of two, 10-item, mood scales, positive (e.g., "*enthusiastic"*) and negative (e.g., "*upset"*) affect. Participants are asked to rate each emotion on a scale of 1 (*Not at all*) to 5 (*Extremely*) based on how much they are experiencing that emotion "right now, in this moment." The psychometric properties of these scales have been assessed in a sample of undergraduate students. Results indicate that the measure is internally consistent (α's ranging from .86 - .90), has strong convergent and divergent validity, and is reliable across time (Watson et al., 1988).

Debriefing Questionnaire. This is a rationally-derived questionnaire containing five items (see Appendix B). Participants were asked to rate on a scale of 1 (*Not at all*) to 7 (*Extremely*) how interesting and boring they found participating in the study to be, as well as how tired and attentive they felt during the study procedures. In addition, participants were asked to rate how stressful they found the speech task and were provided space to include their own comments regarding their experiences participating in the study. This questionnaire was used as a manipulation check and to identify potential outliers.

Procedure.

An overview of the study procedures can be found in Figure 2.3. Upon arrival in the laboratory, informed consent was obtained from all participants by the author or an undergraduate RA, who served as the experimenter. Participants were, then, brought into a sound isolation enclosure within the lab (Model 7296, WhisperRoom Inc., Morristown, TN). The interior of the enclosure measured 5’10” (width) x 7’10” (length) x 6’11” (height). At one end was a desk chair where participants were seated. This chair was positioned 60 inches from a 40 inch Samsung 1080p high definition television screen mounted on the opposite wall. Additionally, located within the sound isolation enclosure were the Tobii eye tracker, two floor lamps with 45 watt halogen bulbs, and a 2 x 4 foot lighting screen placed on the floor in front of the television.

Study procedures began with the completion of the questionnaire battery. The experimenter asked participants to read the instructions for each questionnaire carefully before answering the items. After presenting participants with the instructions, the experimenter left the sound isolation enclosure. Questionnaires were presented on the television screen and participants completed them using a computer keyboard and mouse.

Next, the experimenter prepared participants for the psychophysiological data recording. Once all psychophysiological sensors had been attached, a five-minute nature video on Mt. Olympus was played for participants, while baseline levels of physiological reactivity (i.e., ECG, GSR, respiration, and EMG) were recorded. At the completion of the nature video, participants were instructed to complete Mood Scale 1 (i.e., the PANAS), which was located beside participants, on a clipboard.

Participants, then, completed the pre-training IAPS picture processing task. For each of the trials in this task, participants' eye movements were recorded. In addition, physiological data were collected throughout the duration of the task. Following its completion, participants were instructed to fill out Mood Scale 2. Next, participants completed one of the three attention training conditions. For all conditions, physiological, but not eye tracking, data were collected. Upon completion of the training, participants were instructed to complete Mood Scale 3. Following the attention training, participants completed the post-training IAPS picture processing task to assess change in attention to positive and negative stimuli. The procedure for this portion of the protocol was identical to that of the pre-training assessment. At its conclusion, participants were asked to fill out Mood Scale 4.

Instructions for the speech task were, then, provided to participants. After checking to ensure there were no questions about the instructions, participants were given five minutes to prepare for the speech. Psychophysiological reactivity was recorded during the administration of the instructions, as well as during the preparation period. At the end of the five minutes, participants were asked to complete Mood Scale 5. When they completed this mood rating, the experimenter returned to the sound isolation enclosure and explained to participants that “only about half of the people enrolled in the study” would actually have to give the speech. Whether or not a participant had to give a speech was “determined” by the flip of a coin. The experimenter then flipped a quarter (which, unbeknownst to participants was double-sided) and “determined” that the participant would not have to give the speech. Finally, participants were asked to complete the homophone task to assess for the presence of a negative interpretation bias.

Participants finished their study session by completing a debriefing with the experimenter. This involved filling out the debriefing questionnaire and participating in an open-ended conversation with the experimenter about their opinions of the study. Both of these procedures were done to determine whether or not the participant was aware of any manipulations that took place during the study (e.g., which training condition they were in or that deception was used during the speech task). After this conversation, participants were provided with information regarding the purpose of the study, as well as why deception was necessary to test study hypotheses.

Chapter 3: Data Analytic Plan and Data Preparation

Data Analytic Plan.

A prior power analyses were conducted to determine the appropriate sample size for the proposed project. Results of these analyses indicated that a sample of 90 participants would yield an 80% chance of detecting effects of small magnitude (i.e., *d* = .30) or greater when alpha was set to .05. A sample of 90, or 30 per attention training cell, is consistent with previous research (e.g., MacLeod et al., 2002). Moreover, previous research has produced effects of moderate magnitude (e.g., *d* = .62; Wadlinger & Isaacowitz, 2008). Thus, it is expected that *N* = 90 will be sufficiently large to detect the hypothesized effects of the current proposal.

To statistically examine each of the study hypotheses, the following data analyses were proposed:

I. *Effects on Attention.* It was expected that the completion of the attention training would alter subsequent attentional patterns such that participants in the NAB condition, as compared to those in the PAB or control conditions, would demonstrate increased attention towards dysphoric stimuli, while those in the PAB condition, compared to NAB and control conditions, would demonstrate increased attention towards positive stimuli. To test this, I examined the change in three indices of attentional deployment (i.e., initial orientation, fixation count, and total gaze duration) as a function of condition (NAB, PAB, or control) and time (pre- and post-attention training) using 3 x 2 mixed-factorial ANOVAs. Analyses in support of the study hypotheses would yield no main effects for either condition or time, but a significant condition x time interaction.

II. *Effects on Subsequent Emotional Reactivity.* Similarly, it was expected that the completion of the attention training would alter subsequent emotional reactivity in response to the laboratory stressor. Specifically, it was predicted that participants in the NAB condition would demonstrate increased subjective negative affect and physiological reactivity, and that participants in the PAB condition would show decreased subjective negative affect and physiological reactivity, in response to the speech preparation task as compared to the control condition. To test the predictions regarding subjective emotional responding, 3 x 3 mixed-factorial ANOVAs will be conducted, with condition as the between-subjects factor and time (mood ratings at baseline, attention training, and post-speech task) as the within-subjects factor. It was expected that results would yield a significant main effect of time, but not of condition. Further, a significant condition x time interaction was also expected. Likewise, changes in physiological reactivity will be examined using a series of 3 x 3 mixed-factorial ANOVAs with condition as the between-subjects variable and time (mean reactivity during baseline, attention training, and speech preparation time periods) as the within-subjects variable. Dependent variables for this set of analyses included mean heart rate, respiratory sinus arrhythmia (RSA), galvanic skin response, corrugator, and zygomatic responding during each of the time periods of interest. As with the analyses on subjective emotional responding, a significant main effect of time, but not of condition, was expected, as was a significant condition x time interaction.

III. *Effects on Other Cognitive Biases.* It was predicted that completion of the attention training will affect subsequent interpretation of ambiguous stimuli (i.e., induce an interpretation bias), such that those participants receiving the NAB training, compared to those in the PAB or control conditions, would interpret a greater number of ambiguous words negatively. This was examined by conducting a one-way ANOVA looking at group differences in the proportion of ambiguous words interpreted negatively versus neutrally.

IV. *The Role of Individual Differences.* Lastly, it was hypothesized that individual differences in psychological symptoms and use of ER strategies would moderate the effects of the attention training on emotional reactivity. These hypotheses were tested by examining differences in emotional reactivity variables (e.g., subjective mood ratings) as a function self-reported psychological symptoms of depression, anxiety, and worry, as well as the self-reported frequency of use of rumination, expressive suppression, cognitive reappraisal, and emotional acceptance. Here, linear regression analyses were employed to examine within-condition effects of individual difference variables on emotional reactivity during the stressor task.

Data Preparation.

Identification of Outliers. Prior to conducting data analyses, it was determined that participants with less than 85% accuracy on the training task should be excluded from analyses, as they may not have utilized the task effectively. However, examination of the data determined that no participants fell below this 85% cutoff and only two participants fell below 90% accuracy (accuracy for each of these two data points was 89%). Further, it was determined that participants with mean reaction times (RTs) greater than 1,500ms should be excluded from analyses. Again, the data revealed that all participants demonstrated mean RTs less than 1500ms. Overall, it appeared that participants were quickly and accurately able to complete the training task.

In addition, eye tracking data were examined for outliers. Participants' data were included in analyses if at least 70% of the data were considered valid (per recommendation of A. Sanchez, personal communication, May 21, 2012). Of the 89 study completers, valid data were collected for *n* = 73 participants during the pre-training assessment of attention. For the subset of participants included in eye tracking analyses, the average percentage of data collected during the pre-training assessment was 88.12 (*SD* = 6.87). At the post-training assessment of attention, valid data were collected for *n* = 62 participants. Average percentage of data collected at the post-training assessment was 86.31 (*SD* = 7.01). The decrease in valid data collected during the post-training assessment of attention was likely the result of participant fatigue. At debriefing, *n* = 36 (40.4%) endorsed having difficulty paying attention to either the training or post-training picture processing task. Further, when asked how tired they felt at the end of the experiment, participants' mean response was a 4.79 (*SD* = 1.35), which equated to an average response that was greater than *Moderately*. Importantly, fatigue, as measured by the two abovementioned items from the debriefing questionnaire did not appear to differ as a function of condition assignment (*p*'s > .10).

Finally, four participants were identified as outliers on the homophone task. None of these participants spoke English as their first language and each demonstrated notable difficulty with spelling. The average number of valid trials for these participants was 11.00 (*SD* = .82). In contrast, the average number of valid trials among the participants included in analyses was 18.94 (*SD* = 1.10). Thus, homophone task data collected from these participants were excluded from analyses.

Calculation of Eye Tracking Indices. Data on three indices of attention were collected using the Tobii eye tracker. *Initial orientation* (IO), which assesses the preference to initially attend to one image over another, was calculated by examining the time to first fixation for both the valenced and neutral images presented in a given trial. As with previous research on attentional biases, bias scores were calculated by tallying the number of trials in which the participant first oriented to the emotional image and dividing this by the total number of valid trials (e.g., Armstrong et al., 2010). Bias scores were calculated separately for negative-neutral and positive-neutral trials with a score of .50 (i.e., 50%) indicating no bias, a score of greater than .50 indicating bias *towards* emotional images, and a score less than .50 indicating bias *away* from emotional images.

Each of the other two indices was calculated as indicators of attentional maintenance. *Fixation count* (FC) was assessed by examining the number of times a participant fixated on each of the images in a given trial. *Total visit duration* (TVD) assessed the length of time a participant spent examining each image over the course of a trial. Bias scores for each of these indices were calculated by finding the mean for emotional images and subtracting from this value the mean for neutral images (Armstrong et al., 2010; Rinck & Becker, 2006). As with initial orientation, separate scores were calculated for negative-neutral and positive-neutral trials. With the indices of attentional maintenance, a score of zero represented no bias, a positive value (i.e., greater than zero) indicated bias *towards* emotional images, and a negative value (i.e., less than zero) indicated bias *away* from emotional images.

Calculation of Psychophysiological Indices. All measures of psychophysiological indices were cleaned and analyzed using the data analysis software produced by MindWare Technologies Ltd. (Version 3.0.15, Gahanna, OH). Prior to analysis, data files were examined to ensure valid data were captured for each index of psychophysiological responding. Valid heart rate variability (HRV) data, which included mean HR, mean respiration rate, and RSA, were collected from 89 participants. Valid GSR data were collected from 80 participants and, finally, valid EMG data were collected from 72 participants. Invalid data collection was primarily the result of equipment or sensor malfunction. In addition, some EMG data were lost due to the inability to reduce impedence values below the 50.00 threshold. After the experimenter had reapplied EMG sensors three times without success they moved forward with study procedures in order to prevent excessive physical or psychological burden to the participant. Results of χ^2 analyses, revealed no significant differences in psychophysiological data lost as a function of study condition (all p's > .10).

Once valid data files were identified, they were then cleaned by observing the corresponding video files for any movement that had the potential to create artifacts (e.g., talking, stretching, or rubbing eyes). Data segments in which movement did, indeed, create an artifact were then removed prior to scoring and analyzing the file. HRV data were cleaned and analyzed in 30 second segments. Segment values were then averaged to examine participants' level of arousal during the baseline, attention training, and stressor task conditions. GSR was analyzed by examining the number of skin conductance responses (SCRs) that occurred within each of the three periods of interest (i.e., baseline, attention training, and stressor periods). Finally, the two EMG indices of facial expression (i.e., corrugator and zygomatic) were analyzed by calculating the mean level of reactivity across each of the time periods.

Calculation of Interpretation Bias Scores. Biased interpretation of the word-pairs used in the homophone task was calculated by dividing the number of trials in which the participant provided a negative spelling divided by the total number of valid trials. Thus, a proportion was created such that .50 (50%) reflected no bias, greater than .50 reflected a bias towards the negative interpretation, and less than .50 reflected a bias away from the negative interpretation.

Chapter 4: Results

Group Characteristics.

Descriptive statistics on demographic variables, as well as on symptoms of depression and anxiety are presented by condition in Table 4.1. Study conditions did not differ as a function of age, F (2, 82) = .05, p > .10, gender, χ^2 (2, N = 89) = 1.38, p > .10, race/ethnicity χ^2 (10, N = 89) = 13.42, p > .10, marital status χ^2 (4, N = 89) = 6.64, p > .10, or year in college χ^2 (8, N = 89) = 3.73, p > .10. Further, study conditions did not differ in depression symptoms, F (2, 84) = .10, p > .10, somatic anxiety, F (2, 84) = .42, p > .10, or worry F (2, 78) = .86, p > .10.

Attention Training Task.

Performance on the attention training task was examined by looking at mean accuracy and reaction times, as well as learning, which was calculated by examining the difference in mean reaction time from the first and second halves of the training. It was expected that participants in the NAB and PAB training conditions would show increased learning, represented by a positive difference score, as they began to shift their attention towards the valenced-stimulus. Descriptive statistics for the sample as a whole, as well as per condition are presented in Table 4.2. One-way ANOVAs were conducted to examine between-group differences on each of the three abovementioned training variables. Overall accuracy was found to significantly differ across groups, F (2, 86) = 3.65, p < .05. Post-hoc analyses indicated that participants assigned to the PAB condition (M = .96, SD = .03) were significantly less accurate than control participants (M = .98, SD = .02), t (57) = 2.62, p < .05, and marginally less accurate than participants in the NAB condition (M = .97, SD = .03), t (55) = 1.85, p = .07. Accuracy among participants in the NAB and control conditions did not differ significantly ($p > .10$). Results also demonstrated a marginally significant difference in reaction time performance, F (2, 86) = 2.40, $p = .097$. Participants in the NAB condition (M = 797.74, SD = 78.92) were slower to respond to trials than participants in the control condition (M = 753.24, SD = 71.08), t (60) = 2.34, $p < .05$, none of the post-hoc comparisons approached significance. Interestingly, groups did not differ with regard to learning, F (2, 86) = .84, $p > .10$. Across conditions, participants showed a slowing in reaction time, as indicated by the negative difference scores.

Effects on Attention.

To examine the hypothesis that the attention training would alter attention for positive and negative images presented during the pre-post IAPS paradigm, mixed-factor ANOVAs were conducted for each of the eye tracking indices using condition (NAB, PAB, or control) as a between-subjects factor and time (pre-training and post-training) as a within-subjects factor. Descriptive statistics on pre- and post-training eye tracking indices as a function of condition are presented in Table 4.3.

As expected, no significant effects emerged in participants' initial orientation for negative images (all p's > .05). Examination of participants' initial orientation for positive images yielded a main effect of time, F (1, 54) = 4.42, $p < .05$. Across study conditions, participants demonstrated greater proclivity to orient to positive images at pre-training (M = .60, SD = .01) than they did at post-training (M = .57, SD = .02). However, no main effect of condition, F (2, 54) = .12, $p = .88$, nor a time by condition interaction effect, F (2, 54) = .62, $p = .54$, were found for participants' initial orientation to positive images.

A main effect of time was also found for participants' fixation count for negative images, F (1, 55) = 4.54, p < .05. Again, regardless of study condition, participants fixated less on negative images at post-training (M = 1.70, SD = .20), as compared to pre-training (M = 1.16, SD = .22). There was no main effect of condition on fixation count for negative images, F (2, 55) = 1.28, p = .29, and contrary to predictions, there was no interaction between condition and time, F (2, 55) = .75, p = .48. Further, the examination of fixation count for positive images yielded no main effects or interactions (all p's > .05).

Finally, analyses examining participants' total visit duration determined that participants spent more time examining negative images at pre-training (M = .68, SD = .08), than they did at post-training (M = .35, SD = .10), F (1, 55) = 10.85, p < .01. Participants did not differ in time spent examining negative images as a function of study condition, F (2, 55) = .34, p = .71, and no evidence for the predicted time by condition interaction was found for total visit duration for negative images, F (2, 55) = 1.85, p = .17. No significant effects were produced by the ANVOA examining participants' total visit duration for positive images (all p's > .05).

Effects on Subsequent Emotional Reactivity.

Effects of attention training condition on subsequent emotional reactivity were first assessed by looking at changes in self-reported positive and negative affect. Two 3 x 3 mixed-factorial ANOVAs were conducted with training condition as a between-subjects factor and time (i.e., affect following the baseline, attention training task, and stressor periods) as a within-subjects factor. Results revealed a main effect of time on negative affect, F (2, 168) = 43.62, p < .001. Post-hoc comparisons revealed that a significant increase in negative affect was seen from baseline (*M* = 11.51, *SD* = 2.41) to the training task (*M* = 12.36, *SD* = 3.08), *t* (86) = 2.55, $p < .05$. Similarly, a significant increase in negative affect was seen from training task to the stressor task (*M* = 15.70, *SD* = 5.21), *t* (87) = 6.37, $p < .001$, indicating that the stressor was effective in eliciting the desired response from participants. However, the predicted time by condition interaction for self-reported negative affect was not significant, *F* (4, 168) = 1.49, *p* = .21. A main effect for time was also found for participants' reported positive affect, *F* (2, 172) = 27.98, $p < .001$. Here, post-hoc comparisons revealed that, across conditions, participants reported more positive affect at baseline (*M* = 19.43, *SD* = 6.88) than after completion of the attention training (*M* = 15.27, *SD* = 5.72), *t* (88) = 6.63, $p < .001$. Interestingly, participants endorsed the highest levels of positive affect following the stressor (*M* = 21.62, *SD* = 8.50), which was significantly higher than affect reported following both the baseline period, *t* (88) = 2.37, $p < .05$, and the attention training, *t* (88) = 6.60, $p < .001$. Contrary to hypotheses, the time by condition interaction for positive affect was not significant, *F* (4, 170) = .70, *p* = .59.

The effects of the attention training were also examined by looking at participants' psychophysiological responding. A summary of these results can be found in Table 4.4. Main effects of time were found for HR, RSA, respiration, and GSR. Participants' HR was found to significantly increase from baseline (*M* = 72.95, *SD* = 11.60) to training (*M* = 75.16, *SD* = 11.48), *t* (88) = 5.98, $p < .001$, and from training to the stressor task (*M* = 81.32, *SD* = 12.22), *t* (88) = 11.28, $p < .001$. RSA was found to decrease from baseline (*M* = 6.32, *SD* = 1.10) to training (*M* = 6.06, *SD* = 1.02), *t* (84) = 4.41, $p < .001$, but to increase again from training to stressor (*M* = 6.61, *SD* = 1.30), *t* (84)

= 5.90, $p < .001$. Participants' rate of respiration increased significantly from baseline ($M = 15.06$, $SD = 3.09$) to training ($M = 16.16$, $SD = 2.60$), $t(88) = 3.34$, $p < .01$, but decreased from training to stressor task ($M = 13.43$, $SD = 5.58$), $t(87) = 4.93$, $p < .001$. Lastly, participants' GSR mirrored their HR reactivity, increasing significantly from baseline (M = 12.08, SD = 14.63) to training (M = 25.23, SD = 19.61), $t(79) = 9.41$, $p < .001$, and from training to stressor (M = 34.79, SD = 16.01), $t(79) = 5.15$, $p < .001$. Taken together, results suggest that, as expected, participants showed increased autonomic arousal during the attention training, as compared to the baseline period. Further, they showed the greatest levels of physiological reactivity during the stressor, indicating that it was effective in eliciting a stress response. Unfortunately, none of the predicted time by condition interaction effects was found to be significant (all *p*'s > .10). Further, no significant effects were found for either participants' corrugator or their zygomatic responding (again, all *p*'s > .10).

Effects on Other Cognitive Biases.

To test the hypothesis that the completion of the attention training task would alter other cognitive biases, performance on the homophone task was examined as a function of study condition. First, a one-way ANOVA was conducted examining interpretation biases using the 14 homophones included in the original version of the task (Mathews et al., 1989). Results revealed significant group differences, $F(2, 83) = 5.68$, $p < .01$. Contrary to study hypotheses, participants assigned to the NAB condition ($M = .71$, $SD = .11$) did not differ from control participants ($M = .72$, $SD = .10$) in their interpretation of the homophones, $t(58) = .29$, $p = .77$. However, participants in assigned to the PAB condition ($M = .81$, $SD = .09$) demonstrated significantly greater biases than participants in either the NAB, *t* (50) = .53, *p* < .01, or the control conditions, *t* (54) = 3.00, *p* < .01.

Next, given that pilot testing had revealed that, for six of the original homophone pairs, one spelling was heavily favored over the other, the frequency distribution of each homophone pair was examined and trials with in which one spelling was selected by less than 5% of participants were removed from analyses. This resulted in the removal of five of the original homophones, including guilt/gilt (gilt selected 1.1% of the time), tease/teas (teas selected 2.2% of the time), liar/lyre (lyre selected 3.4% of the time), skull/scull (scull selected 1.1% of the time), and moan/mown (mown selected 2.2% of time). In addition, one of the newly added homophone pairs was removed from analyses (i.e., bawl/ball; bawl selected 0% of the time). Examination of interpretation biases using the remaining 14 homophone pairs using a one-way ANOVA revealed a non-significant trend, *F* (2, 83) = 2.55, *p* = .08. Participants in the NAB condition (*M* = .51, *SD* = .16) did not differ from controls (*M* = .54, *SD* = .13) in their interpretation of the homophones, *t* (58) = .65, *p* = .52. Yet, participants in the PAB condition (*M* = .60, *SD* = .16) continued to show a bias in interpretation that was significantly greater than participants in the NAB condition, *t* (50) = 2.12, *p* < .05, and a bias that was marginally greater than participants in the control condition, *t* (54) = 1.74, *p* = .09.

Exploratory Effects of Relevant Demographic and Psychological Factors.

To explore the potential moderating role of psychological symptoms and habitual use of emotion regulation strategies a series of linear regressions were conducted. The training condition variable was dummy coded such that the control condition was set as the referent group. Moderating variables were then centered. Dummy coded variables were entered into a linear regression, along with the moderating variable of interest, and an interaction term (dummy code x moderator). These were then used to predict subjective affect in response to the speech preparation stressor task. Separate regression analyses were conducted to explore the effects of condition assignment (NAB versus Control/PAB and PAB versus Control/NAB) for each of the moderating variables of interest.

Psychological Symptoms. The BDI-II, BAI, and PSWQ were each examined as potential moderators in the relation between attention training and stress reactivity. Results of relevant regression analyses are presented in Table 4.5. No evidence of moderation was found for either the BDI-II or the BAI (*p*'s > .05). Further, while the PSWQ was found to significantly predict increased negative affect in response to the stressor (β = .30, *t* [80] = 2.40, *p* = .02), the model including PSWQ and Condition (PAB versus Control/NAB) was only marginally significant, *F* (3, 80) = 2.72, *p* = .09, and the main effect of worry did not interact with the effect of training condition (β = -.04, *t* [80] = .29, *p* = .77).

Emotion Regulation Strategies. In addition to psychological symptoms, the moderating effects of habitual use of certain emotion regulation strategies were examined. Specifically, measures of emotional acceptance (AAQ-II), cognitive reappraisal (ERQ-R), expressive suppression (ERQ-S) and rumination (RSQ) were explored as potential moderators. Results of relevant regression analyses are presented in Table 4.6. No evidence for moderation was found for the AAQ-II or the ERQ-R (*p*'s > .05). A significant association was found among expressive suppression and positive affect, such that participants endorsing habitual use this strategy demonstrated greater levels of positive affect following the stressor (β = -.30, *t* [83] = 2.14, *p* = .04). Yet, again, the model including ERQ-S and Condition (NAB versus Control/PAB) was non-significant, *F* (3, 80) = 1.73, *p* = .17, and the effect of expressive suppression did not significantly interact with condition to predict positive affect (β = -.24, *t* [83] = 1.73, *p* = .09). Finally, though the model examining rumination and the PAB training condition did not significantly predict positive affect, *F* (3, 78) = 1.38, *p* = .26, the interaction term was found to be marginally significant (β = -.22, *t* [78] = 1.72, *p* = .09.

Chapter 5: Discussion

The current investigation looked to examine the effects of two attention training tasks on subsequent attentional deployment, emotional reactivity (i.e., subjective, behavioral, and psychophysiological) in response to a stressor, and interpretation biases. Specifically, the study utilized a dot-probe attention training paradigm to shift attention towards negative (NAB condition) or towards positive (PAB condition) stimuli. Training conditions were, then, compared to a no-training control condition. It was hypothesized that, in comparison to the control and PAB conditions, the NAB condition would increase attention for negative stimuli at post-training, contribute to greater emotional reactivity in response to the stressor, and cause a more pronounced negative interpretation bias within the homophone task. In contrast, it was hypothesized that, in comparison to the control and NAB conditions, the PAB condition would result in greater attention for positive stimuli at post-training, decreased emotional reactivity in response to the stressor, and a less pronounced negative interpretation bias within the homophone task.

As a secondary aim, this study explored the ways in which individual differences in psychological symptoms (i.e., depression, somatic anxiety, and worry) and the habitual use of specific ER strategies (i.e., emotional acceptance, cognitive reappraisal, expressive suppression, and rumination) moderated the effects of training condition on emotional responding. It was predicted that the presence of psychological symptoms would exacerbate the effects of the NAB condition, and attenuate the effects of the PAB condition, on participants' subjective emotional reactivity. Finally, as little research has been done to examine the ways in which habitual reliance on certain ER strategies moderates the relation between attention training and emotional responding, it was expected that the four strategies included in the study would moderate the relation between training condition and emotional reactivity, though the direction of these moderation effects was not specified.

Summary of Findings.

Results did not support the first hypothesis that the NAB and PAB training conditions would alter attention from pre- to post-training. Though attention for positive and negative images was found to change as a function of time, no significant time by condition interactions were found for any of the three indices of attentional bias.

Across study conditions, participants' bias to initially orient to positive stimuli decreased from pre- to post-training. Similarly, participants' bias to fixate on negative images, as well as their bias to spend time examining negative images decreased from pre- to post-training. Such main effects are, perhaps, best explained by participants' decreased attentional engagement with stimuli from pre- to post-training. Decreased engagement may have resulted from practice effects, as the same IAPS images were used in both picture processing tasks, or because participants were more fatigued at the post-training assessment. Indeed, there was much evidence to support this second explanation. Many more participants' eye tracking data were considered invalid at post-assessment (i.e., Picture Processing I, $n = 73$; Picture Processing II, $n = 62$). This means that following the attention training, approximately one-third of participants spent more than 25% of the picture processing task doing something (e.g., closing their eyes, looking away from the stimulus presentation screen) that prevented valid data collection. Furthermore, at debriefing, over 40% of participants reported difficulty attending to either the attention training or second picture processing task and average level of fatigue reported was almost a 5 (*M* = 4.79, *SD* = 1.35) on a 7-point scale. Results indicate that participants were not fully engaged during the post-training assessment of attention, which is important, as general disengagement with study procedures may provide insight into why the attention training did not produce effects on post-training attentional biases.

Along these same lines, results did not support the hypothesis that the completion of the NAB or PAB training tasks would alter emotional reactivity in response to the stressor. Time by condition interactions for positive and negative subjective emotional responding were non-significant, as were the time by condition interactions for the two behavioral indicators of emotion (i.e., corrugator and zygomatic facial EMG) and the four indicators of psychophysiological reactivity (i.e., HR, RSA, respiration, and GSR). Despite the fact that neither the NAB or PAB training conditions appeared to impact participants' emotional response to the stressor, emotional reactivity was found to differ as a function of time.

Specifically, subjective negative affect was highest immediately following the speech preparation task, as was mean HR and skin conductance reactivity. This indicates that the speech preparation task was effective in eliciting the desired stress response. Interestingly, subjective positive affect decreased from baseline to attention training, but increased to its highest level immediately following the speech preparation task. The high level of subjective positive affect following the stressor was most likely due to the topic of the speech participants were asked to prepare ("Why am I a good friend?"). Perhaps, an unintended consequence of using this speech topic within a sample of unselected undergraduate students was that asking participants to actively think about their good qualities served as a positive mood induction. However, previous research using both depressed and non-psychiatric community participants has used similar procedures to effectively induce negative affect, without increasing positive affect (Sánchez, 2012; Waugh, Panage, Mendes, & Gotlib, 2010). Thus, it may be useful for future studies to further explore the impact of this task across different clinical and non-clinical populations, as well as with different speech topics that have less chance of increasing positive affect (e.g., global warming or the death penalty). Still, despite the unexpected nature of these findings, the increase in positive affect as a result of the speech preparation task need not be considered a methodological limitation, particularly because reported positive affect had been predicted to vary as a function of condition.

Interpretation of the main effect of RSA proved a bit more complicated. While RSA was found to significantly decrease from the baseline to the attention training period, it returned to baseline levels during the stressor. As decreased RSA is typically associated with difficulty regulating emotional responding (Rottenberg, Wilhelm, Gross, & Gotlib, 2002), we may conclude that this measure did not yield evidence for affective difficulties during the speech task. However, research also indicates that RSA is more strongly implicated in recovery from, rather than reactivity to, negative affect (Waugh et al., 2010). Given that this study did not monitor recovery following the stressor, RSA results may not fully reflect participants' reactivity to the speech preparation task. Lastly, it should be noted that neither measure of facial EMG produced significant effects. Two potential explanations for the lack of significant EMG findings are offered. The first is that neither the training task nor the speech preparation task was arousing enough to produce notable changes in facial expressivity from baseline. This was evidenced by the anecdotal observations of experimenters that relatively few overt facial expressions (positive or negative) were observed during the study procedures. The second explanation is that analyses involving EMG data were underpowered. Of all of the indicators of emotional responding, the two EMG variables had the least number of valid cases ($n = 72$). Given that effects, if present, were likely small, they may have gone undetected. A more thorough discussion of power issues is included in the *General Discussion* section below.

Examination of negative interpretation biases assessed using the homophone task revealed significant between-group differences, but not in the hypothesized direction. Though it was predicted that participants undergoing the NAB training would demonstrate the most pronounced negative interpretation bias, persons assigned to this condition did not differ from controls in the percentage of ambiguous words they interpreted negatively. Instead, participants undergoing the PAB training, who had been hypothesized to demonstrate the least pronounced negative interpretation bias, actually showed the most prominent bias. When using the original version of the task, participants in the PAB condition interpreted significantly more words negatively than either the NAB or control conditions. Further, individuals assigned to the PAB condition continued to interpret significantly more words negatively than the NAB condition and marginally more words negatively than the control group even after problematic homophones were removed from the analyses.

It is unclear why the PAB training produced a negative interpretation bias, but findings may be in line with Fredrickson's (1998) broaden-and-build theory of positive emotion. This theory posits that positive emotions serve to simultaneously *broaden* an individual's thought-action repertoire (conceptualized as the range of cognitive and behavioral reactions one may have in response to the experience of a positive emotion) and *build* their personal resources. In support of this theory, research on cognition and positive emotion has found that positive emotions are associated with increased cognitive flexibility, more extensive cognitive elaboration/associations, and a more global attentional scope that, unlike the narrow attentional scope associated with negative emotion, extends beyond emotion-congruent stimuli (Fredrickson, 1998; Fredrickson & Branigan, 2005).

If the PAB condition contributed to a positive mood state, one may hypothesize that participants in the PAB condition would demonstrate a greater ability to process information in an emotional manner (i.e., spell ambiguous words with the valenced interpretations) with little impact on negative affect or stress responding. To explore this possibility, the relation between positive affect and performance on the homophone task was examined as a function of condition. Positive affect did not differ across training conditions at any point during study procedures. In addition, correlational analyses revealed no significant relations between positive affect and homophone task performance across training conditions (all p's > .10). Thus, the explanation for the increased negative interpretation bias among participants in the PAB condition remains elusive. Further research should be conducted to both replicate this pattern of findings and to more fully explore the mechanisms underlying it.

Finally, depression, somatic anxiety, and worry, as well as the habitual use of emotional acceptance, cognitive reappraisal, expressive suppression, and rumination were each examined as potential moderators in the relation between training condition and subjective emotional reactivity in response to the stressor. Contrary to hypotheses, none of the abovementioned variables of interest were found to moderate these relations. Yet, given that the study did not find initial support for a causal relation between attention training and subsequent negative affect, interpreting the non-significant findings as evidence against the moderating role of the psychological symptoms and ER strategies included within this study aim would be premature.

General Discussion.

Taken together, results of the current investigation suggest that the training tasks did not effectively impact either attention or subsequent emotional reactivity. Given that past research has found that attention training paradigms can elicit such effects (e.g., MacLeod et al., 2002; MacLeod & Bridle, 2009; Wadlinger & Isaacowitz, 2008), it is essential to explore methodological factors unique to this study that may help to account for the discrepancy in results. Not only does such an exploration have obvious implications for future research on attention training, but also it may allow for a more thorough theoretical understanding of what attention biases are and are not, and may provide insight into how the utility of biased attention may differ as a function of the population being studied.

One such aspect of our attention training paradigm was the stimuli included in the tasks. Specifically, the NAB training employed sad facial expressions, selected from the NimStim Face Stimulus Set, as a method for inducing a bias to attend to dysphoric environmental stimuli. Though there are a number of studies that have examined depression-related attentional biases using dysphoric stimuli, this is the first known study to attempt to induce a depression-related bias in a non-depressed sample (see Hallion & Ruscio, 2011). It was expected that this induction would be effective in eliciting change in attention and subsequent emotional reactivity, as anxiety-related biases have been effectively induced in non-anxious samples using similar procedures (MacLeod et al., 2002; Browning et al., 2010). However, research examining the presentation of depression-related attentional biases has produced equivocal results and some researchers have gone so far as to call into question the existence of such biases (see Mogg & Bradley, 2005). As a result, it is difficult to determine whether the lack of significant effects produced by the NAB training reflects issues of study methodology or speaks to larger theoretical questions regarding biased attention for dysphoric content. Conceptual replications of study procedures that address methodological concerns while continuing to investigate the ability to induce depression-related biases may help to elucidate this distinction.

Stimuli used in the PAB condition were happy faces also selected from the NimStim Face Stimulus Set. While one previous study has effectively induced positive attention biases (Wadlinger & Isaacowitz, 2008), the current study was the first to attempt to induce a bias using positive images instead of words. In addition, the authors of the previous study looked at the effects of the positive attention training on subsequent avoidance of negative stimuli, without examining altered attention for positive stimuli or emotional reactivity in response to stress. Thus, while current results appear inconsistent with past research on positive biases, there exists little research with which to compare it. Again, future research should continue to explore the ability to induce PABs before conclusions regarding their impact on attention and emotional reactivity are drawn.

Another unique aspect of the current study was the use of an unselected sample as a method for examining the causal relations among attentional biases and emotional reactivity. Relatively few studies have used attention training to address basic questions about cognition and emotion (MacLeod et al., 2002; Wadlinger & Isaacowitz, 2008), with many more studies attempting to reduce maladaptive attentional biases present in clinical populations (e.g., Amir et al., 2008; Amir et al., 2009; Wells & Beevers, 2010; Baert et al., 2010). Yet, there is much that is still unknown about the nature of attentional biases and, thus, much to be gained from further inquiry into the basic function of biased attention across populations. For example, participants in the current study demonstrated a pre-training preference to engage with *both* positive and negative stimuli over neutral stimuli. While previous research has demonstrated similar positivity biases in non-clinical samples (Joormann & Gotlib, 2007; Segerstrom, 2001), research on NABs has generally conceptualized negative attentional biases as maladaptive and the absence of negative biases, or even attentional avoidance of negative stimuli, as more adaptive for emotional functioning (Bar-Haim et al., 2007; Mogg & Bradley, 2005).

Yet, the current study suggests that, rather than conceptualizing biased attention as a construct that varies dimensionally across clinical and non-clinical populations, it may be more helpful to examine the differential utility of biased attention across populations. Though NABs may be associated with increased stress reactivity among depressed or anxious individuals, evidence from this study indicates that the preference to attend to negative stimuli may not be associated with emotion dysregulation (e.g., high levels of psychological symptoms or over-reliance on ineffective ER strategies) in non-clinical samples.

Importantly, there were also specific methodological limitations of the current study that may explain why the attention training tasks failed to elicit effects, particularly changes in subsequent emotional reactivity. The first is the lapse in time that occurred between the attention training and the stressor. Following the completion of the attention training task, participants were asked to 1) provide a mood rating, 2) complete Picture Processing Task II, and 3) provide another mood rating, before they were given instructions for the stressor task. In general, the time lapse between completion of the training and the stressor task was between 15 and 20 minutes. While some studies have produced effects with a single session of training (MacLeod et al., 2002; Amir et al., 2008), many others have relied on multiple training sessions to produce significant effects on emotional reactivity (Amir et al., 2009; Wells & Beevers, 2010; Baert et al., 2010). Further, those that have relied on single-session training paradigms have not included an assessment of attention. Thus, past research has failed to assess how single-session training effects would maintain across both an assessment of attention and a task eliciting emotional reactivity, and it is possible that effects of the training dissipated during this time lapse. While the inclusion of an objective measure of attention should be noted as a methodological strength of the current project, future research should look to counterbalance the order of the assessment of post-training attentional biases and emotional reactivity in order to examine the attenuation of effects over time. Evidence for attenuation over time would further highlight the importance of employing multiple-session training paradigms.

In addition, training effects on emotional reactivity may have been limited by the experimental task selected to elicit stress (i.e., the speech preparation task). Though previous research has used the same task to document associations between depression-related attentional biases and increased negative affect (Sánchez, 2012), the task may not be ideal for inducing sadness, the primary emotion associated with depression- or dysphoria-related attentional biases. While the study found evidence for increased negative affect on the PANAS, this measure assesses 10 negative emotions, including nervousness, upset, and irritability. Sadness is not assessed by the PANAS. Further, speech tasks are most commonly used to induce anxiety, whereas sadness may be more effectively induced using music, film clips, or the recall of sad autobiographical memories (Martin, 1990). Use of this particular stress task may, in part, explain why participants in the NAB condition, who were trained to attend to dysphoric stimuli, did not differ from their counterparts assigned to the PAB or control conditions in their emotional reactivity. Future studies looking to examine depression-related attentional biases could circumvent this limitation by employing an emotion-congruent task to assess reactivity.

Finally, the study was limited in that a number of the analyses conducted were underpowered. The reason for this is twofold. First, while recruitment goals were met ($N = 92$ individuals recruited; $N = 89$ participants included in the final sample), substantial amounts of data were lost as a result of technical issues or because they were not of high enough quality to be considered valid. Loss of data was most prominent in the collection of continuous focal attention via eye tracking, as well as in the collection of the behavioral and psychophysiological indices of emotional reactivity. Because of this, a number of analyses were conducted on a sample that was significantly smaller than that which had been determined in a priori power analyses to be necessary to detect significant effects. The second reason is that effects seen within the current study appear to be much smaller (e.g., R^2 values ranged from .01 - .09; see Tables 4.5 and 4.6) than those detected in previous studies and upon which power analyses were conducted (e.g., Wadlinger & Isaacowitz, 2008; d = .62). Because of this, even analyses completed on the entire sample may have lacked adequate power to detect significant effects.

Conclusions.

Despite the fact that this study largely failed to find support for its hypotheses, it is not without value to the extant literature on attentional biases and emotional reactivity. Indeed, the non-significant results shed light on what attentional biases are and are not. It has been assumed, for example, that attention for negative emotional stimuli is maladaptive, leading to increased negative emotional reactivity in both clinical and non-clinical populations. However, current findings point to the existence of biased attention for dysphoric images among non-depressed persons who, otherwise, showed no evidence of emotion dysregulation. Moreover, training attention towards positive stimuli was associated with increased negative interpretation biases without evidence for biased attention or negative emotional responding. Thus, again, results call into question the function of cognitive processing of negative emotional stimuli among healthy individuals.

Overall, the study points to the importance of continued revisiting of theory on cognition and emotion. Research on the modification of attentional biases has increased in popularity in recent years, as investigators look to understand the etiology of emotional disorders, such as depression and anxiety, and examine the utility of attention training paradigms as clinical interventions. Indeed, such possibilities are exciting. Still, this study emphasizes that there are many questions about the relations between cognition and emotion that remain unanswered. It will be important to continue to systematically address such questions, using methodologically rigorous experimental designs, before we whole-heartedly embrace the use of attention modification as a common clinical practice.

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Chapter 2 Tables and Figures

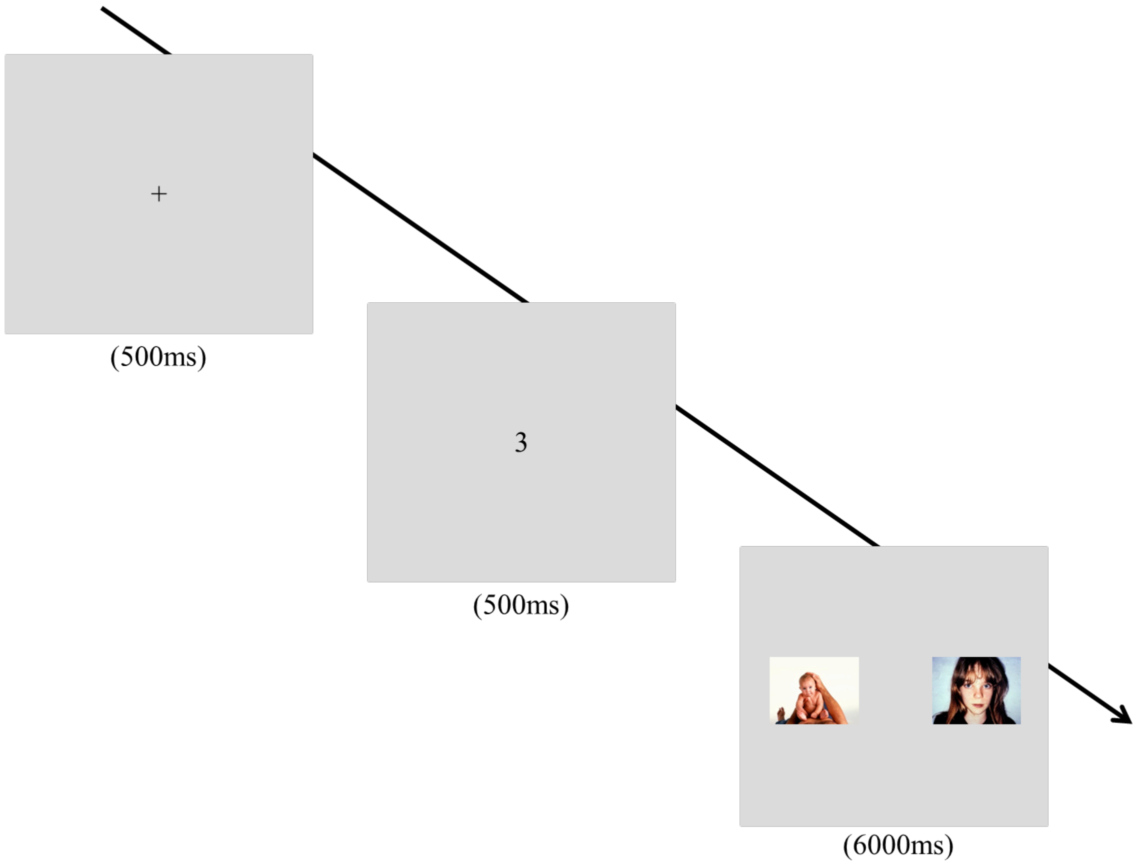

Figure 2.1. Sample trial from the pre- and post-attention training picture processing task.

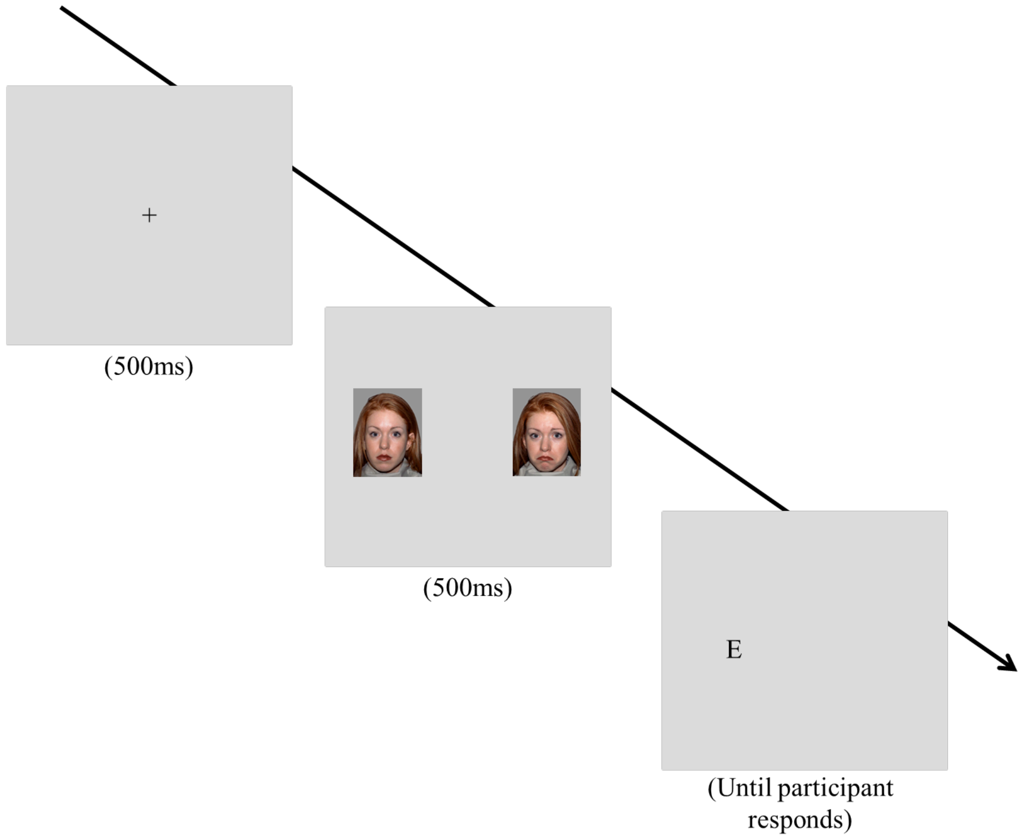

Figure 2.2. Sample trial from the attention training task.

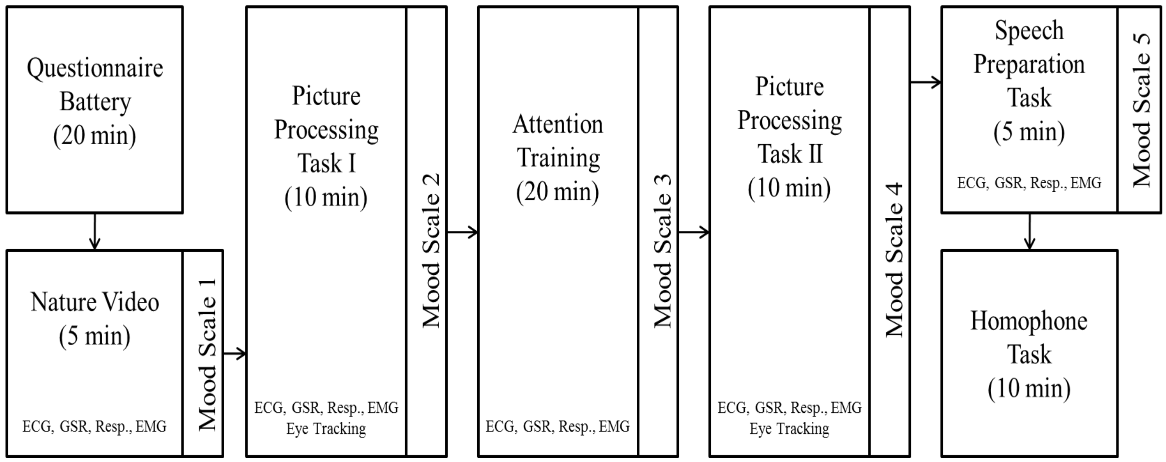

Figure 2.3. Schematic of study procedures.

Chapter 4 Tables and Figures

Table 4.1

Descriptive statistics, including means (standard deviations) and frequencies, for demographic variables of interest and psychological symptoms as a function of training condition.

	NAB	PAB	Control
Age	19.81 (2.77)	19.88 (2.19)	20.00 (2.11)
Gender			
Male	12	15	15
Female	18	12	17
Race/Ethnicity			
White/Caucasian	19	11	15
Hispanic/Latino	5	5	6
Black/African American	4	2	5
Asian	1	6	1
AI/AN	0	0	1
Other	1	3	4
Marital Status			
Single	29	25	32
Married	0	2	0
Separated	1	0	0

Year in College			
Freshman	18	14	15
Sophomore	5	6	8
Junior	5	3	3
Senior	1	3	4
Other	1	1	2

	NAB	PAB	Control
BDI-II	8.37 (8.69)	8.66 (5.69)	9.16 (5.71)
BAI	12.06 (10.09)	11.92 (10.40)	10.17 (5.21)
PSWQ	46.00 (8.90)	43.81 (7.53)	46.79 (9.21)

Note. NAB = Negative attention bias; PAB = Positive attention bias; AI = American Indian; AN = Alaskan Native; BDI-II = Beck Depression Inventory – Second Edition; BAI = Beck Anxiety Inventory; PSWQ = Penn State Worry Questionnaire.

Table 4.2

Descriptive statistics, including means (standard deviations), for the attention training task presented for the entire sample and as a function of training condition.

	Mean Accuracy	Mean Reaction Time	Learning
Entire Sample	.97 (.03)	772.45 (82.61)	-14.48 (68.33)
NAB	.97 (.03)	797.74 (78.92)	-10.88 (60.63)
PAB	.96 (.03)	767.10 (94.38)	-28.44 (97.82)
Control	.98 (.02)	753.25 (71.08)	-14.48 (68.33)

Note. NAB = Negative attention bias; PAB = Positive attention bias.

Table 4.3

Descriptive statistics, including estimate marginal means (standard errors), for eye tracking indices at pre- and post-training as a function of study condition.

	NAB: Pre-Training	NAB: Post-Training
IO-Negative	.52 (.02)	.51 (.02)
IO-Positive	.62 (.02)	.56 (.02)
FC-Negative	2.08 (.33)	1.43 (.38)
FC-Positive	1.87 (.37)	1.98 (.29)
TVD-Negative	.71 (.12)	.50 (.17)
TVD-Positive	.70 (.13)	.69 (.14)
	PAB: Pre-Training	**PAB: Post-Training**
IO-Negative	.53 (.01)	.51 (.04)
IO-Positive	.60 (.02)	.55 (.04)
FC-Negative	1.13 (.38)	1.03 (.31)
FC-Positive	1.60 (.30)	2.32 (.50)
TVD-Negative	.55 (.14)	.36 (.13)
TVD-Positive	.56 (.10)	.70 (.16)
	Ctl: Pre-Training	**Ctl: Post-Training**
IO-Negative	.51 (.01)	.54 (.01)
IO-Positive	.59 (.02)	.58 (.02)
FC-Negative	1.88 (.32)	1.03 (.43)

FC-Positive	1.76 (.34)	1.75 (.29)
TVD-Negative	.79 (.17)	.19 (.20)
TVD-Positive	.76 (.17)	.76 (.20)

Note. NAB = Negative attention bias; PAB = Positive attention bias; Ctl = Control; IO = Initial Orientation; FC = Fixation Count; TVD = Total Visit Duration.

Table 4.4

ANOVA summary table examining the effects of time and attention training condition on psychophysiological responding during the stressor task.

	df	*F*	*p*
Heart rate			
Time	**174**	**125.98**	**< .001**
Condition	88	.96	.38
Time x Condition	176	1.74	.14
RSA			
Time	**166**	**19.21**	**< .001**
Condition	84	.30	.74
Time x Condition	170	.15	.96
Respiration			
Time	**172**	**13.79**	**< .001**
Condition	87	.06	.94
Time x Condition	174	.51	.73
GSR			
Time	**156**	**99.29**	**< .001**
Condition	79	.38	.68
Time x Condition	160	1.64	.17

Corrugator			
Time	138	1.32	.27
Condition	70	.09	.91
Time x Condition	140	1.83	.13
Zygomatic			
Time	88	.55	.58
Condition	45	.09	.92
Time x Condition	90	.78	.54

Note. Significant effects presented in **bold**. RSA = Respiratory sinus arrhythmia; GSR = Galvanic skin response.

Table 4.5

Linear regression analyses exploring the potential moderating effects of psychological symptoms (i.e., depression, somatic anxiety, and worry) on the relation between attentional training condition and positive and negative affect in response to the stressor.

BDI-II x NAB predicting NA					
	R	R^2	Std. Error	df	*F*
Model	.16	.03	5.27	86	.77
		β	*t*		
NAB		-.02	.18		
BDI-II		.04	.24		
NAB*BDI-II		.13	.83		
BDI-II x PAB predicting NA					
	R	R^2	Std. Error	df	*F*
Model	.16	.03	5.27	86	.74
		β	*t*		
PAB		.00	.00		
BDI-II		.18	1.48		
PAB*BDI-II		-.10	.81		

BDI-II x NAB predicting PA

	R	R^2	Std. Error	df	*F*
Model	.13	.02	8.64	86	.49

	β	*t*
NAB	-.06	.53
BDI-II	.07	.43
NAB*BDI-II	-.16	1.02

BDI-II x PAB predicting PA

	R	R^2	Std. Error	df	*F*
Model	.12	.01	8.67	86	.76

	β	*t*
PAB	-.05	.45
BDI-II	-.10	.79
PAB*BDI-II	-.11	.85

BAI x NAB predicting NA

	R	R^2	Std. Error	df	*F*
Model	.12	.01	5.32	84	.77

	β	*t*

NAB			-.02	.21	
BAI			.15	1.02	
NAB*BAI			.08	.51	

BAI x PAB predicting NA

	R	R^2	Std. Error	df	*F*
Model	.11	.01	5.33	84	.80
		β	*t*		
PAB		.01	.05		
BAI		.06	.39		
PAB*BAI		.07	.45		

BAI x NAB predicting PA

	R	R^2	Std. Error	df	*F*
Model	.25	.06	8.45	84	1.73
		β	*t*		
NAB		-.06	.58		
BAI		-.25	1.70[b]		
NAB*BAI		.02	.14		

BAI x PAB predicting PA

	R	R^2	Std. Error	df	*F*

	R	R^2	Std. Error	df	*F*
Model	.24	.06	8.46	84	1.69

	β	*t*
PAB	-.03	.27
BAI	-.20	1.40
PAB*BAI	-.06	.40

PSWQ x NAB predicting NA

	R	R^2	Std. Error	df	*F*
Model	.29	.09	5.18	80	2.38[b]

	β	*t*
NAB	-.06	.55
PSWQ	.25	1.87[b]
NAB*PSWQ	.05	.40

PSWQ x PAB predicting NA

	R	R^2	Std. Error	df	*F*
Model	.29	.08	5.19	80	2.27[b]

	β	*t*
PAB	.02	.20
PSWQ	.30	2.40[a]
PAB*PSWQ	-.04	.29

PSWQ x NAB predicting PA

	R	R^2	Std. Error	df	*F*
Model	.10	.01	8.60	80	.25
		β	*t*		
NAB		-.05	.42		
PSWQ		.07	.54		
NAB*PSWQ		-.10	.74		

PSWQ x PAB predicting PA

	R	R^2	Std. Error	df	*F*
Model	.13	.01	8.56	80	.44
		β	*t*		
PAB		-.05	.44		
PSWQ		.08	.62		
PAB*PSWQ		-.15	1.12		

Note. BDI-II = Beck Depression Inventory Second Edition; BAI = Beck Anxiety Inventory; PSWQ = Penn State Worry Questionnaire; NAB = Negative Attention Bias condition; PAB = Positive Attention Bias condition; ^{a} $p < .05$; ^{b} $p < .10$.

Table 4.6

Linear regression analyses exploring the potential moderating effects of habitual use of emotion regulation strategies (i.e., acceptance, cognitive reappraisal, expressive suppression, and rumination) on the relation between attentional training condition and positive and negative affect in response to the stressor.

			AAQ-II x NAB predicting NA		
	R	R^2	Std. Error	df	*F*
Model	.23	.05	5.17	87	1.50
		β	*t*		
NAB		-.03	.32		
AAQ-II		-.02	.17		
NAB*AAQ-II		-.21	1.56		

			AAQ-II x PAB predicting NA		
	R	R^2	Std. Error	df	*F*
Model	.15	.02	5.25	87	.63
		β	*t*		
PAB		-.02	.22		
AAQ-II		-.16	1.23		
PAB*AAQ-II		.02	.15		

AAQ-II x NAB predicting PA

	R	R^2	Std. Error	df	*F*
Model	.16	.03	8.47	87	.55

	β	*t*
NAB	-.05	.47
AAQ-II	.14	1.01
NAB*AAQ-II	.03	.21

AAQ-II x PAB predicting PA

	R	R^2	Std. Error	df	*F*
Model	.21	.04	8.39	87	1.25

	β	*t*
PAB	.00	.02
AAQ-II	.05	.42
PAB*AAQ-II	.17	1.35

ERQ-R x NAB predicting NA

	R	R^2	Std. Error	df	*F*
Model	.19	.03	5.28	82	.95

	β	t		
NAB	-.03	.25		
ERQ-R	.14	1.09		
NAB*ERQ-R	-.07	.51		

<u>ERQ-R x PAB predicting NA</u>

	R	R^2	Std. Error	df	*F*
Model	.19	.04	5.28	82	.96

	β	*t*
PAB	-.05	.46
ERQ-R	-.22	1.45
PAB*ERQ-R	.06	.37

<u>ERQ-R x NAB predicting PA</u>

	R	R^2	Std. Error	df	*F*
Model	.31	.09	8.27	82	2.71[b]

	β	*t*
NAB	-.07	.60
ERQ-R	.33	2.59[a]
NAB*ERQ-R	-.07	-.51

ERQ-R x PAB predicting PA

	R	R^2	Std. Error	df	*F*
Model	.30	.09	8.28	82	2.64[b]
		β	*t*		
PAB		-.02	.20		
ERQ-R		.23	1.53		
PAB*ERQ-R		.09	.62		

ERQ-S x NAB predicting NA

	R	R^2	Std. Error	df	*F*
Model	.18	.03	5.32	83	.88
		β	*t*		
NAB		-.04	.36		
ERQ-S		-.02	.17		
NAB*ERQ-S		.18	1.32		

ERQ-S x PAB predicting NA

	R	R^2	Std. Error	df	*F*
Model	.19	.03	5.32	83	.95

	β	t
PAB	.00	.02
ERQ-S	.19	1.47
PAB*ERQ-S	-.19	1.45

ERQ-S x NAB predicting PA

	R	R^2	Std. Error	df	*F*
Model	.25	.06	8.55	83	1.73

	β	*t*
NAB	-.05	.45
ERQ-S	.30	2.15[a]
NAB*ERQ-S	-.24	1.73[b]

ERQ-S x PAB predicting PA

	R	R^2	Std. Error	df	*F*
Model	.18	.03	8.68	83	.91

	β	*t*
PAB	-.02	.22
ERQ-S	.10	.80
PAB*ERQ-S	.11	.82

RSQ x NAB predicting NA

	R	R^2	Std. Error	df	*F*
Model	.25	.06	5.29	78	1.69

	β	*t*
NAB	.00	.03
RSQ	.18	1.26
NAB*RSQ	.09	.63

RSQ x PAB predicting NA

	R	R^2	Std. Error	df	*F*
Model	.25	.06	5.30	78	1.65

	β	*t*
PAB	.02	.13
RSQ	.21	1.61
PAB*RSQ	.07	.53

RSQ x NAB predicting PA

	R	R^2	Std. Error	df	*F*
Model	.15	.02	8.49	78	.62

	β	*t*
NAB	-.06	.51

RSQ		-.05	.31		
NAB*RSQ		-.11	.78		

RSQ x PAB predicting PA

	R	R^2	Std. Error	df	*F*
Model	.23	.05	8.26	78	1.38
		β	*t*		
PAB		-.06	.55		
RSQ		.00	.03		
PAB*RSQ		-.22	1.72		

Note. AAQ-II = Acceptance and Action Questionnaire, Second Edition; ERQ-R = Emotion Regulation Questionnaire, Reappraisal Subscale; ERQ-S = Emotion Regulation Questionnaire, Suppression Subscale; RSQ = Rumination on Sadness Questionnaire; NAB = Negative Attention Bias condition; PAB = Positive Attention Bias condition; [a] $p < .05$; [b] $p < .10$.

Appendix A

Table 1

International Affective Picture System (IAPS) image pairs selected for the pre- and post-training assessment of attention

Dysphoric	Neutral	Positive	Neutral	Neutral	Neutral
2053	2850	2057	2441	2210	2493
2141	2214	2091	2840	7185	7187
2205	2190	2216	2485	7025	7235
2750	2570	2260	2520	7030	7020
2800	2830	2304	2440	7000	7050
2900	9070	2341	2890	7150	7009
3220	2271	2345	9700	6150	7705
3230	2579	2530	7493	5740	7034
3300	2516	2550	2495	7100	7130
3301	2385	2650	2870	5500	5534
3350	9210	4603	4605	7950	5731
9007	2200	4610	2580	7010	7041
9041	2280	4614	2221	7004	7080
9220	2600	4641	2383	7038	7090
9415	2487	8120	2372	7180	7002
9530	2410	8200	7550	7161	7036
2276	2749	2208	2514	2480	2357
2455	2393	2340	2235	2272	2595
2700	2880	4599	2745	2635	2499
9421	7640	8461	2191	7035	7040

Table 2

NimStim face stimuli selected for inclusion in the attention training tasks by condition

Practice Trials			
Female		**Male**	
02nc 02no *		20nc 20no *	
03nc 03no *		22nc 22no *	
05nc 05no *		26nc 26no *	
07nc 07no *		27nc 27no *	
		30nc 30no *	
		40nc 40no	
Negative Attentional Bias (NAB)			
Negative - Neutral		**Neutral - Neutral**	
Female	Male	Female	Male
01sc 01nc *	24so 24no *	06nc 06no *	23nc 23no *
08so 08no *	32sc 32nc *	09nc 09no *	28nc 28no *
13so 13no	39sc 39nc	11nc 11no	38nc 38no
14so 14no	41so 41no	12nc 12no	42nc 42no
Positive Attentional Bias (PAB)			
Positive - Neutral		**Neutral - Neutral**	
Female	Male	Female	Male
01hc 01nc *	24hc 24no *	06nc 06no *	23nc 23no *
08hc 08no *	32hc 32nc *	09nc 09no *	28nc 28no *
13ho 13no	39hc 39nc	11nc 11no	38nc 38no
14ho 14no	41ho 41no	12nc 12no	42nc 42no
Control			
Negative/Positive - Neutral		**Neutral - Neutral**	
Female	Male	Female	Male
01sc 01nc *	24so 24no *	06nc 06no *	23nc 23no *
08hc 08no *	32hc 32nc *	09nc 09no *	28nc 28no *
13so 13no	39sc 39nc	11nc 11no	38nc 38no
14ho 14no	41ho 41no	12nc 12no	42nc 42no

Note. sc = sad facial expression with closed mouth, so = sad facial expression with open mouth, hc = happy facial expression with closed mouth, ho = happy facial expression with open mouth, nc = neutral facial expression with closed mouth, no = neutral facial expression with open mouth; * denotes model is Caucasian.

Table 3

Interpretation bias homophone task word lists adapted from Mathews et al. (1989)

Practice Trials	Neutral Trials	Ambiguous Trials
Pencil	Month	Die/Dye
Shoe	Blanket	Slay/Sleigh
Telephone	Survey	Foul/Fowl
Plant	Deed	Moan/Mown
Fabric	Mobile	Groan/Grown
Coffee	Flannel	Liar/Lyre
Salt	Regard	Bore/Boar
Window	Avenue	Pain/Pane
Bird	Radish	Weak/Week
Caravan	Putty	Skull/Scull
	Beads	Tease/Teas
	Melon	Bury/Berry
	Tadpole	Guilt/Gilt
	Curve	Flu/Flew
		Ail/Ale *
		Bawl/Ball *
		Steal/Steel *
		Prey/Pray *
		Sore/Soar *
		Witch/Which *

Note. * indicates ambiguous trials not included in the original version of the task.

Appendix B

Speech preparation task script.

"Next, you will be asked to give a five-minute speech. This speech will be judged by three independent evaluators who are not otherwise affiliated with the study. One is a current undergraduate student, another is a clinical psychology graduate student, and the third is a member of the department faculty. Your speech will be rated based on its clarity, coherence, and persuasiveness as compared to other participants in the study. For this reason, we can't and won't be giving you any feedback on you speech today.

"In addition, it is important that you know that the speech videos may be used for training purposes here at the University. Specifically, the top 10% and the bottom 10% of speeches based on the independent evaluators' ratings may be used of examples of strong and weak public speaking skills, respectively. Do you have any questions about this?

"You speech will be recorded using that camera [***Point to camera on ceiling***]. I will give you the topic of the speech and then give you five minutes to prepare what you will say. You can write down notes on this piece of paper [***Provide Speech Prep Page***], but you won't be able to use them for the actual speech. Please prepare enough material to fill the entire five minutes of the speech.

"The topic of your speech will be, 'Why are you a good friend?' When I leave, you will have five minutes to prepare a speech explaining to us why you are a good friend. Rather than providing an emotional argument or opinion, you should provide a scientific argument with specific examples supporting your position. Do you have any questions? Then you can begin now"

Debriefing Questionnaire

Thank you for participating in our study! This questionnaire is simply to get your reactions to everything you were asked to do today. Please answer honestly, as your opinions are important to us and will be taken into consideration for this and future studies in our lab.

1. **How interesting did you find this study?**

1	2	3	4	5	6	7
Not at all			Moderately			Extremely

2. **How boring did you find participating in this study?**

1	2	3	4	5	6	7
Not at all			Moderately			Extremely

3. **How tired do you feel today?**

1	2	3	4	5	6	7
Not at all			Moderately			Extremely

4. **Did you feel like you were able to pay attention to all parts of the study?**

YES NO

If no, which part(s) did you find difficult to pay attention to?

____

____

____

5. **How stressful did you find the speech preparation?**

1	2	3	4	5	6	7
Not at all			Moderately			Extremely

Other comments about the study:

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