NEGATIVITY BIAS AS A PREDICTOR OF EMOTIONAL REACTIVITY TO A STRESSFUL EVENT

THESIS

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ABSTRACT

Individuals characterized by negativity biases with respect to attention (a tendency for attention to be drawn to threatening stimuli) and interpretation (a tendency to interpret ambiguous information negatively) have been shown to react more adversely to stressful situations. Recent research also has observed a valence asymmetry in attitude formation and generalization. The current studies aimed to demonstrate that negativity biases in attitude formation and attitude generalization relate to individuals’ mood change as result of a stressful anagram task. Participants played a computer game in which they had to learn whether novel stimuli produced positive or negative outcomes and classify other novel stimuli varying in resemblance to those employed in the game. In the first study, we found that, among participants who started out in a good mood and learned the game stimuli well, the learning of negative stimuli better than positive related to a more adverse reaction to the anagram task. In the second study, we observed that for participants initially in a good mood, the extent to which negative attitudes generalized more extensively than positive attitudes correlated with greater emotional reactivity to the anagram task. Thus, very fundamental negativity biases in both attitude learning and generalization proved predictive of emotional reactivity to a stressor.
Dedication

Dedicated to Stephanie and Jim
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CHAPTER 1: INTRODUCTION

When faced with a stressful negative event, individuals can have a variety of reactions. Some may be fine, while others may have an extremely adverse experience. Thus, many vulnerability-stress models of psychological pathologies indicate that a stressful event alone cannot account for the development of these disorders in all individuals (Ingram & Luxton, 2005). Rather, these models argue that some individuals may have certain predispositions or vulnerabilities that make them more likely to react adversely to stressful situations. One such vulnerability that has been discussed extensively in the depression and anxiety literature is the tendency for negative information to dominate over positive in one form or another. This negativity bias, it is argued, makes individuals more susceptible to both major and minor stressful events. Furthermore, if an individual continues to experience these detrimental responses, he/she will be at risk of developing an emotional disorder (Ingram & Luxton, 2005).

Negativity bias in cognitive styles

Cognitive theories posit that a negativity bias is prevalent in the thinking patterns of individuals with depression, and those vulnerable to developing depression. (Beck, 1987; Abramson, Alloy & Metalsky, 1989). For example, Beck states that depressed
individuals show an abundance of negative cognitions, while excluding positive ones. Furthermore, these negative thoughts are not driven by reality. Even when faced with a relatively positive event, a depressed individual can find a way to interpret it as negative. Beck further argues that depressed people possess negative schemas, or cognitive structures. These negative schemas shape how individuals process information, interpretation experiences, and predict the future. Beck asserts that possessing these negative schemas makes non-depressed individuals more susceptible to developing depression after experiencing a stressful life event. Thus, if an individual with a negative schema experiences a stressful event, he/she will process it negatively and, in turn, becomes more susceptible to experiencing negative affect and developing depression.

Abramson et al.’s (1989) hopelessness theory of depression also discusses the importance of a negativity bias in the thinking patterns of depressed individuals. These scientists assert that individuals with depression believe that negative events will occur and feel helpless to prevent them. Abramson et al. further argue that individuals with depression, and those prone to depression, process stressful events in a detrimental manner. Specifically, when these individuals experience a negative event, they believe it is a result of global stable causes, assume it will lead to extreme negative consequences, and believe it is a reflection that they are unworthy. Furthermore, some non-depressed individuals possess a predisposition that makes them more susceptible to view negative events in this harmful manner. Abramson et al. called the tendency to believe the negative events are due to stable global causes, a depressogenic attributional style. They
assert that, when faced with a negative stressful event, individuals who have this cognitive vulnerability are more likely develop depression than others.

Researchers have empirically demonstrated that the negative cognitive styles discussed above contribute to the onset of depression (Alloy, Abramson, Hogan, Whitehouse, Rose, & Robinson, 2000; Alloy, Abramson, Whitehouse, Hogan, Panzarella, & Rose, 2006). Specifically, a large prospective study (the Temple-Wisconsin Cognitive Vulnerability to Depression Project) was conducted to examine the predictive validity of Beck’s and the hopelessness theory. In the beginning of this project, the researchers measured non-depressed college freshmen’s cognitive vulnerability to depression through the Cognitive Styles Questionnaire (CSQ; Alloy, et al., 2000) and Dysfunctional Attitude Scale (DAS; Weissman & Beck, 1978). The CSQ assesses individuals’ inferences about the causes and consequences of negative events, and thus is pertinent to the hopelessness theory. The DAS examines individuals’ need for approval and perfectionism, and hence relates to the negative schemas involved in Beck’s theory. The researchers identified participants that scored in the upper quartile (negative cognitive styles) and in the lower quartile (non-negative cognitive styles) on the DAS and CDQ as those who were at high and low risk groups of developing depression. Alloy et al. (2000) initially found that participants who were in the high risk group had a higher life-time prevalence of depression, i.e., they were more likely to have had an episode of depression in the past than the low risk group. However, based on this finding, it is difficult to assess if the negative cognitive styles were a precursor to the experience of depression. Thus, Alloy et al. (2006) examined the low and high risk groups over a two and half year period. The
participants in the high risk group were more likely than the low risk to develop depression during this time period, even while controlling for prior depressive episodes.

Cognitive theories also assert that negative thinking patterns are prevalent in anxiety disorders, and put individuals at risk of developing these disorders when faced with a negative life event. For example, Riskind (1997) developed a cognitive model of anxiety called the looming vulnerability formulation of anxiety. In this model, Riskind asserts that the perception of a threat as rapidly increasing or growing in physical and temporal proximity to the self is a core cognition in anxiety disorders. In contrast, if the threat is perceived as stagnant; minimal levels of anxiety will be experienced. If an individual has a looming maladaptive cognitive style, he/she will begin to worry and become anxious at the first sign that a stressful event may occur. For example, if individuals with this cognitive style hear their car making strange noises, they may assume the car will break down. Thus, when anticipating a negative event, a person with this cognitive style will potentially develop an anxiety disorder at the anticipation of a stressful event. The looming maladaptive style also influences interpretation, and recall of threatening events.

Riskind, Williams, Gessner, Chrosniak and Cortina (2000) conducted a short-term prospective study to examine if possessing a looming maladaptive cognitive style would predict feelings of anxiety. In this study, the researchers had participants complete the Looming Maladaptive Style Questionnaire (LMSQ; Riskind, Kelly, Moore, Harman & Gaines, 1992), to examine their cognitive styles. After a week, the researchers asked participants to report their current anxiety and worry level. The researchers found that
participants with high LMSQ scores (negative cognitive styles) at time one, reported more anxiety and worry than participants with low LMSQ scores (non-negative cognitive styles). Thus, this study demonstrates that possessing a looming maladaptive cognitive style makes individuals more vulnerable to anxiety and anxiety related behaviors, such as worry.

Negativity Bias in Attention

In addition to its postulated role in cognitive theories of depression and anxiety, the negativity bias in emotional disorders has been presumed to affect a variety of more fundamental cognitive processes. One such process is in the domain of attention, in that individuals with emotional disorders tend to focus their attention on negative content (Mogg, Mathews, Bird & Maggregor-Morris, 1990; Macleod, Mathews & Tata, 1990; Bradley, Mogg, Falla & Hamilton, 1998; Gotlib, Krasnoperova, Yue, & Joormann, 2004). For example, Mogg et al. used an emotional Stroop task to assess high trait anxiety individuals’ negativity bias in attention. Participants were presented with threatening words in various colors. They were instructed to name the color of the word, while not attending to the content. In this study, participants completed this color naming task with both threatening and non-threatening words. Mogg et al. found that for individuals with low trait anxiety there was no difference in the time it took to name the color of the threatening and nonthreatening words. However, individuals high in trait anxiety were slower to say the color of the threatening words in comparison to the non-threatening words. Thus, the high trait anxiety individuals were attending to the threatening content and unable to ignore these words when saying the color.
The negativity bias in attention has also been assessed using a dot probe task (Macleod, et al., 1990). Although there are a number of variations of this task, the primary procedure involves presenting individuals with two words on a computer screen, one of which is threatening and the other neutral. The words appear only very briefly (generally for 500 ms). A dot will then appear in place of one of the words, and participants quickly have to indicate when they see the dot. Thus, if participants are attending to the threatening word, they will be faster to identify the probe when it appears in place of that word. Macleod et al. found that the participants with an anxiety disorder were quicker to identify the probe when it appeared in place of the threatening word than the neutral word. Healthy control participants however, were quicker to indicate they saw the probe when it appeared in place of the neutral word than the threatening word. These results demonstrate that individuals with anxiety disorders have an attentional bias towards threatening or negative words.

A modified form of the dot probe task uses faces in place of words (Bradley, et al., 1998). Bradley et al. employed this paradigm to examine the negativity bias in attention for individuals who scored high and low in trait anxiety. In this study, participants saw two faces, one neutral and one threatening and two vertical or horizontal dots appeared in place of the faces. Participants had to quickly identify if the probe was vertical or horizontal. The faces also appeared for two time lengths, either very briefly (500ms) or moderately long (1250ms). The researchers found that when the face appeared for 500ms individuals high in trait anxiety were significantly quicker to classify the dots when they appeared in place of threatening faces in comparison to those low in
trait anxiety. However, when the faces appeared for 1250ms, there was no significant difference between those high and low in trait anxiety. This finding suggests that the negativity bias in attention for individuals with anxiety occurs at the very early stages of the processing information.

The previous studies focus on the negativity bias in attention among anxious individuals. However, this attentional bias has also been observed in individuals with depression. For example, Gotlib et al. (2004) examined the negativity bias in attention using the face dot probe task in individuals with generalized anxiety disorder (GAD), major depressive disorder (MDD) and healthy controls. In this study, emotional faces (angry, sad and happy) were paired with neutral faces. The faces were presented for 1000ms and a dot appeared in place of the face, either on the left or right side of screen. Participants had to quickly indicate which side of the screen the probe appeared. The researchers found that participants with MDD were quicker to identify the probe when it appeared in place of the sad face in comparison participants with GAD and the healthy controls. However, the participants with MDD did not differ in response times for the happy or angry faces to the GAD and control participants. Furthermore, the participants with GAD did not differ from the control participants in identifying the probe when it appeared in place of the sad, angry or neutral faces. This finding again suggests that for individuals with anxiety disorders, the attentional bias towards threatening faces (such as angry) occurs at the very early stages of processing. For individuals with depression, however, there appears to be a negative attention bias towards sad faces that lasts longer than just the initial stages of processing.
Negativity Bias in Interpretation

A negativity bias related to emotional disorders has also been observed with respect to the interpretation of ambiguous situations. Specifically, some individuals display an interpretation bias when they are presented with an ambiguous event in that they are more likely to interpret it as negative than as positive. A study conducted by Amin, Foa, and Coles (1998) examined the negativity bias in interpretation among individuals with social phobia. In this study, participants with social phobias and non-anxious controls completed an interpretation questionnaire in which they were presented with ambiguous social and non-social situations. Three possible interpretations followed each ambiguous situation, one positive, one neutral and one negative. Participants had to rank the interpretations in order of best to worse explanation for the ambiguous event. The researchers found that individuals with social phobia were more likely to choose the negative interpretation of the ambiguous situations in comparison to the non-anxious controls. However, for the non-social situations there was no difference between the non-anxious controls and the participants with social phobia. Thus, individuals with social phobia demonstrated a negative interpretation bias for ambiguous social situations.

A criticism of the Amin et al. (1998) study was that participants were not making online interpretations. When the participants were presented with the ambiguous situations, they could think through the event, consider alternatives, and then offer their interpretation. Hirsch and Mathews (1997) termed this an offline interpretation bias, since participants had time to think about and reflect on the ambiguous situation (Hirsch &
Mathews, 1997, 2000). Hirsch and Mathews (1997) created a paradigm to explore if individuals high in anxiety would exhibit an online interpretation bias, occurring as a person is actually experiencing the ambiguous event. In this paradigm, participants were presented with ambiguous situations that were missing the final word of the last sentence. This last word could disambiguate the situation as either positive or negative. For example, an ambiguous sentence would be “You wonder, when you are in the interview, if all your preparation will be…” “Forgotten” would disambiguate the sentence as negative while “useful” would disambiguate the sentence as positive. These ambiguous situations were presented as primes in a lexical decision task. So, the final word (either positive or negative) appeared and participants had to quickly indicate whether it was a word or not. Hirsch and Mathews examined the response times of participants who reported high and low levels of anxiety about job interviews. All the ambiguous situations in this study were related to job interviews. The results demonstrated that participants who reported little anxiety about job interviews were faster to identify words that disambiguated the situation as positive, and thus demonstrated a positivity bias. Participants who reported high anxiety about job interviews took the same amount of time to identify positive and negative disambiguating words. So participants with high anxiety lack this positive bias.

A follow up study conducted by Hirsch and Mathews (2000) examined the response times in this interpretation lexical decision task for individuals with social phobia and healthy controls. The ambiguous situations were again specifically related to job interviews, and thus would provoke anxiety in social phobics. The researchers found
that the healthy controls demonstrated a positivity bias, in that they were quicker to say the disambiguating positive word was a word than the disambiguating negative word. In contrast, the participants with social phobia did not exhibit this positivity bias. Moreover, the social phobics were slower to say the disambiguating positive word was a word than the healthy controls.

The negativity bias in interpretation has also been examined using homographs or words with two meanings. Generally, homographs with neutral and threatening meanings have been employed. One study by French and Richards (1992) presented low and high anxious participants with homographs that had neutral and threatening meanings (e.g., terminal) and asked the participants to quickly write words related to the homographs. The researchers found that participants high in anxiety were less likely to write words related to the neutral meanings (e.g., airport as opposed to dying) than those low in anxiety.

It is possible that in the French and Richards (1992) study participants were simply showing a response bias. That is, they may have been aware of both meanings and simply chose to write words related to the negative meaning, instead of actually interpreting the word as negative. To address this possibility, Richards and French (1992) used a lexical decision task to examine participants’ interpretation of the homographs. In this paradigm, participants were presented with a homograph as a prime, followed by a word related to either the neutral or threatening meaning. Participants had to quickly identify whether the following word was a word or not. Participants who were high in
trait anxiety were quicker to identify the word as a word when it was related to the threatening meaning of the homograph in comparison to individuals low in anxiety.

*Negativity bias in attitude formation*

Recently, another form of negativity bias has been related to emotional disorders – a negativity bias in attitude formation (Fazio, Eiser & Shook, 2004; Shook, Fazio & Vasey, 2007). Fazio et al. initially used the BeanFest paradigm to assess average valence asymmetries in individuals’ formation of attitudes toward novel stimuli and their generalization of those attitudes to visually similar stimuli. The novel objects were called beans and were either good or bad in the sense of their potential for yielding a positive or a negative outcome. The beans varied visually in two ways, shape (circular to oblong) and number of speckles (1 to 10), forming a ten by ten matrix of the population of beans. During each trial of the game, participants were presented with a bean and they had to decide whether to approach or avoid the bean. If participants chose to approach the bean, it either increased or decreased their point-value. Thus, in order to succeed at the game participants had to learn which beans were good and which were bad. During the game, or learning phase, participants were presented with many trials of a subset of beans from the matrix. Since participants had no prior contact or knowledge with these objects, participants form attitudes towards these beans based only on their experiences during the game.

Following the learning phase, participants completed a test phase in which they were presented with game beans as well as novel beans they did not see during the game. In a trial of this phase, participants saw a bean and had to quickly indicate if the bean was
good or bad or would have increased or decreased their points during the game. Thus, it was possible to examine the attitudes participants formed toward the game beans, and how these attitudes generalized towards novel beans varying in resemblance to the game beans.

Fazio et al. (2004) found two intriguing valence asymmetries. First, on average, participants learned the nature of the negative beans better than the positive. Second, participants were also more likely to classify novel beans as negative than as positive. Thus, negative attitudes were more likely than positive attitudes to generalize to novel beans. Through further exploration of the learning asymmetry, Fazio et al. discovered that this particular asymmetry was mainly a result of sampling behavior. During the game, participants only learned the valence of the bean if they choose to approach it (contingent feedback). Thus, if participants incorrectly believed a given bean to be negative, they would avoid it and never learn the true valence of the bean. In contrast, if participants believed a negative bean was positive, they would approach it and as a result learn its actual value.

To examine this possibility, the researchers changed the paradigm so participants would be informed of the valence of the bean regardless of whether they decided to approach or avoid it (full feedback). In this full feedback version, participants no longer showed the learning asymmetry, on average. This finding demonstrated that the learning asymmetry was in large part due to the sampling behavior of the participants under conditions in which feedback was contingent upon a decision to approach the bean. The generalization asymmetry however, was not influenced by employing a full feedback
version of the game.

Initially, the BeanFest paradigm was utilized to examine average tendencies and behaviors. However, recently, BeanFest has been used as an individual difference measure, to examine various negativity biases (Shook et al. 2007). One such bias is related to the generalization asymmetry, and examines how likely participants are to classify a novel bean as negative over positive. If an individual exhibits this bias, they are weighting negative information about a bean heavier than positive, and thus this bias is termed the *weighting bias* (Shook et al.). It is best to examine the weighting bias when participants have learned the valence of the game beans very well. In that way, it is possible to assess how much individuals weight resemblance to a known negative versus resemblance to a positive, independently of any differences in learning.

The learning asymmetry itself is influenced by two components. Thus, there are two forms of negativity bias related to the learning asymmetry that can be measured. The first is observed when participants play the contingent feedback version of the game and is called the *sampling bias*. The sampling bias is concerned with how much participants are willing to approach beans they believe may possibly be negative. Thus, if an individual displays a sampling bias, they are overly cautious about exploring beans that could potentially be detrimental (Shook et al., 2007). When participants play the full feedback version, they no longer show a learning asymmetry on average. However, some participants still learn the negative beans better than the positive and this tendency is called a *learning bias*. Since sampling behavior does not influence any valence asymmetry observed under full feedback conditions, this learning bias reflects how much
participants rehearse and attend to the negative beans more than the positive (Shook et al).

Shook et al. (2007) examined if individual differences in the negativity bias observed in BeanFest related to measures of cognitive susceptibility to emotional disorders. The researchers employed the full feedback version of the game, and thus were specifically interested in the learning bias. Participants first played the game and then completed the test phase, during which their learning bias was assessed. After that, participants completed the Cognitive Styles Questionnaire (CSQ; Alloy et al., 2000), Beck’s Depression Inventory (BDI; Beck, Steer, & Brown, 1996) and Beck’s Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988). The researchers found that the learning asymmetry was correlated with the CSQ, BDI and BDA, in that displaying better learning of the negative beans than the positive was related to more negative cognitive styles and greater self-reports of depressive and anxious tendencies. Thus, this study provides initial evidence that the learning bias is related to a susceptibility to emotional disorders.

Although it is useful and informative to see evidence of some degree of correspondence between BeanFest measures and self-report measures of cognitive style, it is important to understand how they differ. The BeanFest paradigm provides a performance-based measure of the negativity bias that does not require participants to introspect on how they would feel during specific situations. Furthermore, participants are presented with novel objects to which they have no prior contact. So participants’ past experiences and knowledge do not influence the measurement of the negativity bias. It is
an assessment of how well individuals learn or classify objects that are simply negative or positive (Shook et al., 2007). Thus, the BeanFest paradigm, provides a unique way to more purely examine negativity bias.

Negativity bias and emotional reactivity

The various studies discussed above demonstrate that possessing a negativity bias can be detrimental since it is associated with emotional disorders. Vulnerability-stress models would also posit that possessing a negativity bias is harmful because it can lead a healthy individual to have an adverse reaction to stressful situations. If an individual continually has a negative reaction to stressful events, he or she is more likely to develop an emotional disorder. According to these stress models, it is this regular pattern of extreme reactivity to stressors that promotes the development of depression and/or anxiety. To better understand this process, researchers have focused upon individuals’ reactions to a specific event and how those reactions might vary as a function of individual differences in cognitive style. (Ingram and Luxton, 2005).

Various studies have found a relationship between the negativity bias in attention and emotional reactivity to a stressful event (Dandeneau, Baldwin, Pruessner, Baccus, and Sakellaropoulo, 2007; Macleod Rutherford, Campbell, Ebensworthy & Holker, 2002). For example Dandeneau et al. examined this relationship using the face version of the dot probe task employed in the Bradley et al. (1998) study. Participants were shown a face with an expression that conveyed rejection and a neutral face. A horizontal or vertical set of dots appeared in place of one the faces, and participants had to quickly indicate the orientation of the dots. Following the dot probe paradigm, participants completed what
was intended to be a stress-inducing task. They were asked to solve difficult arithmetic problems that were calibrated to be just beyond participants’ abilities within a limited amount of time. Periodically during this stressful task, the experimenter would criticize the participants for making errors. Emotional reactivity was measured through the cortisol level in participants’ saliva. Before the task, began the experimenter collected a saliva sample to establish a baseline cortisol level. The researchers also collected cortisol samples seven times during this stressful situation. They found that the attention bias to rejection faces was positively correlated with cortisol release during the stressful task. This finding thus established that there is a relationship between the negativity bias in attention and emotional reactivity to a stressful situation, as measured by cortisol levels.

Dandeneau et al. (2007, Study 3a & 3b) also attempted to manipulate the negativity bias in attention, so as to demonstrate a causal relationship between the attention bias and emotional reactivity to a stressful event. In these experiments, they trained participants to have a positive attentional bias, by instructing them to search for a smiling face among a set of frowning faces. In the first experiment, the researchers had half of the students search for the smiling face among the frowning faces for 80 trials each of the five days preceding their final exam period. Those assigned to a control condition searched for a flower among other plants. The researchers found that the students who searched for the smiling face reported less test-related stress, both leading up to and after taking their exam, than those in the control condition. In a follow up study, telemarketers completed the find-the-smiling-face or find-the-flower task during a week when they had to meet a quota. Each day during this week, participants completed
daily stress measures and on the last day their cortisol release was assessed. The participants who completed the find-the-smile condition reported less perceived stress and had lower cortisol levels than the participants in the control condition.

Macleod et al. (2002) also demonstrated a causal relationship between the negativity bias in attention and emotional reactivity to a stressful event. These researchers trained participants to have either a neutral or negative attention bias, using the dot probe paradigm. As in the traditional dot probe task, a neutral and threatening word appeared on the screen. A dot then appeared in place of one of the words, and participants had to quickly indicate when they saw it. For half of the participants, the dot always appeared in place of the neutral word, while for the other half the dot appeared in place of the threatening word. To ensure that this training had been effective, participants then completed the traditional dot probe paradigm. The researchers found that participants trained to focus on the negative word were faster to identify the probe when it appeared in place of the threatening word in comparison to participants trained to focus on the neutral word.

Participants then completed an anagram task while being filmed. The researchers instructed the participants that they would have three minutes to solve as many anagrams as possible and those who performed the worse and best at the task would have their video shown to an introductory psychology class. There were forty anagrams, half of which were extremely difficult and half of which were unsolvable, thus all participants performed poorly on the task. Furthermore, participants received feedback that they had done poorly and that their video would be shown to the psychology class. Participants’ mood was measured before and after this stressful anagram task. The results
demonstrated that participants who had been trained to have a negative attention bias had a more extreme mood change, and thus more emotional reactivity to the anagram task, than those trained to focus on the neutral word. This experiment further demonstrates that the negativity bias in attention causes higher emotional reactivity to a stressful situation.

Research has also demonstrated that the negativity bias in interpretation plays a causal role in emotional reactivity to a stressful event (Murphy, Hirsch, Mathews, Smith & Clark, 2007; Wilson, MacLeod, Mathews, Rutherford, 2006). For example, Wilson et al. trained participants to have a negative or benign interpretation bias using homographs with neutral and threatening meanings. Participants were told that they were completing a lexical processing task, in which they would be presented with word fragments and would have to determine the word. Participants were instructed that they would also be presented with another word as a clue to help them complete the word fragments. The clue word was actually a homograph with a neutral and negative meaning. Half of the participants were given word fragments that would disambiguate the homograph as a neutral and the other half were given word fragments that would indicate the homograph was threatening. Thus, half of the participants were trained to have a neutral interpretation bias and the other half were trained to have a negative interpretation bias. Participants then watch a distressing movie and their moods were measured before and after the movie. Participants who were trained to have a negative interpretation bias reported stronger mood change and thus more emotional reactivity to the stressful movie than participants trained to have a neutral interpretation bias.
Murphy et al. (2007) also examined the causal relationship between the interpretation bias and emotional reactivity to a stressful situation. The participants in this study reported being social anxious, and thus had a negative interpretation bias in relation to ambiguous self-relevant social events. The researchers trained one-third of the participants to have a positive interpretation bias, one-third to have a non-negative interpretation bias, and did not train the last third as a control group. To train participants, the researchers presented them with a social self-relevant situation that a socially anxious individual typically would perceive as negative, such as the participant giving a speech. The description of the situation ended with positive feedback, non-negative feedback or no feedback. So in the example of the speech, positive feedback was that the participant was very steady, and the non-negative was that the participant was not shaking during the speech. In total, 95 such situations were presented. The researchers then examined if this training was successful in changing participants’ interpretation bias. Specifically the researchers presented participants with ambiguous situations and instructed them to remember the details of each description. Participants then completed a recognition test, which included positive and negative descriptions of the ambiguous situation. The researchers found that participants in the positive and benign interpretation condition were more likely to remember positive interpretations of the situation, in comparison to those in the control condition. Thus, training was successful. Following the interpretation task, participants were informed they were going to have a meeting with two other individuals, whom they had never met. This provides a stressful situation for socially anxious individuals. The participants then reported their anticipated anxiety
to this encounter. Participants who were trained to have a positive and neutral interpretation bias reported less anxiety about the encounter than those in the control condition.

The previous research, thus, demonstrates that negativity biases in various processes (e.g., attention and interpretation) result in more adverse reactions to stressful situations. As discussed earlier, the stress-vulnerability hypothesis states that individuals who have a more adverse reaction to stressful events are more susceptible to developing emotional disorders. Specifically, if an individual with a tendency to react negatively to a stressful event experiences many successive events or a prolonged event, they are more likely to develop emotional disorders (Ingram & Luxton, 2005). The research examining the negativity bias and emotional reactivity exposed participants to minor stressful situations. Thus, the researchers could examine how participants react to these small events, which is indicative of their tendencies when faced with large-scale stressful situations (Dandeneau et al. 2007; Macleod et al. 2002; Murphy, et al. 2007; Wilson et al. 2006). Since the researchers found a relationship between the negativity bias and emotional reactivity, the studies suggest that a negativity bias in attention and interpretation may be related to the development of emotional disorders.

*Present Studies*

The present research aims to expand upon previous studies that have examined the relationship between the negativity bias and emotional reactivity to a stressful event. Specifically, these studies will look at the negativity bias measured by BeanFest and reactivity to a stressful situation. As mentioned earlier, BeanFest provides a unique way
to assess the negativity bias because it is a performance based measure utilizing stimuli with which participants have had no prior knowledge. Thus, it examines how participants learn and classify purely good and bad objects. Furthermore, the research aims to examine a process that differs from the attention and interpretation bias. The attention bias is concerned with the very early stages of information processing, specifically where does one initially focus attention. For example, in anxiety disorders this bias is only visible in the dot probe task when faces are presented for very short duration (Bradley et al. 1998). The interpretation bias observes individuals’ explanations for specific ambiguous situations or individuals’ resolution of the ambiguity inherent to homographs, both of which involve content that is likely to be associated with a lengthy history of experiences. BeanFest in contrast examines individuals’ attitude formation and generalization towards novel stimuli. In that way, it assesses a very fundamental difference in the processing of stimuli as a function of their associated valences.

The Shook et al. (2007) study provided preliminary evidence that the learning bias in BeanFest is related to self-report measures of susceptibility to developing emotional disorders. The experience of a negative reaction to a stressful situation suggests that an individual may be more vulnerable to developing emotional disorders. Thus, the current research will expand on the Shook et al. study, by providing further evidence that the negativity biases assessed by BeanFest are related to vulnerability to developing emotional disorders. Specifically the first study will examine if the learning bias is related to emotional reactivity to a stressful situation. The second study will look
at the relationship between emotional reactivity to a stressful event and the weighting bias.

The stressful situation was modeled after the anagram task employed in the Macleod et al. (2002) experiment. Participants were lead to believe that the anagram task was related to verbal intelligence and, hence, would have wanted to perform well on the task. However, the anagrams were difficult or completely unsolvable and thus all participants performed poorly at the task. Participants’ mood was assessed before and after the anagram task to examine their emotional reactivity. Although the anagram task was designed to be stressful, it is also only mildly stressful, since it was a task for a study that had no real bearing the participants’ lives. Thus, participants could have a variety of reactions to the task. We predict that participants who display a stronger learning bias during the BeanFest game will focus on the negative aspects of the anagram task, and thus have a more adverse reaction than those who do not have a learning bias (Study 1). We also predict that participants who exhibit a stronger weighting bias will weight the negative aspects of the task stronger than the positive, and show more emotional reactivity than those who have a weaker or no weighting bias (Study 2).
CHAPTER 2: STUDY 1, LEARNING BIASES PREDICTING EMOTIONAL REACTIVITY

The purpose of the first study was to examine if a negativity bias measured by BeanFest related to emotional reactivity to a stressful situation. Since Shook et al. (2007) found that the learning bias was related to vulnerability to developing emotional disorders, the current study focused specifically on the learning bias. The participants first played the full feedback version of the game and then completed a stressful anagram task. Participants’ mood was measured before and after this task to assess their emotional reactivity to a stressor. We predicted that participants with a learning bias would display greater mood change in a negative direction.

Methods

Participants

Ninety-seven (56 female and 41 male) Ohio State University students enrolled in an introductory to psychology course participated in this study for research credit. Three participants were excluded because they were clearly not engaged in the BeanFest game (e.g., pressing only the yes or no key through the majority of the test phase). Five participants were excluded because the number of anagrams they passed was 5 standard deviations above the mean, indicating that they were not attempting to solve the
anagrams. Eighty-nine participants (54 female and 35 male) were included in the final analyses.

Materials

BeanFest is a computer game in which participants’ goal is to accumulate points by accepting or approaching positive beans and avoiding or rejecting negative beans. Each bean has a positive or negative point value. Participants must learn the value of each bean in order to gain points and avoid losing points. Participants’ point value can range from 0 to 100. During a trial in the game, participants are shown a bean, and must decide whether to approach or avoid the bean. If participants accept a bean, their point value adjusts according the valence of the bean. Positive beans increase participants’ point value, while negative beans decrease participants’ points. If participants decide not to approach a bean, their point value does not change.

The beans differ by shape and number of speckles on a 10 by 10 matrix. Thus, there are a total of 100 possible beans that may be presented to participants. The beans vary by shape on the x-dimension of the matrix, from circular to oval to oblong. The beans vary by number of speckles on the y-dimensions, ranging from 1 to 10 speckles. Six regions containing five to seven beans from the matrix were selected to be presented during the game in this study (see Figure 1). These regions were carefully selected and each was assigned a point value of +10 or -10 in such a way as to ensure that there were no linear relationships between the shape or number of speckles and the valence of the bean. Thus, participants must determine which specific beans are positive and negative and cannot just learn a simple linear rule.
Procedure

When participants first arrived in the lab they were shown to a testing room that consisted of four cubicles each containing a Dell Optiplex computer, monitor, keyboard and response box and were each seated in one of the cubicles. The experimenter then explained the purpose of the study. Participants were led to believe that the goal of the study was to examine if verbal intelligence related to how well individuals learn which objects are good and bad in an imaginary world. The experimenter explained that participants would first play the BeanFest in order to examine how well they learned the value of novel objects. Following the game, the experimenter indicated that participants would complete a series of anagram, which would be used to assess their verbal intelligence. At multiple points during this introduction, the experimenter emphasized that the anagram task was a measure of verbal intelligence. The experimenter then told the participants that they would complete a short mood questionnaire, because mood can sometimes affect how well individuals perform on both the BeanFest and anagram task. Participants completed a seven-item mood questionnaire, which instructed them to indicate how they were feeling at this exact moment. Two discrete emotions (happy-sad, very depressed-very elated, very bad-very good, very tired-very energetic, very dissatisfied-very satisfied, very sedated-very aroused, very anxious-very relaxed) were used as end points on a +3 to -3 scale, and participants had to specify where their current mood fell on the scale.

Once all participants had completed the mood questionnaire, the experimenter handed out written instructions to BeanFest. The experimenter read the instructions out
loud while the participants read along. Participants then completed a practice block of six trials. During this block the participants were presented with one bean from each of the six different regions in the matrix. For each practice trial, participants were instructed to accept the bean, i.e., to respond yes on the response box. This was intended to ensure that participants would become familiar with the BeanFest feedback and point displays.

Once participants had finished the practice trials, they completed the game phase, which was divided into three blocks, each consisting of 36 trials. During each block, the 36 beans from the six selected sections of the matrix were presented. Thus, each bean was presented three times. The first 12 trials were fixed to ensure that participants did not experience an unlucky string of negative beans, and lose the game right away. After these 12 trials, presentation of the beans was randomized within blocks.

During a trial, participants were shown a bean in the upper part of the monitor. They had to indicate whether they wished to approach or avoid the bean. The participants had a response box that consisted of two buttons labeled “yes” and “no.” Participants pressed the yes button if they wished to approach the bean and the no button if they wished to avoid the bean. The participant’s decision was displayed in the lower left of the screen, along with some additional information. If participants chose to approach the bean, they saw that their decision was yes, and the value of the bean they had selected (+10 or -10). If participants did not approach the bean, the screen displayed their decision as no. Participants, however, still saw the value the bean would have had, because this was full-feedback version of Beanfest. This ensured that participants received information about the value of each bean on each and every trial, irrespective of their
decision. Thus, the learning bias could be assessed without having it tainted by the individual’s willingness to sample. In the lower right of the screen was a box with participants’ current points, and a point bar reflecting the participants’ score graphically. The bar would fluctuate as a result of participants current points. If participants choose not to approach a bean, their score would not change; however, if participants’ approached a bean, their points and point bar would adjust based on the value of the bean.

Participants’ points could range from 0 to 100, and participants started the game with 50 points. If participants reached 0 points they would lose the game, and if they reached 100 points they would win the game. Any time participants won or lost, the game would restart with 50 points. As in Experiment 1 of Fazio et al. (2004) and Shook et al (2007), these specific parameters of the game were intended to frame the game in a neutral and balanced manner – one that did not differentially emphasize either gains or losses. Each time a participant restarted the game, the beans retained their original value, so previous good beans were still good and bad beans were still bad. How many times participants restarted the game, depended on how many times participants won or lost. However, all participants were shown three blocks of 36 beans no matter how many times they won or lost. After the three blocks, the game phase ended.

Once participants completed the game phase, the experimenter handed out instructions for the test phase. Participants once again read along while the experimenter read the instructions aloud. During the test phase, participants were shown each of the 100 beans from the matrix in two blocks of 50 randomized trials. Participants were asked to indicate whether they believed a given bean would have been good or bad during the
game phase, i.e. would a bean have increased or decreased their point value during the game. Participants received no feedback during this test phase, and there were no points or point bar displayed. After participants completed the test phase, they answered the question “How well did you perform on the Beanfest game?” This question was on a 7-point likert scale, from -3 (worse than expected) to 3 (better than expected). The intent of this self-appraisal item was to bolster the credibility of the cover story presenting the BeanFest game as an intellectual task. However, it also provided a means of estimating any contribution that self-perceived success at BeanFest might have on final mood state.

The experimenter then read the instructions for the anagram task, informing the participants that they would have three minutes to complete 20 anagrams. Participants were encouraged to try and answer every anagram. However, they were informed that if they really could not solve an anagram they had the option of skipping it. The experimenter reminded participants that they were under a time constraint of three minutes, and thus, they should not spend all three minutes on one anagram. The end of the instructions reminded participants that this was a measure of their intelligence, so they should try to do their best at the task. Participants were provided scratch paper to facilitate their attempts to find the solutions.

During the anagram task, an anagram was presented on the computer monitor with two options below, “answer this anagram” or “skip this anagram.” If participants choose to answer the anagram, a text box would appear, and participants could answer the anagram in this box. If participants choose to skip the anagram, the computer would
move to next anagram. After three minutes, the computer automatically switched to the next part of the experiment.

Nine of the anagrams available for presentation were very difficult to solve as determined by pretesting, (e.g., vahled-halved) and 10 were unsolvable (e.g., onejsp). The first anagram was fixed and the rest were presented to participants in random order (see Table 1 for list of anagrams). The first anagram was “tachy,” and was a relatively easy anagram, according to pilot data (the answers were yacht or Cathy). Since most participants were able to solve this anagram, this initial success served to make the task more believable and ensured that participants would not think all the anagrams were extremely difficult or unsolvable.

After participants completed the anagram task, they answered the question “How well do you believe you performed on the Anagram Test.” This question used a 7 point likert scale from -3 (worse than expected) to 3 (better than expected). This question was employed to bolster the cover story regarding our interest in anagram performance as an assessment of intelligence. Participants then completed the same seven question mood questionnaire they filled out at the beginning of the study.

At the end of the study participants completed a short questionnaire that probed them for any suspicion about the true purpose of the study in general and specifically the anagram task, No participant expressed any suspicion. Participants were then thanked for their participation and debriefed.
Results

Anagram task and mood change

We first examined if participants’ mood decreased from time one to time two, i.e., after the anagram task. As expected, participants reported feeling worse after the anagram task ($M=-.02\ SD=.84$) than before ($M=.70, SD=.87$), $t(88)=10.73\ p<.001$. Thus the anagram task had the desired effect of worsening participants’ mood states.

However, despite the substantial decline, on average, there was variability in mood change. Mood change scores (time two minus time one) ranged from -.71 to -2.14, with $M=-.72$ and $SD=.63$. Our goal was to examine the predictors of this variability in mood change.

Variables related to mood change

Before we considered the predictor variable of most concern, the learning asymmetry, we thought it important to identify other variables that might influence mood following the experience with the anagram task. The first variable we examined was mood as measured at the beginning of the study. Individuals who started out in a relatively good mood would most likely stay in a better mood after the anagram task than participants who started out in a bad mood. Indeed, initial mood state did correlate with final mood reports, $r(88)=.73, p<.001$.

Certain variables associated with the anagram task also seemed likely to affect mood at time two. One variable is how many anagrams participants answered. Half of the anagrams were very difficult, but were actually solvable and the unsolvable anagrams
were designed to appear as though there was an actual answer. Thus, some participants solved a few of the difficult anagrams, and provided reasonable answers for the unsolvable anagrams. No participant did extremely well at the task since the maximum number of anagrams to which participants responded was only five out of the 20 anagrams ($M=1.78, SD=.99$). However, a participant who was able to answer three or more anagrams would most likely be in a better mood after the task, than participants who answered only one or none of the anagrams. Indeed, the number of anagrams attempted significantly correlated with mood change (time two minus time one) ($r(88)=.27, p<.05$). Another variable related to the anagram task that also proved influential concerned how many anagrams participants had to pass during the task. The majority of participants did not pass very many anagrams during the task ($M=4.16, SD=1.43$), because they were attempting to actually solve each anagram as it was presented. However, the instructions clearly told participants to skip an anagram if they truly felt they could not answer it. Thus, the number of anagrams participants had to skip represented the number they failed to solve. So participants who passed many anagrams would be in a worse mood than participants who skipped relatively few. This reasoning was supported by the observed correlation of $r(88)=-.21, p<.05$ between the number of anagrams passed and mood change.

Yet another variable that we suspected might influence mood at time two is perception of performance on the BeanFest game. After participants finished the BeanFest game, they rated how well they performed on the game from “worse than expected” to “better than expected.” On average participants thought they did slightly
worse than expected \((M=-.16)\), but the variance was substantial \((SD=1.42)\). Thus, if participants felt they did poorly on the BeanFest game, they might be in a worse mood at time two than participants who felt they did well. Supporting this logic, there was a significant correlation between mood change and perception of BeanFest game\((r(88)=.43 \ p<.001)\).

To examine the joint influence of these four variables on mood at time two, we entered them as predictors in a regression analysis. Taken together, these four variables accounted for a significant proportion of variance in participants’ mood after the anagram task \((R^2=.65, F(4)=39.72, \ p<.001)\) We found that mood at time one \((B=.64, t(88)=4.34, \ p<.001)\), anagrams passed \((B=-.12, t(88)=-2.18, \ p<.05)\) and perception of BeanFest performance \((B=.24, t(88)=4.34, \ p<.001)\) significantly related to mood at time two.

Number of anagrams answered was marginally predictive of mood at time two \((B=.10, t(88)=1.86, \ p=.067)\).

Overall learning and the learning bias

Examination of the BeanFest variables began with a consideration of how well participants learned the games beans. To index learning, we calculated the correlation (i.e. a phi coefficient) between participants’ classification of each game bean (positive or negative) during the test phase and the bean’s actual value (positive or negative). The average phi coefficient was .32 with a standard deviation of .30. As in past research, this mean was significantly better than chance, \(t(88)=3.73, \ p<.001\), indicating that participants did learn on average. However, it is also important to note that some participants showed very poor learning. The phi coefficient value one standard deviation below the mean was
almost zero, which is equivalent to guessing while classifying the game beans. As shall be evident shortly, it proved important to consider this variability in learning when examining the hypothesis.

To examine the learning bias, we first calculated the proportion of positive beans and negative beans participants correctly classified. On average, learning was above chance for both positive beans ($M=.64$, $SD=.18$), $t(88)=7.55$, $p<.001$, and negative beans ($M=.67$, $SD=.19$), $t(88)=8.48$, $p<.001$. Participants were slightly better at learning the negative beans on average than the positive. However, consistent with other experiments that have employed the full feedback version of the BeanFest game, the learning asymmetry (proportion of positive correct minus negative correct) was not statistically significant, ($M=-0.03$, $SD=.21$), $t(88)=1.56$, $p=.12$.

*Learning bias and mood change*

Next we examined the relationship between the learning bias and emotional reactivity. However, some participants did not learn the game beans well, and appeared to be guessing when classifying the beans. Any valence asymmetry that is observed when participants are essentially guessing may not be very meaningful. It certainly could not be considered to reflect their typical learning patterns. Hence, we thought it would be important to take overall learning (Test Phi Coefficient) into account when examining the relationship between the learning bias and mood at time two. We ran a regression predicting mood at time two from mood at time one, learning bias, and overall learning, the two-way interactions between each of these variables, and the three way interaction,
while controlling for the other variables already documented to relate to mood at time two (anagrams correct, anagrams passed, and perceptions of BeanFest performance).

There were no main effects for overall learning or the learning bias. However, there was a marginally significant interaction between these two variables, ($B=.14$, $t(88)=1.83$, $p=.07$). This two-way interaction was qualified by a marginal three-way interaction between overall learning, learning bias, and mood at time one ($B=.15$, $t(88)=1.73$, $p=.088$).

To probe this three-way interaction, we first considered participants who started out in a good mood at time one, by examining the values predicted by the regression equation for an initial mood score that was one standard deviation above the mean. At this value of initial mood, there was significant two-way learning bias by overall learning interaction ($B=.289$, $t(88)=2.42$, $p<.05$). To examine this two-way interaction, we first considered participants who learned well (one standard deviation above the mean). For these participants, the learning asymmetry significantly related to mood at time two, in the predicted direction ($B=.37$, $t(88)=2.43$, $p<.05$). For participants who did not learn well (one standard deviation below the mean) the relationship between learning bias and mood at time two was in the opposite direction but was not significant ($B=-.206$, $t(88)=1.48$, $p<.14$) (see Figure 2). We then looked at participants who started in a bad mood at time one, i.e., a value one standard deviation below the mean. At this value of initial mood, there was no sign of an interaction between learning bias and overall learning ($B=-.01$, $t<1$) (see Figure 3).
We found that for participants who started out in a good mood at time one and who learned the game beans well, the learning bias related to emotional reactivity in the predicted direction. However, we did not find that the learning asymmetry related to mood at time two for participants who did not learn well. It is difficult to interpret what the valence asymmetry might mean for these participants, since they were clearly not engaged in the task and performed at chance in terms of classifying the beans correctly. For such individuals, it seems doubtful that the valence asymmetry reflects how well they were learning and remembering positive versus negative beans.

We did not observe a similar interaction between overall learning and the learning bias among participants who entered the study in a bad mood. No relations involving the learning bias were apparent for such individuals. The null effect may be due to the difficulty of inducing these participants into an even worse mood. To examine this possibility, we looked at the correlation between mood at time one, and the difference between mood scores across time (time 1 minus time 2). We found a significant negative correlation ($r(88)=-.41, p<.001$). The scatterplot and regression line are depicted in Figure 4. Participants who started out in a good mood reported a stronger mood decline after the difficult anagram experience than participants who started out in a bad mood. Essentially, then, there was no reactivity to predict for participants who entered the laboratory feeling grumpy.

Discussion

On average, participants were in a worse mood after completing the anagram task. Thus, we successfully created a task to which they emotionally reacted. In general,
participants showed evidence of having learned the valence of the game beans.

Furthermore, since participants played the full feedback version, sampling behavior did not dictate how well participants learned positive and negative beans. Fazio, Eiser, and Shook (2004) found that employing a full feedback version of the game attenuates the learning asymmetry, or learning negative beans better than positive. Thus, in the current study, just as in past research, no significant learning asymmetry was observed.

Although participants learned well on average, there was much variability in learning. Some participants showed no indication that they had learned, and performed no better than chance when classifying the beans. Most likely, these participants were not engaged in the task, and thus not taking the effort to learn the beans. It is difficult to know exactly what the learning bias is indexing for such disengaged participants. However, it is not likely reflecting how well participants learned and remembered negative versus positive information, but rather some form of a response bias. Presumably, it is for this reason that we found a relation between emotional reactivity and the learning bias for participants who learned the game beans well, but did not observe such a relation for poor learners. The extent of learning significantly moderated the relation.

For participants who learned well, those who learned the negative beans better than positive experienced a more adverse reaction to anagram task. However, we found this relationship between the learning bias and emotional reactivity only for participants who started out in a good mood. Participants who started out in a bad mood had little
decreased mood as a result of the anagram task, since they were already experiencing negative affect.

In sum, we found the predicted relation between the learning bias and emotional reactivity among individuals who entered the lab in a relatively positive mood state and who were sufficiently engaged in the BeanFest learning task. Thus, the study provides evidence that a fundamental asymmetry in the learning of positive versus negative information relates to how much an individual adversely reacts to a stressful event.

However, two related factors prompted us to conduct a second study aimed at providing a conceptual replication of the finding. The first concerns the poor learning exhibited by some participants and the qualifying effect this had upon the relation of major interest. In addition, since there was variability in learning, BeanFest performance had the unintended effect of influencing participants’ mood. Although we control for this variable in our analysis, it would be preferable to create a situation in which mood was influenced more singly by the stressful anagram task.

Study 2 examined if the \textit{weighting bias} relates to emotional reactivity to a stressful situation. The weighting bias assesses how participants classify novel beans as a function of their resemblance to known positive or known negative beans. In other words, it assesses how individuals weight positive versus negative information. Besides examining a new form of negativity bias, Study 2 by virtue of its focus on the weighting bias, should address the hesitations noted about Study 1. The weighting bias is best assessed when participants learn all the game beans very well. Therefore, utilizing the weighting bias paradigm ensures that participants’ learning of game beans is no longer an
issue when examining the data. Furthermore, because all participants will do well at the
game, varying perceptions of BeanFest performance should no longer influence mood
change.
CHAPTER 3: STUDY 2, WEIGHTING BIAS PREDICTING EMOTIONAL REACTIVITY

The current study examined if the weighting bias was related to mood change as a result of the stressful anagram task. In this study, participants completed a version of the BeanFest paradigm that helped them learned all the game beans very well to ensure that the weighting could be observed without interference from discrepancies in learning. This was achieved by employing a simplified matrix and multiple practice phases.

This study expanded on the Study 1, by examining if a different form of negativity bias that can be assessed via BeanFest was related to the intensity of an adverse reaction to a negative event. This study also aimed to address the issue of some participants’ poor learning of the game beans in Study 1. Since the setup of the BeanFest game ensured that participants learn the game beans well, variability in learning would not be relevant. Also, due to the use of a simplified matrix and the practice opportunities, all participants would do well on the BeanFest game. Hence, in the current study, performance on the game should not affect mood change as it did in the previous study. In Study 1 we found significant results only among participants who started out in a relatively good mood. Those who entered the laboratory setting already somewhat upset were not affected by the anagram task. Thus, we predicted that the weighting bias would
relate to emotional reactivity to a stressful event primarily for participants who started out in a good mood.

**Methods**

**Participants**

Sixty (32 female and 28 male) Ohio State University students enrolled in an introductory to psychology class participated for course created. Three participants were excluded because they did not learn the game beans to criterion (85% correct), and two participants were not used in the analysis because the number of anagrams they passed was five standard deviations above the mean. This left a total of 55 participants (29 female and 26 male).

**Materials**

The BeanFest paradigm was similar to the one employed in study 1. Participants’ point value ranged from 0 to 100, and when participants approached a bean their point value was adjusted according to the value of the bean. If participants choose avoid a bean, their point value did not change, and they learned the value of the bean had they decide to approach it.

The main difference between this version of the BeanFest game and the one utilized in Study 1 involved the beans presented during the game. In order to ensure that participants would learn the value of all the beans well, 10 beans from each of the four corners of the matrix were shown during the game, making a total of 40 game beans. Each corner was assigned either a +10 or -10 value (see Figure 5). Thus, the presented beans were more perceptually distinct than in the previous study. Participants could learn
simple associations to help them remember the value of the beans (i.e. circular with few speckles is good, while oblong with many speckles is bad).

**Procedure**

As in Study 1, participants were led to believe that the purpose of this study was examined how their performance on the BeanFest game was related to performance on a more traditional intellectual task, involving verbal aptitude. Furthermore, as before, participants were told that mood can affect how much effort they put into each task, and thus their mood would be measured at various points in the study. Participants then completed the same 7-item mood questionnaire used in Study 1.

The BeanFest paradigm was employed in a slightly different manner than in Study 1. The main purpose of these changes was to ensure that participants learned all the game beans very well. Since we were interested in the weighting bias, we wanted to eliminate any discrepancy in learning of positive or negative beans, or variability in overall learning among participants. This consistency would ensure the participants’ response to the novel beans presented during the test phase would provide a relatively pure measure of the weighting bias, uncontaminated by differential learning.

Participants were first handed instructions to the practice game and read them silently while the experimenter read out loud. Prior to the beginning of the practice game, the participants first completed a short block of eight trials intended to familiarize them with the feedback displays. During these trials, two beans from each of the four regions of the matrix were presented. Participants were instructed to respond yes or
approach every bean in this block. Thus, participants received information regarding the value of these eight beans.

Following the practice phase, participants played the practice game. The practice game consisted of one block with 40 trials. In the 40 trials, participants were shown all 40 beans from the four regions of the matrix once. All the trials were randomly presented, except for the first 12, to ensure participants did not have an unlucky string of beans and loose the game right away. The trials and monitor displays were the same format as in the Study 1. Participants also used the same response box with a yes and no key, indicating approach and avoid as in Study 1. Participants played the full-feedback version of the game, and thus, received information regarding the valence of the bean regardless of whether they decided to approach or avoid it. This version of the game was utilized ensure participants learned all the game beans well.

The practice game had the same point setup and goals as the game in Study 1. Participants started with 50 points, and were trying to gain points and avoid losing points. If participants point-level reached zero they were informed that they had lost, and would restart a new game with 50 points. If participants reached 100 they would be informed that they won, and again restart a new game with 50 points. The practice game ended after the 40 trials were completed.

Following the practice game, participants completed a classification training task. This task was employed simply to help participants learn the valence of the various game beans. The classification training involved 2 blocks of 40 trials each. The beans from the four regions were shown once during each block, and were randomized within the block.
During a trial, participants were shown a bean in the upper middle portion of the screen. Participants quickly had to classify it as good (would increase their points) or bad (bad would decrease their points). The participants used the keyboard to classify the beans, specifically the A key, for good and 5 key on the number pad, for bad. There was no point value or point bar presented during the trials. If participants correctly classified the bean, the next trial was presented. However, if participants incorrectly identified the bean, a screen appeared that said “Error! This was *not* a Positive (or Negative).”

Following the classification training task, participants played what was presented as the actual BeanFest game. The game was the same as the practice game, except there were two blocks of 40 trials, instead of one. After the BeanFest game, participants completed the test phase. The test phase was the same as the test phase in Study 1. Participants were presented with all 100 beans from matrix, within two blocks of 50 randomized trials. Thus, participants saw all 40 games beans, and 60 novel beans. Performance with respect to the game beans provided a means of determining whether participants had learned to criterion. Judgments of the novel beans were used to assess the weighting bias.

After the test phase, participants answered the question “How well did you perform on the Beanfest game?” This question was on a 7-point likert scale, from -3 (worse than expected) to 3 (better than expected). Participants then completed the same anagram task employed in Study 1, followed by the question “How well do you believe you performed on Anagram Test.” Participants responded on a 7-point scale ranging from -3 (worse than expected) to 3 (better than expected). Participants then completed the
mood questionnaire. This was followed by the same short questionnaire used in Study 1 to probe for any suspicion about the true purpose of the study. (No participant reported any suspicion.) Finally participants were thanked for their participation and debriefed.

Results

Anagram task and mood change

As for Study 1, participants reported a significant decrease in mood from time one ($M=.75, SD=.79$) to time two ($M=-.15, SD=.90$) $t(54)=8.64, p<.001$. Thus, we were successful in significantly reducing participants’ mood from time one to time two.

Variables related to mood change

As in Study 1, we found it important to look at variables other than the weighting bias that may affect mood at time two. To examine if the same variables that proved relevant in Study 1 related to mood at time two in this study, we ran a regression predicting mood two from mood at time one, number of anagrams answered, number of anagrams passed, and perception of BeanFest performance. Mood at time one ($B=.50, t(54)=5.27, p<.001$) and anagrams answered ($B=.271, t(54)=2.78, p<.01$) significantly predicted mood at time two, and anagrams passed was marginally significant ($B=-.161, t(54)=-1.67, p=.10$) at predicting mood two. Perception of BeanFest performance, however, did not significantly predict mood at time two ($B=.06, t<1$). This was to be expected, for the BeanFest game in this study had been designed in such a way as to ensure that all participants learned the game beans very well. On average participants indicated that they did better than expected on the BeanFest game. The mean score was 1.11 on the -3 (worse than expected) to +3 (better than expected) scale, $t(88)=6.10$, 

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In general, then participants felt that they did well on BeanFest

*Learning in BeanFest*

The BeanFest game was implemented so as to make sure that participants learned well. As a result, the proportion of game beans participants correctly classified was very high ($M = .96, SD = .04$). Furthermore, participants learned both positive beans ($M = .96, SD = .06$) and negative beans ($M = .97, SD = .06$) well. The main purpose of ensuring that participants learned the game beans well was so the weighting bias – the primary predictor variable in Study 2 – would not be influenced by overall learning or by any differential learning of positive versus negative beans. This goal was accomplished, since participants showed no evidence of a learning bias.

*Weighting bias*

During the test phase, participants were presented with 60 novel beans that they had not seen during the game. When participants classified a novel bean as positive, it was given a score of +1, and when they classified it as negative it was assigned a score of -1. Thus, if a participant classified novel beans as positive and as negative equally often, showing no weighting bias, they would have an average score of 0.
When calculating the weighting bias, we took into account that the novel beans vary in their resemblance to positive and negative game beans (see Figure 6)\(^1\). In terms of the matrix, some are positioned considerably closer to a positive region than to a negative region. For others, the reverse is true. And, still others are proximal to positive and negative regions roughly to the same extent. These latter beans bear an approximately equal resemblance to known positives and known negatives. Hence we term them “ambivalent” beans. In contrast, those beans very close to either a positive or negative region can be considered “univalent.” They clearly resemble either a known positive or a known negative, not both\(^2\). In addition, there are beans located in the center of the matrix, and thus a far distance from both a positive and negative section. We termed these beans “center” beans, and they do not have a strong resemblance to either a

\(^1\) We classified the novel beans from matrix into either univalent, center, or ambivalent beans, based on calculated ambivalence scores for each bean. Resemblance to a positive (versus a negative) was indexed as the Euclidean distance in the matrix separating a novel bean from its nearest positive (or negative) game bean. We then used the Jamieson method for calculating ambivalence scores (Thompson, Zanna & Griffin, 1995). This resulted in beans with ambivalence scores of 4.17, 3.20, 2.25, 1.33, 0.80, 0.50, and 0.17. The 24 beans that had ambivalence scores higher than 2, and thus were high in resemblance to both positive and negative beans, were termed ambivalent beans. Twenty-four beans with ambivalence scores lower than 2, and that were close to either a negative or positive game bean region were called Univalent beans. Finally 12 beans with ambivalence scores lower than two that also were far from both positive and negative game beans were termed center beans. These bear little resemblance to either known positives or known negatives. The mean ambivalence scores for the ambivalent beans, the univalent beans, and the center beans were 3.21, 0.49, and 0.92, respectively.

\(^2\) Since participants learned the game beans almost perfectly, their mean response to these beans was very close to zero (\(M=-.01, SD=.05\)). This is exactly as expected given that the positive and negative game beans were equal in frequency. The same was true of the univalent beans. The mean was almost zero (\(M=-.09, SD=.13\)), suggesting that participants were classifying the univalent beans the same as the adjacent game beans. Nevertheless, the minimal variance resulted in this mean response to the univalent beans being significantly different from 0, \(t(54)=5.56, p<.001\). However, the response to the ambivalent beans (\(M=-.17\)) was significantly more negative than to the univalent beans \(t(54)=2.28, p<.05\). This difference demonstrates that participants are showing a stronger weighting bias with the ambivalent than univalent beans. In addition responses to univalent and ambivalent beans were only marginally correlated \((r=.23, p>.09)\)
known positive or negative. A weighting bias would not be well reflected in these beans because there are no negative or positive aspects for participants to weight.

Since the ambivalent beans were high in positive and negative aspects, we reasoned that these beans would best represent the weighting bias. There were six such beans in each quadrant of the matrix, for a total of 24 ambivalent beans. So we employed the mean response to these 24 beans as an index of the weighting bias. On average participants showed a generalization asymmetry, in that their average response to these 24 four ambivalent beans was significantly lower than zero ($M=-.17$, $SD=.23$) $t(54)=5.31$, $p<.001$. This is consistent with past research, which has found that, on average, participants are more likely to classify novel beans as negative than as positive (Fazio, Eiser, & Shook, 2004).

**Weighting bias and mood change**

We next examined if the weighting bias related to emotional reactivity to the anagram task. We predicted mood at time two from mood at time one, the weighting bias, and the two-way interaction between the weighting bias and initial mood, while controlling for number of anagrams answered and number passed. There was no significant main effect for the weighting bias, but there was significant interaction between the weighting bias and mood at time one ($B=.24$, $t(54)=2.61$, $p<.05$). To examine this two-interaction, we first focused on the regression line for an initial mood value one

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3 The mean response to the center beans was significantly different from 0 ($M=-.26$, $SD=.35$), $t(54)=5.42$, $p<.001$. However, the average response to the center beans and ambivalent beans appeared to be indexing different processes, since the correlation between the response to the two types of beans was not significant ($r=.16$, $p<.20$). The center beans are low in positive and negative aspects, and in turn most likely reflect some form of a response bias, while the ambivalent beans, high in positive and negative traits, demonstrate a weighting bias.
standard deviation above the mean. In this case of an initial good mood, the weighting bias significantly predicted mood at time two (B=.32, \( t(54)=2.49 \ p<.05 \)). At an initial mood score one standard deviation below the mean, the weighting bias was not significantly related to mood at time two (\( B=-.15, \ t(88)=1.22, \ p>.20 \)) (see Figure 7).

As in Study 1, we found significant results only for participants who started out in a good mood at time one. We again postulated this was because it is difficult to induce participants who entered the laboratory in a bad mood into an even worse mood. To explore this, we again calculated mood change by using the difference between mood at time one and mood at time two. The correlation between this difference and mood at time one was significant (\( r(88)=-.33 \ p<.05 \)). Thus, this again suggested that participants who began the study in a bad mood were less likely to experience a decline in mood than participants who were in a good mood at the start of the study.

Discussion

The main aim of this study was to replicate Study 1’s findings using the weighting bias while also addressing the issue of some participants not learning well. To assess the weighting bias, it is important to ensure that participants learn all the game beans well, so that discrepancies in learning in general and between positive and negative beans do not influence assessment of this bias. To accomplish this goal, we employed a version of the game that helped participants learn all the beans well. We found that this version of the game was successful, since participants learned the game beans much better than chance. Thus, participants’ differential learning of the game beans was not an issue, as it was in Study 1. Participants also learned the positive and negative game beans equally well;
there was no evidence of a learning asymmetry. However, when classifying novel beans, participants showed a generalization asymmetry, in that they were more likely to classify a novel bean as negative than as positive. Thus, participants, on average, were weighting negative information more heavily than positive. Variability in this weighting bias predicted mood two after the anagram task for participants who started out in a good mood. Participants who had a stronger weighting bias exhibited a more adverse reaction to the anagram task.

As in Study 1 we did not find any significant results for the participants who started out in a bad mood. We again postulated that it was difficult to put participants who started out in a bad mood into an even worse mood. Indeed, participants who started out in a good mood showed more mood change than participants who started out in a bad mood.
CHAPTER 4: GENERAL DISCUSSION

In both Studies 1 and 2, we found that the anagram task was successful in reducing some participants’ mood from the beginning of the experiment. In Study 1 variability in mood change related to learning bias for participants who learned the game beans well and started out in a good mood. In Study 2, we found the mood change related to the weighting bias, for participants who started out in a good mood. Since the weighting bias is best examined when participants learn all the game beans well, we employed a paradigm that would ensure that participants learned all the game beans to criterion. Thus, learning of the game beans was no longer an issue as it was in Study 1. In both Study 1 and Study 2, we found significant results only for participants who started out in a good mood. We postulated that this was a result of lack of variability in mood change for participants who started out in bad mood. If an individual is already in a bad mood, it is difficult to decrease their mood more. In fact, we found in both studies that individuals who started out in a good mood, showed more mood change in response to the anagram task than individuals who stared out in a bad mood.
BeanFest Measures of Negativity Bias

The vulnerability stress hypothesis states that certain individuals have predispositions that make them more susceptible to stressful events (Ingram & Luxton, 2005). Thus, if an individual with this vulnerability faces either many successive stressful situations or a prolonged event, they are more likely to develop an emotional disorder than people who do not have this tendency. In the current research we employed a difficult anagram task to examine individuals’ reactions to a minor stressful event. Participants’ responses to the anagram task presumably were indicative of how they would respond to larger scale stressful events in their everyday lives, and in turn their vulnerability to emotional disorders.

Shook, Fazio and Vasey (2007) initially found that the learning bias assessed via BeanFest related to measures of susceptibility to developing emotional disorders. Thus, this study presented initial evidence that the leaning bias may have detrimental outcomes. The current Study 1 expanded upon the Shook et al. findings by demonstrating that the learning bias measured by BeanFest correlates with negative reactions to stressful events. This finding provides further evidence that the learning bias relates to vulnerability to emotional disorders. Study 2 demonstrated that the weighting bias predicted adverse reactions to stressful events. Given that the weighting bias was not assessed in the Shook et al. research, Study 2 provides the first evidence that possessing a weighting bias relates to emotional reactivity and, hence, potentially to the development of emotional disorders.
Psychometric advantages of BeanFest based measures.

The two current studies provide evidence for the potential utility of BeanFest as performance-based measure for assessing susceptibility to emotional disorders. There are many advantages to employing performance based measures, since questionnaires in general have various limitations. For example, the wording and format of questions can have unintended consequences for how respondents interpret the essence of what is being asked and for how they answer (Schwarz, 1999). Furthermore, questionnaires pertaining specifically to anxiety and depression have additional shortcomings. Individuals may be concerned with self-presentation, and be apprehensive to report their anxiety. Or, individuals may have the desire to please the researcher and over- or under-estimate their level of anxiety according to their perceptions of the researcher’s predilections (Kendall & Flannery-Schroeder, 1998). Finally, many measures of cognitive vulnerability, such as the Cognitive Styles Questionnaire, the Dysfunctional Attitudes Scale and Looming Maladaptive Styles Questionnaire, require individuals to imagine how negative or positive a situation would be, introspect on how they would feel in regards to it, and project how the situation will unfold in the future. Individuals may have difficulty reporting and reflecting on their internal states, and thus have a hard time completing these questionnaires (Vasey & Logan, 2000). In BeanFest, participants are not required to introspect, or reflect on their current feelings. Rather, participants simply play a game that involves completely novel stimuli.

As noted earlier, past research has employed various performance-based measures of the negativity bias to examine its relationship to emotional reactivity to an adverse
event. For example, measures assessing attentional focus have been used look at the negativity bias (Dandeneau et al., 2007; Macleod et al., 2002). In the first study of Dandeneau et al. paper, the researchers found that individuals who showed a strong attentional bias, as measured by a face dot probe task, had a more adverse reaction to a stressful task than those with a weak attentional bias. Furthermore, in follow up studies, Dandeneau manipulated the negativity bias in attention by having participants in the experimental condition search for a smiling face among frowning faces. The researchers found that this attentional training reduced emotional reactivity for students during finals and telemarketers when they had to meet a quota. In addition, Macleod et al. found that training participants to focus their attention on threatening words during a dot probe task led to their experiencing a more adverse reaction to a stressful anagram task than participants who had been trained to focus on the neutral word.

Performance-based measures have also been employed to examine a negativity bias in interpretation and its relationship to emotional reactivity to stressful situations (Murphy et al., 2007; Wilson et al. 2006). Murphy et al. found that training participants to have a negative interpretation bias of homographs with neutral and threatening meanings, led to their reporting more adverse reactions to a disturbing movie than participants who had been trained to have a neutral interpretation of the homographs. Furthermore, Wilson et al. trained socially anxious participants, who generally display a tendency to interpret ambiguous situations as negative, to have in one condition a positive interpretation bias and in another condition a neutral interpretation bias. The researchers found that participants who had been trained to have positive and neutral interpretations reported
less anxiety to an upcoming interaction with two strangers than participants who had not received training.

This previous research employing performance-based measures related to attention and interpretation provides evidence that a negativity bias can lead individuals to have an adverse reaction to stressful situations. However, there are some limitations to the stimuli used in these measures. Generally these are stimuli to which participants would have had considerable prior exposure, such as facial expressions, threatening words or social situations. As a result, participants’ past experiences may influence how they react to these stimuli. For example, an individual with a strong negativity bias may see the homograph “terminal,” and still interpret it as the neutral meaning, because they recently were in an airport or frequently fly. In addition, the stimuli employed in the measures often confound negative and threatening. For example, the dot probe task used in the Macleod et al. (2002) study employed neutral and threatening words. Wilson et al. (2006) also used homographs with threatening and neutral meanings. These studies may not be examining how a negativity bias operates, but rather, how a bias towards threatening information does. As a result, it is difficult to know if it is a bias concerning purely negative valence, or a more specific bias concerning threatening information that is resulting in individuals having adverse reactions to stressful situations.

BeanFest utilizes novel stimuli, with which individuals have no prior contact. As a result individuals’ past experience with the stimuli cannot influence their performance. Rather individuals’ reactions to the beans are solely a result of their experiences during the game. Furthermore, the concept of the game is relatively simply. Some beans are
positive and will increase points, and some beans and will decrease points. Therefore, the negativity biases assessed by BeanFest are a result of how well individuals learn and weight negative versus positive information about the beans, not confounded with any other construct. Thus, BeanFest provides a pure measure of the negativity bias.

**Processes assessed by BeanFest**

In addition to the psychometric advantages associated with it, BeanFest also focuses on processes that are not assessed by prior performance-based measures related to emotional reactivity. The research examining attention is primarily interested in individuals’ attentional focus in the very initial stages of processing. The interpretation bias examines how individuals interpret vague information, generally situations or events whose meaning or eventual outcome is left unspecified. In contrast, BeanFest assesses individuals’ attitude formation and generalization towards novel stimuli. Specifically, the learning bias focuses on how well individuals attend and rehearse, and in turn learn positive versus negative novel stimuli. BeanFest also can be used to assess how much individuals weight resemblance to a known positive entity versus a known negative (the weighting bias). Thus, the processes assessed by BeanFest have not been examined by previous performance based measures.

**Limitations and Future Directions**

Although these two studies provide evidence that the learning and weighting biases relate to emotional reactivity to a stressful event, we cannot make any causal inferences from these results. We cannot infer that possessing a learning or weighting bias causes individuals to have a more adverse reaction to negative events. Rather, it is
possible that individuals who consistently react to stressful situations develop a negativity bias as a result of these negative experiences.

Past research examining attention and interpretation, however, has demonstrated that possessing a negativity bias in these processes does in fact cause more emotional reactivity to stressful situations (Dandeneau et al. 2007; Macleod et al 2002; Murphy, Hirsch, Mathews, Smith & Clark, 2007; Wilson, Macleod, Mathews, Rutherford, 2006). These studies manipulated the negativity bias, by inducing either negative or positive bias in attention or interpretation. In these past experiments researchers found that an experimentally enhanced negativity bias caused individuals to exhibit more emotional reactivity to stressful situations. Therefore, we have reason to predict that if we were to experimentally manipulate a learning bias or weighting bias, it would cause individuals to have a more adverse reaction to stressful situations.

Recent research has succeeded in experimentally manipulating the weighting bias (Pietri, Fazio & Shook, 2009). The BeanFest paradigm was used as a means of providing individuals with trial-by-trial feedback as to whether they were appropriately weighting resemblance to a negative versus resemblance to a positive and, thus, effectively recalibrated their tendencies. In this retraining procedure, participants first learned the target game beans to criterion, as in the Study 2. They then were exposed to novel beans of varying resemblance to the game beans and decided on each trial whether the novel bean was positive or negative. In the recalibration condition, participants received feedback as to the accuracy of their decisions and thus gradually came to weight resemblance to a positive or a negative equivalently. Evidence was obtained
demonstrating that this recalibration transferred to two later judgmental tasks. In one case, this involved the development of attitudes toward other novel stimuli. Specifically these novel stimuli were donuts that varied in color and hole size. Recalibration through BeanFest resulted in a smaller weighting bias when later judging donuts than was true for participants who had not been retrained. In a second experiment, recalibration transferred to participants’ interpretation of ambiguous situations. Participants in the retraining condition interpreted ambiguous situations more positively than did participants in the control condition. Both of these findings demonstrated that it is possible to use the BeanFest paradigm to experimentally manipulate the negativity bias, and allow for causal inferences.

Future research should employ this retraining paradigm with the stressful anagram task, to explore if a stronger weighting bias causes more adverse reactions to a stressful situation. Specifically, participants who have undergone the retraining procedure should display less emotional reactivity to the stressful anagram task. Thus, we would be able to examine whether greater weighting of resemblance to negative than to a positive leads to more adverse reactions to a stressful situation.
LIST OF REFERENCES


APPENDIX A

TABLES AND FIGURES
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*Table 1.* Anagrams employed in the stressful task. Solvable=there is a correct answer, but all except for “Tachy” are difficult to solve. Insolvable=there is no correct answer.
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*Figure 1.* Bean Matrix in Study 1. X= shape from oval (1) to oblong (10). Y= number of speckles from 1 to 10. The cells with a point value present the beans presented during the game.
Figure 2. Regression lines relating the learning bias to mood at time two, given an initial mood score one standard deviation above the mean, as a function of overall learning.
Figure 3. Regression lines relating the learning bias to mood at time two, given an initial mood score one standard deviation below the mean, as a function of overall learning.
Figure 4. Relationship between Mood Change (Mood at Time 1 minus Mood at Time 2) and mood after the anagram task (Time 2).
Figure 5. Bean Matrix in Study 2. X = shape from oval (1) to oblong (10). Y = number of speckles from 1 to 10. The cells with a point value present the beans presented during the game.
Figure 6. Relationship between Mood at the beginning of the study (Time 1) and mood after the anagram task (Time 2).

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Figure 7. Regression lines relating the weighting bias to mood at time two, as a function of mood at time 1.