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Valence weighting as a predictor of emotional reactivity to a stressful situation

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Abstract

Individuals who have a more adverse reaction to stressful situations are at heightened risk for developing emotional disorders. The current studies aimed to demonstrate that valence biases in attitude generalization relate to individuals' emotional reactivity following a stressful task. Participants played a computer game in which they had to learn whether previously unknown stimuli (i.e., "beans") produced positive or negative outcomes. They then had to classify novel stimuli, which varied in resemblance to those employed in the game, as either positive or negative. Attitude generalization, i.e., the extent to which participants weight resemblance to a positive versus negative, is critical to the classification of these novel stimuli, which provided the basis for indexing valence weighting. Participants then completed a stressful anagram task, in which they had three minutes to solve as many anagrams as possible. Half the anagrams were difficult, and half were insoluble, thus creating a failure experience. Mood was assessed before and after the task as a measure of emotional reactivity. In two studies, we observed that for participants initially in a good mood, the extent to which negative attitudes generalized more extensively than positive attitudes was predictive of greater emotional reactivity to the stressful anagram task.

Valence weighting as a predictor of emotional reactivity to a stressful situation

When faced with a stressful negative event, individuals may have a variety of reactions. Some may be fine, whereas others may have an extremely adverse experience. Because stressful situations are not regularly construed in the same manner, vulnerability-stress models of psychological pathologies argue that stressful events alone cannot account for the development of these disorders (e.g., Ingram & Luxton, 2005; Ingram & Price, 2001). Rather, these models assert that how individuals react to these stressful events is important to the onset of many clinical disorders. Furthermore, some individuals may have certain predispositions or vulnerabilities that make them more likely to react adversely to both minor and major stressful situations. Cognitive theories of depression and anxiety posit that individuals with certain negative thinking patterns react more adversely to stressful situations and, as a result, are prone to developing these emotional disorders (Abramson, Alloy, & Metalsky, 1989; Beck, 1987; Riskind, 1997).

Although stressful situations, such as an argument with a significant other or a mistake at work, have many negative aspects, there still may be positive or less negative facets on which one can focus. The argument may have been over a minor issue that will soon be forgotten, or with enough effort the mistake at work may easily be corrected. Given that a stressful situation may involve various characteristics of varying valence, the current research aims to demonstrate that how individuals weight positive and negative aspects may play an important role in the emotions that they come to experience. People who give more weight to negative information than positive, i.e., who show a strong negativity bias, should have more adverse reactions than individuals with a more neutral or positive bias.

We are particularly interested in how the weighting of positives and negatives may relate to reactivity to a stressful event because stress reactivity, as noted, can have important consequences for psychological well-being. For example, although the total number of stressors experienced by college students is prospectively predictive of the onset of depressive symptoms, the perceived impact of these stressors, or reactivity, is all the more predictive (e.g., Felsten, 2004). Daily dairy studies have also shown the negative impact of reactivity. In such studies, participants report stressful events that occurred during the day, their current level of negative and positive affect, and depressive symptoms. Increases in reactivity (i.e., higher negative affect and lower positive affect) as a result of stressful events predicted later depression symptoms (e.g., O'Neil, Cohen, Toplin & Gunthert, 2004; Parrish, Cohen, & Laurenceau, 2011). Furthermore, prospective studies have found that reactivity to daily life stressors is predictive of developing clinical level of major depression as well as psychosis (Wichers et al., 2009; Lataster et al., 2008). Thus, individuals' reactions to stressful events are often more predictive of psychological well-being than the occurrence of the event itself.

Performance-Based Measure of Valence Weighting

The current research employs a measure that has been useful in assessing individual differences in the weighting of valence information (Pietri, Fazio, & Shook, submitted). When assessing a novel object or situation, individuals are essentially engaged in attitude generalization. They must judge how similar the novel attitude object is to known objects that they associate with positive or negative valence. When both appear relevant, do the positive attitudes generalize more strongly or do the negative attitudes? How individuals generalize their attitudes can provide a useful assessment of how they weight positive and negative information.

Does resemblance to a known positive or resemblance to a known negative carry the greater weight in the assessment of the novel object?

Past research has examined the attitude generalization process through a paradigm called BeanFest, which was initially used to assess average valence asymmetries in individuals' formation of attitudes toward novel stimuli and generalization of those attitudes to visually similar stimuli (Fazio, Eiser, & Shook, 2004). 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. As participants had no prior knowledge regarding these objects, participants formed attitudes towards these beans based only on their experiences during the game.

Following the game, or learning phase, participants completed a test phase in which they were presented with game beans as well as novel beans they had not seen during the game. On any given trial, participants saw a bean and had to indicate if the bean was good or bad (i.e., 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. Further exploration of this learning asymmetry revealed that this particular asymmetry was mainly a result of sampling behavior. During the game, participants only learned the valence of the bean if they chose 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. We will return to consideration of this learning asymmetry in the General Discussion.

The second asymmetry observed by Fazio et al. (2004) is of particular interest to the current research in that it lies at the core of the valence weighting bias. Although participants were clearly influenced by the degree to which a given novel bean resembled a known positive versus a known negative, negative attitudes were more likely than positive attitudes to generalize to novel beans. On average, individuals weighted resemblance to a known negative bean more heavily than resemblance to a known positive.

The present research focuses on individual differences in the generalization of positive versus negative attitudes. Although a negativity bias is observed on average, there is variability in the extent to which individuals display this asymmetry. Specifically, when classifying a novel bean, some people weight resemblance to a negative much more strongly than resemblance to a positive, even more so than the average participant, whereas other people weight positive information equal to negative or even more than negative. It is this *weighting bias*, or how individuals weight positive and negative information when generalizing attitudes to a novel object, that we believe will be particularly useful when considering how individuals react to stressful situations.

Past research utilizing the estimate of valence weighting provided by the pattern of attitude generalization in BeanFest has found the index to predict individuals' reactions across a variety of situations. Importantly, because the measure is concerned purely with valence, this weighting bias index should not be domain-specific. Indeed, it has been found to relate to a range of judgments. Specifically, the weighting bias correlated with fear of rejection when considering hypothetical interpersonal events, assessment of ambiguously threatening situations, fear of entering new situations, and risk tendencies involving both hypothetical and actual behavior (Pietri et al., submitted). Given that individuals' weighting of valence information related to such a wide array of judgments, we believe this bias assessment procedure captures a fundamental individual difference.

Interestingly, post-experimental interviews with BeanFest participants suggested that they lacked the ability to introspect and self-report on their attitude generalization tendencies. To examine this possibility empirically, participants in one past study (Pietri et al., submitted) completed a questionnaire inquiring directly about their positive/negative weighting tendencies (e.g., "To what extent do you tend to give more weight to positive information over negative information?") Furthermore, to assess whether the performance-based measure of valence weighting captures a different process than other domain non-specific measures of sensitivity to positives and negatives, participants completed the Approach/Avoidance Temperament Questionnaire (ATQ, Elliot & Thrash, 2010). The ATQ was specifically chosen because Elliot and Thrash asserted that these temperaments represent a core, umbrella personality trait. In accord with this reasoning, their findings revealed the ATQ to correlate as expected with measures of neuroticism, extraversion, behavioral inhibition system/behavioral approach system, and promotion/prevention. The performance-based measure of valence weighting provided by BeanFest did not correlate with either the weighting bias questionnaire or the ATQ (Pietri et al., submitted). Thus, it appears that individuals cannot introspect and self-report on their valence weighting when engaged in attitude generalization. We suspect that BeanFest is a particularly useful performance-based measure largely because it utilizes novel stimuli and experimentally associates those stimuli with differing valence. As a result, it provides an assessment of valence weighting per se, unconfounded by the differential familiarity, distinctiveness, and diagnosticity that often accompany positive versus negative information (e.g., Skowronksi & Carlston, 1989). Those natural confounds may play a role in the difficulty individuals appear to have when asked to report on their valence weighting tendencies.

Although past research has shown the valence weighting in attitude generalization to relate to a variety of judgments, the index has proven most predictive for situations that were somewhat novel, or that individuals were unlikely to have encountered previously. For example, the weighting bias correlated with participants' likelihood of taking a risk that they were unlikely to have experienced in the past, but did not relate to their rated likelihood of taking risks that they had likely encountered in the past. Presumably, individuals can draw on their past behavior when making judgments about situations they have previously experienced. Whether they took a risk in the past may inform their predictions about whether they would act similarly in the future. Moreover, if individuals engaged in the risky behavior in the past, whether they experienced a favorable outcome will contribute to their decision to take a similar risk. Thus, valence weighting is most relevant to the assessment of relatively novel situations that require some integration of positive and negative aspects in order to reach a judgment, prediction, or decision. It is this process that occurs when generalizing positive and negative attitudes to novel objects (Pietri et al., submitted).

Stressful situations can be unique experiences for individuals. For example, Bradley & Jones' (1989) Daily Stress Inventory, which is often used to assess the impact of typical stressors, includes many novel or unusual events (e.g. “Feared illness/pregnancy” “Had confrontation with an authority figure”). Furthermore, by their very nature, life-altering stressors are often new experiences, such as moving to a new city or losing a loved one. As a result, disambiguating the meaning and significance of the event may be open to considerable variability. How individuals weight the negative versus the more positive or neutral aspects of such occurrences will be important to how they react. On the basis of the previous research findings showing the weighting bias to correlate with judgments of hypothetical situations involving the possibility of stress (e.g., threat or rejection), we believe this valence weighting bias will relate to emotional reactivity in an actual stressful situation.

Valence biases and emotional reactivity

To better understand what predisposes individuals to be reactive to stressful situations, researchers have focused upon individual differences in cognitive processing styles. Often these studies have participants experience a stressor in the laboratory. For example, participants may complete a difficult (or even impossible) task and, hence, experience a failure (e.g., Dandeneau, Baldwin, Pruessner, Baccus, & Sakellaropoulo, 2007; Macleod, Rutherford, Campbell, Ebsworthy, & Holker, 2002), or they may watch a distressing movie (e.g., Wilson, MacLeod, Mathews, & Rutherford, 2006). Participants’ mood is typically assessed before and after the stressful task, and mood change serves as an index of emotional reactivity to the stressful event.

Researchers have found a relationship between such emotional reactivity and a negativity bias in attention and/or interpretation. In the typical attentional bias paradigm, participants are presented with two words or faces on a computer screen, one of which is threatening and the other neutral. The words or faces appear only very briefly (generally for 500 ms). A probe then appears in place of one of the words/faces, and participants quickly have to indicate the nature of the probe (e.g., two vertical or horizontal dots). Thus, if participants are attending to the threatening word/face, they will be faster to identify the probe when it appears in place of that stimulus (Dandeneu et al., 2007; Macleod et al., 2002). The interpretation bias is generally measured by presenting participants with homographs, or words that have both neutral and threatening meanings (e.g., terminal), or ambiguously negative situations (e.g., You walk into a room and someone looks in your direction). Participants then indicate the meaning of the word or the most likely explanation for the situation. Those who respond with the more threatening interpretation are considered to show a negativity bias (Murphy, Hirsch, Mathews, Smith, & Clark, 2007; Wilson et al., 2006). The research findings demonstrate that individuals who focus their attention on negative stimuli, or interpret ambiguous situations or words negatively, tend to have a more adverse reaction to a stressful situation.

Present Studies

The present research examines the relation between the weighting bias and emotional reactivity to a stressful event in the laboratory. A task that provokes stress in the laboratory may not necessarily be one that participants are likely to experience in their everyday life. Despite this limitation, researchers have found that predictors of emotional responses in the laboratory are also related to reactions to real-life stressors (for an example, see Dandeneau et al., 2007). Thus, examining reactivity in the laboratory is a useful proxy to understanding how individuals are likely to react to real life stressors.

As mentioned earlier, BeanFest provides a unique way to assess valence weighting in attitude generalization because it is a performance-based measure utilizing stimuli with which participants have had no prior knowledge. It thus provides a very pure assessment of the weighting of positive and negative, unconfounded by the usual correlates of valence. For this reason, the present studies examine a process that differs from the prior research associating attention and interpretation biases to stress reactivity. The attention bias is concerned with the very early stages of information processing, specifically where individuals initially focus (and maintain) attention. The interpretation bias observes individuals' explanations for specific ambiguous situations or their resolution of the ambiguity inherent to homographs, both of which involve content that is likely to be associated with a lengthy history of past experiences. In contrast, the weighting bias as assessed by BeanFest concerns individuals' attitudinal generalizations regarding novel stimuli. Furthermore, as previously mentioned, this appears to be a process about which individuals have difficulty reporting. Thus, we are examining if the same process that individuals use when generalizing their attitudes, weighting similarity to known positives versus similarity to known negatives, occurs when individuals react to a stressful situation. Such attitude generalization should play a critical role in individuals' emotional response to the stressful event.

In addition, this research aims to expand upon past weighting bias work in that the present studies are the first to examine the relation between this bias and individuals' reactions to an *actual* stressful occurrence. The earlier work focused on reactions to hypothetical scenarios. The stressful situation used in the current studies was modeled after an anagram task employed in the Macleod et al. (2002) experiment. Participants were led 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 to the experience. Although the anagram task was designed to produce a failure experience, it also was intended to be only mildly stressful; ultimately, it was a task for a study that had no real bearing on the participants' lives. Thus, participants could vary considerably in their reactions to the task. We predicted that participants who exhibited a stronger negative weighting bias on the BeanFest measure would weight the negative aspects of the anagram experience more heavily and, hence, show more emotional reactivity than those with a more neutral or positive weighting bias.

Study 1: Weighting Bias and Emotional Reactivity

Method

Participants

Ninety-seven (56 female and 41 male) students enrolled in an introductory psychology course participated for research credit. Two participants were excluded from the analysis, because they had very positive final mood scores, over 2.5 standard deviations above the mean. The data from five other 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. Ninety participants (53 female and 37 male) were included in the final analyses.

Procedure

The study was introduced as an examination of the relation between verbal intelligence and how well individuals could learn about objects in a novel world. The anagram task and mood measures were closely modeled after those used by Macleod et al. (2002). Participants first completed a seven-item mood questionnaire, which instructed them to indicate how they were feeling at that exact moment, presumably because their current state might impact their performance. Two discrete labels (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 each +3 to -3 scale, and participants were instructed to specify where their current mood fell on the scale (α=.86). There were two purposes to this initial mood questionnaire. First, it provided a baseline with which to examine mood change resulting from the anagram task. Second, it allowed us to examine the possibility that the stressful situation may be more impactful for people who are not already in a bad mood at the very beginning of the experiment.

The procedure for BeanFest was the same as that employed in Experiment 4 of Fazio et al. (2004). The game phase was divided into three blocks, each consisting of 36 trials. During each block, the 36 beans from six selected regions of the matrix were presented (see Figure 1). Each trial began with the appearance of a bean in the upper part of the monitor. Participants had to indicate whether they wished to approach or avoid the bean, using a response box with two buttons labeled "yes" and "no." If participants chose to approach the bean, they saw the value of the bean they had selected (+10 or -10) and their points score was updated accordingly. If participants did not approach the bean, their current point value did not change. However, participants were shown the value the bean would have had if it had been chosen. In other words, BeanFest was implemented in its full-feedback version in which information gain is not structurally contingent upon approach behavior. Under such conditions, learning does not vary, on average, as a function of the valence of the beans (see Fazio et al., 2004).

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 4 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. How many times participants restarted the game depended on how many times they won or lost. However, all participants were shown three blocks of 36 beans no matter how many times they won or lost, after which, the game ended.

Participants then completed the test phase, in which they 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 to be good or bad, i.e., would have increased or decreased their point value during the game. Participants received no feedback during this test phase, and no cumulative point score was displayed.

The experimenter then read the instructions for the anagram task, the presumed measure of verbal intelligence. Participants were informed that they would have three minutes to complete 20 anagrams. They were encouraged to try to answer every anagram. However, participants were told that if they really could not solve an anagram they had the option of skipping it. 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 chose to answer the anagram, a text box would appear, and participants could answer the anagram in this box. If participants chose to skip the anagram, the computer would present the next anagram. After three minutes, the computer automatically concluded the task.

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, while the rest were presented in random order. 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 the anagram task, participants completed the same seven-item mood scale that had been administered at the beginning of the session (α=.82).

At the end of the study, participants completed a short questionnaire that probed for any suspicion about the true purpose of the study in general and specifically the anagram task. No participants expressed any suspicion. Thus, participants believed all aspects of the cover story, including that the anagram task was a measure of verbal intelligence, and that the mood measures were administered in order to examine whether mood states impacted performance.

Results

Anagram task and mood change

As expected, participants reported feeling worse after the anagram task (M=-.07, SD=.78) than before (M=.65, SD=.85), $t(89)=10.76$, $p<.001$. 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=.64. Our goal was to examine the predictors of this variability in mood change.

Variables related to mood change

Before considering the predictor variable of most interest, the weighting bias, we thought it important to identify other variables that might have influenced mood following the experience with the anagram task. As is to be expected, initial mood state correlated substantially with final mood reports, $r(89)=.70$, $p<.001$. However, certain variables associated with the anagram task also seemed likely to affect mood at time two. One such variable was how many anagrams participants answered. Some participants managed to solve a few of the difficult anagrams and/or to provide an occasional reasonable answer for an unsolvable anagram. No participant did extremely well at the task; the maximum number of anagrams to which any participant responded was only five out of the 20 anagrams (M=1.80, SD=.99). However, we reasoned that a participant who answered relatively more anagrams would 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), $r(89)=.28$, $p<.01$. Another variable related to the anagram performance that proved influential concerned how many anagrams participants had to pass during the task. The instructions explicitly told participants to skip an anagram if they truly felt they could not answer it. On average, participants did not pass very many anagrams (M=4.13, SD=1.45). However, the more they did so, the more their mood worsened, $r(89)=-.22$, $p<.05$.

Yet another variable that we suspected might influence mood at time two was performance on the BeanFest game. To index performance, we calculated the number of times participants won and lost during the game phase of the paradigm, and created a difference score of wins minus losses, (M=2.04 SD=2.07). We presumed that how many times participants won versus lost would influence their final mood, because the computer clearly displayed these outcomes. Thus, individuals who saw they were doing well on BeanFest should be in a better mood than those who did poorly. In fact, performance did correlate significantly with mood change, $r(89)=.23$, $p<.05$.

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=.56, $F(4)$=27.47, p<.001. Mood at time one (B=.73, $t(89)$=10.14, p<.001), number of anagrams answered (B=.18, $t(89)$=2.45, p<.05), number of anagrams passed (B=-.13, $t(89)$=-1.74, p<.10), and BeanFest performance (B=.14, $t(89)$=1.90, p<.06) each contributed to the prediction of mood at time two.

The residual approach to the estimation of weighting bias

We were next interested in how the weighting bias related to mood change. Our approach to estimating the weighting bias involved considering the extent to which participants classified novel beans, ones they had not seen during the BeanFest game, as more likely to be positive (or negative) than was to be expected on the basis of their learning of the positive and negative game beans. It focused on a regression equation predicting the average response to the novel beans from the proportion of positive game beans learned correctly and the proportion of negative game beans learned correctly. For any given individual, deviation from this predicted value, i.e., the residual, provided our estimate of the extent to which the individual weighed resemblance to a known negative versus resemblance to a known positive more heavily than the "average" participant. In other words, the residual indexed the extent to which the individual was showing a relative weighting bias in favor of one valence or the other.

The specific details of the residual approach followed exactly from Pietri et al. (submitted). The BeanFest procedure described in the current method section was employed not only in the present study but also in many past studies, including the six reported by Pietri et al. Given this commonality and the interest in locating a given participant in relation to a normative regression equation, Pietri et al. aggregated the BeanFest data across all the studies that employed the same method. This provided a sample of 321 participants with which the regression parameters could be estimated very stably. The data from the current study was included in this aggregate sample. Across the relevant studies, three variables were generated from the test phase data and used in the regression equation. The first two concerned learning of the game beans. Specifically, the proportion of positive game beans correctly classified and the proportion of negative game beans correctly classified were calculated. The remaining 64 beans from the matrix are novel ones that had not been presented during the game. Those judged to be positive were assigned a value of +1 and those judged to be negative a value of -1. The average response to the novel beans was then calculated and served as the outcome variable in the regression equation.

Naturally, the response to any given novel bean is partly a function of how well visually-similar game beans are learned. The earlier BeanFest research repeatedly demonstrated that attitudes toward the game beans generalize to visually similar novel beans (Fazio et al., 2004; Shook et al., 2007). Beans that are closer in proximity to a negative game bean are likely to be classified as negative, whereas those closer to a positive game bean are classified as positive. Or, put another way, those bearing more resemblance to negative game beans are more likely to be judged negative and those more similar to positive beans are more likely to be deemed positive. In the aggregate sample, the proportion of positive game beans correctly classified and the proportion of negative beans correctly classified together accounted for 42% of the variance in average response to the novel beans, $F(2, 318) = 113.24$, $p < .001$. The multiple regression equation was:

$$\text{Novel} = .53(\text{Positive Correct}) - .78(\text{Negative Correct}) + .12$$

Both regression weights were highly significant: for the proportion of positive game beans correctly classified, $t(320) = 8.33$, $p < .001$, and for the negative, $t(320) = 14.50$, $p < .001$. Thus, if participants learn the positive beans well, they are more likely to classify the novel beans as positive, and if they learn a high proportion of the negative beans, they classify more novel beans as negative. Also noteworthy, however, is that the regression weight for the negative predictor variable is nearly 1.5 times the size of that for the positive. Thus, an individual who had learned the positive and negative beans equally well (e.g., proportions correct of .8) was likely to display an average response to the novel beans that was negative in value (-.08) according to the regression equation. This greater weight for the negative variable relative to the positive accords with the generalization asymmetry observed in past BeanFest studies. On average, individuals display a negativity bias, more strongly generalizing their negative attitudes than their positive attitudes. This generalization asymmetry represents an example of the negativity bias that many scientists have discussed (e.g., Baumeister et al., 2001; Rozin & Royzman, 2001). People on average weight negative information more strongly than positive (see Fazio et al., 2004, for detailed discussion).

Although the relation between the response to the novel beans and the learning of positive and negative game beans is very strong statistically, there naturally is variability around this general trend. That variability is depicted in Figure 2, which displays a scatterplot of predicted values from the regression equation and actual values. Some participants fell below the regression line, classifying more of the novel beans as negative than is to be expected on the basis of their learning of the game beans. Others classified more novel beans positively than expected on the basis of their learning and, hence, fell above the regression line. We employed this deviation from the predicted value, i.e., the residual, as the estimate of an individual's weighting bias. More negative (positive) values indicate a tendency to classify more novel beans as negative (positive) than is to be expected from one's learning pattern. Or, stated differently, more negative (positive) values reflect a tendency when judging novel stimuli to more strongly weight resemblance to a negative (positive) than resemblance to a positive (negative), relative to what is typical in the aggregate sample. The current study focuses on the power of these estimates of individuals' weighting bias to predict emotional reactivity to the stressful anagram task.

Weighting bias and mood change

To test the hypothesis, we conducted a regression analysis predicting mood at time two from mood at time one, the weighting bias as estimated by the residuals, and the two-way interactions between mood one and the weighting bias, while controlling for the other variables already documented to relate to mood at time two (anagrams correct, anagrams passed, and BeanFest performance).

No main effect of the weighting bias was evident, $t<1$. However, there was a significant interaction between mood at time one and the weighting bias, $t(89)=2.41$, $p<.05$. To probe this two-way interaction (see Figure 3), 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 one standard deviation above the mean. At this value of initial mood, the weighting bias significantly related to mood at time two; those with a more negative weighting bias reported poorer final mood states ($B=.17$, $t(89)=2.07$, $p<.05$). At a value of initial mood one standard deviation below the mean, the weighting bias was not significantly related to mood at time two ($B=-.1$, $t(89)=1.29$ $p=.2$).

Thus, among participants who started out in a relatively good mood, the weighting bias related to emotional reactivity in the predicted direction. We did not observe a similar relation between the weighting bias and final mood for participants who started the study in a bad mood.

The null effect may be due to the difficulty of shifting these participants into an even worse mood. To look at this possibility, we examined the relation between initial mood and post-task mood, as illustrated in Figure 4. The dotted line is for reference purposes; it depicts post-task mood scores perfectly matching initial mood scores. The solid line is the actual regression line predicting mood 2 from mood 1. The regression line clearly falls below the dotted one, indicating that on average participants' mood decreased from the beginning of the experiment to after the anagram task. However, we see that this difference is most pronounced for participants who started out in a good mood. For participants who began the study in a relatively bad mood, there is little, if any, difference between these lines. Indeed, the correlation between mood at time one and mood change (the difference between time 2 and time 1 mood scores) was highly significant, $r(88)=-.48$, $p<.001$. Thus, 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 already feeling negatively.

Discussion

On average, participants were in a worse mood after completing the anagram task. Thus, we successfully created a task to which most reacted emotionally. Furthermore, participants who weighted negative information more strongly than positive during attitude generalization had a particularly adverse reaction to the anagram task. However, we found a relation between the weighting bias and emotional reactivity only among participants who started out in a good mood. Participants who entered the experimental session in a negative mood displayed little decreased mood as a result of the anagram task, since they were already experiencing negative affect.

The study provides evidence that an asymmetry in the weighting of positive versus negative information in attitude generalization relates to how much an individual reacts adversely to a stressful event. For a number of reasons, we decided to conduct a second study aimed at providing a conceptual replication of the finding. The variability in BeanFest performance had the unintended effect of influencing participants' mood. Although we controlled 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. Furthermore, in the interest of convergent validity, we wanted to assess the weighting bias using a variation in the BeanFest game. Specifically, instead of statistically controlling for differences in learning of positive and negative beans, we used a version of BeanFest that ensured participants learned all the game beans well. If all participants do well at the game, varying degrees of BeanFest performance should no longer influence mood change. In addition, we can consider a new manner of assessing the weighting bias – one that does not rely on the statistical residual approach – and examine its relation to emotional reactivity to a stressor.

Study 2: The Learning-to-Criterion Approach to the Weighting Bias

The current study also examined whether valence weighting in attitude generalization related to mood change after experiencing the stressful anagram task. However, this study expanded on Study 1 by employing another method of assessing the weighting bias. In this study, participants completed a version of the BeanFest paradigm that facilitated their learning all the game beans very well to ensure that the weighting bias could be observed without the potential for any interference from discrepancies in learning. This goal was achieved by employing a simplified matrix and multiple practice phases. As a result, we no longer had to control for the learning of positive and negative game beans when indexing the weighting bias.

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, game performance 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 again would relate to emotional reactivity to a stressful event primarily among participants who were initially in a good mood. That is, we expected to again observe an interaction between the weighting bias and initial mood when predicting final mood

Method

Participants

Sixty (32 female and 28 male) students enrolled in an introductory to psychology class participated for course credit. 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. The main difference 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. Participants could learn fairly simple associations to 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 began the study by completing the 7-item mood questionnaire (α=.83). The BeanFest paradigm was implemented in a slightly different manner than in the previous study to ensure participants learned all the game beans well. Participants first played a practice game, which consisted of one block of 40 trials. Participants were randomly presented with each of the 40 beans once.

Following the practice game, participants completed a classification training task, designed to help them learn the valence of the various game beans. The task 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 (would decrease their points). 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, which consisted of two blocks of 40 trials. They then completed the test phase. As in Study 1, participants were presented with all 100 beans from the matrix, within two blocks of 50 randomized trials. Thus, participants saw all 40 game 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.

Participants then completed the same anagram task employed in Study 1, followed by the mood questionnaire (α=.67). 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).

Results

Anagram task and mood change

Again, 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, the anagram task did adversely affect participants, on average.

Variables related to mood change

As in Study 1, we found it important to consider 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 at time two from mood at time one, number of anagrams answered, number of anagrams passed, and BeanFest performance. Mood at time one (B=.56, $t(54)$=5.36, p<.001) and anagrams answered (B=.31, $t(54)$=2.91, p<.01) significantly predicted mood at time two, and anagrams passed was marginally significant (B=-.18, $t(54)$=-1.71, p<.10). No participants lost during the game phase, so we used number of times participants' won the game as the index of BeanFest performance. This variable did not significantly relate to mood at time two (B=-.33, t<1). This was to be expected, for the BeanFest game in this study had been designed in such a way so as to ensure that all participants learned the game beans very well. Thus, all participants did well at the game as indicated by the lack of losses, as well as the high number of wins (M=6.62, SD=1.16).

Learning-to-criterion approach to estimation of weighting bias

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) equally well. The main purpose of ensuring that participants learned the game beans well was to guarantee that the index of the weighting bias would not be influenced by overall learning or by any differential learning of positive versus negative beans.

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 evidence of a weighting bias, they would have an average score of 0.

When calculating the weighting bias, we took into account that the novel beans vary considerably in their resemblance to positive and negative game beans (see Figure 5).[1] In terms of this simplified matrix, some beans 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 termed 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 distant from both positive and negative sections. We termed these beans "center" beans, and they do not have a strong resemblance to either a 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.[3]

Because the ambivalent beans were high in both positive and negative aspects, we reasoned that these beans would best represent the valence weighting that occurs during attitude generalization. There were six such beans in each quadrant of the matrix, for a total of 24 ambivalent beans. 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 ambivalent beans was significantly lower than zero (M=-.17, SD=.23) $t(54)=5.31$, $p<.001$. This finding is consistent with the general negativity bias seen in the regression equation that underlies the residual approach to indexing the weighting bias. Nevertheless, the standard deviation indicates that there is considerable variability around this mean.

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 ($t<1$), but the predicted interaction between the weighting bias and mood at time one was significant, $t(54)=2.61$, $p<.05$. Decomposing this interaction (see Figure 6), we first focused on the regression line for an initial mood value one 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, $t(88)=1.22$, $p>.20$).

As in Study 1, we found significant results only among participants who started out in a relatively good mood at time one. We again presumed this was because it is difficult to put participants who entered the laboratory in a bad mood into an even worse mood. To explore this possibility, we again calculated mood change as mood at time two minus mood at time one and found this difference score to correlate negatively with initial mood, $r(88)=-.33$, $p<.05$. Once again participants who began the study in a bad mood were less likely to experience a decline in mood than participants who were initially in a good mood.

Discussion

The main aim of this study was to replicate Study 1's findings using a new means of indexing the weighting bias. Specifically, we sought to ensure that participants learned all the game beans well, so we would not have to control for discrepancies in learning between positive and negative beans. To accomplish this goal, we employed a version of the game that helped participants learn all the beans well. The effort was successful in that participants learned the game beans to near perfection and there was no evidence of a learning asymmetry. However, when classifying novel beans, participants showed a generalization asymmetry; they were more likely to classify a novel ambivalent bean (one that bore some resemblance to both known positives and known negatives) as negative than as positive. Thus, as discussed in relation to the residual method of examining the weighting bias, participants, on average, were weighting negative information more heavily than positive when generalizing their attitudes. Nevertheless, variability in this weighting bias predicted emotional reactivity to the anagram task, at least among participants who started out in a good mood.

General Discussion

In both Studies 1 and 2, participants reported a significant decrease in mood following the anagram task, thus confirming that we were successful in creating a situation that was, on average, at least somewhat stressful. In Study 1, among participants who began the experiment in a relatively good mood, those who exhibited a stronger negative weighting bias as measured through the residual method on the BeanFest measure showed more emotional reactivity. In Study 2, we again found a relation between mood change and valence weighting among participants who entered the study in a good mood. However, in Study 2 we utilized the learning-to-criterion method of assessing the weighting bias. The BeanFest paradigm was implemented in such a way as to ensure that participants learned all the game beans very well. Thus, there was no longer variability in the learning of positive and negative game beans, and we could simply use participants' classification of the novel beans that bore resemblance to both known positives and known negatives as an index of the weighting bias. The more of these ambivalent beans that were characterized as negative, the more negative the participant's weighting bias, and the stronger the emotional reactivity reported. Thus, Study 2 provided convergent validity for Study 1, using a different method of indexing valence weighting during attitude generalization.

In both studies, we found significant results only for participants who entered the study in a good mood. We postulated that this was a result of the lack of variability in mood change for participants who started in a bad mood. In fact, we found in both studies that individuals who began the study in a good mood, showed more mood change in response to the anagram task than individuals who started out in a bad mood. However, at least for participants who were initially in a good mood, both weighting bias indices related to emotional reactivity, suggesting that the process by which individuals weighed positive versus negative resemblance during attitude generalization is similar to the way that individuals understood the positive and negative aspects of this somewhat stressful event.

Past research examining individual differences in valence weighting has found this bias to be predictive in a wide array of novel situations that require some integration of positive and negative aspects in order to reach a judgment, prediction, or decision. Because the BeanFest procedure provides an assessment of valence weighting with respect to novel objects, this weighting bias is not domain specific. Indeed, in the earlier research, the measure correlated with fear of rejection when considering requests that one might make of another person, discomfort with new situations, assessment of situations that had the potential to grow threatening, and risk tendencies in both hypothetical and actual behavior (Pietri et al., submitted). However, this earlier work concerned relations between the weighting bias and reactions to stressful scenarios that were hypothetical in nature. The current findings expand upon this research because these results are the first to find a relation between this bias and reactions to an *actual* stressful event.

It is important to remember that our measure of this weighting bias is performance-based in nature, which offers many benefits. Specifically, there are some well-known disadvantages associated with self-report questionnaires. 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 about reporting their anxiety (Kendall & Flannery-Schroeder, 1998; Vasey & Lonigan, 2000). BeanFest is a particularly useful performance-based measure because it utilizes novel stimuli, with which individuals have no prior contact. As a result individuals' past experience with the stimuli cannot influence their performance. People's reactions to the beans are solely a result of their experiences during the game. Thus, BeanFest provides a very pure measure of the weighting bias, unconfounded by the usual correlates of valence such as familiarity, distinctiveness, or diagnosticity (e.g., Skowronksi & Carlston, 1989).

Past research has successfully employed the BeanFest paradigm as an individual difference measure in the domain of emotional disorders (Shook, Fazio, & Vasey, 2007), as well as political ideology (Shook & Fazio, 2009). However, this past work examined valence biases other than that associated with attitude generalization and weighting -- specifically, two biases pertaining to the learning asymmetry. The first is the *sampling bias* and is observed when participants play the contingent-feedback version of the BeanFest game. The sampling bias reflects how willing participants are to approach a bean that they believe may be negative in the interest of gaining information about the value of the bean. Recent research has associated such a sampling bias with political ideology; liberals display a greater willingness to explore (Shook & Fazio, 2009). The second is the *learning bias*, and can be examined when feedback is not contingent upon approach behavior, and therefore sampling behavior no longer dictates information gain. The learning bias reflects how well participants rehearse and attend to the positive versus negative outcome information. Shook et al. (2007) found that a learning bias favoring the negative beans was related to more negative cognitive styles and greater self-reports of depressive and anxious tendencies within a college student sample. Furthermore, Conklin, Strunk, and Fazio (2009) found that individuals who met criteria for major depressive disorder showed a more negative learning bias compared to non-depressed controls. Thus, the learning bias is associated with vulnerability to developing emotional disorders as well as clinical levels of depression.[4]

Thus far, there has not been research examining the relation between the weighting bias and vulnerability to emotional disorders. The current studies are the first to explore this possibility in that stress reactivity is known to have important consequences for psychological well being. Many stress-vulnerability models argue that individuals who have adverse reactions to stressful situations are at heightened risk of developing emotional disorders (e.g., Ingram & Price, 2001). Cognitive theories of depression and anxiety assert that individuals who have negative cognitive styles tend to be emotionally reactive to stressful situations and thus, are vulnerable to developing these disorders (Beck, 1987; Abramson, Alloy & Metalsky, 1989; Riskind, 1997). Furthermore, research has found that in comparison to people who are less sensitive, individuals who are reactive to stressful or negative events develop more depressive symptoms over time (Felsten, 2002; Parrish, Cohen, & Laurenceau, 2011). Thus, the current research suggests that having a negative weighting bias may be associated with a vulnerability to developing emotional disorders.

It is important to note some limitations associated with the current research. First, we did not measure participants' reactions to a stressor from their everyday life, but rather a stressful laboratory situation that was necessarily somewhat artificial in nature. Future research should examine the relationship between the weighting bias and emotional reactivity to real-life stressors outside of the laboratory.

In addition, although the current studies provide evidence that the weighting bias relates to emotional reactivity to a stressful event, we obviously cannot draw any causal inferences from these findings. We cannot infer that possessing a negative weighting bias causes individuals to have a more adverse reaction to negative events. Past research has successfully manipulated negativity biases in both attention and interpretation, and has shown that these biases exert a causal influence on emotional reactivity to a stressful event. Training individuals to attend to positive stimuli results in less emotional reactivity (e.g., Wilson et al., 2006; Dandeneau et al., 2007). Thus, future research should aim to experimentally manipulate the weighting bias in order to examine its possible causal influence. Training individuals with a negative weighting bias to weight positive and negative information more equally during attitude generalization may result in less emotional reactivity and all its associated advantages. Indeed, the BeanFest paradigm could easily be utilized to identify individuals who weight negative information more strongly than positive. It is these individuals who are particularly at risk for having strong negative reactions to stressful events, and it is they who might benefit most from a training procedure that promotes weighting positive information equally to negative.

Despite the limitations we have noted, the current research represents a crucial first step in demonstrating that how individuals weight positive versus negative information relates to how they react to a stressful situation.

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Footnotes

[1]We classified the novel beans from the 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 average 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 ($r=.23$, $p>.09$).

[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.

[4] Because the six studies reported by Pietri et al. (submitted) and the current Study 1 all employed the full feedback version of the BeanFest game and the complicated matrix, the relation between the outcome variable and the learning bias could be examined in each study. The learning bias did not significantly relate to any of the measures, with the single exception of the current Study 1 examining emotional reactivity to a stressful task. Mood change related to the learning bias, again for participants who are started out in a good mood. Most likely, how individuals react to a stressful event is a result of a combination of factors including not only how they weight positive and negative information, but also the extent to which they rehearse and ruminate upon the negative information. Thus, it makes sense that such reactivity relates to both the learning and weighting bias.

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
X1	10	10	10			-10	-10	-10		
X2	10	10			-10	-10	-10			
X3						-10				
X4									10	
X5		-10						10	10	10
X6	-10	-10	-10						10	10
X7	-10	-10								
X8					10					
X9				10	10	10			-10	-10
X10			10	10	10			-10	-10	-10

Figure 1. Bean Matrix. 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.

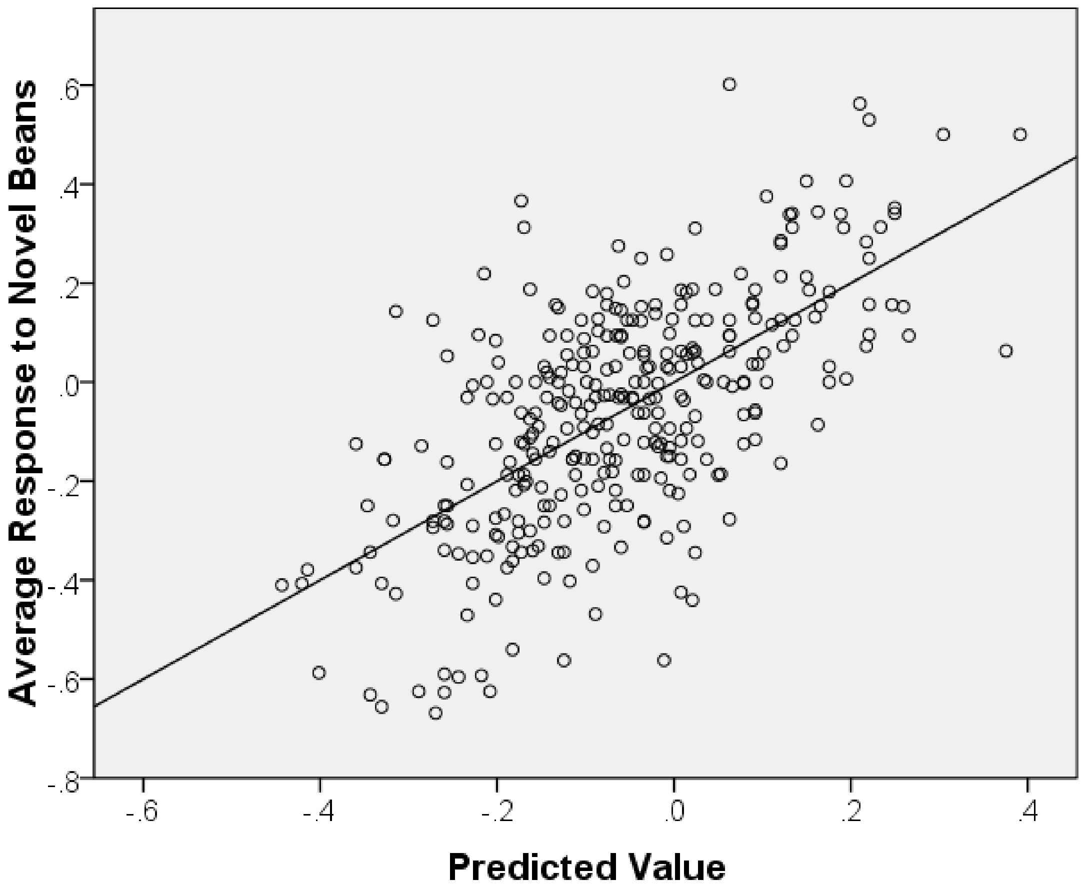

Figure 2. The predicted values from the regression equation and actual response to novel beans.

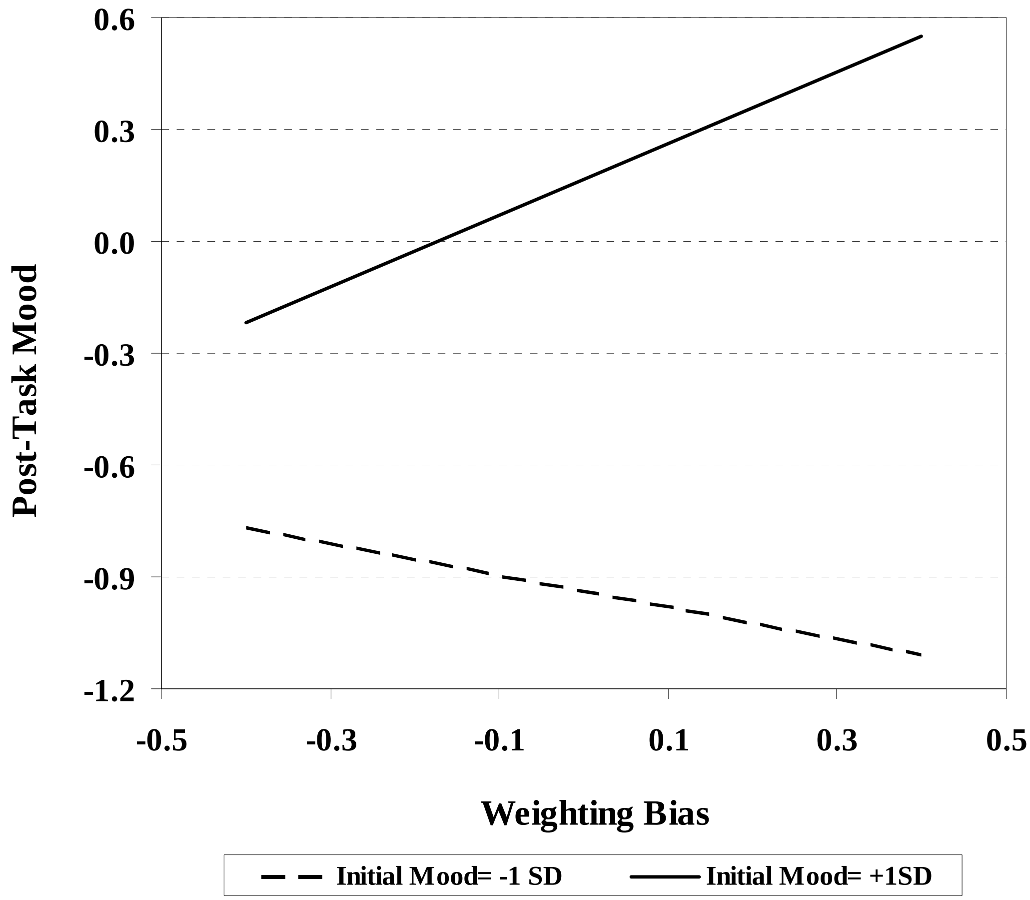

Figure 3. Study 1 regression lines relating the weighting bias to mood at time two, as a function of mood at time one.

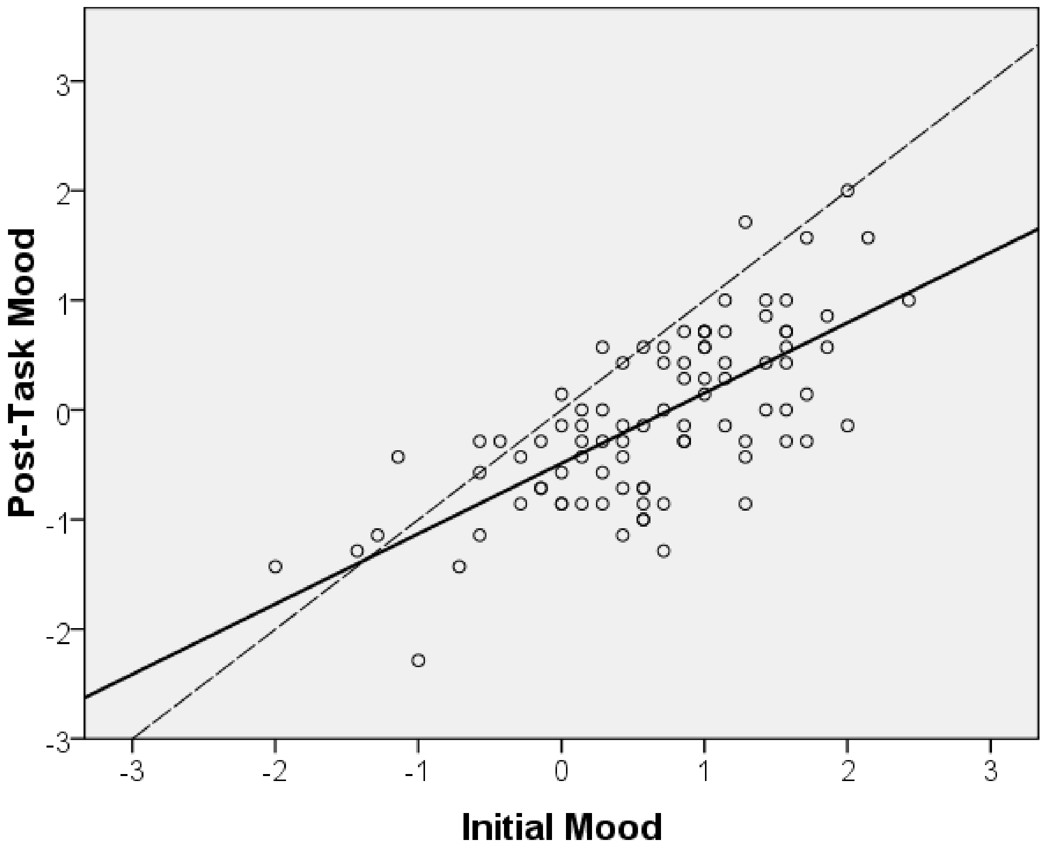

Figure 4. Solid line is the regression line of initial mood predicting post-task mood in Study 1, while the dotted line is the hypothetical line displaying identical mood scores at the two times.

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
X1	+	+	+	+	A	A	-	-	-	-
X2	+	+	+	U	A	A	U	-	-	-
X3	+	+	U	U	A	A	U	U	-	-
X4	+	U	U	U	C	C	U	U	U	-
X5	A	A	A	C	C	C	C	A	A	A
X6	A	A	A	C	C	C	C	A	A	A
X7	-	U	U	U	C	C	U	U	U	+
X8	-	-	U	U	A	A	U	U	+	+
X9	-	-	-	U	A	A	U	+	+	+
X10	-	-	-	-	A	A	+	+	+	+

Figure 5. The beans classified as Univalent (U), Ambivalent (A), or Center (C)

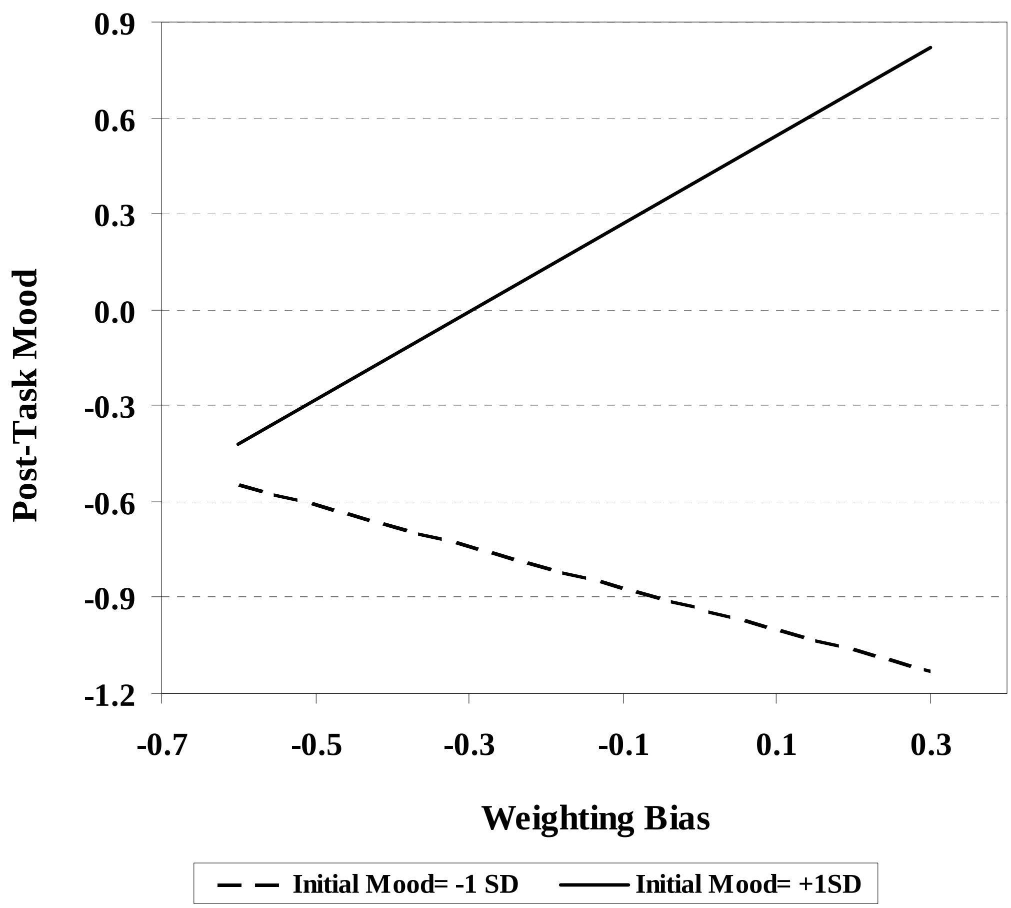

Figure 6. Study 2 regression lines relating the weighting bias to mood at time two, as a function of mood at time one.