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ORIGINAL ARTICLE

Eye Gaze Tracking Reveals Different Effects of a Sad Mood Induction on the Attention of Previously Depressed and Never Depressed Women

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Abstract This study examined the effect of a sad mood induction (MI) on attention to emotional information and whether the effect varies as a function of depression vulnerability. Previously depressed ($N = 42$) and never depressed women ($N = 58$) were randomly assigned to a sad or a neutral MI and then viewed sets of depression-related, anxiety-related, positive, and neutral images. Attention was measured by tracking eye fixations to the images throughout an 8-s presentation. The sad MI had a substantial impact on the attention of never depressed participants: never depressed participants who experienced the sad MI increased their attention to positive images and decreased their attention to anxiety-related images relative to those who experienced the neutral MI. In contrast, previously depressed participants who experienced the sad MI did not attend to emotional images any differently than previously depressed participants who experienced the neutral MI. These results suggest that for never depressed individuals, a sad MI activates an emotion regulation strategy that changes the way that emotional information is attended to in order to counteract the sad mood; the absence of a difference for previously depressed individuals likely reflects a maladaptive emotion regulation response associated with depression vulnerability. Implications for cognitive theories of depression and depression-vulnerability are discussed.

Keywords Attention · Emotion · Depression · Depression vulnerability · Previously depressed · Sad mood induction · Eye tracking

Introduction

During the past decade a great deal of research has focused on the interactions between cognition and emotion. The impact of emotional information on memory encoding and retrieval has been well documented in behavioral studies (e.g., Anderson et al. 2006; Eich et al. 2008; Kensinger 2007; Ochsner 2000) and neuroimaging studies (see Dolcos 2010, for a review) and continues to be a major research area in cognitive neuroscience. The impact of emotional information on attention has not been as extensively studied, although this is a rapidly developing field (Riggs et al. 2011; Yiend 2010). Researchers have also learned a great deal about how mood states can affect memory (see Eich et al. 2008), but much less is known about how negative and positive mood states affect attention. For depression researchers these interactions are especially important because there is a growing consensus that depressed and dysphoric individuals attend to emotional information differently than never depressed individuals (see Gotlib and Joormann 2010, for a review). For example, researchers studying selective attention in depressed and dysphoric individuals have documented biases in the allocation of attention to emotional information (Armstrong and Olatunji 2012; Yiend 2010). Relative to never depressed individuals, depressed individuals exhibit increased attention to depression-relevant themes and stimuli (e.g., depression-related words; images related to sadness) and decreased attention to positive stimuli (e.g., positively valenced words and images). The existence of attentional biases

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points to an important individual difference in the interaction between mood and attention related to depression vulnerability.

Cognitive models of depression maintain that attentional biases are not merely symptoms of depression but are an important cognitive vulnerability for those at risk for depression—the biases are assumed to be trait-like characteristics of vulnerable individuals that play an important role in maintaining vulnerability to depressive episodes (e.g., Beck and Clark 1988; DeRaedt and Koster 2010; Gotlib and Joormann 2010; Ingram et al. 1998, 2008; Koster et al. 2011). In the case of previously depressed individuals not currently experiencing a depressive episode, attentional biases are presumed to be latent, and a dysphoric mood is one stressor thought to be necessary to activate the biases (e.g., Ingram et al. 1994; Just et al. 2001; Miranda and Gross 1997; Miranda and Persons 1988; Scher et al. 2005; Teasdale and Dent 1987). For these reasons depression researchers have used mood inductions designed to elicit feelings of sadness when looking for evidence of attentional biases in previously depressed individuals. The purpose of the present study was to determine how an induced sad mood affects attention to emotional information in previously depressed and never depressed individuals using an eye gaze tracking paradigm known to be especially effective for measuring attentional biases in depression (see Armstrong and Olatunji 2012).

Effect of Sad Mood Inductions on Attention

The existing research on the effects of mood inductions on attention is not extensive, and only a few studies have compared previously depressed individuals to never depressed/non-depressed individuals. Ingram et al. (1994) used a sad MI in combination with a dichotic listening task in their study. In the dichotic listening task, participants are presented with competing auditory stimuli and are instructed to listen to a target message in one ear while attempting to ignore distractor stimuli presented in the other ear (typically emotionally valenced words). Errors in tracking the target message occur when participants momentarily divert their attention to a distractor. Participants were randomly assigned to a sad or neutral MI condition. In the neutral MI condition there were no group differences in the number of tracking errors, whereas in the sad MI condition previously depressed participants made more tracking errors than never depressed participants when the distractor stimuli were either positive or negative words. Ingram et al. concluded that the sad MI affected attentional tracking to emotional stimuli only for the previously depressed participants. Similar results were reported by Ingram and Ritter (2000), who found no differences in the tracking errors of high- and low-risk depression groups in their normative moods and a significant difference in tracking errors for negative distractor words following a sad mood priming condition. In a review of these and similar dichotic listening studies, Ingram et al. (2008) concluded that a sad MI primes a preexisting attentional sensitivity to emotional information (especially negative information) in vulnerable individuals.

McCabe et al. (2000) used a deployment of attention task to compare the effect of a sad MI on attention to emotional words in previously depressed and never depressed individuals. Participants were shown a pair of words (one neutral, one negative) for 750 ms and chose the word they believed was presented first, although both words were presented simultaneously. The chosen word was assumed to be attended to first (i.e., the word first attended was perceived as being presented earlier). McCabe et al. found that in the neutral MI condition, previously and never depressed participants directed attention away from negative words, which was interpreted as a "protective bias" in the allocation of attention. In contrast, in the sad MI condition previously depressed participants attended equally to negative and neutral words and no longer diverted attention away from negative words, whereas never depressed participants maintained their protective bias and diverted their attention away from negative words [see Chepenik et al. (2007) for a different pattern of results with non-depressed individuals]. McCabe et al. speculated that the absence of this protective bias in previously depressed individuals may be a trait-related characteristic that contributes to their vulnerability to depression. Subsequent research has documented that a protective bias is observed in a variety of attention tasks in never depressed individuals, whereas the absence of such a bias appears to be a distinguishing characteristic in depressed individuals and those vulnerable to depression (Ingram et al. 2008).

Joormann et al. (2007) did not examine attention in previously depressed individuals per se, but their study is informative because it illustrates how a sad MI can have different effects depending upon an individual's depression vulnerability. Research shows that children of depressed mothers are at elevated risk for developing depression (Gotlib et al. 2006). Using an emotional faces dot-probe task, Joormann et al. compared young girls (ages 9–14) whose mothers had a history of depression (the high-risk group) to young girls whose mothers did not have such a history (the low-risk group). They found that for girls in the high-risk group a sad MI biased attention toward negative facial expressions, whereas for those in the low-risk group there was a bias toward positive facial expressions. Joormann et al. speculated that the lack of a positive bias in the high-risk girls constitutes an important risk factor for developing future depression.

Several recent studies have examined the impact of positive and negative MIs on attention in individuals not selected specifically for their depression status. The key question in this research is whether there are mood-congruent effects on the allocation of attention to emotional information (e.g., increased attention to negative stimuli when in a negative mood). These studies are informative because they contribute to depression researchers' understanding of how attention is modulated by positive and negative moods in non-depressed individuals. In Becker and Leinenger's (2011) study, participants experienced a positive, negative, or neutral MI, followed by an attentionally demanding multiple-object tracking task. In this task, participants saw six circle shaped objects in a display, three that were empty and three that contained a scrambled face. The participants' task was to count how many times the three empty circles "bounced" against the side of the display. On some trials, an unexpected distractor circle with a happy or sad face within it moved across the display. Participants were more likely to notice an unexpected face when its emotional expression was congruent with their mood; in fact, frowning faces were detected almost exclusively by participants who received the negative MI.

Becker and Leinenger's (2011) results are consistent with those of Isaacowitz et al. (2008), who compared older and younger adults' attention to faces in response to different moods. On each trial, participants saw a pair of faces for 4 s; one face had a neutral expression and the other was happy, sad, angry, or afraid. Gaze durations to each face were assessed using eye tracking. In the sad MI condition, younger adults' gaze patterns were congruent with their negative mood (i.e., attending more to angry and afraid faces), whereas older adults exhibited the opposite bias (attending more to happy faces and away from angry and sad faces). Thus, both mood-congruent and mood-incongruent effects on attention were found depending on the participant's age, an outcome that Isaacowitz et al. suggested could be due to older adults being more likely to use attention to regulate their emotions (as proposed by socio-emotional selectivity theory; Mather and Carstensen 2005).

The Present Research

The purpose of our study was to determine what effect a sad MI would have on previously depressed and never depressed individuals' attention to emotional images. Our study differed from previous mood induction studies in several important respects. First, we used an eye tracking paradigm similar to that used in several recent studies of attention to emotion in depressed and dysphoric individuals (Arndt et al. 2015; Duque and Vázquez 2015; Eizenman et al. 2003; Kellough et al. 2008; Leyman et al. 2011; Sears et al. 2010, 2011). We presented participants with sets of four images and tracked their eye fixations throughout each 8-s presentation. Eye tracking was used to measure attention to the images because it provides a direct and continuous record of the focus of attention, whereas in many other attention tasks the focus of attention must be inferred through the use of response latencies (e.g., the dot-probe task, the deployment of attention task). Each trial consisted of one depression-related image, one anxiety-related image, one positive image, and one neutral image. Presenting multiple images on each trial, each with a different valence, allowed us to look for group differences in attention to both positive and negative images when multiple images compete for attention. The combination of the group manipulation, the mood induction manipulation, and the image type manipulation allowed us to address several questions. Our primary research questions were: (1) Would the sad MI have different effects on previously depressed and never depressed individuals' attention to emotion?, and (2) Would previously depressed individuals who experienced a sad MI attend to depression-related images more than previously depressed individuals who experienced a neutral MI (due to the activation of a latent attentional bias)?

Methods

There were four groups of participants in the study: two groups of never depressed individuals, one group assigned to a sad MI and the other group assigned to a neutral MI, and two groups of previously depressed individuals, one group assigned to a sad MI and the other group assigned to a neutral MI. Like other investigators, we randomly assigned participants to the MI conditions, because random assignment permits stronger causal inferences. Following the mood induction procedure participants viewed sets of four images (one depression-related, one anxiety-related, one positive, and one neutral) while their eye gaze was continuously tracked and recorded to measure their attention to the images.

Measures

The Patient Health Questionnaire-9 (PHQ-9; Spitzer et al. 1999) is a nine-item depression scale based on the diagnostic criteria for major depressive disorder as described in the Diagnostic and Statistical Manual 4th Edition (DSM-IV; APA 1994). The measure assesses how many days over the previous 2 week period the respondent has experienced each of the nine DSM-IV criteria for depression (depressed mood, anhedonia, appetite change, sleep disturbance, psychomotor agitation or retardation, loss of energy, feelings

of worthlessness or guilt, diminished concentration, and suicidal ideation). Each question is scored on a four-point scale ("Not at all", "Several days", "More than half the days", "Nearly every day"). To count toward a diagnosis of depression, the participant had to indicate that she had experienced the criterion for more than half the days, with the exception of the suicidal ideation item, where any endorsement counted towards a diagnosis of a depressive episode. To meet criteria for an episode of depression, the respondent must endorse at least five of the nine criteria, including at least one of the first two cardinal criteria (depressed mood, anhedonia). The internal consistency of the PHQ-9 has been shown to be high, with Cronbach alphas of .86 and .89 in a study of two different patient populations (Kroenke et al. 2001).

A modified version of the PHQ-9 was used to assess for past history of depression (PHQ-9 Lifetime; Spitzer et al. 1999). We used the same diagnostic template for scoring responses as used for scoring the PHQ-9. The only difference from the PHQ-9 is that the PHQ-9 Lifetime changes the time period of focus from the previous 2 weeks to any 2 week or longer period in one's lifetime. This measure has been found to have convergent validity with a diagnosis of a history of depression using the Structured Clinical Interview for DSM-IV Disorders (SCID; Cannon et al. 2007).

The BDI-II (Beck et al. 1996) is a 21-item self-report inventory that measures an individual's depressive symptoms over the past 2 weeks. Each item is rated from zero to three, with a total score of 63, higher scores indicating more symptoms of depression. As reported by Beck et al. (1996), the BDI-II has excellent internal consistency in student ($\alpha = .93$) and outpatient samples ($\alpha = .92$) and excellent test–retest reliability ($r = .93$).

The State Trait Anxiety Inventory (STAI; Spielberger et al. 1983) is a 40-item self-report measure used to assess transient and enduring levels of anxiety. It consists of both state and trait measures, each containing 20 statements that describe how one feels either "at this moment" or "generally". State anxiety refers to the participant's present feelings of anxiety, whereas trait anxiety measures the participant's stable proneness to anxiety and how this anxiety tends to influence the perception of threats in the environment. Participants rate each statement on a scale from 1 (*not at all*) to 4 (*very much so*), with scores ranging from 20 to 80. Internal consistency of this measure has been reported to range from .86 to .95 (Spielberger et al. 1983).

The Balanced Inventory of Desirable Responding (BIDR; Paulhus 1991) is used to assess socially desirable responding tendencies. We administered the BIDR because the instructions for the sad MI had the potential to create a situation where participants may have felt compelled to report they had experienced a shift in mood (i.e., the demand characteristics of the MI procedure may be more powerful for some individuals). The BIDR is a 40-item self-report measure of self-deceptive enhancement (the tendency toward a positively biased understanding of the self) and impression management (IM; deliberate positively biased presentation of the self to others). Questions were answered using a seven-point Likert scale ranging from "not true" to "very true". For the purposes of the present study only scores on the IM scale were of interest. The scale has good internal consistency and convergent-discriminant validity. Cronbach alpha coefficients are 0.80 for the total BIDR and in the range of 0.80–0.86 for IM (Paulhus 1991).

Participants also completed a demographics inventory that included questions about age, relationship status, ethnicity, previous episodes of depression and anxiety, experiences with psychotherapy, and recent changes in mood.

Participants and Group Assignment

Participants included both University of Calgary undergraduate students recruited through an online research participation system and individuals recruited through the use of advertisements placed on campus. To control for gender, only females were recruited for the study. Participants volunteered to participate in the study in exchange for extra course credit or a $20.00 (CAN) gift card. All participants provided informed consent prior to participation.

Potential participants were identified using an online survey consisting of the PHQ-9, PHQ-9 Lifetime, and the BDI, to assess for experiences with depression ($N = 941$). Those who completed the survey were invited for a laboratory visit if their responses on these measures indicated that they were likely to meet the criteria (described below) for the never depressed or previously depressed group ($N = 253$). The majority of these participants (over 90 %) were students. During the laboratory visit, participants completed the PHQ, PHQ-9 Lifetime, and the BDI. Participants were assigned to the never depressed and previously depressed groups based on their responses on the laboratory administration of these measures.

Participants classified as "never depressed" had scores on the PHQ-9 and PHQ-9 Lifetime that indicated they did not presently and had never met criteria for a diagnosis of depression. In addition, these participants had to have a BDI score equal to or less than six to be included in the never depressed group. Participants classified as "previously depressed" had scores on the PHQ-9 Lifetime that indicated that they met criteria for a diagnosis of depression in the past, but their scores on the PHQ-9 and BDI indicated that they were not currently experiencing depressive symptoms (with BDI scores equal to or less than six). In addition, as described below, participants assigned to the sad MI condition had to be successfully mood induced to be included in the data analyses. The final

Table 1 Participant characteristics for the never depressed and previously depressed groups

	Never depressed participants		Previously depressed participants	
	Neutral mood induction ($N = 28$)	Sad mood induction ($N = 30$)	Neutral mood induction ($N = 19$)	Sad mood induction ($N = 23$)
Age	22.3 $(6.1)_a$	21.7 $(6.2)_a$	23.0 $(6.1)_a$	25.0 $(10.8)_a$
BDI	3.1 $(1.9)_a$	2.8 $(2.1)_a$	3.4 $(2.0)_a$	3.0 $(2.0)_a$
PHQ-9	1.9 $(2.3)_a$	2.1 $(1.7)_a$	3.1 $(2.0)_a$	2.3 $(1.8)_a$
PHQ-9 LT	5.0 $(3.8)_a$	4.2 $(3.3)_a$	17.9 $(5.1)_b$	17.5 $(4.3)_b$
STAI state	32.6 $(10.9)_a$	36.3 $(10.9)_{ab}$	31.1 $(7.8)_a$	39.4 $(11.0)_b$
STAI trait	34.5 $(6.4)_a$	33.9 $(6.4)_a$	35.8 $(9.6)_a$	37.8 $(7.0)_a$
BIDR IM	6.3 $(3.2)_a$	6.8 $(3.9)_a$	6.2 $(3.1)_a$	5.2 $(3.5)_a$

Standard deviations in parentheses

BDI Beck depression inventory, *PHQ-9* Patient Health Questionnaire-9, *PHQ-9 LT* Patient Health Questionnaire-9 Lifetime, *STAI state* State-trait anxiety inventory (state score), *STAI trait* State-trait anxiety inventory (trait score), *BIDR IM* Balanced Inventory of Desirable Responding–Impression Management Scale

Means in the same row with the same subscript are not significantly different at $p < .05$

sample consisted of 100 participants approximately equally divided between the sad MI ($N = 53$) and the neutral MI ($N = 47$): 28 never depressed participants in the neutral MI group, 30 never depressed participants in the sad MI group, 19 previously depressed participants in the neutral MI group, and 23 previously depressed participants in the sad MI group.

Participant characteristics are listed in Table 1. As shown in Table 1, the never and previously depressed participants did not differ in terms of their age, BDI scores, PHQ-9 scores, or STAI trait scores. As expected, the never depressed participants had significantly lower PHQ-9 Lifetime scores than the previously depressed participants. The ethnicity of the groups was very similar, with 69 and 74 % of the participants in the never depressed and previously depressed groups self-identifying as "Caucasian" (most of the remaining participants self-identified as "Asian"). The four groups did not differ on their BIDR impression management scores ($F < 1$); thus, there was no reason to believe that the groups differed in socially desirable response tendencies that could have influenced the self-reported effectiveness of the sad MI.

Measures of Mood

Two different measures were used to assess participants' mood states. The first, the Visual Analogue Mood Scale (VAMS; Luria 1975), is a 100 mm horizontal line with endpoints labeled "very sad" on the left and "very happy" on the right. A participant indicates their current mood by placing a mark on the horizontal line. The VAMS is scored from 0 to 100, determined by measuring in mm the distance from the left side of the scale to the participants' rating. The VAMS has been shown to have acceptable to very good reliability, with test–retest reliabilities ranging from $r = .59$ to $r = .80$ (Luria 1975). The second measure was an 11-point horizontal scale ranging from −5 (labeled *very sad*) to +5 (labeled *very happy*), with a midpoint of 0 (labeled *neutral*). Participants chose one of the 11 points on the scale to represent their current mood. Participants rated their mood using both scales at three different time points: immediately before the mood induction, immediately after the mood induction, and after completing the questionnaires.

Mood Induction Procedure

Participants assigned to the sad MI were told that the purpose of the procedure was to induce a sad mood, because previous research suggests that explicit instructions facilitate mood induction (Westermann et al. 1996). Participants assigned to the sad MI watched a digital video clip from the movie *The Champ* (Lovell and Zeffirelli 1979), approximately 9 min in duration. The video depicts a young boy's reaction to his father's death. This video has been used in previous mood induction studies (e.g., Miranda et al. 1998) and has been validated in three studies as very effective at eliciting sadness (Gross and Levenson 1995; Hewig et al. 2005; Rottenberg et al. 2007). Before watching the video, participants were instructed to imagine how they would feel if a similar event was happening to them and to focus on a specific individual who was important in their life (their father, mother, husband, etc.). After viewing the video, participants were asked to imagine delivering a eulogy at the person's funeral and to write a paragraph describing the eulogy. While composing the eulogy, the music *Russia Under the Mongolian Yoke* was played at half speed. This piece of music has been found to

intensify feelings of sadness when used in mood induction procedures (e.g., Kelvin et al. 1999; Lethbridge and Allen 2008). Participants rated their mood state using the VAMS and the 11-point mood scale after they completed their eulogy. Consistent with previous mood induction studies (see Scherrer and Dobson 2009), and based on the premise that latent attentional biases will be activated only in a dysphoric mood state, participants had to be successfully mood induced in order to be included in the analyses. This was defined as at least a 20 mm decrease on the VAMS pre- versus post-mood induction (e.g., Singer and Dobson 2007; Teasdale and Fogarty 1979).

Participants assigned to the neutral MI watched a digital video that described how to hang an interior door ("EZ Hang Door Installation: How to Hang a Door", EZHang-Door 2009). This instructional video was chosen for its factual, non-emotional content and was approximately 9 min in duration (similar in duration to the video shown in the sad MI). After viewing the video, participants were asked to write a paragraph describing how they would explain to another person how to hang an interior door. They then rated their mood using the mood rating scales. Thus, the neutral MI procedure was similar to the sad MI procedure in terms of the activities participants engaged in. Equally important, it provided a common experience for participants assigned to the neutral MI condition so that a superior baseline measure of attention to the images could be obtained.

Stimuli for the Eye Tracking Phase of the Study

The stimuli were 160 colour images, divided equally among four categories: depression-related, anxiety-related, positive, and neutral. We presented anxiety-related images (which included themes of threat and injury) to distinguish between themes of sadness and threat. The distinction between depression-related and anxiety-related images was intended to differentiate between themes of sadness and threat; because both types of images contain negative emotional content, it was important to differentiate between the two in order to assess the specificity of any attentional biases observed. The majority of images were collected from the Internet and the remainder from the International Affective Picture System database (Centre for the Study of Emotion and Attention 1999). The depression-related images included scenes of people appearing sad and unhappy, neglected animals (e.g., a puppy in a small cage), scenes of poverty, and gloomy landscapes. The anxiety-related images included themes of threat and injury, such as people being threatened with weapons, people with physical injuries (e.g., a burn on an arm), dangerous situations (a person walking along a cliff), vehicle accidents, and threatening animals. The positive images showed people smiling and laughing, children playing, rabbits and kittens, and vacation activities and destinations (e.g., a beach at a tropical resort). The neutral images were selected to include people in various activities and to have no obvious positive or negative theme (e.g., a woman talking on the telephone; a group of people having a meeting). They also included pictures of objects (e.g., a bicycle, a computer) and a variety of landscapes (e.g., office buildings). Care was taken to ensure that there were no obvious systematic differences between the image categories (e.g., more landscapes in the neutral category than in the other categories; more people in the depression-related category than in the positive category).

The images were categorized by a separate group of female undergraduate students ($N = 152$). They were shown 221 images, presented on a computer display one at a time, and for each image they were asked to choose one of four categories that best described the image: (1) positive/happy, (2) sad/depressing/gloomy, (3) anxiety-provoking/dangerous/fearful, or (4) neutral/no emotion. Each image was also rated for valence on a scale from −5 (*very negative*) to +5 (*very positive*), with a midpoint of zero (*neutral*). An image was chosen for use in the study if at least 85 % of the raters agreed to its category. The mean valence ratings for the depression-related, anxiety-related, positive, and neutral images were −2.6, −3.1, 3.0, and .09, respectively. *T* tests indicated that the mean ratings for all four image types differed significantly (all $ps < .01$).

Apparatus for Eye Tracking

Eye movements were recorded by an Eyelink I eye tracking system (SR Research Ltd., Ottawa, ON, Canada), which uses infrared video-based tracking technology. The system has an average gaze error less than 0.5° of visual angle and a sampling rate of 250 Hz (allowing for a temporal resolution of 4 ms). Participants wore a small lightweight headband equipped with a camera positioned below the right eye to track the position of the right eye's pupil as it moved. The eye-tracker was connected to a Dell Dimension 8300 computer and a ViewSonic G225fb 21-inch flat screen monitor with a vertical retrace rate of 160 Hz. The computer controlled the visual display and recorded the horizontal and vertical coordinates corresponding to the position of the right eye every 4 ms. Eye movements were tracked and recorded continuously throughout the presentation of each set of images.

Procedure for Eye Tracking

After completing the mood induction procedure, participants were fitted with the headband camera and the eye

tracking system was calibrated in preparation for data collection.

Data collection began once the calibration was successful. At the start of each trial the participant fixated on a black dot in the center of the display for 2 s to ensure proper gaze measurement. On each trial, participants were shown four images: a depression-related image, an anxiety-related image, a positive image, and a neutral image. One image was placed in each of the four corners of the display (top left, top right, bottom left, bottom right). Images were randomly assigned to the four corners of the display and across all of the trials each image type was equally likely to appear in each corner. The four images were then presented for 8 s; participants were told to look at the images in any fashion they wished. All the participants were shown the same images. There were 45 trials in total, the first five being practice trials and the remaining 40 being data trials. Two random trial sequences were created, the second version the opposite of the first, to control for order effects. The two trial sequences were alternated across participants.

After viewing the images, participants were seated in a private room and completed the BIDR and the STAI. Participants who received the sad MI were administered a positive MI that involved watching a film clip from the movie *When Harry Met Sally* (Reiner 1989). This film has been validated as successful in inducing a positive mood state (Schaefer et al. 2010). Participants were then debriefed fully.

Results

The mood induction data and analyses are described first, followed by the eye tracking data and analyses.

Mood Induction Efficacy

The VAMS data and the 11-point mood rating data are listed in Table 2. The four groups did not differ in their pre-mood induction VAMS ratings, $F(3, 96) = 1.61$, $p > .10$, or their pre-mood induction 11-point mood ratings, $F(3, 96) = 1.27$, $p > .10$.

As noted previously, a successful mood induction was defined as a decrease in the VAMS rating of at least 20 mm in the post-mood induction rating relative to the pre-mood induction rating. For never depressed participants assigned to the sad MI ($N = 38$), 30 were successfully mood induced (78.9 %), with a mean VAMS decrease of 43.4 mm (79.7 vs. 36.3). The mean decrease for the 11-point mood rating was 4.7 (3.1 vs. −1.6). A within-subjects t test indicated that never depressed participants' VAMS ratings were significantly lower following the sad MI, $t(29) = 10.13$, $p < .001$. The same was true for their mood ratings, with significantly lower ratings following the sad MI, $t(29) = 12.76$, $p < .001$. For previously depressed participants assigned to the sad MI ($N = 27$), 23 were successfully mood induced (85.1 %), with a mean VAMS decrease of 36.9 mm (72.7 vs. 35.8). The mean decrease for the 11-point mood rating was 3.7 (2.5 vs. −1.2). T tests indicated that previously depressed participants' VAMS ratings and mood ratings were significantly lower following the sad MI, $t(22) = 9.92$, $p < .001$, and $t(22) = 8.36$, $p < .001$, respectively. Together these analyses confirm that the sad MI was effective and produced the intended shift in participants' mood.[1] Additional analyses showed that the negative mood induction produced equivalent mood shifts for previously depressed and never depressed participants: for the VAMS ratings the pre- versus post-mood induction changes were 36.9 and 43.4 mm, respectively, $t(51) = 1.12$, $p > .10$; for the 11-point mood ratings the corresponding changes were 4.7 and 3.7, respectively, $t(51) = 1.95$, $p = .06$.

Table 2 also lists the VAMS and 11-point mood ratings for the never depressed and previously depressed participants assigned to the neutral MI. For the never depressed participants, the pre- and post-mood induction VAMS ratings were not significantly different (73.7 vs. 70.8), $t(27) = 1.94$, $p = .06$. For the 11-point mood ratings there was a small but statistically significant difference between the pre- and post-mood induction ratings (2.6 vs. 2.2), $t(27) = 2.29$, $p < .05$, likely reflecting some participants' lack of interest in the neutral MI video (and perhaps also the higher sensitivity of the 11-point mood rating measure relative to the VAMS). In any event, this difference (a decrease of 0.4 units on the 11-point scale) is negligible relative to the corresponding difference observed in the sad MI condition (a decrease of 4.7 units). For previously depressed participants the pre- and post-mood induction VAMS ratings (71.6 vs. 71.1) were not significantly different, $t(18) = 0.32$, $p > .10$, nor were the pre- and post-mood induction mood ratings (2.5 vs. 2.2), $t(18) = 1.37$, $p > .10$.

Eye Tracking Data

The fixation data were processed using the EyeLink Data Viewer analysis software (SR Research) to filter for blinks, missing data, and other recording artifacts (using the default settings). To be included in the analyses, a fixation had to be at least 100 ms in duration. The dependent variables were the total fixation time for each image (in

[1] There were no obvious differences for any of the demographic variables (age, BDI, BIDR, PHQ-9, etc.) between those who were successfully mood induced and those who were not. In addition, the pre-mood induction ratings of mood for non-induced participants were similar to those who were successfully mood induced.

Table 2 Pre-mood induction and post-mood induction ratings of mood

	Neutral mood induction		Sad mood induction	
	Never depressed	Previously depressed	Never depressed	Previously depressed
VAMS				
Pre-induction	73.7 (16.0)	71.6 (16.2)	79.7 (13.5)	72.7 (13.3)
Post-induction	70.8 (18.2)	71.1 (15.9)	36.3 (19.1)	35.8 (17.5)
Mood rating				
Pre-induction	2.6 (1.8)	2.5 (1.6)	3.1 (1.3)	2.5 (1.6)
Post-induction	2.2 (1.9)	2.2 (1.5)	−1.6 (1.7)	−1.2 (1.6)

Standard deviations in parentheses. *VAMS* visual analog mood scale. Mood rating 11-point mood rating scale (+5 to −5)

milliseconds) and the number of fixations for each image, both measures reflecting the engagement of attention with the images. These measures were computed for each image type on a trial by trial basis and then averaged over the 40 trials. The fixation data are listed in Table 3.

The number of fixations and the total fixation times to each image type were first analyzed together using multivariate analysis of variance (MANOVA) because these two variables are always correlated (i.e., as the number of fixations to an image increases, the total fixation time also increases) and MANOVA is the appropriate analysis for correlated dependent variables (Tabachnick and Fidell 2007). (The overall correlation was .72, averaged across all factors.) The design was a 2 (Group: never depressed, previously depressed) × 2 (Type of Mood Induction: sad, neutral) × 4 (Image Type: depression-related, anxiety-related, positive, neutral) mixed-model three-factor MANOVA. The most important result was the three-way interaction between Group, Type of Mood Induction, and Image Type, Wilk's $\Lambda = .95$, $F(6, 574) = 2.15$, $p < .05$, partial $\eta^2 = .05$. As described below, this interaction reflected the fact that the effect of the sad MI on attention to the images was very different for the never depressed and previously depressed groups.

The three-way interaction was followed up by analyzing the data for the never depressed and previously depressed groups separately, using MANOVA and ANOVA (analysis of variance). For these analyses, the critical statistical test was the interaction between Group and Image Type; to control the Type I error rate follow-up tests were carried out only if this interaction was statistically significant ($p < .05$). Statistically significant interactions were followed up with between-groups t tests using an alpha of 5 %.

For the never depressed participants, the number of fixations and the total fixation times were analyzed together using a 2 (Type of Mood Induction: sad, neutral) × 4 (Image Type: depression-related, anxiety-related, positive, neutral) mixed-model MANOVA. There was an effect of Image Type, Wilk's $\Lambda = .44$, $F(6, 334) = 27.52$, $p < .001$, partial $\eta^2 = .33$, with the most fixations and the longest total fixation times for the positive images and the fewest fixations and the shortest total fixation times for the neutral images. The effect of Type of Mood Induction was not significant, Wilk's $\Lambda = .99$, $F < 1$. Most important was the significant interaction between Type of Mood Induction and Image Type, Wilk's $\Lambda = .90$, $F(6, 334) = 2.84$, $p < .01$, partial $\eta^2 = .05$. This interaction was present in separate ANOVAs for the number of fixations, $F(3, 168) = 4.58$, $p < .01$, partial $\eta^2 = .08$, and the total fixation times, $F(3, 168) = 5.32$, $p < .01$, partial $\eta^2 = .09$. For brevity only the total fixation time analyses are described further, though the pattern in the number of fixations was identical (see Table 3). The total fixation data are show in Fig. 1.

To follow up the Type of Mood Induction × Image Type interaction, t tests were used to compare the sad and neutral MI groups for each image type. These revealed a significant difference between the groups for anxiety-related images, $t(56) = 2.95$, $p < .01$; the never depressed participants in the sad MI group had shorter total fixation times for anxiety-related images than the never depressed participants in the neutral MI group (1,465 vs. 1,883 ms). There was also a significant difference between the groups for positive images, $t(56) = 2.12$, $p < .05$; the never depressed participants in the sad MI group had longer total fixation times for positive images than the never depressed participants in the neutral MI group (2,298 vs. 1,872 ms). There were no group differences for depression-related or neutral images (both $ps > .10$). Thus, never depressed participants who experienced the sad MI increased their attention to positive images and decreased their attention to anxiety-related images relative to those who experienced the neutral MI. This outcome suggests that participants who experienced the sad MI attended to the images to repair or counteract their negative mood. This interpretation will be discussed in more detail in the "General Discussion" section.

The analyses of the previously depressed participants' data revealed a different pattern of results. In the MANOVA there was an effect of Image Type, Wilk's $\Lambda = .439$, $F(6, 238) = 20.21$, $p < .001$, partial $\eta^2 = .34$, with the most fixations and the longest total fixation times for the positive images and the fewest fixations and the shortest total fixation times for the neutral images. As can

Table 3 Mean number of fixations and total fixation time (in milliseconds) for depression-related, anxiety-related, positive, and neutral images

Image type	Never depressed participants		Previously depressed participants	
	Neutral MI	Sad MI	Neutral MI	Sad MI
Number of fixations				
Depression	6.7 (1.4)	6.5 (1.7)	7.6 (1.6)	7.0 (1.4)
Anxiety	7.7 (2.3)	6.4 (2.3)	7.2 (1.7)	6.8 (1.6)
Positive	7.7 (2.2)	9.1 (2.5)	7.7 (2.4)	7.6 (2.3)
Neutral	3.9 (0.8)	4.3 (1.0)	4.0 (1.2)	4.0 (0.9)
Total fixation time				
Depression	1,560 (281)	1,453 (418)	1,792 (412)	1,727 (337)
Anxiety	1,883 (556)	1,465 (522)	1,716 (463)	1,706 (459)
Positive	1,872 (674)	2,298 (836)	1,934 (718)	1,888 (574)
Neutral	938 (287)	992 (265)	1,012 (551)	983 (241)

MI mood induction. Standard deviations in parentheses

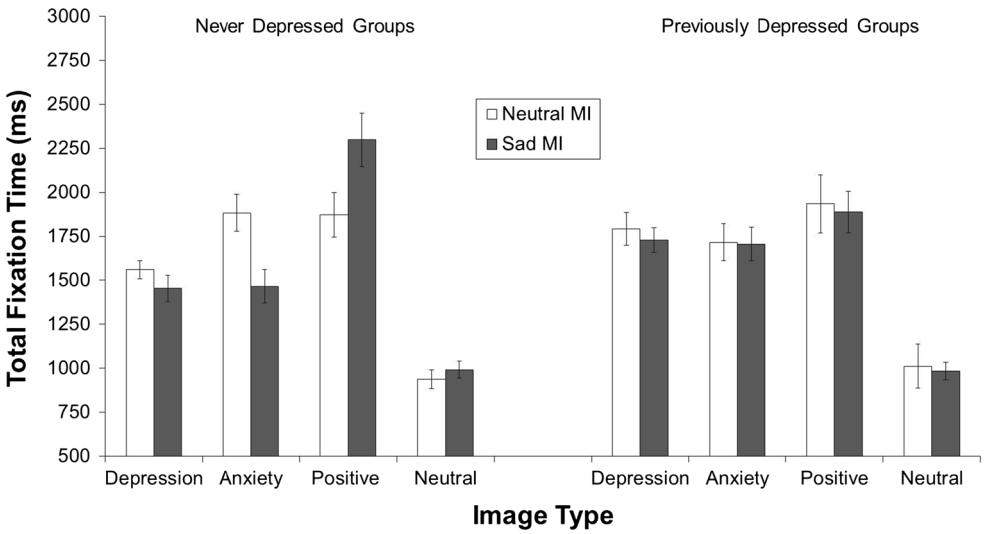

Fig. 1 Mean total fixation time for depression-related, anxiety-related, positive, and neutral images, for never depressed and previously depressed participants who experienced a neutral or sad mood induction (MI). Standard errors are shown for each group

be seen in Table 3, both groups of previously depressed participants attended to positive images the most and to neutral images the least, the same pattern observed for the never depressed participants. In addition, there was no effect of Type of Mood Induction, Wilk's $\Lambda = .938$, $F(2, 39) = 1.28$, $p > .10$, which was also the case for the never depressed participants. However, unlike the data for the never depressed participants, there was no interaction between Type of Mood Induction and Image Type, Wilk's $\Lambda = .936$, $F(6, 238) = 1.33$, $p > .10$. This interaction was also not present in separate ANOVA analyses of the number of fixations ($F < 1$) or the total fixation times ($F < 1$). Statistical power analyses of the test of these interactions indicated that power was 77 % for the analysis of the number of fixations and 88 % for the analysis of the total fixation times. (Power analyses were computed by using the effect sizes from the corresponding interactions in the data of the never depressed participants and an alpha level of 5 %; power was calculated using the G*Power 3.1 software package; Faul et al. 2007).

The absence of an interaction between Type of Mood Induction and Image Type indicates that for previously depressed participants attention to the images was not affected by the sad MI. As can be seen in Table 3, relative to those who experienced the neutral MI, previously depressed participants who experienced the sad MI did not decrease their attention to anxiety-related images (total fixation times of 1,716 vs. 1,706 ms), nor did they increase their attention to positive images (total fixation times of 1,934 vs. 1,888 ms). Thus, unlike the never depressed participants, the previously depressed participants who experienced the sad MI did not attend to the emotional images differently than those who experienced the neutral MI. This outcome was unexpected and points to an important difference in the way that previously depressed individuals respond to a sad MI.

To confirm that the previously depressed and never depressed participants who experienced the sad MI attended to the images differently, we compared the fixation data of these two groups directly using a Group × Image Type

MANOVA. The Group × Image Type interaction was significant, Wilk's $\Lambda = .91$, $F(6, 304) = 2.43$, $p < .05$, partial $\eta^2 = .05$, and the same interaction was present in separate ANOVA analyses of the number of fixations, $F(3, 153) = 3.00$, $p < .05$, partial $\eta^2 = .06$, and the total fixation times, $F(3, 153) = 4.11$, $p < .01$, partial $\eta^2 = .08$. *T* tests revealed that never depressed participants had significantly longer total fixation times for positive images than previously depressed participants (2,298 vs. 1,888 ms), $t(51) = 2.01$, $p < .05$. In addition, never depressed participants had significantly shorter total fixation times for depression-related images (1,453 vs. 1,727 ms), $t(51) = 2.56$, $p < .05$. The same was true for anxiety-related images (1,465 vs. 1,706 ms), but the difference was not statistically significant, $t(51) = 1.75$, $p = .08$. These results confirm that previously depressed and never depressed participants who experienced the sad MI differed in the way they directed their attention to the emotional images.[2]

General Discussion

The purpose of this study was to determine what effect a sad mood would have on never depressed and previously depressed individuals' attention to emotional information. For previously depressed participants, the key question was whether a sad MI would activate a latent attentional bias presumed to contribute to depression vulnerability (DeRaedt and Koster 2010; Gotlib and Joormann 2010; Ingram et al. 2008; Koster et al. 2011). Based on previous literature, the prediction was that previously depressed participants who experienced a sad MI would attend to depression-related images more than previously depressed participants who experienced a neutral MI, due to the activation of an attentional bias (Just et al. 2001; Miranda and Persons 1988; Miranda and Gross 1997; Scher et al. 2005).

For the never depressed participants the key question was whether the sad MI would have a mood-congruent or mood-incongruent effect on attention. Two outcomes were possible based on previous research. The first was that the never depressed participants who experienced the sad MI would decrease their attention to negative images (depression-related and/or anxiety-related) due to a protective attentional bias (Ellis et al. 2011; Ingram et al. 2008; Joormann and Gotlib 2007; Matthews and Antes 1992; McCabe et al. 2000). This would be evidence of a mood-incongruent effect on attention. The second possibility was that never depressed participants who experienced the sad MI would increase their attention to negative images and decrease their attention to positive images, which would be evidence of a mood-congruent effect on attention. In what follows, we consider the data for the previously depressed and never depressed participants separately given the very different effect the sad MI had for these two groups.

Effect of the Sad Mood Induction for Never Depressed Individuals

For never depressed participants the sad MI had a substantial effect on their attention to positive and anxiety-related images. Relative to those who experienced the neutral MI, never depressed participants who experienced the sad MI had significantly longer total fixation times to positive images and significantly shorter total fixation times to anxiety-related images. These results show that never depressed participants responded to the sad MI by increasing their attention to positive images and decreasing their attention to anxiety-related images, an outcome best characterized as a mood-incongruent effect. (A decrease in attention to depression-related images was also observed but it was not statistically significant, perhaps because these images were rated as being significantly less negative than the anxiety-related images according to the valence ratings we collected.) This pattern of attending is consistent with the engagement of a protective bias like that observed in other studies of attention to emotion (e.g., Ingram et al. 2008; Matthews and Antes 1992; McCabe et al. 2000). Diverting attention away from negative stimuli and toward

[2] Also of interest is a comparison of the previously depressed and never depressed participants who experienced the neutral MI. For this analysis we also had eye tracking data from a group of currently depressed individuals ($N = 28$) who were shown the same images and experienced the same neutral MI procedure (these data were collected as part of an unpublished study). Depression status was assessed using the PHQ-9 (the mean PHQ-9 of the currently depressed participants was 16.1, SD = 4.3, and the mean BDI was 29.2, SD = 7.8). A MANOVA comparing the fixation data of the three groups produced a significant multivariate Group × Image Type interaction, Wilk's $\Lambda = .89$, $F(12, 430) = 2.05$, $p < .05$, partial $\eta^2 = .05$. The same interaction was present in separate analyses of the fixation count and total fixation time data, $F(6, 216) = 2.28$, $p = .05$, partial $\eta^2 = .05$; $F(6, 216) = 2.49$, $p < .05$, partial $\eta^2 = .07$, respectively. Follow up analyses of the total fixation time data showed that currently depressed participants attended to depression-related images significantly more than never depressed participants (1,920 vs. 1,560 ms), $t(54) = 3.76$, $p < .001$, replicating the findings of Eizenman et al. (2003), Kellough et al. (2008), and others. Previously depressed participants also attended to the depression-related images more than never depressed participants (1,792 vs. 1,560 ms), $t(45) = 2.18$, $p < .05$, and currently depressed and previously depressed participants did not differ, $t(45) = 1.20$, $p = .23$. This outcome indicates that previously depressed participants exhibited an attentional bias for depression-related images equivalent to that of currently depressed participants. For positive images the group differences were not as pronounced. Currently depressed participants attended to positive images less than never depressed participants (1,575 vs. 1,872 ms), $t(54) = 1.82$, $p = .07$, and less than previously depressed participants (1,575 vs. 1,934 ms), $t(45) = 1.96$, $p = .05$. There was no difference between previously depressed and never depressed participants (1,934 vs. 1,872 ms), $t(45) = 0.34$, $p = .73$.

positive stimuli would be an adaptive response to the sad MI because it would help counteract the negative affect experienced and facilitate the return to a more positive mood state (Koster et al. 2011).

This strategy can also be conceptualized as a protective factor against depression. A recent study examining the effects of a sad MI in those currently depressed concluded that depression severity and negative attentional biases led to greater impairments in the ability to regulate mood reactivity and sad mood in general in response to a sad MI (Clasen et al. 2013). The implication is that the ability to employ emotion regulation strategies successfully may be closely related to the presence and magnitude of the attentional biases that contribute to depression vulnerability.

Our results are different from those of previous studies that examined the effect of a sad MI on never depressed individuals' attention. As described previously, in some of these studies a sad MI had little or no effect on attention to emotional information (Ingram et al. 1994; Ingram and Ritter 2000). In other studies, a sad MI produced mood-congruent effects on attention (i.e., an increase in attention to negative information; Becker and Leinenger 2011; Isaacowitz et al. 2008, for younger adults only). With the exception of the Isaacowitz et al. study, our study was quite different than these previous studies and so one might not necessarily expect equivalent findings to emerge. Certainly the dichotic listening task (Ingram et al. 1994; Ingram and Ritter 2000) and the multiple object tracking task (Becker and Leinenger 2011) measure attentional processing under different circumstances than we did (e.g., under more attentionally demanding conditions).

The Isaacowitz et al. (2008) study, on the other hand, used a design similar to our own. In their study, eye gaze was tracked and recorded throughout a 4-s presentation while participants freely viewed pairs of emotional and neutral faces. Our participants were similar in age ($M = 22.13$) to Isaacowitz et al.'s group of younger participants ($M = 19.72$). Unlike Isaacowitz et al., however, we found that participants' gaze patterns were incongruent with their induced sad mood. In fact, our results were essentially the same as those for the older participants in Isaacowitz et al.'s study—participants increased their attention to positive images and decreased their attention to negative images in response to the sad MI. Of course, our study differed from Isaacowitz et al.'s study in several important respects, including the type of images presented, the presentation duration of the images, the type of mood induction technique, and the procedure for selecting participants. It is not clear which of these differences could have contributed to the different outcomes observed and so this will be an important consideration for future research.

We believe that participants' spontaneous emotion regulation strategies are the key for understanding how attention is affected by a sad MI. For the never depressed participants in our study, the most straightforward explanation of their fixation data is that they increased their attention to positive images and decreased their attention to negative images in an effort to counteract and repair their sad mood state. As noted, this outcome can be interpreted as reflecting a protective bias that diverts attention away from negative information and toward positive information (Ellis et al. 2011; Ingram et al. 2008; Joormann and Gotlib 2007; Matthews and Antes 1992; McCabe et al. 2000). It is also consistent with a general attentional strategy for regulating emotional experiences (Bebko et al. 2011; Gross 2007). In either case, our results support the idea that never depressed individuals may be less vulnerable to developing depression due to an emotion regulation strategy that enhances attention to positive stimuli under conditions of stress or sadness (DeRaedt and Koster 2010). A tendency to spontaneously attend to and process positive stimuli and avoid negative stimuli in response to a dysphoric mood state is likely an important resilience factor for never depressed individuals (Joormann and D'Avanzato 2010).

Effect of the Sad Mood Induction for Previously Depressed Individuals

In contrast to our findings for never depressed participants, we found that the attention of previously depressed participants was unaffected by the sad MI. Contrary to our prediction, previously depressed participants who experienced the sad MI did not attend to the depression-related images any differently than previously depressed participants who experienced the neutral MI. Note that this outcome cannot be attributed to the sad MI procedure being less effective for previously depressed participants because, as noted previously, the percentage of previously depressed participants successfully mood induced (85.1 %) was similar to the percentage of never depressed participants successfully mood induced (78.9 %). In addition, the VAMS and mood rating data showed that the sad MI had a similar effect for previously depressed and never depressed participants (see Table 2). Thus, for previously depressed participants, the absence of any effect of the sad MI on their attention reflects an important difference in how these individuals respond to a sad mood.

Based on previous literature, the specific prediction was that previously depressed participants who experienced the sad MI would attend to the depression-related images more than previously depressed participants who experienced the neutral MI, due to the activation of a latent attentional bias. In retrospect, another possibility was that previously depressed participants would exhibit a mood-incongruent attentional bias similar to that observed for never depressed participants—they would increase their attention to

positive images and decrease their attention to negative images (anxiety-related and depression-related) in an effort to counteract their sad mood. Given that neither of these outcomes was observed, the question is how to explain the stark contrast between the results for the never depressed and previously depressed groups.

We propose that for previously depressed participants the absence of an effect of the sad MI on attention reflects the absence of a protective bias in the allocation of attention. Researchers have documented many instances in which previously depressed and depression-vulnerable individuals fail to divert their attention away from negative information and toward positive information as never depressed individuals do (Ellis et al. 2011; Ingram et al. 2008; Joormann and Gotlib 2007; Matthews and Antes 1992; McCabe et al. 2000). Our results appear to be another manifestation of this phenomenon. The absence of this protective bias can also be interpreted as a symptom of maladaptive emotion regulation, in that selective attention is not used to repair a dysphoric mood state. Recall that Bebko et al. (2011) found evidence of a relationship between how attention is allocated and the ability to successfully regulate mood states. This may in part explain the increase in attention to positive images observed for our never depressed participants who experienced the sad MI relative to those who experienced the neutral MI, and may also have implications for depression vulnerability given that our previously depressed participants did not exhibit the same pattern of attending. Several studies have reported that previously depressed individuals do exhibit deficits in emotion regulation relative to never depressed individuals. For example, Ehring et al. (2008) found deficits in emotion regulation in individuals with a history of depression—they reported more difficulties regulating negative emotions and decreased use of positive regulatory strategies relative to never depressed individuals (see also Rottenberg et al. 2002). Our results may therefore demonstrate one consequence of maladaptive emotion regulation in previously depressed individuals—the absence or impairment of a compensatory attentional strategy used to counteract a dysphoric mood state. This may be a trait characteristic of individuals vulnerable to depression and would likely make them more susceptible to sustained negative affect that could eventually trigger a depressive episode.

Limitations and Considerations for Future Research

Several limitations of the present study should be noted. First, the contrast between the sad and neutral MI conditions was a between-subjects manipulation. This design does not allow one to conclude definitively that the sad MI produced changes in the attention behavior of never depressed individuals and that those changes were absent in previously depressed individuals. A within-subjects manipulation would have the advantage of being able to compare the same individual's attention to emotional images following a neutral MI and a sad MI; an alternative and simpler design would compare attention to emotional images prior to a sad MI and immediately after. These types of within-subjects designs would permit stronger causal inferences and a more sensitive test of the effect of a sad MI on attention.[3] For these reasons it is worth keeping in mind that we cannot rule out the possibility that there is a small effect of a sad MI on the attention of previously depressed individuals, albeit one that would have to be substantially smaller than the one we observed for never depressed individuals. A within-subjects design would also allow one to identify individuals who attend to emotional images to repair their mood following a sad MI (assuming this is the case). The ability to identify and distinguish "mood repairers" from "non-repairers" would be a significant contribution to this research because it would allow researchers to examine this important individual difference directly.

In terms of generalizability, it will be important to replicate our findings in a sample with more diversity, as most of our participants were young undergraduate students and all of them were women. We recruited only females to control for potential gender differences, given that adult females are twice as likely to develop depression than adult males (Dobson and Dozois 2008) and given that there is evidence for differences in the factors related to the development and experience of depression between genders (Lai 2011; McGinness et al. 2012; Silverstein et al. 2013). Men and women may also differ in their response to a sad MI, their attention to emotion, and their use of attention to repair mood, which are considerations for future research. Another limitation of our study was the use of self-report measures to assess for current and past depression, given that they are typically not as reliable for the diagnosis of a disorder as a clinical interview and given the decreased reliability of retrospective accounting of symptoms.

In retrospect, using a measure to assess individual differences in emotional regulation strategies would have been quite valuable in our study given previous findings of differences in attentional allocation associated with specific emotional regulation strategies (Bebko et al. 2011; Isaacowitz et al. 2009). Being able to link participants' emotion regulation strategies with their pattern of attending would

[3] On the other hand, there would be several disadvantages with a within-subjects design: different images would have to be used if participants experienced both a neutral and sad MI, carry over and order effects could be an issue because the neutral MI would always be presented first, and the demand characteristics of a sad MI procedure would likely be more influential for participants who first experience a neutral MI.

have enriched our findings and future research would benefit from the incorporation of these types of measures. In addition, had we obtained mood ratings immediately after the eye tracking phase of the study we could have correlated mood ratings with attentional biases, in order to determine whether the increased attention to positive images observed for the never depressed individuals who experienced the sad MI led to a larger improvement in mood state. A recent study by Sanchez et al. (2014) suggests that this would be the case. They found that attentional deployment to happy faces following a sad MI predicted undergraduate students' mood recovery at the end of the experimental session. Like Sanchez et al., we believe that such findings indicate that attentional processing of positive information plays a role in mood repair. This type of analysis would be especially valuable when examining the impact of a sad MI on attention to emotion in previously depressed individuals.

Another question for future research is how a sad MI affects the attention of currently depressed individuals. Our study did not include a group of currently depressed participants and so we can only speculate how a sad MI would have affected their attention to emotional images. One recent study examining attentional biases as a possible maintenance factor in depression used a sad MI before a dot-probe task and found that a more severe level of depression led to greater difficulty in mood repair due to the attentional bias for dysphoric stimuli (Clasen et al. 2013). Clasen et al. concluded that the presence of attentional biases likely impacts the success of emotional regulation strategies in depression. The growing body of literature indicating that clinical depression is associated with maladaptive emotional regulation (Joormann and D'Avanzato 2010) is likely very relevant to this question. We hypothesize that individual differences in the ability to regulate emotional responses to negative experiences contributed to the differences we observed between never depressed and previously depressed participants—that previously depressed participants, unlike never depressed participants, failed to direct their attention purposively to counteract the sad MI. If true, then we predict that currently depressed participants would exhibit a similar maladaptive emotion regulation response and would attend to emotional images similarly to previously depressed participants.

Finally, it is important to note that our study and others like it examine a vulnerability to, or a consequence of depression. The use of groups with a history of depression to examine vulnerabilities ignores those who have not yet experienced an initial episode [as discussed by Just et al. (2001)]. Ingram et al. (1998) pointed out that studies that use previously depressed individuals examine vulnerability from a "perpetuation of depression standpoint" despite the fact that it is difficult to determine if the vulnerability existed before the individuals' first depressive episode. Other researchers have proposed that cognitive vulnerabilities may be a consequence of previous depressive episodes as opposed to an initial vulnerability factor or cause (Lewinsohn et al. 1981). Prospective research designs would allow one to delineate the course of attentional biases in depression and would significantly advance the understanding of initiating and maintaining factors.

Conclusions

The purpose of our study was to determine what effect a sad MI would have on attention to emotional images for previously depressed and never depressed individuals. Our sad MI procedure was equally effective for previously depressed and never depressed participants, but the eye tracking data revealed substantial differences in the way that attention was directed to emotional images. Whereas never depressed participants increased their attention to positive images and decreased their attention to anxiety-related images relative to those who experienced the neutral MI, presumably to counteract and repair their sad mood, previously depressed participants who experienced the sad MI did not attend to the emotional images any differently than those who experienced the neutral MI. Our study therefore demonstrates that a sad mood can produce very different effects on attention to emotion depending upon one's depression history. We propose that our results are evidence of maladaptive emotion regulation associated with depression vulnerability.

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Conflict of Interest Christopher Sears and Kristin Newman declare that they have no conflict of interest.

Ethical standard This research was approved by the authors' institutional research ethics board (the Conjoint Faculties Research Ethics Board at the University of Calgary).

Informed Consent Informed consent was obtained from all the individuals participating in the study.

Animal Rights No animal studies were carried out by the authors for this article.

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