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Attentional biases in dysphoric college students

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ATTENTIONAL BIASES IN DYSPHORIC COLLEGE STUDENTS

by

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DEDICATION

This manuscript is dedicated to my family who has always believed in my ability to excel, but especially to my mother who has reminded me time and time again that success lies within me. I also dedicate this work to my loving fiancé who has been immensely supportive and patient throughout the process.

Thank you all for your words of inspiration and encouragement.

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ATTENTIONAL BIASES IN DYSPHORIC COLLEGE STUDENTS

By

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ABSTRACT

Cognitive biases in attention to emotional stimuli in an ethnically diverse sample of dysphoric and non-dysphoric college students were explored. The present study advanced the literature by using ecologically valid eye movement data to assess attention. We hypothesized that dysphoric participants would orient their attention toward sad faces more quickly than the students without dysphoria. We also hypothesized that the dysphoric participants would sustain their attention on sad faces longer than the non-dysphoric participants. Caucasian and Latino undergraduate students were categorized into dysphoric (n = 30) and non-dysphoric (n = *36* based depressive symptom endorsement on the BDI-II (non-dysphoric: BDI-II ≤ 6, dysphoric: BDI-II ≥ 14). Eye movements were recorded with an eye-tracking device while the students viewed picture pairs of faces expressing sadness, happiness, or no emotion. The task consisted of 48 face pairs presented twice for a total of 96 trials. Consistent with the literature, dysphoric participants showed a negative bias in duration when sad faces were paired with neutral faces, but not when they were paired to happy faces. Dysphoric participants were not more likely to initially orient toward sad faces and when they did, latency was not significantly shorter to the sad face than to the other faces. Furthermore, depressive symptom scores were not associated with attentional biases for the dysphoric participants. Taken together, these findings are consistent with literature suggesting dysphoria and depression are characterized by elaboration of mood-congruent stimuli at later stages of information processing. However, the context in which the negative stimuli is presented is important. The elaboration of mood congruent stimuli was only evident in the context of a paired neutral stimuli; a paired positive stimuli did not support this elaboration effect. Additionally, symptom severity on the BDI-II did not influence the elaboration bias dysphoric participants exhibited. These findings have significant implications for the treatment and prevention of depression.

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Introduction

Depression is one of the most debilitating mental disorders with serious implications to physical, social, and occupational functioning. One in five people are afflicted with Major Depressive Disorder at some point in their lifetime (e.g., Rottenberg, Gross, & Gotlib, 2005) and up to 30 million people in the United States meet criteria for some form of depressive disorder (Kessler, McGonagle, Swartz, & Blazer, 1993). Depression will be the second leading cause of disability worldwide by the year 2020 and it may be the leading cause of disability in more developed regions (WHO, 2001). Because of its great prevalence, depression has been referred to as the "common cold of mental illness" (Dougher & Hackbert, 1994). However, the implications of depression are far more severe. Suicide is among the ten leading causes of death among individuals between 10 and 64 years of age, and it is second among those between 10 and 45 years of age (McKeown, Cuffe, & Schulz, 2006). Given the major health implications of this disorder, it is crucial to understand risk factors associated with its onset as well as factors contributing to its maintenance.

Theorists assert that underlying cognitive mechanisms likely play a significant role in the onset and maintenance of emotional disorders. Particular interest has been placed on attentional biases and their relation to the experience of depression and anxiety. Cognitive models propose that cognitive processes are a function of schemata, which shape how one perceives, recalls, and attends to information (Aaron T. Beck, 1976; Bower, 1981). According to this model, distorted schemata in depressed individuals result in cognitive biases in attention to negative information. Discrepant findings between cognitive biases in anxiety and those in depression suggest the relationship between cognition and emotional disorders is more complex than appears. Some theorists even suggest such discrepant findings suggest the roots of anxiety and depression do not lie in cognitive biases to negative stimuli (Coyne & Gotlib, 1983). Whereas anxious individuals demonstrate an immediate bias towards mood-congruent stimuli (i.e. fear-inducing stimuli), attention towards mood-congruent stimuli in depressed individuals is delayed (Caseras, Garner, Bradley, & Mogg, 2007; I. H. Gotlib, Krasnoperova, Yue, & Joormann, 2004; Mogg & Bradley, 2005). Instead, once depressed individuals attend to stimuli eliciting depressed affect, they experience difficulty disengaging and shifting attention elsewhere, suggesting that attention may play an important role in maintaining depressed affect.

Interest in understanding the relation between cognitive process underlying emotional disorders has increased dramatically in the past twenty-years, providing a greater understanding of the role cognitive mechanisms play in the etiology of emotional disorders, as well as in their maintenance and recurrence. Earlier cognitive theorists, such as Beck (1976) and Bower (1981), posit that cognitive processes are a function of schemata affecting how information is perceived, recalled, and attended. Bower (1981) makes the analogy that emotions are like a magnet in that they draw an individual's attention to material consistent with their emotions. Mood-congruent stimuli "pop out" to the perceiver, and as such, the recognition threshold is smaller. That is, individuals are quicker to recognize material congruent to their emotional state than non-relevant material; it is more salient.

According to these models, cognitive biases toward mood-congruent stimuli occur consistently across emotional disorders and across all domains of cognition (i.e.

perception, attention, and memory). However, past research has failed to offer consistent evidence in support of these models. For example, investigators have found a memory bias in depression but not anxiety (Rinck & Becker, 2005). Furthermore, past research has consistently shown that anxious individuals present initial orienting towards threatening and fear-eliciting material (e.g.,Bradley, Mogg, Millar, & Bonham-Carter, 1997; Caseras, et al., 2007; Eizenman, et al., 2003; I. H. Gotlib, et al., 2004; Mogg, Bradley, & Williams, 1995). However, findings of an attentional bias toward negative stimuli in depression have not been as consistent. Whereas some researchers have found attentional biases in depression (Broomfield, Davies, MacMahon, Ali, & Cross, 2007; I. H. Gotlib, et al., 2004; J. Joormann & Gotlib, 2007; Mathews, Ridgeway, & Williamson, 1996; Mogg, et al., 1995; Mogg, Mathews, & Eysenck, 1992) others have failed to find the presence of such cognitive biases (Bradley, Mogg, & Millar, 2000; Mogg, et al., 1995; Mogg, Bradley, Williams, & Mathews, 1993). In addition other researchers have suggested that depressed individuals are not biased towards negative stimuli, but rather that depressed individuals are no longer biased towards positive stimuli as are non-depressed individuals (I. H. Gotlib, McLachlan, & Katz, 1988; Mogg, Mathews, May, & Grove, 1991; Shane & Peterson, 2007) and rather present “even-handedness” (Coyne & Gotlib, 1983).

Interests in the association between attentional biases and emotional disorders, particularly depression and anxiety, have increased dramatically over the decades. Investigators have consistently provided evidence supporting the hypothesis that attentional biases to mood-congruent material are present in anxiety (e.g. Bradley, et al., 2000; MacLeod, Mathews, & Tata, 1986). Anxious individuals are likely to attend immediately to fear-eliciting stimuli, although they will also disengage from the stimuli with ease. Whether this hypothesis also holds true for depression has caused much debate; evidence is lacking and methodological approaches are not sound. For the most part, research in this area has used reaction time paradigms, such as the visual probe task and emotional Stroop task, to explore attentional biases. However, the adequacy of reaction time paradigms is questionable; they may not provide an accurate assessment of attention and may potentially confound data (Caseras, et al., 2007) . When words are used as stimuli, it becomes difficult to conclude whether delay in response is the result of different processes competing for cognitive resources (Mogg & Bradley, 2005). Delay in response may be attributed to either interference at the early attention stage or at a later stage of response.

MacLeod, Mathews, and Tata (1986) explored the association between cognitive biases and emotionally threatening information in emotional disorders by presenting anxious and depressed participants with word pairs (neutral and threat-related). A visual dot probe was presented next, in which participants had to immediately respond by pressing a button. MacLeod and colleagues (1986) hypothesized that anxious individuals would shift attention toward threatening material, and thus exhibit shorter latencies when responding to probes presented in the field of threatening material than when the probes were presented in the neutral field. They also explored whether such biases would be present in depressed individuals, or whether these would be specific to anxiety. Consistent with the hypothesis, results showed that anxious individuals, unlike controls, shift their attention toward threatening stimuli. Such attentional biases were not present in depressed participants. However, all negative stimuli presented during the study was comprised of threatening material, found to be specific to anxiety, which may have accounted for null findings in the depressed sample.

Gotlib and colleagues (1986) conducted three experiments using a color perception task instead of the visual probe task. Like the visual probe task, the color perception task requires participants to respond to the onset of stimuli following the presentation of emotion-laden words. Two colored bars follow emotion-laden words and participants are to determine which bar appears first; although unbeknownst to the participant, both bars appear simultaneously. Stimuli exposure duration differed across experiments. In the first two experiments, stimuli were presented for 500 ms and in the third experiment stimuli were presented for 730 ms. Non-depressed individuals were found to manifest a bias toward positive information. Depressed individuals did not present this positive bias. Mogg et al. (1991) replicated these findings. Anxious individuals in their study demonstrated a deficiency in a bias toward positive information. Based on such findings, they concluded this pattern of attentional bias is characteristic of anxiety and not depression. However, depression was not directly assessed, only state and trait anxiety were assessed. It is possible to attribute these findings to the use of threatening faces to detect attentional biases in depression, rather than the use of sad faces, which are specific to depression (I. H. Gotlib, et al., 2004). Similarly, McCabe and Gotlib (1995) did not find a bias toward negative-content words among a sample of mildly depressed individuals. Neither did their sample present a bias toward positive-content words as did non-depressed controls in the same study. These findings suggest that depression is not characterized by a tendency to attend toward negative stimuli, but rather by a failure to attend to positive stimuli; thus, lacking a positive, protective bias characteristic of non-depressed individuals (Bradley, et al., 1997; I. H. Gotlib, et al., 1988; Shane & Peterson, 2007).

Other studies using a reaction time paradigm suggest depression is characterized by attentional biases to mood-congruent stimuli. One such study required depressed participants to complete a dichotic listening task while simultaneously completing a light-probe reaction time task(McCabe & Gotlib, 1993). Depressed participants took longer to respond to the display of the light probe when negative words were presented in an unattended channel of the dichotic tape than when positive- or neutral-content words were presented. Such differences in cognitive processing were not evident in the non-depressed sample. Using an emotional Stroop task, Broomfield et al (2007) found that depressed geriatric patients experienced greater interference of word content when responding to the color of negative words presented. Depressed patients were slower in the color naming of negative words. An attentional bias toward negative words was not demonstrated by non-depressed elderly controls. Rinck and Becker (2005) found that both, women with major depressive disorder and women with social phobia, were more vigilant toward mood-congruent words.

Another possible factor contributing to the discrepancy in findings is that of duration of stimuli exposure (Bradley, et al., 1997; Leyman, De Raedt, Schacht, & Koster, 2007). A considerable number of studies exploring attentional biases in depression after displaying stimuli for less than 1,000 ms have suggested that they are not present in depression (Bradley, et al., 1997; I. H. Gotlib, et al., 2004; Mathews, et al., 1996; Mogg, et al., 1995). However, when exposing depressed/dysphoric participants to stimuli presented for longer than 1,000 ms an attentional bias towards negative material is evident. That attentional biases occur at different instances in depression and anxiety suggests that attention is not a ‘unitary phenomenon’ (as cited by Leyman et al., 2007) and occurs at different stages of processing in depression and anxiety. In anxiety, attentional biases occur during earlier stages of processing, as indicated by initial shift of gaze towards threatening material followed by ease of disengagement. Cognitive biases in anxiety, or hypervigilence to threatening stimuli, are theorized to serve the purpose of alerting anxious individuals of potential danger. Danger warrants immediate action; thus, anxious individuals may be able to quickly disengage from such stimuli. Depression, on the other hand, is not characterized by hypervigilence to threatening material, but it is instead characterized by rumination and brooding (Nolen-Hoeksema, 2000). It is theorized that individuals manifesting depressive symptomatology exhibit attentional biases at later stages of information processing in which elaboration takes place. Because of these ruminative features, depressed individuals tend to fixate on material at this stage and struggle to disengage their attention from such material because most of their attentional resources are engaged in the processing of the negative information (Jutta Joormann, Dkane, & Gotlib, 2006).

Mogg and colleagues (1995) conducted a study in which anxious, depressed, and non-disordered individuals were presented with pairs of emotion-laden words: half were presented subliminally (14 ms) and the other half supraliminally (1,000 ms). Subsequently, a chain of random letters masked word stimuli. Whereas both, anxious and depressed, groups were biased toward negative (anxiety- and depression-relevant) words presented supraliminally, only anxious individuals were biased toward negative words presented subliminally. These findings support the hypothesis that a ‘preconscious bias’

(Mogg, et al., 1995) characterizes anxiety, but not depression. Instead, it appears depression is characterized by a postconscious bias, once stimuli have undergone elaboration. Caseras et al (2007) note that a stimuli exposure of at least 1,000 ms is necessary to detect an attentional bias in depression. Paralleling the findings of Mogg et al. (1995), Donaldson et al. (2007) found that at 1,000 ms (post-conscious duration), but not at 500 ms (preconscious bias), depressed individuals exhibit a greater tendency to attend to negative words than to positive or neutral words. Mogg et al. (1995) go on to say that biases in depression occur at the disengagement stage, when extensive elaboration has likely taken place. In another study (Leyman, et al., 2007), pairs of angry, happy, and neutral faces were presented to depressed and non-depressed participants for a duration of 1,000 ms. Depressed participants exhibited maintained attention on angry faces, whereas non-depressed participants avoided angry faces and were able to disengage readily. Although a bias was found toward angry faces, which are anxiety-specific, these findings suggest that depressed individuals may attend to negative information, regardless of the emotion elicited, when it is presented long enough to come to the focus of their attention.

Researchers have suggested that covert attention may be better assessed with indices of overt attention, such as eye movement monitoring (Caseras, et al., 2007), rather than more subjective indices (i.e. reaction time), which lack ecological validity. The use of an eye-tracking paradigm, along with longer stimuli exposure durations, may allow for a more accurate assessment of cognitive processing in depression. Eizenman and colleagues (2003) monitored the eye movements (i.e. gaze and fixation) of patients diagnosed with major depressive disorder as they scanned various images displayed on a screen for 10.5 seconds. Depressed individuals glanced longer at mood-congruent images than did non-depressed controls. These findings were replicated by Caseras et al. (2007), who recorded the eye movements of dysphoric and non-dysphoric undergraduate college students as they viewed image pairs of negative, positive, and neutral content displayed for a duration of 3,000 ms. Attentional biases were evident in dysphoric, but not non-dysphoric, participants. Matthews and Antes (1992) were unable to detect such cognitive biases in an eye-tracking study they conducted on dysphoric and non-dysphoric participants. Although an attentional bias toward negative material was not evident in dysphoric participants, a positive bias was present among non-dysphoric participants and not among non-dysphoric participants. This suggests dysphoric individuals may be deficient in a mechanism protecting them from aversive material; thus, resulting in greater detection of negative material. However, Matthews and Antes presented participants stimuli consisting of positive and negative themes. Fixations on positive and negative themes varied across slides, indicating that the slides may have differed significantly enough to fail to consistently detect a bias (Matthews & Antes, 1992). Furthermore, the sample was comprised of participants experiencing depressive symptoms at a subclinical level. Yovel and Mineka (2004) noted that mood-congruent attentional biases are not reliably present in non-clinical samples as they are in clinical samples. Individuals experiencing mild depression or dysphoria exhibit an 'even handedness' (Coyne & Gotlib, 1983), whereas clinically depressed individuals manifest an actual attentional bias (Bradley, et al., 1997).

Investigating cognitive biases in depression has serious implications other than elucidating the relation between depression and attention. According to Beck's model of cognitive schemas (1976), negative schemata and cognitive biases to mood-congruent stimuli predispose an individual to depression – attentional biases precede depression. Another model, the diathesis-stress model (Dalgleish & Watts, 1990), suggests that although there may be a tendency to attend to negative material, there is no onset of depression until an individual experiences a major life stressor, or a series of stressors. Joorman and Gotlib (2007) found that both currently and formerly depressed individuals manifest an attentional bias toward sad faces, providing evidence. Joorman, Talbot, and Gotlib (2007) also found that daughters of currently or formerly depressed mothers selectively attended to negative facial expressions, whereas daughters of mothers who have never been diagnosed with depression did not. That daughters of formerly depressed mothers are biased toward negative material may suggest that they are at higher risk for experiencing depression, supporting the cognitive vulnerability model. The identification of such processes has serious implications in the prevention of depression, as well as the development and implementation of treatments for depression. Wells and Beevers (2010) demonstrated that manipulation of selective attention reduced subsequent depressive symptoms in depressed individuals.

Visual probe tasks have been a commonly used means of assessing attentional biases (Donaldson, et al., 2007; e.g., I. H. Gotlib, et al., 2004; MacLeod, et al., 1986; Shane & Peterson, 2007). A typical visual probe task consists of the presentation of a pair of stimuli (i.e. words, images) – one emotion-laden and the other neutral. After a brief period, the stimuli disappear, with one of the stimuli replaced by a probe. The participant is then asked to respond to the location of the word as quickly as possible. It is assumed that latency to detect the probe is an indication of where the participant was attending.

Short response latencies suggest attention was focused on the stimulus replaced by the probe, and vice versa. In a study in which clinically depressed participants were presented faces followed by a target stimulus to which they had to respond, Gotlib et al. (2004) found an attentional bias towards depression-relevant faces. Donaldson, Lam, and Mathews (2007) replicated these findings in a formerly depressed sample; although their findings indicate that attentional biases are dependent on display duration, with attentional biases more apparent at longer displays. However, MacLeod, Mathews, and Tata (1986) failed to find attentional biases in depression, although these biases were evident in anxiety. Mogg, Millar, and Bradley (2000), on the other hand, failed to find significant differences between depressed and anxious individuals in reaction time to the presentation of a stimulus replacing sad faces.

The adequacy of response latency in visual probe tasks as an index of covert attention is questionable and may be unreliable. Mogg & Bradley (2005) argue visual probe tasks only provide "snapshot[s] of attentional biases." That a participant's latency to respond to the probe's location is short is not necessarily indicative of attention towards the field in which the probe appeared. A possible explanation is that a participant happens to glance to the direction in which a probe is to be displayed soon enough to react quickly to the probe.

Like visual probe tasks, emotional Stroop tasks have been widely used by investigators in attempts to assess attention (Grant & Beck, 2006; Mogg & Bradley, 2005). In the modified Stroop task, which has been considered the 'gold standard' in the literature of attentional biases (I. H. Gotlib, et al., 2004), participants are presented words written in different colors. They are then to name the color in which the word is written while disregarding the meaning of the word. Theoretically, reaction time is dependent on cognitive resources allocated to the processing of the meaning of the displayed word. In a study examining attentional biases in social anxiety and dysphoria, Grant and Beck (2006) presented participants with four types of emotion-laden words: social anxiety threat, depressive threat, neutral, and positive. Whereas the social anxiety group presented attentional biases, the same was not evident in the depressed group. However, in a previous study, Gotlib and Cane (1987) displayed negative words for 1500 ms to depressed individuals, who manifested a bias towards words of this type. Segal, Gemar, Truchon, Guirguis, and Horowitz (1995) replicated the findings of Gotlib and Cane (1987), albeit using a set of words relevant to, or self-descriptive of, participants, which may also have been an important factor contributing to the findings.

It has been suggested that discrepancy in findings may be a result of the different mechanisms contributing to performance in the emotional Stroop task. For example, it may be that mechanisms independent of emotional status may play into performance in the emotional Stroop effect, such as the triggering of task-irrelevant processes (i.e. negative thoughts) by word content (Mogg & Bradley, 2005). Mogg, Millar, and Bradley (2000) also contend that it is difficult to determine whether interference has occurred at the attentional stage or the response selection stage, as the stimulus and response occur concurrently.

A relatively new paradigm of assessing covert attention via cognitive processes among depressed individuals is the use of eye movement recordings, which allows for assessment at the earliest stage of cognitive processing – sensory input (cf. Matthews & Antes, 1992). According to Matthews and Antes (1992), measuring eye movements (e.g., fixation and gaze) as stimuli is observed is a "less artificial" index of attention allowing for continuous measurement of attention via overt attention (Caseras, et al., 2007). Because of its continuous assessment of eye movements, including shift, gaze, and fixation, eye-tracking data possess sound ecological validity; it is more objective and it is not confounded by extraneous variables as are reaction time paradigms.

The use of eye-tracking data in the investigation of the relation between cognitive processes and psychopathology is not novel. Eye tracking has been used in the studies investigating attentional biases in anxiety (Bradley, et al., 2000; Mogg, et al., 2000). Few studies have employed this paradigm in exploring bias towards negative material in depression. However, those studies assessing attention via eye movements have suggested that attention of depressed individuals does gravitate toward mood-congruent stimuli. For instance, in a study of visual attention, Matthews and Antes (1992) recorded eye fixations of depressed individual as they viewed emotion-laden images with positive and negative regions to provide support to the hypothesis that depressed individuals fixate on stimuli relevant to their emotional condition. Although the researchers found that dysphorics looked at happy regions more often, longer, and sooner than they did sad regions, they also found that dysphorics fixated on sad regions more often than did non-dysphoric participants, suggesting that the attention of dysphorics is drawn towards negative material. Eizenman (2003) replicated these findings in a study in which depressed participants' eye fixation and gaze were monitored with an eye-tracking device as they scanned images competing images presented at the same time: social theme, threatening theme, dysphoric theme, and neutral theme. Depressed participants in this study tended to fixate on dysphoric themes significantly longer than did nondepressed participants. The continuous monitoring of eye movements provides a more accurate assessment of attention, including its onset and shift. Given the greater ecological validity, data is more reliable and one need not concern oneself with various extraneous variables.

Research investigating underlying mechanisms of depression has used primarily Caucasian samples; thus, the generalizability of these cognitive models to other racial/ethnic populations is not well understood. Therefore, the present study seeks to explore cognitive biases in the processing of emotional stimuli in Caucasian and Hispanic undergraduate college students. Specifically, the present study seeks to replicate findings of a bias towards negative stimuli in depressed individuals. In addition, the present study will extend previous findings by using both a new paradigm to assess attention and sophisticated eye tracking instrumentation to measure attentional resources. Past studies have used a reaction time paradigm, such as visual probe tasks and modified Stroop tasks, in which latency to react to a target stimulus serves as an index of attention. However, because the ecological validity of such methods is questionable, eye movements (i.e. gaze and fixation) will be recorded to provide a more adequate assessment of attention. Furthermore, because depression has serious interpersonal implications that may further serve to maintain the disorder, faces rather than an array of images or verbal stimuli will be used as stimuli.

Previous research has inconsistently shown a negative bias of initial fixation among depressed individuals. Such disparate findings have been attributed to the use of reaction time as an index of covert attention. The present study is among the growing number of studies using a more ecologically valid approach to assessing attention, thus allowing for greater sensitivity to various attention indices, including initial orienting, latency to initial orienting, and duration of total fixations on stimulus. The first hypothesis concerned direction of initial fixation and latency of first fixation. It was hypothesized that dysphoric participants would initially direct their attention toward negative stimuli (i.e., sad faces) more frequently than they would to positive or neutral faces, and that they would present a greater latency of first fixation than would non-dysphoric participants. The second hypothesis concerned duration of fixation on negative stimuli. Consistent with previous research, it was hypothesized that dysphoric participants would have longer fixation times on negative stimuli, thus suggesting a greater inability to disengage from negative stimuli (e.g., Caseras et al., 2007).

Method

Participants

Undergraduate students (n = 86, 76% female) were recruited from introductory psychology courses at the University of New Mexico (UNM). Informed consent was obtained from each participating student and they were provided course credit for their participation. The Institutional Review Board at UNM approved this study.

Participants were recruited from a larger study in which students completed a large battery of questionnaires, including the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996)). Participants whose scores were below 7 or above 13 were contacted and invited to participate in the present study. Following the conclusion of the larger study from which participants were initially recruited, an online screening session was developed to recruit additional participants using the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977). Participants whose scores were below 10 or above 16 were contacted and invited to participate in the present study. Eligibility for participation was also dependent on ethnic identification. Participants who identified as non-Hispanic White or Hispanic in the screening session were recruited for the study. Ten participants were excluded from all analyses, five who did not identify as non-Hispanic White or Hispanic, one who reported being 60 years of age, and two whose data could not be identified. The final sample consisted of 45 (57.7%) self-identified White students and 33 (42.3%) self-identified Hispanic students.

Apparatus

A head-mounted infrared corneal-reflection-pupil-center eye-tracking system, the EyeLink II (SR Research Ltd., Ontario, Canada) was used to track saccadic eye movement from both eyes during the attention task performance. Both eyes were analyzed except when due to technical difficulties adequate readings could not be obtained for both eyes. Pupil diameter was sampled at 250 hertz (Hz) and drift correction was used to account for instability in fixation. A 17-inch monitor controlled by a personal computer was used to administer the attention task and a game controller was used to register participants' responses.

Procedure

Participants meeting the inclusion criteria were invited to participate in the laboratory session. Upon arrival, participants were consented into the study and were informed the purpose of the study was to explore risk and maintenance factors for depression. Once participants consented, the Snellen wall chart eye exam was administered to assess visual acuity and to ensure participants' ability to complete the attention task would not be impaired due to poor visual acuity. Participants were then seated approximately 85 cm from the computer monitor. A headmounted eye-tracking device was adjusted to comfortably fit participants.

Designation to the dysphoric or non-dysphoric groups was based on level of depressive symptom endorsement on the BDI-II (non-dysphoric: BDI-II ≤ 6, dysphoric: BDI-II ≥ 14) completed at the conclusion of the laboratory session. Eighty-six participants attended the laboratory session of which 78 are considered for the present study following the exclusion of eight participants. 34 endorsing dysphoric levels of depressive symptomotology and 39 endorsing minimal levels of depressive symptomotology. Five additional participants not meeting depressive symptomotology criteria were enrolled inadvertently. Of the dysphoric participants 27 continued to endorse moderate to severe depression at the time of the laboratory session, two endorsed minimal depression, and two were in the mid-range. Of the non-dysphoric participants, 33 continued to endorse minimal depression, two endorsed moderate to severe depression, and four were in the mid-range. Of the participants who did not meet criteria at screening, one endorsed moderate to severe depression and one endorsed minimal depression at the time of the laboratory session. Participants were designated to either the dysphoric or non-dysphoric condition depending on their level of endorsement of depressive symptomotology at the time of the laboratory session, regardless of their level of endorsement at screening, Participants not endorsing either minimal or moderate to severe levels of depressive symptomotology were excluded from the analyses (n = 12). The final dysphoric group was comprised of 30 participants (BDI: M = 24.3, SD = 7.6), and the final non-dysphoric group was comprised of 36 (BDI: M = 2.2, SD = 1,9).

Attention task. The attention task was administered on a Windows XP PC-based system as required by the eye-tracking system. The monitor refresh rate was set to 60 Hz (16.7 ms). Each trial began with the presentation of a white central fixation cross (1in x 1 in) displayed on a black background for at least 500 ms. The dot remained on the screen until fixation was detected and the experimenter manually began the trial. Following fixation, a pair of faces was displayed for 2,500 ms. The photographs, which were obtained from the Montreal Set of Facial Displays of Emotions (Beaupre, Cheung, & Hess, 2000) were displayed side by side. Each photograph measured 9 x 12 cm, with 4 cm setting photograph pair apart from the photographs' respective center points. At the offset of the face pairs, a white dot probe with a diameter of 2 cm was displayed on the location of a preceding photograph (i.e., left or right half of the monitor) for a duration of

200 ms. Participants were instructed to indicate whether the dot was displayed on the left or the right half of the monitor as quickly as possible by pressing the corresponding button on a game console controller. Participants were informed their sole task was to react to the location of the dot, thus de-emphasizing the presentation of the face stimuli. Participants were prompted to indicate where the dot was located if after 1,000 ms a response had not registered. Each trial concluded at the offset of the probe and was followed by an intertrial delay of 1500 ms. Following completion of a trial participants were again instructed to focus on the central fixation cross, and a new trial commenced.

Calibration was necessary to ensure participant-pupillometer agreement on the center of visual field and to ensure valid readings were obtained throughout the attention task. The intertrial interval was set at 1500 ms, Participants were asked to refrain from blinking during trial periods marked by the onset of the fixation cross and their response to the dot display. Three practice trial blocks preceded the actual study to ensure participants understood the task at hand. The experimental portion of the attention task consisted of the completion of 96 trials. The entire task (i.e., instructions, practice, and test) took approximately 25 minutes, with the experimental portion taking approximately 18 minutes.

Montreal Set of Facial Displays of Emotions (MSFDE). Face stimuli depicting sadness, happiness, or neutral emotion were selected from the MSFDE (Beaupre, Cheung, & Hess, 2000). The study set consisted of 48 pairs of photographs, each presented twice in reverse order (i.e., happy-sad presented as sad-happy in second presentation). The stimuli set consisted of photographs of 16 different individuals: eight Caucasian and eight Latino, with an equal distribution of males and females. Three pairings based on displayed emotion were possible: happy-sad, happy-neutral, and neutral-sad. Photographs in each pair measured 9 x 12 cm and were displayed side by side with their respective centers 17 cm apart.

Beck Depression Inventory-II (BDI-II). The BDI-II is a 21-item self-administered measure used to assess severity of depression in clinically depressed individuals and to screen for possible depression in non-clinically depressed individuals. The BDI-II has been shown to have adequate reliability and construct validity in a clinical sample (Beck, et al., 1996) and in an ethnically diverse college sample (Carmody, 2005; Storch, Roberti, & Roth, 2004). The BDI-II is scored by summing ratings on each item – item ratings range from 0 to 3. Total scores on the BDI-II can range from 0 to 63. Moderate levels of depression are defined as BDI-II scores greater than or equal to 14; thus, we will use this score to identify a dysphoric group in our sample. Individuals who are relatively void of depressive symptoms have BDI-II scores of 6 or less; thus, we will use scores less than or equal to 6 to identify a control group.

Eye Movement Data: Recording and Data Preparation

This study was specifically aimed at assessing attentional biases among non-dysphoric and dysphoric undergraduate students. In the initial descriptive analyses, means for participants' demographic, clinical, and cognitive processing measures and frequency distributions for categorical variables were examined. Constructs of interest were initial fixation to mood-congruent stimuli, mean fixation time on mood-congruent stimuli, and dot probe task reaction time. Initial fixation to mood-congruent stimuli was defined as the proportion of number of trials in which eye movement was directed toward dysphoric-congruent stimuli. Initial fixation to mood-congruent stimuli was dependent on: a) fixation on the center of the screen (i.e. central fixation cross) prior to onset of face stimuli and b) initiation of first saccade following the presentation of face stimuli onset (i.e., no movement prior to stimuli display) and prior to its offset. Initial fixation bias scores were obtained by calculating the proportion of valid trials in which eye movements were initially directed to either happy or sad faces to total valid trials across all conditions (i.e., slide-content of happy, sad, or neutral faces). Mean fixation to dysphoric-congruent was calculated by averaging all instances in which gaze was fixated on dysphoric faces.

Parameters and preferences were specified by a MatLab program developed to analyze the eye-tracking data generated by EyeLink II during the attention task. EyeLink II reported saccades were only recognized as actual saccades when a minimum distance of 25 units was crossed in any direction. Additionally, initial fixations on either stimulus were recognized as valid fixations following the offset of the central fixation cross when there was a minimum horizontal displacement of 25 units from the baseline determined by the central fixation cross. Trials in which any of these parameters were violated were excluded from analyses. Additionally, participants' eye-tracking data was dropped entirely from analyses if either one third (10.67) or more of trials in any block or if one third (32) or more of trials across all blocks met exclusion criteria (i.e., invalid initial fixation location, lack of significant movement from baseline, or excessive blinking during stimuli display). A total of 13 participants were dropped from analyses: seven non-dysphoric participants and six dysphoric participants.

Results

Demographics

Table 1 presents the demographics of non-dysphoric (*n* = 30) and dysphoric (*n* = 23) participants. No significant differences were found between the two groups in age or sex. Dysphoric students had significantly higher BDI-II scores than non-dysphoric students. Dysphoric students had higher scores son the BAI than did non-dysphoric students. BAI score did not significantly correlate with any of the variables of interest (i.e., initial fixation, latency, and fixation duration variables). As such, BAI score was not included as a covariate in any of the following analyses.

Table 1

Demographic Comparisons of Dysphoric and non-Dysphoric Samples

Variable	Non-dysphoric		Dysphoric		Statistic
	M	*SD (or %)*	**M**	*SD (or %)*	
N	30		23		
Age (in years)	23.1	6.2	22.7	7	$t(51) = 0.22, p = 0.83$
Sex (female, %)	20	66.7	19	82.6	$X^2(1) = 2.63, p = 0.11$
Primary Ethnicity (%)					$X^2(1) = 3.06, p = 0.08$
White	19	63.3	9	39.1	
Latino	11	36.7	14	60.9	
BDI-II	2.1	1.9	24.5	7.3	$t(51) = 16.21, p < 0.01$
BDI-II (pre)	2.3	2.7	26.8	9.7	$t(26) = 9.44, p < 0.01$
CES-D (pre)	7.1	9.1	26.0	12.6	$t(23) = 4.38, p < 0.01$

Direction of Initial Fixation

A mixed ANOVA of initial fixation bias was conducted with dysphoria group (non-dysphoric, dysphoric) and affect (happy face, sad face) as independent variables. Initial fixation scores were obtained by calculating the average number of trials in which the first fixation recorded was directed toward either emotional face, as a proportion of the number of valid trials across the experiment. The interaction between dysphoria group and affect to which initial fixation was directed was of primary importance in this analysis. However, this interaction was not significant, $F(1, 51) = 0.06$, *n.s*. Similarly, there were no significant main effects of affect, $F(1, 51) = 0.62$, *n.s*., or of dysphoria group, $F(1, 51) = 1.50$, *n.s*. Neither dysphoria group exhibited a greater tendency to initially fixate toward either happy or sad faces, nor did initial fixation bias scores differ between dysphoria groups. (See Table 2).

Table 2

Means and Standard Deviations for Initial Fixation Bias Scores by Dysphoria Group

Variable	Non-dysphoric		Dysphoric	
	M	*SD*	**M**	*SD*
Happy	34.6	4.44	34.2	4.31
Sad	34.2	5.24	33.9	4.21

Given the range of BDI-II scores within the dysphoric group, regression analyses were conducted to investigate the relationship between depressive symptom endorsement on the BDI-II and initial fixation bias scores within the dysphoric group. Three separate regression analyses were conducted with BDI-II scores predicting dysphoric participants' tendency to initially fixate toward happy, sad, or neutral faces. In the regression analyses predicting initial fixation toward happy faces, BDI-II significantly accounted for 26.3% of the variance in initial fixation toward happy faces, $F(1, 22) = 0.7.51$, $p < 0.05$. The regression predicting initial fixation toward sad faces did not produce significant results, $R^2 = 0.093$, $F(1, 51) = 0.16$, *n.s*. Similarly, the regression analysis of initial fixation toward neutral faces did not suggest BDI-II is a significant predictor of initial fixation bias toward neutral faces, $R^2 = 0.035$, $F(1, 22) = 0.39$, *n.s*. Among dysphoric participants, BDI-II score is a significant positive predictor of initial fixation toward happy faces. As BDI-II score increases, the tendency to initially fixate to happy faces also increases.

Latency to First Fixation

A mixed ANOVA of latency of first fixation conducted with dysphoria group (non-dysphoric, dysphoric), condition (happy-sad, happy-neutral, sad-neutral), and affect of face attended (happy, sad, neutral) as independent variables. Table 3 presents means and standard deviation for latency to first fixation for both dysphoric groups. There were no significant interaction effects on latency to first fixation: Condition X Dysphoria Group, $F(2, 102) = 0.28$, *n.s.*; Affect X Dysphoria Group, $F(2, 51) = 0.30$, *n.s.*; Condition X Affect X Dysphoria Group, $F(2, 102) = 1.17$, *n.s.* Further, there were no significant main effects of affect, $F(1, 51) = 0.39$, *n.s.*, or of dysphoria group, $F(1, 51) = 0.43$, *n.s.*, indicating that latency of first fixation was not dependent on stimulus affect or on dysphoria group status. However, there was a significant main effect of condition, $F(2, 102) = 3.$, $p < 0.05$, suggesting that latency to first fixation varied across conditions regardless of dysphoria group status or of stimulus affect.

Given the range of BDI-II scores within the dysphoric group, regression analyses were conducted to investigate the relationship between depressive symptom endorsement on the BDI-II and latency to first fixation within the dysphoric group. Two separate regression analyses were conducted for each of the three conditions (happy-sad, happy-neutral, sad-neutral) with BDI-II scores predicting latency to first fixation toward happy, sad, and neutral faces.

Happy-sad face pairs. The first regression investigating the relationship between BDI-II and latency to first fixation toward happy faces when paired with sad faces did not produce significant results, $R^2 = 0.004$, $F(1, 22) = 0.09$, *n.s.* In the following regression investigating the degree BDI-II was a significant predictor of latency to first fixation toward sad faces when paired with happy faces, results were not significant, $R^2 = 0.000$, $F(1, 22) = 0.08$, *n.s.* These regression analyses did not provide significant evidence suggesting that BDI-II is a significant predictor of latency to first fixation toward either happy or sad faces in trials in which these faces were paired.

Happy-neutral face pairs. The regression of latency to first fixation toward happy faces when paired with neutral faces did not produce significant results, $R^2 = 0.009$, $F(1, 22) = 0.20$, *n.s.* In the second regression analysis of latency to first fixation toward neutral faces, BDI-II was not a significant predictor of latency to first fixation toward neutral faces, $R^2 = 0.005$, $F(1, 22) = 0.11$, *n.s.* Neither regression analysis produced significant results, suggesting that BDI-II is not a significant predictor of latency of first fixation toward either happy or neutral faces in trials in which these faces were paired with each other.

Sad-neutral face pairs. The regression of latency to fist fixation toward sad faces when paired with neutral faces did not indicate there is a significant relationship between BDI-II score and latency of first fixation toward neutral faces, $R^2 = 0.003$, $F(1, 22) = 0.06$, *n.s*. Results from the regression of latency to first fixation toward neutral faces when paired with sad faces paralleled the findings of the previous regression; BDI-II did not significantly account for the variance of latency of first fixation toward neutral faces, $R^2 = 0.026$, $F(1, 22) = 0.55$, *n.s.* BDI-II score was not a significant predictor of latency of first fixation to sad or neutral faces in trials displaying the sad-neutral face pair.

Duration of Fixations

A mixed ANOVA of average duration of total fixations toward a specific affect was conducted with dysphoria group (non-dysphoric, dysphoric), condition (happy-sad, happy-neutral, sad-neutral), and affect of face attended (happy, sad, neutral) as independent variables. Table 3 presents average duration of fixation on dominant sides for both dysphoric groups. There was a significant Affect X Dysphoria Group interaction, $F(1, 51) = 7.73$, $p < 0.01$, indicating that facial affect has a different effect on duration of total fixations as a function of dysphoria group. Additionally, there was a significant main effect of condition, $F(2, 102) = 6.79$, $p < 0.01$, as well as a significant quadratic trend of condition, $F(1, 51) = 14.47$ $p < 0.01$. These findings suggest duration of total fixations varied across conditions, depending on which facial affects had been paired together regardless of dysphoria group status.

Table 3

Means and Standard Deviations for Latency to First Fixation and Duration of Fixations by Dysphoria Group

	Latency to First Fixation				Duration of Fixations			
Variable	Non-dysphoric		Dysphoric		Non-dysphoric		Dysphoric	
	M	*SD*	***M***	*SD*	***M***	*SD*	***M***	*SD*
Happy-Sad								
Happy	0.39	0.23	0.34	0.24	1.20	0.28	1.23	0.20
Sad	0.40	0.30	0.34	0.24	1.29	0.29	1.22	0.20
Happy- Neutral								
Happy	0.43	0.25	0.40	0.32	1.21	0.29	1.23	0.25
Neutral	0.44	0.32	0.38	0.30	1.22	0.26	1.20	0.23
Sad-Neutral								
Sad	0.41	0.24	0.33	0.21	1.22	0.25	1.32	0.21
Neutral	0.40	0.22	0.41	0.36	1.30	0.28	1.22	0.22

Additional analyses of variance were conducted for each condition to further explore the significant interaction between affect and dysphoria group. For happy-sad trials, there was not a significant interaction effect, $F(1, 51) = 2.01$, *n.s*. (see Figure 1). However, the effect of affect was marginally significant, $F(2, 51) = 3.18$, $p = 0.08$. Dysphoric participants spent almost as much time on happy faces ($M = 0.91$, $SD = 0.19$) than they did on sad faces ($M = 0.91$, $SD = 0.20$). Non-dysphoric participants, on the other hand, attended to sad faces ($M = 0.88$, $SD = 0.20$) longer than they did to happy

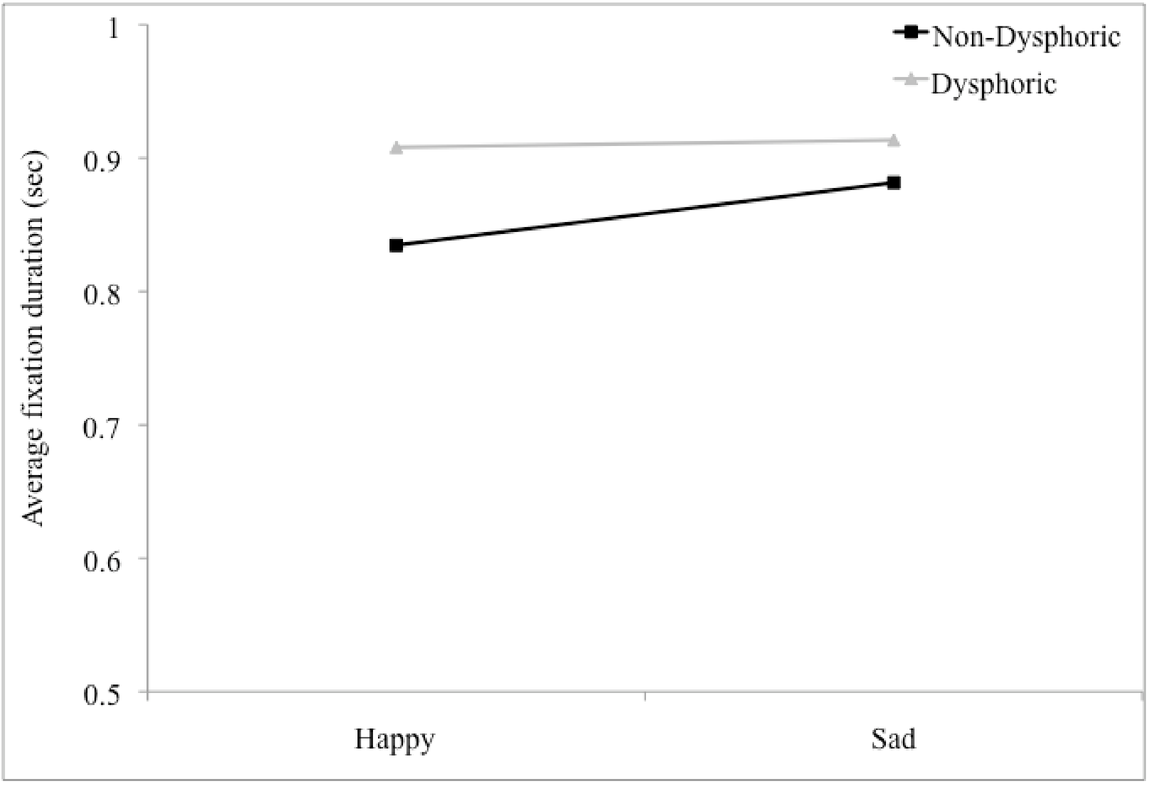

Figure 1. Average fixation duration in seconds for happy-sad face trials by dysphoria group.

faces ($M = 0.83$, $SD = 0.23$). There was not a significant effect of dysphoria group, $F(1, 51) = 0.89$, *n.s.* Duration of total fixations was not significantly influenced by facial affect or by dysphoria group.

For happy-neutral trials, there was not a significant interaction effect, $F(1, 51) = 0.66$, *n.s.* (see Figure 2). There was a marginally significant main effect of affect, $F(2, 51) = 3.20$, $p = 0.08$, with dysphoric participants attending longer at happy faces ($M = 0.91$, $SD = 0.21$) than at neutral faces ($M = 0.88$, $SD = 0.21$). There was not a significant effect of dysphoria group, $F(1, 51) = 0.89$, *n.s.* Duration of total fixations was not significantly influenced by facial affect or by dysphoria group.

For sad-neutral trials, the analysis produced a significant interaction between affect and dysphoria group, $F(1, 51) = 7.62$, $p < 0.01$, (see Figure 3). Whereas non-dysphoric participants spent less time fixated toward sad faces ($M = 0.83$, $SD = 0.21$) and more time fixated toward neutral faces ($M = 0.89$, $SD = 0.22$), the converse was true for dysphoric participants who spent more time fixated toward sad faces ($M = 0.96$, $SD = 0.13$) and less time fixated toward neutral faces ($M = 0.91$, $SD = 0.23$). No significant main effects of affect, $F(1, 51) = 0.42$, *n.s.*, or of dysphoria group, $F(1, 51) = 2.01$, *n.s.* were evident, suggesting duration of fixations toward either sad or neutral faces was not solely dependent on affect or dysphoria group.

Regression analyses were conducted to further investigate the relationship between BDI-II scores and duration of total fixations toward faces on which most attention was spent relative to the face to which it was paired. Regression analyses were only conducted for the dysphoric group due to the range of BDI-II scores the group presented. Two separate regression analyses were conducted for each of the three

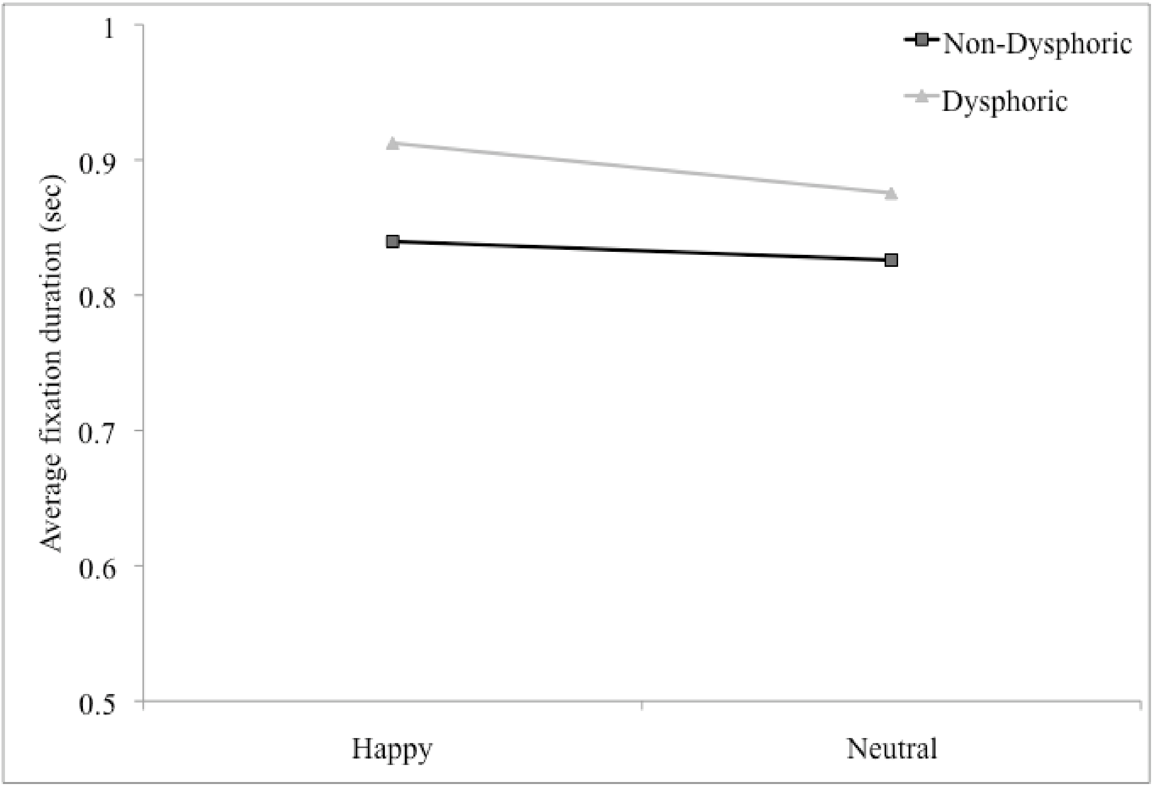

Figure 2. Average fixation duration in seconds for happy-neutral face trials by dysphoria group

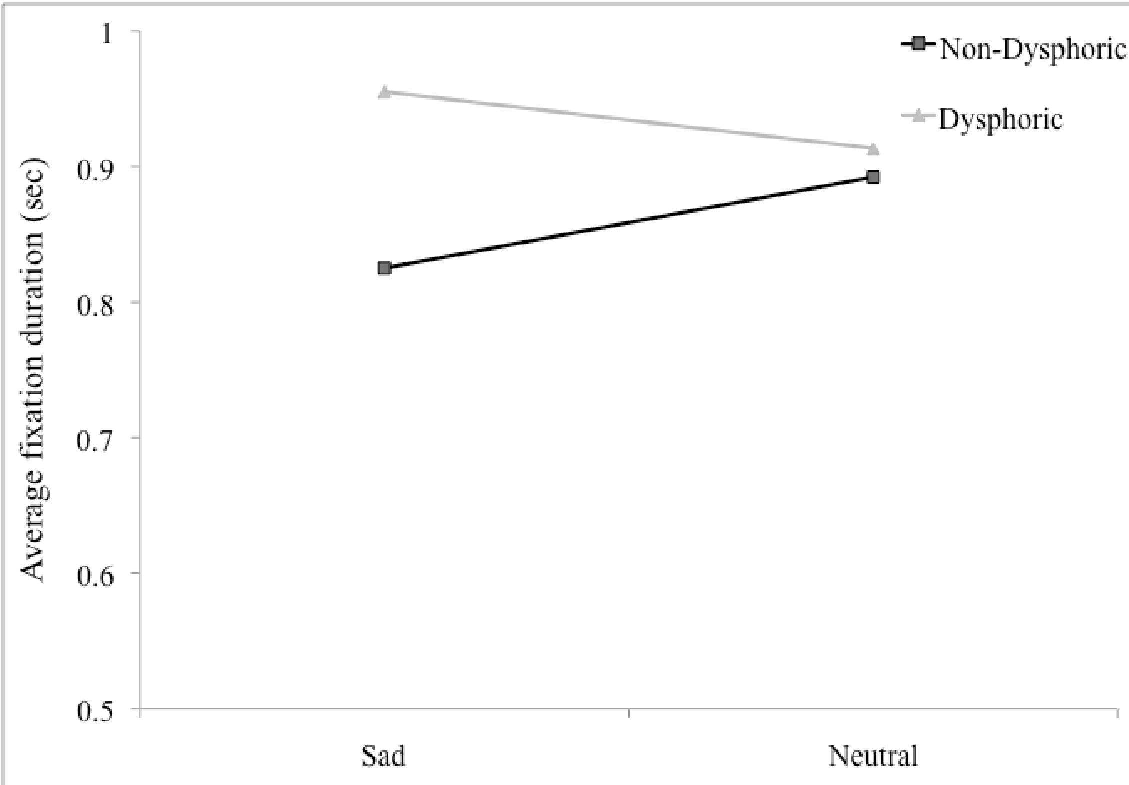

Figure 3. Average fixation duration in seconds for sad-neutral face trials by dysphoria group.

conditions (happy-sad, happy-neutral, sad-neutral) with BDI-II scores predicting duration of total fixations toward dominant side.

Happy-sad face pairs. In the regression investigating the relationship between BDI-II scores and duration of total fixations toward happy faces when these were paired with sad faces, BDI-II score was not found to significantly account for the variation in duration of total fixations toward happy faces, $R^2 = 0.009$, $F(1, 22) = 0.20$, *n.s.* A regression analysis of duration of total fixations toward sad faces when these were paired with happy faces was also conducted. Again, BDI-II score did not significantly account for variation in duration total fixations to the dominant face, $R^2 = 0.001$, $F(1, 22) = 0.02$, *n.s.* These findings reflect that BDI-II score is not a significant predictor of the amount of time an individual will spend on either happy or sad faces when these are paired presented simultaneously.

Happy-neutral face pairs. Regressions of duration of total fixations were also conducted for happy-neutral face pairs. In the regression of duration of total fixations toward happy faces when these were paired with neutral faces, BDI-II was not a significant predictor of duration of total fixations toward happy faces, $R^2 = 0.006$, $F(1, 22) = 0.12$, *n.s.* Similarly, the regression of duration of total fixations toward neutral faces when these were paired with happy faces did not suggest a significant relationship between BDI-II score and duration of total fixations toward neutral faces, $R^2 = 0.003$, $F(1, 22) = 0.06$, *n.s.* These findings do not reflect that dysphoric participants spend time on dominant faces on trials in which happy and neutral faces are paired with each other as a function of their BDI-II scores.

Sad-neutral face pairs. The regression of duration of total fixations toward sad faces when these were paired with neutral faces was not indicative of a significant relationship between BDI-II score and duration of total fixations toward sad faces, R^2 = 0.000, $F(1, 22) = 0.01$, *n.s.* Similarly, the regression of duration of total fixations toward dominant neutral faces when these were paired with sad faces did not suggest BDI-II score is a significant predictor of duration of total fixations toward dominant neutral faces, $R^2 = 0.023$, $F(1, 22) = 0.50$, *n.s.* These regression analyses do not suggest BDI-II scores account for significant variation in duration of total fixations toward sad or neutral faces when these faces are paired with each other.

Exploratory Analyses

Further analyses were conducted to explore additional variables of interest, including duration of fixation toward the affect to which most attention was directed (i.e., side on which most time was spent) and frequency of fixations toward happy, sad, and neutral faces. Frequency of fixations was of particular importance because it has previously been used as an index of attention. Greater frequency of fixation may be indicative of inability to disengage from a stimulus, and thus may be suggestive of an attentional bias.

Duration of Dominant Fixations. A mixed ANOVA of fixation duration toward dominant side (i.e., side on which most time was spent) was conducted with dysphoria group (non-dysphoric, dysphoric), condition (happy-sad, happy-neutral, sad-neutral), and affect of face attended (happy, sad, neutral) as independent variables. Table 3 presents average duration of fixation on dominant sides for both dysphoric groups. There was a significant Affect X Dysphoria Group interaction, $F(1, 51) = 9.37$, $p < 0.05$, indicating that facial affect has a different effect on duration of total fixations toward the dominant side as a function of dysphoria group. Additionally, there was a significant main effect of condition, $F(2, 102) = 4.01$, $p < 0.05$, as well as a significant quadratic trend of condition, $F(1, 51) = 2.15$, $p < 0.05$. These findings suggest duration of total fixations toward the side on which most attention was spent varied across conditions, depending on which facial affects had been paired together regardless of dysphoria group status.

Additional analyses of variance were conducted for each condition to further explore the significant interaction between affect and dysphoria group. For happy-sad trials, results showed a significant interaction between affect and dysphoria group, $F(1, 51) = 4.09$, $p < 0.05$ (see Figure 4). Although non-dypshoric participants spent less total time fixated toward dominant happy faces ($M = 1.20$, $SD = 0.28$) than did dysphoric participants ($M = 1.23$, $SD = 0.20$), when the sad face was the dominant face, non-dysphoric participants spent more time in total fixated toward sad faces ($M = 1.29$, $SD = 0.29$) than did non-dysphoric participants ($M = 1.22$, $SD = 0.20$) who spent roughly the same amount of time fixated toward both happy and sad faces. There were no significant main effects of affect, $F(1, 51) = 0.34$, *n.s.*, or of dysphoria group, $F(1, 51) = 0.34$, *n.s.* Duration of fixation on a dominant face was not influenced by facial affect or by dysphoria group.

For happy-neutral trials, no significant interaction effects, $F(1, 51) = 0.56$, *n.s.*, or main effects of affect, $F(1, 51) = 0.34$, *n.s.*, or dysphoria group, $F(1, 51) = 0.00$, *n.s.*, were found (see Figure 5). Duration of fixation on either dominant happy or neutral faces was not dependent on affect nor was it influenced by dysphoria group.

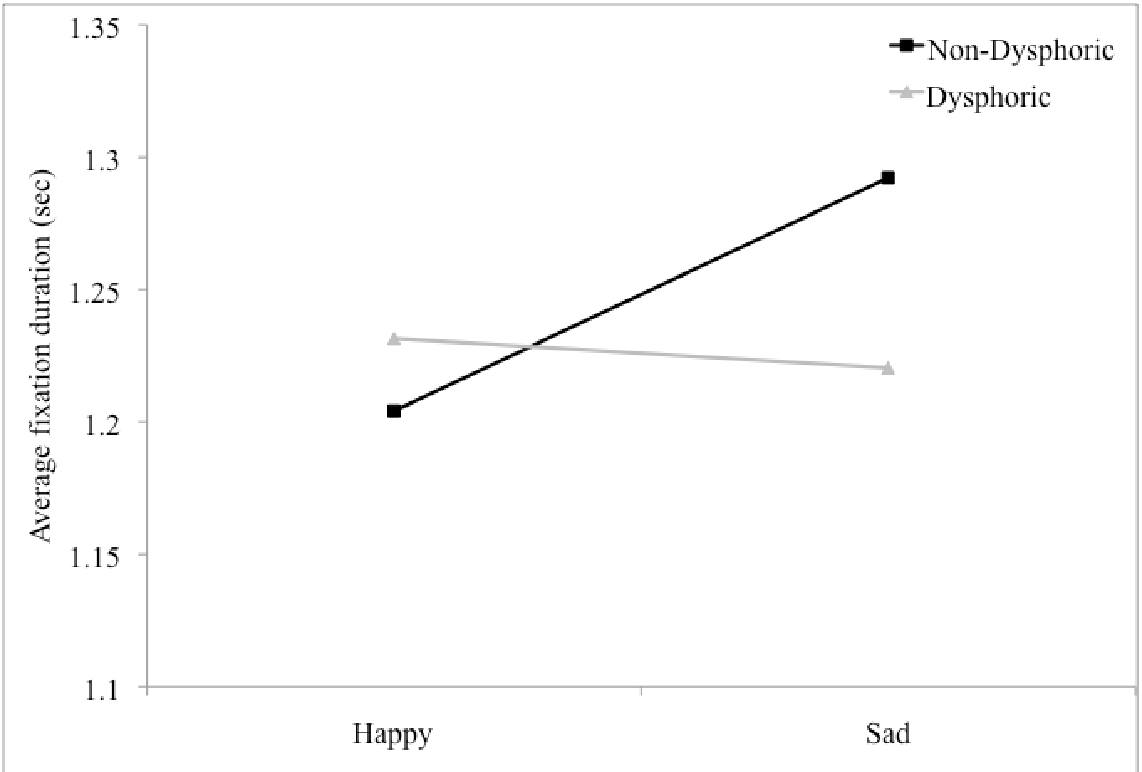

Figure 4. Average fixation duration in seconds for happy-sad face trials by dysphoria group.

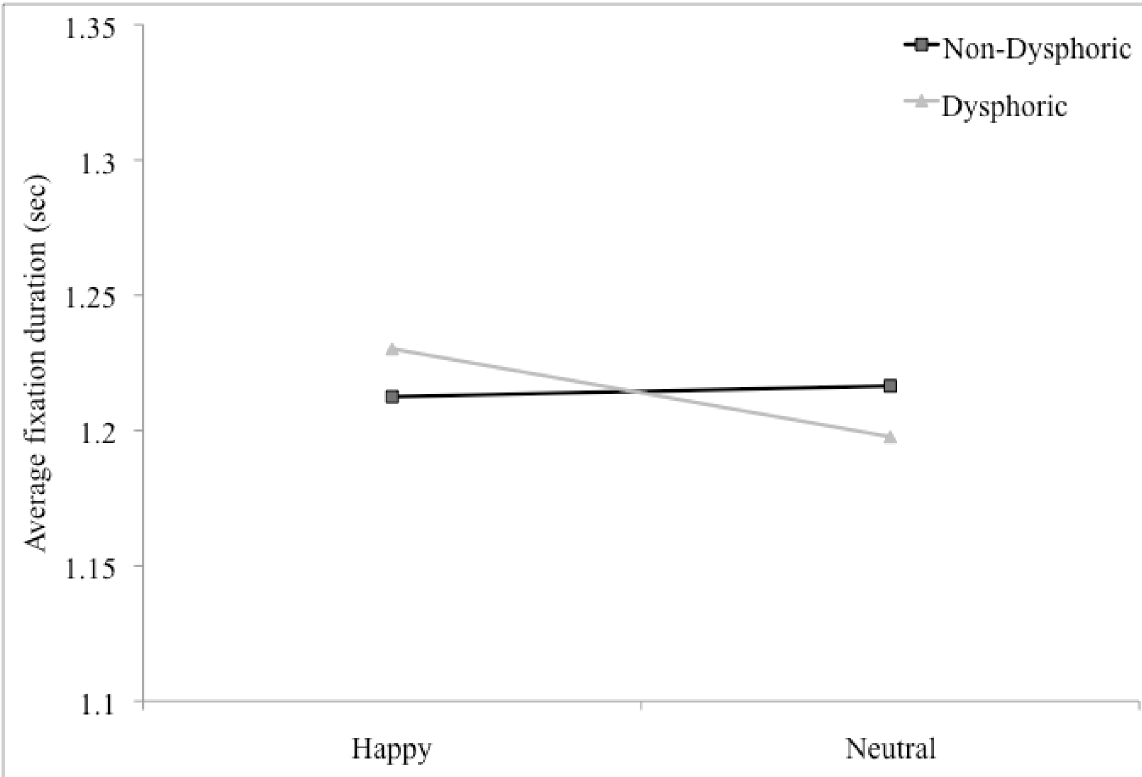

Figure 5. Average fixation duration in seconds for happy-neutral face trials by dysphoria group.

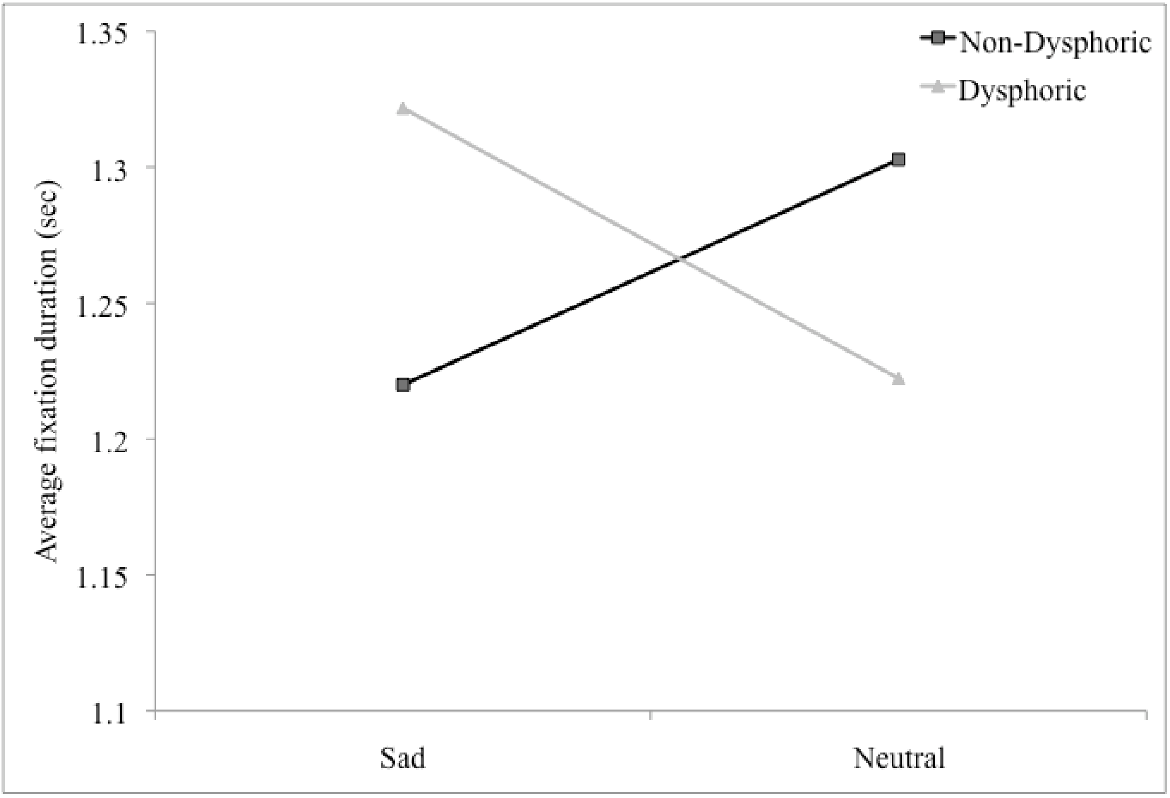

Figure 6. Average fixation duration in seconds for sad-neutral face trials by dysphoria group.

For sad-neutral trials, the analysis produced a significant interaction between affect and dysphoria group, $F(1, 51) = 7.94$, $p < 0.01$, (see Figure 6). Whereas non-dysphoric participants spent less time fixated toward dominant sad faces ($M = 1.22$, $SD = 0.25$) and more time fixated toward dominant neutral faces ($M = 1.30$, $SD = 0.28$), the converse was true for dysphoric participants who spent more time fixated toward dominant sad faces ($M = 1.32$, $SD = 0.21$) and less time fixated toward dominant neutral faces ($M = 1.22$, $SD = 0.22$). No significant main effects of affect, $F(1, 51) = 0.07$, *n.s.*, or of dysphoria group, $F(1, 51) = 0.03$, *n.s.*, were evident, suggesting duration of fixations toward dominant faces not solely dependent on either affect or dysphoria group.

Regression analyses were conducted to further investigate the relationship between BDI-II scores and duration of total fixations toward faces on which most attention was spent relative to the face to which it was paired. As in previous regression analyses, was conducted for the dysphoric group due to the range of BDI-II scores the group presented. Two separate regression analyses were conducted for each of the three conditions (happy-sad, happy-neutral, sad-neutral) with BDI-II scores predicting duration of total fixations toward dominant side.

Happy-sad face pairs. In the regression investigating the relationship between BDI-II scores and duration of total fixations toward dominant happy faces when these were paired with sad faces, BDI-II score was not found to significantly account for the variation in duration of total fixations to the dominant face, $R^2 = 0.010$, $F(1, 22) = 0.21$, *n.s.* A regression analysis of duration of total fixations toward dominant sad faces when these were paired with happy faces was also conducted. Again, BDI-II score did not significantly account for variation in duration total fixations to the dominant face, R^2 =

0.009, $F(1, 22) = 0.18$, *n.s.* These findings reflect that BDI-II score is not a significant predictor of the amount of time an individual will spend on a face on which they have spent most of their time relative to the face with which it is paired.

Happy-neutral face pairs. Regressions of duration of total fixations on dominant sides were also conducted for happy-neutral face pairs. In the regression of duration of total fixations toward dominant happy faces when these were paired with neutral faces, BDI-II was not a significant predictor of duration of total fixations toward dominant happy faces, $R^2 = 0.004$, $F(1, 22) = 0.08$, *n.s.* Similarly, the regression of duration of total fixations toward dominant neutral faces when these were paired with happy faces did not suggest a significant relationship between BDI-II score and duration of total fixations toward dominant neutral faces. These findings do not reflect that dysphoric participants spend time on dominant faces on trials in which happy and neutral faces are paired with each other as a function of their BDI-II scores.

Sad-neutral face pairs. The regression of duration of total fixations toward dominant sad faces when these were paired with neutral faces was not indicative of a significant relationship between BDI-II score and duration of total fixations toward dominant sad faces, $R^2 = 0.000$, $F(1, 22) = 0.00$, *n.s.* Similarly, the regression of duration of total fixations toward dominant neutral faces when these were paired with sad faces did not suggest BDI-II score is a significant predictor of duration of total fixations toward dominant neutral faces, $R^2 = 0.000$, $F(1, 22) = 0.00$, *n.s.* These regression analyses do not suggest BDI-II scores account for significant variation in duration of total fixations toward dominant sad or dominant neutral faces when these faces are paired with each other.

Frequency of Fixations. A mixed ANOVA of the frequency of fixations toward a specific affect was conducted with dysphoria group (non-dysphoric, dysphoric), condition (happy-sad, happy-neutral, sad-neutral), and affect of face attended (happy, sad, neutral) as independent variables. Table 3 presents the number of total fixations on happy, sad, and neutral faces both dysphoric groups. There were no significant interaction effects: Condition X Dysphoria Group, $F(2, 102) = 0.12$, *n.s.*; Affect X Dysphoria Group, $F(2, 51) = 0.30$, *n.s.*; Condition X Affect X Dysphoria Group, $F(2, 102) = 0.43$, *n.s.* Further, there were no significant main effects of affect, $F(1, 51) = 0.11$, *n.s.*, or of dysphoria group, $F(1, 51) = 2.89$, *n.s.*, indicating that frequency of fixations was not dependent on stimulus affect or on dysphoria group status. However, there was a significant main effect of condition, $F(2, 102) = 3.63$, $p < 0.05$, suggesting that frequency of fixations varied across conditions regardless of dysphoria group status or of stimulus affect.

Given the range of BDI-II scores within the dysphoric group, regression analyses were conducted to investigate the relationship between depressive symptom endorsement on the BDI-II and frequency of fixations toward happy, sad, and neutral faces within the dysphoric group. Two separate regression analyses were conducted for each of the three conditions (happy-sad, happy-neutral, sad-neutral) with BDI-II scores predicting latency to first fixation toward happy, sad, and neutral faces.

Happy-sad face pairs. The first regression investigating the relationship between BDI-II and latency to first fixation toward happy faces when paired with sad faces did not produce significant results, $R^2 = 0.087$, $F(1, 22) = 2.00$, *n.s.* In the following regression investigating the degree BDI-II was a significant predictor of latency to first fixation toward sad faces when paired with happy faces, results were not significant, $R^2 = 0.024$,

$F(1, 22) = 0.52$, *n.s*. These regression analyses did not provide significant evidence suggesting that BDI-II is a significant predictor of latency to first fixation toward either happy or sad faces in trials in which these faces were paired.

Happy-neutral face pairs. The regression of latency to first fixation toward happy faces when paired with neutral faces did not produce significant results, $R^2 = 0.031$, $F(1, 22) = 0.67$, *n.s.* In the second regression analysis of latency to first fixation toward neutral faces, BDI-II was not a significant predictor of latency to first fixation toward neutral faces, $R^2 = 0.028$, $F(1, 22) = 0.61$, *n.s.* Neither regression analysis produced significant results, suggesting that BDI-II is not a significant predictor of latency of first fixation toward either happy or neutral faces in trials in which these faces were paired with each other.

Sad-neutral face pairs. The regression of latency to fist fixation toward sad faces when paired with neutral faces did not indicate there is a significant relationship between BDI-II score and latency of first fixation toward neutral faces, $R^2 = 0.047$, $F(1, 22) = 1.04$, *n.s*. Results from the regression of latency to first fixation toward neutral faces when paired with sad faces paralleled the findings of the previous regression; BDI-II did not significantly account for the variance of latency of first fixation toward neutral faces, $R^2 = 0.077$, $F(1, 22) = 1.76$, *n.s.* BDI-II score was not a significant predictor of latency of first fixation to sad or neutral faces in trials displaying the sad-neutral face pair.

Discussion

We investigated mood-congruent attentional biases to sad faces in dysphoric students relative to non-dysphoric students using eye-tracking methods. A bias to maintain attention on sad faces (also referred to as dysphoric or negative stimuli) was found in the dysphoric samples when the sad face was paired with a neutral face over a 2.5-second duration. However, this attentional bias did not translate to the happy-sad face pair for the dysphoric students; these students spent a similar amount of time to both the happy and sad faces over the 2.5-seconds presentation. Furthermore, depressive symptom scores, as measured by the Beck Depression Inventory-II (BDI-II; Beck et al., 1996), were not associated with the attentional bias for the dysphoric participants. No attentional bias for the dysphoric students was found for initial gaze for either first fixation or latency to first fixation. These findings suggest that individuals with dysphoria will attend more to negative stimulus (i.e., a sad face) when paired with a neutral stimulus over a brief period of 2.5 seconds than will non-dysphoric participants. However, when the negative stimulus is paired to a positive stimulus (i.e., a happy face) no attentional bias is found. In addition, no initial attentional bias is present; thus, a brief period of time is needed for the dysphoric participants to take in the stimuli as a whole in order to dwell on the dysphoric stimuli. This bias was only evident when duration was assessed as total fixation time as opposed to frequency of fixations toward a specific affect. Finally, there appears to be a qualitative difference between having some depression symptoms present and having little or no symptoms; however, once a threshold for symptoms is reached, there appears to be little effect of attention bias with the amount of symptoms. These findings suggest that an attentional bias to negative stimuli for dysphoria exists and may maintain depressive symptomology.

Attentional Bias to Sad Faces

Dysphoric participants showed a bias in duration spent on the sad face in the sad-neutral face pair over a 2.5 second duration. Whereas some studies have failed to demonstrate a bias in maintenance of attention on dysphoric stimuli (Matthews & Antes, 1992), the present findings and those of other studies (e.g., Caseras, et al., 2007; Eizenman, et al., 2003; Kellough, Beevers, Ellis, & Wells, 2008) suggest that dysphoric and depressed individuals will spend greater time processing negative information than other emotion-laden or neutral information. Caseras and colleagues (2007) obtained data on the duration of eye movements, as measured by electrooculography (EOG), on sad stimuli and found that dysphoric participants had a bias to fixate longer on dysphoric scenes than on neutral scenes. Using a different index to assess maintained attention, Kellough and colleagues (2008) found that their clinically depressed sample spent more time attending to dysphoric stimuli associated with feelings of loss and sadness (e.g., boy crying) than did a never-depressed sample over a 30-second duration. The authors found that the depressed sample were more likely to repeatedly fixate toward dysphoric stimuli than to other emotion-laden stimuli.

The present study's findings, along with those of prior research, provide evidence in support of the hypothesis that depression is characterized by sustained and elaborative processing of dysphoric stimuli. Late stage elaborative processing of negative information is consistent with brooding and ruminative nature of depression suggested by some researchers (Nolen-Hoeksema, 2000). Depressed individuals do not immediately attend to mood-congruent stimuli. But, once attention has been drawn to negative stimuli, specifically dysphoric stimuli, disengagement from the stimuli is inhibited because significant attentional resources are directed toward the processing of negative information (Joorman, et al., 2006). Longer duration on mood-congruent stimuli is not evident in anxiety as it is in depression or dysphoria, as anxiety is characterized by hypervigilence and not rumination and brooding (Mogg, et al., 1992).

Dysphoric participants did not show a bias in the maintenance of attention on the sad face in the happy-sad face pair over a 2.5-second duration. This finding is not in line with the findings showing an attentional bias when sad faces are paired with neutral faces, and it is inconsistent with research demonstrating a negative bias in the maintenance of attention in depression. A possible explanation is that when emotion-laden stimuli are presented simultaneously, neither of the emotions is particularly salient; they both compete for attentional resources. However, the existing literature suggests a bias for dysphoric stimuli will exist even when other negative and positive stimuli are presented within the same visual area. Eizenman and colleagues (2003) had clinically depressed subjects visually scan various slides, each containing four themes: neutral, dysphoric, threatening, and interpersonal contact. Although these themes were presented simultaneously in each of these slides, no competing effects between the various emotional stimuli were evident. In fact, the average glance duration on dysphoric stimuli was significantly larger for depressed subjects. Similarly, Kellough and her research team (2008) found that the simultaneous presentation of emotional-laden stimuli did not "disrupt biased attention" for dysphoric stimuli in a sample of clinically depressed college students.

Interestingly, these biases were found in subjects meeting clinical criteria for depressive disorder and to the best of our knowledge, have not been replicated in dysphoric samples. Attentional biases may not be as robust among mildly depressed individuals compared to clinically depressed individuals (Bradley, et al., 1997; McCabe & Gotlib, 1993). The degree to which depressive symptoms are experienced may play an important role in negative biases in maintained attention. It is likely that our dysphoric sample did not experience depressive symptoms sufficiently severe to cause an attentional shift in cognitive processes. Among individuals who present clinical levels of depression, specificity and sensitivity to mood-congruent stimuli may be heightened, making content less critical. This apparent "even-handedness" the dysphoric participants present may also account for the absence of any bias in happy-neutral face pairs (Coyne & Gotlib, 1983; Gotlib, et al., 1988; Mogg, et al., 1991).

An alternative hypothesis for this interesting and noteworthy finding of no dysphoria attentional bias in the sad-happy face pair concerns an unexpected finding concerning preferences the non-dysphoric sample exhibited. The non-dysphoric participants had a tendency to maintain attention on the sad face in the sad-happy face pair, but to avoid the sad face in the sad-neutral face pair. In fact, the non-dysphoric participants attended less to the happy face and more to the sad face in the happy-sad face pair than did the dysphoric participants, although this finding was not a significant pattern. It is unclear why the non-dysphoric sample showed a preference for the sad face instead of the happy face, as would be expected based on research demonstrating a positive bias in non-dysphoric individuals (e.g., Caseras, et al., 2007). A possible explanation is that the non-dysphoric participants were drawn to the sad face due to its novelty. Anecdotally, during the laboratory session a couple participants commented on the exaggerated and comical nature of the sad faces relative to the happy and the neutral faces. Although this is anecdotal and the number of participants who commented on the sad faces is minimal, it does suggest the need for further exploration. Although this seems like a plausible explanation for the tendency to fixate on the sad face in the happy-sad face pair, it is not a plausible argument for the tendency to avoid the sad face in the sad-neutral face pair.

In the present study, the dysphoric participants did not demonstrate a bias to initially fixate toward sad faces. However, literature suggesting an initial fixation bias toward negative stimuli in depression has been inconsistent. In fact, Caseras and colleagues (2007) found a greater tendency of participants, regardless of dysphoric status, to initially orient toward positive stimuli as well as a tendency to avoid negative stimuli. Matthews and Antes (1992), on the other hand, found that only non-depressed participants immediately gravitated toward happy stimuli relative to sad stimuli; dysphoric participants failed to present a bias toward any emotional face.

Mogg and her research team (2000) offer a convincing argument as to why selective attentional biases in initial orienting may be absent in depression. In a study investigating attentional biases to emotion-laden stimuli, participants who met criteria for either generalized anxiety disorder (GAD) or depressive disorder, only GAD participants were more likely to initially direct their attention toward mood-congruent stimuli (i.e., fear-eliciting stimuli) than were depressive participants. Additionally, they were also quicker to initiate eye movement toward mood-congruent stimuli than were depressive participants. An initial orienting bias toward mood-congruent stimuli in anxiety is a consistent finding (e..g, Bradley, Mogg, Millar, & Bonham-Carter, 1997; MacLeod, Mathews, & Tata, 1986; Mogg, Bradley, & Williams, 1995). Cognitive biases in anxiety have been attributed to hypervigilence to threatening stimuli, believed to account for the rapid shifts in attention toward and away from fear-inducing material. Drevets and Raichle (1995; as cited in Moggs, et al., 2000) speculate neural systems involved in immediate attention to environmental cues may be inhibited in depressed individuals, although maintained attention on negative stimuli at later stages of cognitive processing would not be affected.

Findings of the present study lend support to hypotheses suggesting that depression is characterized by delayed engagement and rumination, although the degree to which an individual is attending to mood-congruent stimuli may be dependent on context. These findings suggest that, like in depression (Kellough, et al., 2008), dysphoria is characterized by attentional biases evident at elaborative stages of information processing. The present study did not produce evidence in support of an initial fixation bias. This finding is consistent with other eye-tracking studies that have not found an initial orientation bias (e.g., Caseras, et al, 2007; Kellough, et al., 2008) and with studies that have found that this bias is only present in anxiety (e.g., Mogg, et al., 1995; Mogg, et al., 1992).

Study Limitations

A major limitation in this study is the use of a non-clinical sample of undergraduate college students who reported depressive symptoms on the Beck Depression Inventory-II, which is typically used for purposes of rating severity of depressive symptoms and not as a diagnostic instrument. Our use of a convenient student sample limits the generalizability of our findings and may not apply to clinically depressed adults or adolescents. However, whereas most studies using similar samples used liberal cutoff scores for dysphoria group assignment (e.g., BDI-II score of 10 suggesting mild depressive symptomotology in Caseras et al., 2007), the present study employed a more conservative BDI-II cutoff score of 14, which is indicative of moderate levels of depressive symptomotology (Beck, et al., 1996). Although such a conservative cutoff score increases the likelihood that the two groups are sufficiently distinct for purposes of comparison, there was a drawback. There were several participants who had to be excluded from analyses in the present study because their BDI-II score at the time of the experiment no longer indicated a moderate to severe level of depressive symptoms; the window of exclusion (i.e., $6 \leq$ or ≥ 14) was larger than that used in other studies (e.g., $6 \leq$ or ≥ 10). Additionally, the loss of these participants inevitably had an impact on the power of the study.

Clinical Implications

The findings from the present study may have significant clinical implications, specifically concerning the amelioration of depressive symptomotology. General findings suggesting a negative attention bias in depression have already led to a novel approach that, although promising, is still in its infancy. To our knowledge, there is only one study that has investigated the effects of manipulating selective attention for dysphoric stimuli on reducing depressive symptoms (Wells & Beevers, 2010). Dysphoric participants who underwent a training task designed to draw their attention toward non-dysphoric stimuli instead of toward dysphoric stimuli showed a significant reduction in depressive symptoms from baseline to a post-study follow-up mediated by the modification in attention bias. It is unclear whether these findings can be generalized to clinically depressed populations, as this study used a convenience sample of dysphoric undergraduate students who endorsed mild to moderate symptoms of depression on a brief depression measure. Given inconsistent findings suggesting there may be quantitative and perhaps qualitative differences between clinical depression and subclinical depression, or dysphoria, it would be advantageous to the field if the effect of manipulating negative attentional biases were explored in clinically depressed samples. This would further elucidate the commonalities and unique features between clinical depression and subclinical depression. Additionally, it would be fruitful to explore how selective attention training interventions could be implemented for the prevention of clinical depression in individuals endorsing depressive symptoms but who do not meet criteria for an official diagnosis. Finally, a laboratory intervention (e.g., Wells & Beevers, 2010) may not be practical, as it requires an individual to attend laboratory sessions and its effect occurs outside the awareness of the dysphoric or depressed individual. The present findings may provide a stepping-stone for the development of interventions designed to train an individual to become aware of his/her attentional biases and to actively modify these biases. Such an intervention could be in the form of take-home computer assignments serving as adjuncts to existing therapies, including cognitive-behavioral therapy and behavioral activation.

Conclusions

Future directions include exploring the relationship between different indices of attention, to determine the reliability of both reaction time tasks (e.g., stroop and dot probe tasks) and physiological measures (i.e., eye tracking) in reflection attentional biases

(Caseras, et al., 2007). The application of physiological measures in obtaining indices of attention is a relatively novel approach compared to the application of reaction time paradigms, which traditionally have been used as indices of various cognitive processes (e.g., attention and memory). Additionally, it is necessary to further explore the degree to which dysphoric and depressed individuals experience difficulty in disengaging from dysphoric stimuli, which would be consistent with theories of rumination and brooding (e.g., Nolen-Hoeksema, 2000). The absence of a bias in maintained attention (i.e., elaborative processing) on mood-congruent stimuli when the sad face was paired with the happy face suggests there may not only be quantitative differences between clinical and subclinical depression, but that there may be qualitative differences as well. The underlying mechanisms driving the differential effect of context between clinical and subclinical depression deserve further exploration.

In summary, the present study suggests that dysphoric is characterized by elaboration of mood-congruent stimuli at later stages of information processing under specific circumstances. Dysphoric individuals do not show a preference for mood-congruent stimuli when it is paired with other emotion-laden stimuli that may be competing for attentional resources; they allocate similar amounts of attentional resources to both stimuli. However, when a mood-congruent stimulus is presented alongside neutral stimulus, a striking preference to sustain attention on the mood-congruent stimulus becomes evident. A significant strength of the present study is the use eye movements as ecologically valid indices of attention. Further studies are required to better understand the mechanisms by which attention to mood-congruent stimuli is maintained. The clinical implications of these findings in the prevention and treatment of depression are significant and require further attention and exploration.

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