

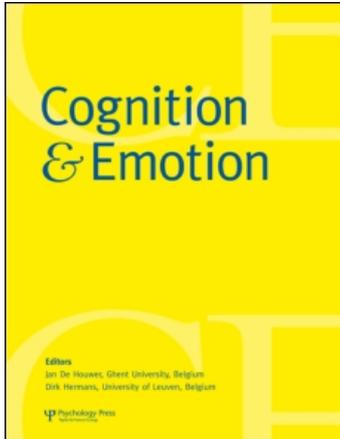
This article was downloaded by: [Sears, Christopher R.]

On: 24 November 2010

Access details: Access Details: [subscription number 930113550]

Publisher Psychology Press

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Cognition & Emotion

Publication details, including instructions for authors and subscription information:

<http://www.informaworld.com/smpp/title~content=t713682755>

Attentional biases in dysphoria: An eye-tracking study of the allocation and disengagement of attention

Christopher R. Sears^a; Charmaine L. Thomas^a; Jessica M. LeHuquet^a; Jeremy C. S. Johnson^a

^a University of Calgary, Calgary, Alberta, Canada

Online publication date: 24 November 2010

To cite this Article Sears, Christopher R. , Thomas, Charmaine L. , LeHuquet, Jessica M. and Johnson, Jeremy C. S.(2010) 'Attentional biases in dysphoria: An eye-tracking study of the allocation and disengagement of attention', *Cognition & Emotion*, 24: 8, 1349 – 1368

To link to this Article: DOI: 10.1080/02699930903399319

URL: <http://dx.doi.org/10.1080/02699930903399319>

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.informaworld.com/terms-and-conditions-of-access.pdf>

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

Attentional biases in dysphoria: An eye-tracking study of the allocation and disengagement of attention

Christopher R. Sears, Charmaine L. Thomas, Jessica M. LeHuquet, and Jeremy C. S. Johnson
University of Calgary, Calgary, Alberta, Canada

This study looked for evidence of biases in the allocation and disengagement of attention in dysphoric individuals. Participants studied images for a recognition memory test while their eye fixations were tracked and recorded. Four image types were presented (depression-related, anxiety-related, positive, neutral) in each of two study conditions. For the simultaneous study condition, four images (one of each type) were presented simultaneously for 10 seconds, and the number of fixations and the total fixation time to each image was measured, similar to the procedure used by Eizenman et al. (2003) and Kellough, Beevers, Ellis, and Wells (2008). For the sequential study condition, four images (one of each type) were presented consecutively, each for 4 seconds; to measure disengagement of attention an endogenous cuing procedure was used (Posner, 1980). Dysphoric individuals spent significantly less time attending to positive images than non-dysphoric individuals, but there were no group differences in attention to depression-related images. There was also no evidence of a dysphoria-related bias in initial shifts of attention. With respect to the disengagement of attention, dysphoric individuals were slower to disengage their attention from depression-related images. The recognition memory data showed that dysphoric individuals had poorer memory for emotional images, but there was no evidence of a conventional mood-congruent memory bias. Differences in the attentional and memory biases observed in depressed and dysphoric individuals are discussed.

Keywords: Depression, Dysphoria, Attention, Eye tracking, Recognition memory.

Visual attention has been a subject of intensive study in cognitive psychology for several decades and many of its characteristics are now understood (Pashler, 1998; Wright & Ward, 2008). It is generally agreed that there can be only one focus

of attention at any one time, that the scope of attention is quite limited, and that only information selected to be attended undergoes extensive processing. As a consequence, when multiple sources of information compete for attention, an

Correspondence should be addressed to: Christopher Sears, Department of Psychology, University of Calgary, 2500 University Drive NW, Calgary, Alberta, Canada, T2N 1N4. E-mail: sears@ucalgary.ca

This research was supported by a Natural Sciences and Engineering Research Council (NSERC) of Canada grant to CRS. Portions of these data were presented at the 18th annual meeting of the Canadian Society for Brain, Behavior, and Cognitive Science (London, Ontario, June 2008), and the 69th annual meeting of the Canadian Psychological Association (Montreal, June 2009).

We thank two anonymous reviewers for their excellent feedback and suggestions. The materials used in the study are available from the authors upon request.

individual must prioritise its allocation, shifting the focus of his or her attention from one source to another. Researchers studying selective attention in clinical populations have discovered attentional biases in the allocation of attention, such that concern-related or mood-congruent material is given priority. One of the most well-documented attentional biases is the bias associated with high levels of anxiety: researchers have found that anxiety increases attention to threat-related stimuli, and that anxious individuals focus their attention preferentially on stimuli related to danger and threat (see Calvo & Avero, 2005; Mogg & Bradley, 2005, for reviews).

The evidence for an attentional bias in depression is less convincing. According to cognitive schema models (Beck, 1976; Beck & Clark, 1988), depression is caused and maintained by biases in the processing of emotion-congruent information, and a key prediction is that depressed individuals should selectively attend to and remember emotion-congruent information. Contrary to this prediction, in many studies depressed individuals do not exhibit an attentional bias (see Mogg & Bradley, 2005; Rinck & Becker, 2005, for reviews). As Mogg and Bradley noted, however, most studies have used the emotional Stroop task and the visual probe task. While these tasks have proved to be useful tools for the study of attention in depression, the mixed findings in the literature are likely partly related to the various limitations of these tasks. Neither task provides a full picture of attentional processing, because they do not differentiate between the different components of attention (such as the maintenance of attention versus the disengagement of attention) and because processing is measured over brief intervals of time (typically 1 second or less). Ideally, researchers should measure the focus of attention throughout an extended interval in which multiple stimuli compete for attention, from initial orienting to subsequent shifts of attention between competing stimuli. Eye-movement tracking and recording can provide such information because the direction of an individual's gaze and the focus of their attention are tightly coupled (Wright & Ward, 2008). Although only a few studies have used eye-gaze

tracking to look for attentional biases in depressed and dysphoric individuals, the evidence for attentional biases is much clearer in these studies.

Previous eye-tracking studies

Caseras, Garner, Bradley, and Mogg (2007) presented dysphoric and non-dysphoric participants with pairs of images to examine shifts of attention to positive, negative, and neutral scenes. The image pairs were presented for 3 seconds and consisted of a neutral image paired with either a positive or a negative image. The participant's task was to respond to a central fixation target (an asterisk or a circle), presented between the two images, as quickly and accurately as possible. Although the task did not require participants to attend to the images, Caseras et al. reported that on 99% of trials there was a shift in gaze to one of the images of the pair. On each trial, the type of image (positive, negative, or neutral) that was first fixated was recorded, in addition to the latency of the first shift in gaze and the duration of gaze on the first fixated image. Caseras et al. found that dysphoric and non-dysphoric participants did not differ in their initial orienting to images: for both groups there was a bias to shift attention toward positive images and away from negative images, relative to neutral images. For both groups gaze durations were longer for negative images than for neutral images, but the difference between negative and neutral images was larger for dysphoric participants (188 ms) than for non-dysphoric participants (100 ms). This interaction was not present for the positive-neutral image pairs. Caseras et al. concluded that dysphoria is characterised by a bias in the maintenance of attention on negative information but not the initial orienting of attention. They speculated that the bias to maintain attention on negative images may reflect a difficulty disengaging attention from negative information, a possibility examined in the present study.

Three studies have used eye-gaze tracking to examine attention to emotional images over longer intervals (Eizenman et al., 2003; Kellough, Beevers, Ellis, & Wells, 2008; Mathews & Antes, 1992). Mathews and Antes presented participants

with seven images, each for 20 seconds, and tracked participants' eye movements while they examined these images (the participant's task was to make an aesthetic judgement for each image). Each image contained spatially separate "happy" and "sad" regions (e.g., one of the images was a painting depicting an animal skull beside a flower), and the number of fixations and fixation durations to these regions was measured. Mathews and Antes found that both dysphoric and non-dysphoric participants fixated happy regions significantly more frequently than sad regions, and that the two groups did not differ in how frequently they fixated happy regions. The two groups did differ on how frequently they fixated sad regions, with dysphoric participants fixating sad regions significantly more frequently than non-dysphoric participants. For fixation durations there were no statistically significant between-group differences, although the trend was for dysphoric participants to fixate on sad regions longer than non-dysphoric participants and to fixate on happy regions less. Mathews and Antes concluded that their results provided some support for a dysphoria-related bias in the allocation of attention, but argued that their more important finding was the evidence of a powerful positive cognitive bias that was only attenuated by negative mood.

Eizenman et al. (2003) tracked the eye movements of a small group of depressed individuals ($n = 8$) and a matched sample of non-depressed individuals ($n = 9$) while they examined 15 slides of images, each slide containing four images. There were eight critical slides, and each critical slide contained an image with a neutral theme, an image with a dysphoric theme, an image with a threatening theme, and an image with a positive/social theme. The participants were asked to examine the images in any manner they wished throughout the 10.5-second presentation time. Eizenman et al. found that depressed individuals spent more time attending to dysphoric images than non-depressed individuals, as their total fixation durations to the dysphoric images were significantly longer. Eizenman et al. did not find that depressed individuals attended to positive images any differently than non-depressed individuals. Eizenman

et al. also reported that depressed individuals had significantly longer average glance durations for dysphoric images, and speculated that this reflected a difficulty in shifting attention away from dysphoric images.

Kellough et al. (2008) recently reported on a study similar to that of Eizenman et al. (2003). Using a similar procedure and the same image types, participants viewed 12 sets of 4 images over a longer period (30 seconds per set) so that changes in the allocation of attention over time could be examined. Like Eizenman et al., Kellough et al. found that clinically depressed individuals spent a significantly greater percentage of time attending to dysphoric images than non-depressed individuals, and time-course analyses indicated that this bias was maintained over an entire 30-second trial. Unlike Eizenman et al., they also found that depressed individuals spent a significantly smaller percentage of time viewing positive images than non-depressed individuals. Kellough et al. also looked at which image types were fixated first on each trial and found no group differences, consistent with Caseras et al.'s (2007) finding that there is no depression-related bias in the initial orienting of attention.

Disengagement of attention in dysphoria and depression

Previous eye-tracking studies have examined biases in the initial orientation and allocation of attention in depression and dysphoria. Although researchers have speculated that depressed individuals have difficulty disengaging attention from depression-related stimuli (Bradley, Mogg, & Lee, 1997; Caseras et al., 2007; Eizenman et al., 2003), only a few studies have tested this possibility using a task that explicitly required participants to disengage their attention from a stimulus, and none have used eye tracking to monitor attentional disengagement.

Ellenbogen and Schwartzman (2009) used a modified spatial cueing task to assess the speed of disengagement from pictorial cues depicting dysphoria, threat, and neutral content. Clinically depressed and control participants were instructed to quickly respond to a target (a black dot)

presented on the left or right of a central fixation marker. The target was preceded by a supraluminal (750 ms presentation) or a masked pictorial cue (17 ms presentation), which was either a dysphoric, threatening, or neutral image. On 78% of the trials the cue was valid, such that the target appeared in the same location as the cue, and on 22% of the trials the cue was invalid, such that the target appeared in the location opposite the cue. The invalid cue trials were the trials of interest. Ellenbogen and Schwartzman reasoned that on invalid cue trials, participants would disengage their attention from the cue because the appearance of the target would automatically capture attention, and hence response latencies on these trials would reflect ease of attentional disengagement. Ellenbogen and Schwartzman found that depressed individuals were slower to disengage from supraluminal dysphoric image cues than from neutral image cues (a 15 ms difference), whereas for non-depressed individuals the disengagement times from dysphoric and neutral images were nearly identical. There were no group differences for masked image cues or for those depicting threat. Ellenbogen and Schwartzman concluded that their results demonstrated that the disengagement of attention from negative information was impaired in depression.

A similar conclusion was reached by Koster, De Raedt, Goeleven, Frank, and Crombez (2005), who examined the disengagement of attention from positive and negative words in dysphoric and non-dysphoric individuals. Like Ellenbogen and Schwartzman (2009), Koster et al. used a modified spatial cueing task and responses on invalidly cued trials to measure attentional disengagement. On each trial a target (a black rectangle), presented on the left or right of a central fixation marker, was preceded by a positive, negative, or neutral word, presented for 1500 ms. On 50% of the trials the cue word was invalid, such that the target appeared in the location opposite the cue. Koster et al. found that dysphoric participants were slower to disengage attention from negative word cues than from neutral word cues (a 12 ms difference), whereas non-dysphoric participants were not. (For positive words the opposite outcome

was observed.) They concluded that attentional disengagement from negative words was impaired in dysphoria.

The present study

The purpose of our study was to examine dysphoria-related biases in the orientation, maintenance, and disengagement of attention, using an eye-tracking system to continuously monitor participants' gaze while viewing emotional images. Our study was partly motivated by some of the inconsistent results between the studies that tested dysphoric individuals (Caseras et al., 2007; Mathews & Antez, 1992) and those that tested clinically depressed individuals (Eizenman et al., 2003; Kellough et al., 2008). For example, whereas Caseras et al. found that dysphoric individuals did not attend to positive images any differently than non-dysphoric individuals, Kellough et al. found that clinically depressed individuals attended to positive images less than non-depressed individuals. The possibility of generalising from a dysphoric student sample to a clinically diagnosed sample has been debated in the literature for some time (e.g., Cox, Enns, Borger, & Parker, 1999; Flett, Vredenburg, & Lester, 1997; Vredenburg, Flett, & Krames, 1993), but there are too few studies on attentional processing in depressed and dysphoric individuals to know if the same concerns are applicable. In the present study, we examined attentional processing in dysphoric individuals using a task that allowed direct comparisons with the data collected by Eizenman et al. and Kellough et al. from clinically depressed individuals.

An important difference between our procedure and those of Eizenman et al. (2003) and Kellough et al. (2008) is that we showed participants several hundred images and asked them to study the images for a recognition memory test. An advantage of having participants study the images (as opposed to merely viewing the images) is that it provided them with a clear purpose and motivation for attending to the images, likely an important consideration when assessing individual differences in the distribution

of attention. Our study is one of the few to use images and a recognition task to test for mood-congruent memory; most studies have examined memory for valenced and neutral words using recall tasks (see Burt, Zembor, & Niederehe, 1995; Matt, Vazquez, & Campbell, 1992; Williams, Watts, MacLeod, & Mathews, 1997, for reviews). A recent study by Hamilton and Gotlib (2008) showed that non-depressed individuals had better recognition memory for positive images than for negative images, whereas for depressed individuals positive and negative images were remembered equally well. Our study allowed for an equivalent test of recognition memory in dysphoric individuals.

Our study was also motivated by the fact that researchers have not examined the endogenous disengagement of attention in depression or dysphoria. An important distinction in attention research is between the exogenous and endogenous cueing of attention—in the exogenous cueing paradigm the observer's attention is automatically drawn to a location by the abrupt onset of a peripheral cue, whereas in the endogenous cueing paradigm the cue is typically a directional arrow that directs the observer to intentionally move their attention in the direction of the cue (Posner, 1980). In the exogenous cueing paradigm shifts of attention are stimulus driven, automatic, and reflexive, whereas in the endogenous cueing paradigm they are volitional and under the control of the observer. Both Ellenbogen and Schwartzman (2009) and Koster et al. (2005) used an exogenous cueing paradigm to examine attentional disengagement. Endogenous and exogenous attentional cueing are not equivalent; in fact, quantitative and qualitative differences between them have led to debate over whether both types of cues recruit the same unitary attentional mechanism or whether they recruit separate attentional systems (Klein & Shore, 2000; Wright & Ward, 2008). We suspected that an endogenous cueing procedure would be an ideal way of testing for a dysphoria-related bias in the disengagement of attention, because shifts of endogenous attention reflect more conscious cognitive processing than shifts of exogenous attention and because endogenous

cues can be used to assess an individual's ability to interrupt their processing of negative information.

Our main research questions were as follows: (1) Would dysphoric individuals attend to depression-related and positive images differently than non-dysphoric individuals? (2) Would dysphoric individuals be slower to disengage attention from depression-related images? (3) Would there be differences between dysphoric and non-dysphoric individuals in their recognition memory for emotional images?

METHOD

Participants studied four types of images (depression-related, anxiety-related, positive, neutral) in two study conditions (the simultaneous study condition and the sequential study condition). These conditions differed in the way the images were presented and the components of attention examined (the allocation and maintenance of attention in the simultaneous study condition; the disengagement of attention in the sequential study condition). For the simultaneous study condition, on each trial four images (one of each image type) were presented simultaneously for 10 seconds, similar to the procedure used by Eizenman et al. (2003). Participants could study the images in any manner they wished, and throughout the 10 seconds the number of fixations to each image and the amount of time spent looking at each image were recorded.

For the sequential study condition, on each trial four images (one of each image type) were presented consecutively, each for 4 seconds. Participants were asked to study each image for the recognition memory test. To measure disengagement of attention, images were probed occasionally by presenting a superimposed, semi-transparent arrow in the centre of the image that pointed to one of the four corners of the display (an endogenous attention cue; Posner, 1980); the participants' task was to immediately move their gaze off the image in the direction the arrow was pointing whenever the probe appeared. Participants had to remain vigilant throughout each trial

because both the appearance of a probe and the direction the probe pointed to were not predictable. The key dependent variable was the speed with which the participant could move their gaze off a probed image. Slower disengagement times were taken to reflect greater difficulty moving attention away from the image.

Participants

The participants were 129 undergraduate students from the University of Calgary who volunteered to participate in the study in exchange for extra course credit. To control for gender only females were recruited for the study. To be eligible to participate, students were required to have normal or corrected-to-normal vision and could not wear eyeglasses during data collection because of the potential for interference with the eye gaze recording. The mean age of the participants was 20.8 years (range of 18 to 44).

Participants completed the second edition of the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996), the Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988), the Beck Anxiety Inventory (BAI; Steer & Beck, 1997), and a demographics questionnaire. The BDI is a self-report inventory consisting of 21 items that assesses participants' depressive symptoms over the past two weeks. Each item is rated on a scale from 0 to 3, with summary scores ranging between 0 and 63. (To comply with institutional ethics requirements the item dealing with suicidal intent was removed, and therefore the maximum score was 60.) The PANAS assesses participants' pleasant and unpleasant mood states. It consists of 20 words that describe different emotions (e.g., excited, proud, upset, guilty, distressed); participants read each word and indicate "to what extent you have felt this way", using a scale from 1 (*very slightly or not at all*) to 5 (*extremely*). These same 20 words were rated for two time frames: "during the past few days" and "during the past few weeks". For the 10 positive affect items and for the 10 negative affect items the minimum score was 10 and the maximum score was 50. The BAI is a self-report inventory

consisting of 21 items, each item describing a common symptom of anxiety. The participant is asked to rate how much she or he has been bothered by each symptom over the past week on a 4-point scale ranging from 0 (*not at all*) to 3 (*severely—it bothered me a lot*). The demographic questionnaire included questions about previous episodes of depression, experiences with psychotherapy, and recent changes in mood.

Participants were assigned to groups based on their BDI scores. Participants in the dysphoric group had BDI scores greater than or equal to 20, the BDI cut-off score recommended by Dozois, Dobson, and Ahnberg (1998) for a "dysphoric-depressed" classification when using undergraduate samples. There were 20 participants in the dysphoric group (mean age = 22.2). For the non-dysphoric group we selected participants with BDI scores less than or equal to 6, a lower cut-off than recommended by Dozois et al. (they recommended a score less than or equal to 12). Using a lower cut-off allowed us to create a greater separation between the groups, and because of the large number of participants in our study ($N=129$) we could still assign a large number of participants to the non-dysphoric group ($N=52$, mean age = 21.1). The dysphoric group had significantly higher BDI scores than the non-dysphoric group, $M=25.1$ ($SD=3.9$) versus $M=3.1$ ($SD=2.2$), $t(70)=29.7$, $p<.01$, and significantly higher BAI scores, $M=22.6$ ($SD=7.6$) versus $M=9.4$ ($SD=5.2$), $t(70)=8.28$, $p<.01$. The dysphoric group had higher scores on the PANAS negative items ("during the past few days"), $M=26.6$ ($SD=6.6$) versus $M=16.2$ ($SD=4.8$), $t(70)=7.24$, $p<.01$, and significantly lower scores on the PANAS positive items ("past few days"), $M=22.1$ ($SD=4.5$) versus $M=32.9$ ($SD=6.6$), $t(70)=6.60$, $p<.01$.

Dysphoric participants reported more episodes of depression, with 57.8% reporting "two to five" episodes of depression in the past few years compared to 19.2% of non-dysphoric participants, $\chi^2(1)=9.99$, $p<.01$. Almost all of the dysphoric participants reported that their last depressive episode was within the past year (92.8%), compared to 31.8% of the non-dysphoric participants

who reported previous depressive episodes, $\chi^2(1) = 17.92$, $p < .01$. Most of the dysphoric participants reported having felt depressed lately (73.8%), whereas none (0%) of the non-dysphoric participants did.

Stimuli

The stimuli were 720 colour images, divided equally between four categories: depression-related, anxiety-related, positive, and neutral. Most of the images (540) were collected from the Internet, and the other 180 were taken from the International Affective Picture System database (Lang, Bradley, & Cuthbert, 2005). The depression-related images included scenes of people appearing sad and unhappy, neglected animals (e.g., a puppy in a small steel cage), scenes of poverty, and dark, gloomy landscapes. The anxiety-related images involved themes of threat and injury, and included scenes of people being threatened with weapons, people with physical injuries (e.g., an untreated 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 neutral landscapes (e.g., office buildings). The 720 images used in the study were selected from a larger set of images (~ 1000) assembled by the four authors; an image was selected for use in the study only if the majority agreed to its category (depression-related, anxiety-related, positive, or neutral).

From the set of 720 images, 120 critical images were chosen, divided equally between the depression-related, anxiety-related, positive, and neutral categories (participants were shown all 720 images in the experiment). These consisted of all 80 images shown in the simultaneous study condition (20 from each category) and the 40 probed images

shown in the sequential study condition (10 from each category). All the data collected in the study was from these 120 critical images, the other 600 images being used as filler (non-probed) images in the sequential study condition. Prior to the study, the critical images were categorised by an independent group of raters. These were 33 female undergraduate students (none of whom participated in the present study) who were shown a total of 320 images, one at a time on a computer display and in a random order, and were asked to choose one of four categories that best described each image: (1) positive/happy; (2) sad/depressing/gloomy; (3) anxiety-provoking/dangerous/fearful; and (4) neutral/no emotion. An image was chosen for use as a critical image if at least 90% of the raters agreed to its category.

Apparatus

Eye movements were recorded by an EyeLink I eye tracking system (SR Research Ltd., Mississauga, Ontario, Canada), which uses infrared video-based tracking technology. Participants wore a small, lightweight headband equipped with cameras positioned below the eyes that tracked the position of the pupils as they moved. The system has an average gaze error of less than 0.5 degrees and a sampling rate of 250 Hz (allowing for a temporal resolution of 4 ms). The EyeLink system is designed to compensate for small changes in head position during tracking so a head rest is not necessary. The eye-tracking system 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 co-ordinates corresponding to the position of the right eye every 4 ms (eye movements were recorded from the participant's right eye only). Eye movements were tracked and recorded continuously throughout each trial.

Procedure

Participants were fitted with the headband camera when they arrived for the study and then the eye-tracking system was calibrated. Participants were

provided with written and spoken instructions at the beginning of the session. They were told that they would be studying images for a recognition memory test and that their eye movements would be recorded while they studied the images. They were asked to study the images carefully because their memory for the images would be tested seven days later.

As noted, participants studied images in two study conditions: the simultaneous study condition and the sequential study condition. The trials for the two study conditions were blocked, with the trials for the simultaneous study condition always presented first (due to concerns with carry-over effects from the sequential study condition to the simultaneous study condition, but not vice versa). For the simultaneous study condition, participants were shown four images on each trial: 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. All the images were 325×243 pixels in size and were presented at a display resolution of 1024×768 pixels on a white background. At the start of each trial participants fixated on a black dot in the centre of the display for three seconds. The four images were then presented for 10 seconds, and participants proceeded to study the images in any order they wished. Eye movements were tracked and recorded continuously throughout each trial. There were 24 trials in total, the first four trials being practice trials to familiarise participants with the procedures before data collection began.

For the sequential study condition, participants were shown four images, one at a time, one from each of the depression-related, anxiety-related, positive, and neutral categories. A trial sequence is shown in Figure 1. At the start of each trial, participants fixated on a black dot in the centre of the display for three seconds. The first image was then presented in the upper left corner of the display, for four seconds, and was then covered

with a solid grey rectangle to prevent further study. The second image then appeared in the top right corner of the display, for four seconds, and was then covered by a solid grey rectangle. This sequence continued for the third and fourth images, with the third image presented in the bottom left corner of the display and the fourth image in the bottom right corner. Participants were asked to study each image for the recognition memory test. The four image types were randomly assigned to one of the four corners of the display, and across the 160 trials each image type was equally likely to appear in each corner.

To measure the disengagement of attention, on 25% of the trials one of the four images was probed by presenting a semi-transparent arrow in the centre of the image that pointed to one of the four corners of the display. As shown in Figure 1, each corner of the display contained a solid black fixation marker (+); when a probe appeared, the participant's task was to immediately move their gaze to the fixation marker the probe arrow was pointing to. Participants kept their gaze on the cued fixation marker until the next image appeared and then moved their gaze to the new image to study it. The 40 probe trials were randomly distributed among the set of 160 trials, with an equal number of depression-related, anxiety-related, positive, and neutral images being probed. Probe arrows were equally likely to point to the four corners of the display. When an image was probed, the arrow appeared either 1.5, 2.0, 2.5, or 3.0 seconds (randomly determined) after the onset of the image. Participants therefore had to remain vigilant throughout each trial because the appearance of a probe and the direction the probe arrow pointed to were not predictable.

Each participant's session was divided into five blocks of trials. The first block consisted of 4 practice trials for the simultaneous study condition, followed by 20 data trials. After a short break the second block of trials began, which consisted of 6 practice trials for the sequential study condition (three of them probe trials), followed by 40 data trials. The three remaining blocks consisted of trials for the sequential study condition (40 trials per block).

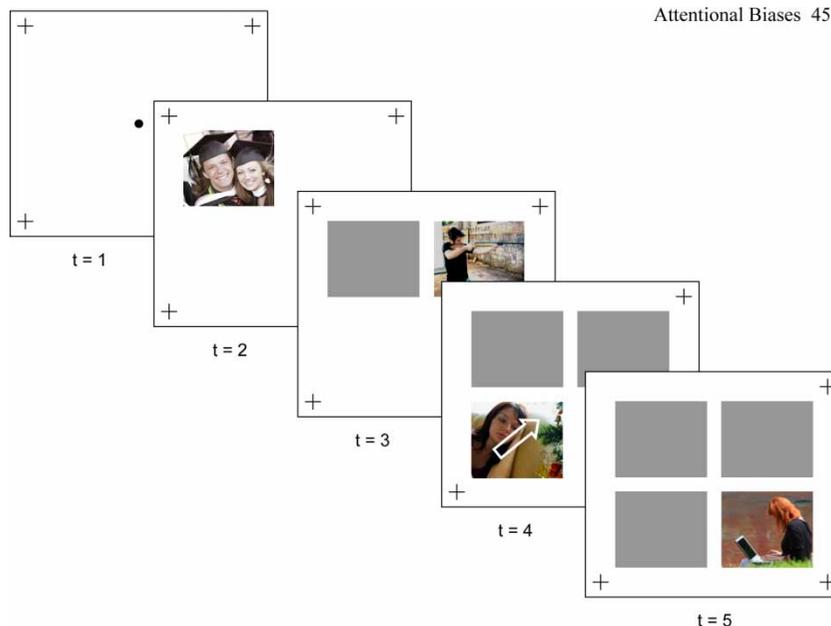


Figure 1. An example of a trial sequence in the sequential study condition. At the start of a trial ($t=1$) the participant fixated on the marker at the centre of the display, for 2000 ms. The first image then appeared in the upper left corner ($t=2$) and the participant moved their gaze to the image to study it. After 4 seconds had elapsed the image was replaced by a solid grey rectangle to prevent further study and then the next image appeared ($t=3$), again for 4 seconds. In this example, the third image in the sequence ($t=4$), a depression-related image, is probed by presenting an arrow cue pointing to the upper right corner of the display; the participant's task was to move their gaze to the fixation marker in the corner as soon as the probe appeared and to keep their gaze at that location until the next image appeared ($t=5$). (The example pictures shown here were not taken from the LAPS.) [To view this figure in colour, please visit the online version of this Journal.]

Participants were reminded of the recognition memory test before leaving the laboratory and told to expect an e-mail with further instructions in seven days. The e-mail sent to participants included detailed instructions and a hypertext link to the recognition memory test. The memory test was administered via the Internet using the Survey Monkey website (www.surveymonkey.com) and could be completed from any computer with Internet access. Participants were asked to complete the memory test (in private) as soon as possible after receiving their e-mail notification. Participants who did not complete the memory test within three days of receiving their first e-mail were sent a second e-mail notification.

Participants were shown 320 images for the recognition memory test, one image at a time, and were asked to choose one of four responses for each

image: “sure old”, “guess old”, “sure new”, or “guess new”. This procedure provided information on both the accuracy and the confidence of a participant's response, unlike simple “yes” and “no” response options. The 320 images included the 80 images shown in the simultaneous study condition and the 40 probed images shown in the sequential study condition (i.e., the 120 critical images). There were also 40 randomly selected non-probed images shown in the sequential study condition (equally divided between the four image categories) and 160 “new” images that participants did not study (equally divided between the four image categories). The instructions were as follows: “If you are sure the picture is one you studied, choose Sure Old. If you are not sure but guess that the picture is one you studied, choose Guess Old. If you are sure the picture is not one you studied, choose Sure New. If you are not sure but

guess the picture is one you did not study, choose Guess New". Participants were informed that 50% of the images were "old" images they had studied in the laboratory and 50% were new images they had not studied.

RESULTS

The data from the simultaneous study condition and the data from the sequential study condition were analysed separately. For some participants, data from both the simultaneous study condition and the sequential study condition was not available due to calibration loss, inadequate gaze tracking, or other equipment failure; as a consequence, the number of participants in the two analyses was not identical. The data from the simultaneous study condition are shown in Tables 1 and 2; the data from the sequential study condition are shown in Tables 2 and 3 and in Figure 2.

Simultaneous study condition

For the eye-movement data, the dependent measures were the number of fixations to each image type (depression-related, anxiety-related,

positive, neutral), the amount of time spent looking at each image type (total fixation time, measured in milliseconds), the type of image initially fixated on each trial, and the total fixation time for initially fixated images (measured in milliseconds). To be included in the analyses a fixation had to be at least 100 ms in duration. These measures were computed for each image type for each trial and then averaged over all 20 trials. For all analyses, the critical statistical test was the interaction between Group (dysphoric vs. non-dysphoric) and Image Type (depression-related, anxiety-related, positive, neutral). Statistically significant interactions were followed up by testing for differences between means using planned *t*-tests and an alpha of 5% to maximise statistical power.

Type of image initially fixated. At the start of each trial participants were fixating at the centre of the display; when the four images appeared they moved their gaze to one of the images to study it. Like Caseras et al. (2007), we reasoned that the first shift of gaze would be a good measure of the initial orienting of attention. If dysphoric individuals were more likely to first

Table 1. Mean number of fixations, total fixation time (in milliseconds), and total fixation time on first fixated images for the depression-related, anxiety-related, positive, and neutral images in the simultaneous study condition

Image type	Non-dysphoric group (n = 52)	Dysphoric group (n = 20)
<i>Number of fixations</i>		
Depression-related	7.8 (0.16)	7.3 (0.25)
Anxiety-related	8.1 (0.17)	7.9 (0.28)
Positive	7.8 (0.18)	6.8 (0.29)
Neutral	7.2 (0.17)	7.0 (0.28)
<i>Total fixation time</i>		
Depression-related	1977 (33.6)	1965 (54.2)
Anxiety-related	2159 (40.5)	2120 (65.3)
Positive	2019 (39.2)	1757 (63.2)
Neutral	1900 (46.1)	1807 (74.4)
<i>Total fixation time on first fixated image</i>		
Depression-related	2072 (69.4)	2137 (113.7)
Anxiety-related	2393 (68.1)	2265 (111.7)
Positive	2154 (70.1)	1769 (114.9)
Neutral	2050 (91.8)	1999 (150.4)

Note: Standard errors are shown in parentheses.

Table 2. *D-prime measures of recognition memory for images studied in the simultaneous study condition and for probed images studied in the sequential study condition*

<i>Image type</i>	<i>Non-dysphoric group</i>	<i>Dysphoric group</i>
<i>Simultaneous study condition</i>		
Depression-related	1.32 (0.07)	1.16 (0.12)
Anxiety-related	1.22 (0.08)	1.53 (0.13)
Positive	1.08 (0.06)	1.09 (0.11)
Neutral	0.86 (0.07)	1.07 (0.12)
<i>Sequential study condition</i>		
Depression-related	0.94 (0.08)	0.64 (0.14)
Anxiety-related	1.30 (0.07)	1.54 (0.11)
Positive	0.95 (0.09)	0.81 (0.15)
Neutral	0.87 (0.10)	1.13 (0.17)

Note: Standard errors are shown in parentheses.

look at depression-related images then this would be evidence of a bias in the initial orienting of attention.

An analysis of the type of image initially fixated revealed an effect of Image Type, $F(3, 210) = 5.01$, $MSE = 0.01$, $p < .01$, partial $\eta^2 = .07$, but no effect of Group and no interaction between Group and Image Type (both $F_s < 1$). There were more initial shifts of gaze to anxiety-related images (27.4% of all trials) than there were to depression-related (25.9%), positive (26.3%), and neutral images (20.4%). Dysphoric participants fixated depression-related images first on

25.8% of trials, compared to 25.9% of trials for non-dysphoric participants. Thus, like Caseras et al. (2007) and Kellough et al. (2008), we found that dysphoric individuals did not initially orient their attention to depression-related images any more frequently than non-dysphoric individuals.

Number of fixations and total fixation time. The number of fixations and the total fixation times to each image type were first analysed together using a multivariate analysis of variance (MANOVA) because these two measures were highly correlated and MANOVA is designed to handle correlated

Table 3. *Mean disengagement time for probed images (in milliseconds) and mean disengagement time relative to neutral images (in milliseconds) in the sequential study condition*

<i>Image type</i>	<i>Dependent measure</i>	
	<i>Disengagement time</i>	<i>Difference from neutral images</i>
<i>Non-dysphoric group</i>		
Depression-related	740 (22.1)	+1
Anxiety-related	766 (19.3)	+27
Positive	702 (15.6)	-37
Neutral	739 (15.8)	—
<i>Dysphoric group</i>		
Depression-related	881 (39.5)	+90
Anxiety-related	807 (34.6)	+16
Positive	722 (28.0)	-69
Neutral	791 (28.3)	—

Note: Difference from neutral images calculated by subtracting the disengagement time from depression-related, anxiety-related, and positive images from the disengagement time from neutral images. Standard errors are shown in parentheses.

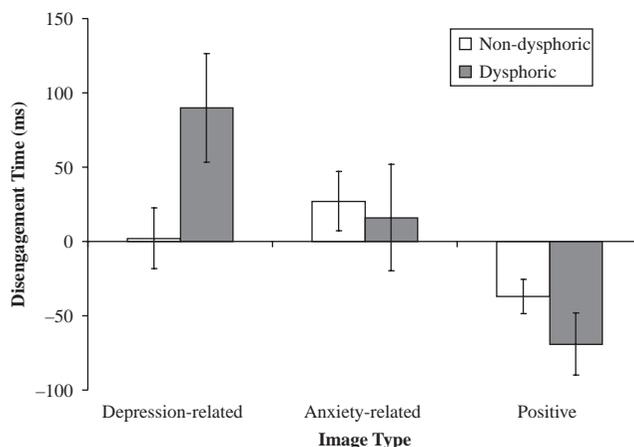


Figure 2. Mean disengagement times relative to neutral images (in ms) for depression-related, anxiety-related, and positive images in the sequential study condition.

dependent variables (i.e., as the number of fixations to an image increased, the total fixation time also increased, with correlations ranging from .48 to .67 for the four image types).

There was an effect of Image Type, Wilk's $\Lambda = .59$, $F(6, 65) = 7.36$, $p < .001$, partial $\eta^2 = .40$, with the most fixations and the longest total fixation times to the anxiety-related images and the fewest fixations and shortest total fixation times to the neutral images (see Table 1). The effect of Group was not significant, Wilk's $\Lambda = .94$, $F(2, 69) = 2.11$, $p > .10$. Most important was the interaction between Group and Image Type, Wilk's $\Lambda = .73$, $F(6, 65) = 3.87$, $p < .01$, partial $\eta^2 = .26$. The interaction indicated that the number of fixations and the total fixation times for the different image types were not the same for the two groups. The same interaction was present in separate univariate (ANOVA) analyses of the number of fixations, $F(3, 210) = 2.75$, $MSE = 0.62$, $p < .05$, partial $\eta^2 = .04$, and total fixation times, $F(3, 210) = 3.34$, $MSE = 54,669.57$, $p < .05$, partial $\eta^2 = .05$.

The source of these interactions can be seen in Table 1. The largest difference between the two groups was in their attention to positive images. Dysphoric participants made fewer fixations and had shorter total fixation durations to positive images than non-dysphoric participants. Follow-up

between-group t -tests confirmed these observations: compared to non-dysphoric participants, dysphoric participants made fewer fixations to positive images, $t(70) = 2.79$, $p < .01$, and their total fixation durations to positive images were shorter (an average of 262 ms shorter), $t(70) = 3.52$, $p < .01$. For the depression-related, anxiety-related, and neutral images, there were no significant differences between the groups for the number of fixations or for total fixation durations (all $ps > .10$).

We also analysed the total fixation times for the first fixated images; that is, the total fixation time on the first image fixated on each trial (one participant from the non-dysphoric group had to be excluded from this analysis because she did not fixate on a neutral image first on any of the trials). These data are also shown in Table 1. There was an effect of Image Type, $F(3, 204) = 6.20$, $MSE = 229,433.01$, $p < .01$, partial $\eta^2 = .08$, and a marginally significant interaction between Group and Image Type, $F(3, 204) = 2.20$, $MSE = 229,433.01$, $p = .08$, partial $\eta^2 = .03$. The interaction mirrored the interactions seen in the previous analysis, with dysphoric participants looking at positive images less than non-dysphoric participants (1769 ms vs. 2154 ms), $t(69) = 2.78$, $p < .01$. The fact that this was true for the first images fixated demonstrates that the group

difference in attention to positive images was present from the beginning of each trial, as opposed to developing over the course of the 10-second trial interval.

Recognition memory. Not all participants completed the memory test; 5 of the 52 participants in the non-dysphoric group (9.6%) and 3 of the 20 participants in the dysphoric group (15.0%) did not complete it. Participants in the non-dysphoric group completed the memory test an average of 9.1 days after studying the images versus 10.0 days for the participants in the dysphoric group, $t(62) = 0.91, p > .10$.

The recognition memory data was analysed using the signal detection measure *d*-prime, which provides a measure of recognition memory accuracy independent of decision criteria and response bias. *D*-prime is calculated using hit and false-alarm rates; hit rates were created by summing the "sure old" and "guess old" responses to studied images, and false-alarm rates were created by summing the "sure old" and "guess old" responses to non-studied foil images. The *d*-prime data are shown in Table 2; higher values of *d*-prime reflect better recognition memory. In the analysis there was no main effect of Group ($F < 1$), but there was a main effect of Image Type, $F(3, 186) = 10.86, MSE = 0.14, p < .01$, partial $\eta^2 = .14$, and a Group \times Image Type interaction, $F(3, 186) = 3.89, MSE = 0.14, p < .01$, partial $\eta^2 = .05$. Follow-up comparisons did not produce any significant between-group differences in *d*-prime for depression-related, positive, or neutral images (all $ps > .10$), while the difference for anxiety-related images was marginally significant (1.53 vs. 1.22, for the dysphoric and non-dysphoric groups, respectively), $t(62) = 1.93, p = .06$. Within-group comparisons between the image types revealed different patterns of recognition accuracy for the dysphoric and non-dysphoric participants. For non-dysphoric participants, *d*-prime was lowest for neutral images (0.86) and significantly higher for anxiety-related (1.22), depression-related (1.32), and positive images (1.08), $t(46) = 4.42, p < .01$; $t(46) = 5.11, p < .01$; and $t(46) = 3.23, p < .01$, respectively. Thus, non-dysphoric participants had

better memory for emotional images (anxiety-related, depression-related, and positive) than for neutral images. For dysphoric participants a different pattern emerged. For dysphoric participants, *d*-prime was higher for anxiety-related images (1.53) than for neutral images (1.07), $t(16) = 4.66, p < .01$, whereas for depression-related images (1.16) and positive images (1.09) *d*-prime was equivalent to the *d*-prime for neutral images (1.07), $t(16) = 0.79, p > .10$, and $t(16) = 0.18, p > .10$, respectively. Thus, dysphoric participants also had better memory for anxiety-related images than for neutral images, but unlike non-dysphoric participants, their memory for depression-related and positive images was no better than their memory for neutral images.

Sequential study condition

The key dependent measure was the disengagement time from probed images: the amount of time elapsed between the appearance of the probe arrow and the participant's saccade away from the image in response to the probe (this interval was measured automatically by the eye tracker). Recognition memory for all 40 probed images was also analysed (although this memory data should be interpreted with caution given that the participants' studying of the probed images was disrupted by the probes). For all analyses, the critical statistical test was the interaction between Group (non-dysphoric vs. dysphoric) and Image Type (depression-related, anxiety-related, positive, neutral).

Disengagement time from probed images. Table 3 shows the disengagement times (in milliseconds) for each of the four image types. In the analysis there was a main effect of Group, $F(1, 61) = 5.47, MSE = 33,463.41, p < .05$, partial $\eta^2 = .08$, as the dysphoric participants were slower to disengage from the images than the non-dysphoric participants (800 ms vs. 737 ms). There was also a main effect of Image Type, $F(3, 183) = 7.56, MSE = 10,596.97, p < .01$, partial $\eta^2 = .11$, and a Group \times Image Type interaction, $F(3, 183) = 3.08, MSE = 10,596.97, p < .05$, partial $\eta^2 = .05$. The slowest disengagement times were for the depression-related images

(811 ms) and the fastest for the positive images (712 ms). The Group \times Image Type interaction was due to the significant difference between the groups on the disengagement times for depression-related images: dysphoric participants were 141 ms slower than non-dysphoric participants to move their gaze away from these images, $t(61) = 3.11$, $p < .01$, whereas the two groups did not differ in their disengagement times for positive images, $t(61) = 0.62$, $p > .10$, neutral images, $t(61) = 1.69$, $p > .10$, or anxiety-related images, $t(61) = 1.02$, $p > .10$. The absence of a difference for anxiety-related images indicates that the additional difficulty dysphoric participants experienced disengaging from depression-related images was specific to depression-related content and did not generalise to images with other negative or unpleasant themes.

Figure 2 shows the differences in disengagement times for the emotional image types relative to neutral images (these data are also shown in Table 3). An analysis of these data assessed how much faster or slower participants moved their gaze away from anxiety-related, depression-related, and positive images relative to neutral images (i.e., using the neutral images as a baseline, like the analyses of Ellenbogen & Schwartzman, 2009, and Koster et al., 2005). An advantage of analysing these index scores is that they control for overall group differences in disengagement time (recall that the overall disengagement times were slower for dysphoric participants). For these data there was also an interaction between Group and Image Type, $F(2, 122) = 3.53$, $MSE = 13,561.61$, $p < .05$, partial $\eta^2 = .05$. As can be seen in Table 3, dysphoric participants were 90 ms slower to disengage from depression-related images than from neutral images, $t(14) = 2.46$, $p < .05$, whereas non-dysphoric participants were no slower to disengage from depression-related images than from neutral images (the 1 ms difference was not statistically significant). Interestingly, both groups of participants were no slower to disengage from anxiety-related images than from neutral images, the difference being 27 ms for the non-dysphoric participants, $t(47) = 1.33$, $p > .10$, and 16 ms for the dysphoric participants, $t(14) = 0.43$, $p > .10$.

In contrast, both groups were significantly faster to disengage from positive images than from neutral images, with the difference being larger for dysphoric participants (69 ms), $t(14) = 3.26$, $p < .05$, than for non-dysphoric participants (37 ms), $t(47) = 3.14$, $p < .05$. This result may be related to the pattern of total fixation times for positive images in the simultaneous study condition—dysphoric participants attended to positive images significantly less than non-dysphoric participants, and these participants were also faster to disengage from positive images in the sequential study condition. Both of these results indicate that, for dysphoric participants, positive images did not engage attention as strongly as they did for non-dysphoric participants.

Recognition memory. Table 2 lists d -primes for the studied probed images. There was a main effect of Image Type, $F(3, 186) = 14.41$, $MSE = 0.26$, $p < .01$, partial $\eta^2 = .18$, with the highest d -prime for anxiety-related images (1.42) and the lowest for depression-related images (0.79). There was no main effect of Group ($F < 1$), but there was a significant interaction between Group and Image Type, $F(3, 186) = 3.61$, $MSE = 0.26$, $p < .05$, partial $\eta^2 = .05$. Follow-up comparisons did not produce any statistically significant between-group differences for any of the images types, although the differences for anxiety-related and depression-related images were marginally significant (both $ps = .09$). Within-group comparisons produced a pattern of differences consistent with those observed in the memory data from the simultaneous study condition. Specifically, for non-dysphoric participants, d -prime was higher for anxiety-related images (1.30) than for neutral images (0.87), $t(46) = 3.48$, $p < .01$, whereas d -prime for positive images (0.95) and depression-related images (0.94) was no different than d -prime for neutral images (0.87), $t(46) = 0.73$, $p > .10$, and $t(46) = 0.69$, $p > .10$, respectively. Thus, non-dysphoric participants' memory for anxiety-related images was better than their memory for neutral images, whereas their memory for depression-related and positive images was equivalent to their memory for neutral images.

For dysphoric participants, d -prime for anxiety-related images (1.54) was significantly higher than d -prime for neutral images (1.13), $t(16) = 2.22$, $p < .05$, which indicates that their memory for anxiety-related images was better than their memory for neutral images (like the non-dysphoric participants). But unlike the non-dysphoric participants, dysphoric participants' memory for depression-related images (d -prime = 0.64) and positive images (d -prime = 0.81) was poorer than their memory for neutral images (d -prime = 1.13), $t(16) = 2.91$, $p < .01$, and $t(16) = 2.36$, $p < .05$, respectively. Considered together, the recognition data from both the simultaneous and sequential study conditions point to small but potentially important differences between the dysphoric and non-dysphoric participants' memory for depression-related and positive images.

DISCUSSION

The purpose of our study was to examine dysphoria-related biases in the orientation, allocation, and disengagement of attention. To do so, we tracked and recorded the eye gaze of participants studying depression-related, anxiety-related, positive, and neutral images. Our study was one of the few to examine biases in the allocation of attention in dysphoric individuals and the study's design allowed us to make direct comparisons with the data collected by Eizenman et al. (2003) and Kellough et al. (2008) from clinically depressed individuals. We turn now to a detailed consideration of the dysphoria-related differences in attention and memory that we have observed.

Dysphoria-related differences in the allocation of attention

With respect to the allocation of attention (examined in the simultaneous study condition), we found that dysphoric participants attended to positive images differently. Dysphoric participants attended to positive images significantly less than non-dysphoric participants, and this was true when considering the total fixation time to positive

images (averaged across all positive images studied) and when considering the total fixation time to only the first image fixated on each trial. Mathews and Antes (1992) reported an equivalent result, as their dysphoric participants also attended to positive images less than their non-dysphoric participants. These results are consistent with the literature showing that disturbances in positive emotional responding are characteristic of people experiencing dysphoria; dysphoric individuals fail to demonstrate the positive or "protective" cognitive bias of non-dysphoric individuals (Gotlib, McLachlan, & Katz, 1988), manifested in the present study by a reduction in attention to positive stimuli.

Interestingly, Kellough et al. (2008) reported an analogous finding in a sample of clinically depressed individuals, whereas Eizenman et al. (2003) did not; Eizenman et al. did not find that their clinically depressed participants attended to positive images any differently than their control participants. This discrepancy is not easily explained given the many similarities between the two studies (although Eizenman et al.'s sample of depressed participants was smaller, $N = 8$, and older, $M = 36.8$, than Kellough et al.'s sample: $N = 15$, with an age range of 18 to 21 years). An important issue for future research will be to determine if both depressed and dysphoric individuals show a reduction in attention to positive images when multiple emotional images compete for attention.

Unlike the situation for positive images, dysphoric participants did not attend to depression-related images any differently than non-dysphoric participants. In this respect our results differ somewhat from those of Mathews and Antes (1992), who found that dysphoric participants fixated on the sad regions of complex images more frequently than non-dysphoric participants. On the other hand, for total fixation durations, Mathews and Antes did not find that dysphoric participants looked at sad regions significantly longer than non-dysphoric participants, consistent with what we observed. In contrast, in both Eizenman et al.'s (2003) and Kellough et al.'s (2008) study there was unambiguous evidence that depressed participants spent more time attending to dysphoric images. Considered together, it would

appear that an attentional bias for dysphoric images is much more pronounced in depressed individuals than in dysphoric individuals. Although one should be cautious generalising from the handful of studies available (two of them with dysphoric individuals and two with depressed individuals), if it is confirmed that dysphoric individuals differ from depressed individuals in their allocation of attention to dysphoric information then this distinction will have important theoretical and methodological implications for depression researchers.

We also found that dysphoric and non-dysphoric participants did not differ in their attention to anxiety-related images, as there were no differences between the groups on their total fixation durations or number of fixations to these images. An equivalent result was reported by Eizenman et al. (2003) and Kellough et al. (2008), who found that depressed and control groups did not differ on fixation times to threatening images. Thus, it seems clear that, regardless of the high comorbidity of depression and anxiety, depressed and dysphoric individuals are unlike anxious individuals in that they do not attend preferentially to stimuli related to danger and threat.

Lastly, like Caseras et al. (2007) and Kellough et al. (2008), we found that dysphoric participants did not initially orient their attention to depression-related images (or to anxiety-related images) any more frequently than non-dysphoric participants. Depression-related images did not automatically "capture" the attention of dysphoric participants as they would be expected to according to some theoretical accounts of information-processing biases in depression (e.g., Beck & Clark, 1988). Recall that Kellough et al. (2008) reported the same result with a sample of clinically depressed individuals. Our study contributes to the growing body of evidence pointing to an important difference between anxiety-related and depression/dysphoria-related biases in attention; namely, that high levels of anxiety are associated with a bias in the initial orienting of attention (with attention automatically drawn to threat-related cues), whereas high levels of

dysphoria are not (Calvo & Avero, 2005; Mogg & Bradley, 2005).

Dysphoria-related differences in the disengagement of attention

With respect to the disengagement of attention (examined in the sequential study condition), the novel result was that dysphoric participants were slower than non-dysphoric participants to disengage their attention from depression-related images. We also found that dysphoric participants were slower to disengage their attention from depression-related images than neutral images, whereas for non-dysphoric participants the disengagement times for depression-related and neutral images were virtually identical. These results show that dysphoric individuals experience greater difficulty shifting attention away from depression-related images once they come into the focus of attention. Our results compliment and extend those of Koster et al. (2005) and Ellenbogen and Schwartzman (2009), who reported a similar finding using an exogenous cuing task that measured automatic shifts of attention. Our research shows that the endogenous disengagement of attention from depression-related information is also slower in dysphoric individuals, and whether this is also true for depressed individuals will need to be established.

For positive images a different pattern emerged. While both dysphoric and non-dysphoric participants were faster to disengage their attention from positive images than from neutral images, for dysphoric participants the difference in disengagement times between positive and neutral images was larger. This is an intriguing result that will need to be replicated, especially because Koster et al. (2005) observed a similar result with an exogenous cuing task (see their Table 4). (Ellenbogen & Schwartzman, 2009, did not present positive images in their study.) If dysphoria is associated with faster disengagement from positive information this would imply that positive information has a reduced ability to engage attention, consistent with the view that

disturbances in positive emotional responding are characteristic of people experiencing dysphoria.

One final point to make about the endogenous cueing task is that dysphoric participants' slower disengagement times from depression-related images was not coupled with longer fixation durations to depression-related images in the simultaneous study condition—one might have expected that slower disengagement from depression-related images would be associated with increased attention to the same type of images in the simultaneous study condition. On the other hand, different attentional processes were measured in the two study conditions (the disengagement of attention vs. the allocation and maintenance of attention) and it is possible that attentional processes are not uniformly affected in dysphoria. It may also be the case that the endogenous disengagement of attention is more sensitive to an attentional bias than either the allocation or maintenance of attention over extended time intervals. Endogenous cues assess an individual's ability to immediately interrupt their processing of negative information, and this may be a particularly effective way of measuring a mood-congruent attentional bias. Our study was the first to use an endogenous cueing task to test for a dysphoria-related effect on the disengagement of attention and our results demonstrate that this procedure has considerable promise for future research.

Dysphoria-related differences in recognition memory for emotional images

The results of the recognition memory test were fairly straightforward. For images studied in the simultaneous study condition, dysphoric participants' memory for depression-related and positive images was no better than their memory for neutral images, whereas the non-dysphoric participants had better memory for these images than for neutral images. For probed images studied in the sequential study condition, dysphoric participants had poorer memory for depression-related and positive images than neutral images, whereas the non-dysphoric participants' memory for these images was equivalent to their memory for neutral

images. In neither study condition were there clear between-group differences in recognition memory performance. These two tests of participants' memory for the images were not equivalent, because the images were studied under different circumstances (multiple images vs. single images) and for different lengths of time. Moreover, in the sequential study condition the endogenous cueing procedure disrupted participant's studying of probed images. In the end, we have more confidence in the memory data from the simultaneous study condition because it reflects a more conventional test of recognition memory. Nevertheless, the data from both study conditions were consistent in showing differences between the dysphoric and non-dysphoric participants in their memory for emotional images (depression-related and positive images) versus their memory for neutral images.

To our knowledge, no other study has examined recognition memory for neutral and emotional images in dysphoric individuals as we have, and thus there is no straightforward comparison available between our results and those of an equivalent study. Nonetheless, the memory data of the non-dysphoric participants in the simultaneous study condition is consistent with the cognitive psychology literature showing that images with emotional content tend to be better remembered than neutral images (Bradley et al., 1997; Christianson, 1992; Dolcos, LaBar, & Cabeza, 2005; Ochsner, 2000). The fact that dysphoric participants did not show this emotional enhancement of recognition memory is the outcome of interest.

As noted previously, most studies of memory in depressed and dysphoric individuals have looked for group differences in memory for emotionally valenced words using recall tasks. The standard finding is that non-dysphoric individuals recall more positive words than negative words, depressed individuals recall more negative words than positive words, and dysphoric participants exhibit an "even-handedness" in their recollection, remembering positive and negative words equally well (Matt et al., 1992). Researchers have long recognised that data from recognition memory tasks often fail to show the same pattern, however

(White, Ratcliff, Vasey, & McKoon, 2009), and in many studies there are no depression-related differences in recognition memory for emotional material (e.g., Neshat-Doost, Taghavi, Moradi, Yule, & Dalgleish, 1998; Ridout et al., 2008). A recent study by Hamilton and Gotlib (2008) is an exception. Hamilton and Gotlib had participants study positive, negative, and neutral images and administered a recognition memory test seven days later (as we did in our study). They found that whereas non-depressed individuals had better memory for positive images than for negative images, depressed individuals did not; instead, depressed individuals had slightly better recognition memory for negative images (although it should be noted that the critical interaction between Group and Type of Image was not statistically significant in their analyses). Because our test of recognition memory was similar to that of Hamilton and Gotlib, our results may point to an important difference between the memory biases of depressed and dysphoric individuals. That is, dysphoric individuals may not exhibit a mood-congruent memory bias for emotional images, but may instead fail to exhibit the standard emotional enhancement of memory seen in non-depressed individuals. Depression researchers will need to use recognition memory tests more frequently for this possibility to be evaluated.

Several caveats are necessary when interpreting our memory data. First, recognition memory is less affected by experimental manipulations (including between-group manipulations) than recall memory, and so our test for a mood-congruent memory bias was likely less sensitive than it would have been had we used a recall task. In addition, it has long been known that recognition memory for images is much better than it is for words (e.g., Shepard, 1967), with higher hit rates and lower false-alarm rates over a wide range of study-test delay intervals; indeed, hit rates for studied images can be quite high even when memory is tested one year after study (e.g., Dolcos et al., 2005). For these reasons, our ability to measure a mood-congruent memory bias for emotional images may have been quite limited, and small differences between participants' memory for positive and depression-related images

may have been difficult to measure. Second, it is possible that we would have obtained different results had we not instructed our participants to study the images (i.e., had we used an incidental learning task). As discussed below, studying the images may have led to a more uniform allocation of attention to the images, and this would have compounded any difficulties detecting group differences in recognition memory.

Considerations for future research

One consideration for future eye-tracking research is the instructions provided to participants viewing multiple images, because differences in the participant's task may have qualitative and quantitative effects on the distribution of their attention. Recall that Eizenman et al. (2003) and Kellough et al. (2008) asked their participants to simply view images as they were presented ("as if they were watching television" in Kellough et al.'s study), whereas Mathews and Antes (1992) asked their participants to make an aesthetic rating for each image and our participants were asked to study each image for a recognition memory test. When participants are asked to rate each image or to study each image, it is quite likely they will distribute their attention differently compared to when they are asked to passively view images. For one, every image will probably receive some minimal amount of attention, producing a more uniform distribution of attention among the images presented during each trial. In addition, studying or rating images probably invokes a more deliberate and elaborative type of processing of each and every image, regardless of the image type, which would tend to equalise the distribution of attention throughout a trial. The end result would be that it would be more difficult to observe individual differences in the allocation and maintenance of attention because any such differences would be attenuated. Thus, it is possible that we have underestimated the impact of dysphoria on selective attention by having participants study the images. If true, the fact that we still observed differences between dysphoric and non-dysphoric individuals speaks to the

resilience and persistence of the attentional bias—even when the task demands encouraged participants to attend fully and equally to all images there was still a group difference in attention to positive images. Researchers will need to carefully consider task demands when studying attentional biases in eye-tracking paradigms in light of these issues.

Conclusions

After reviewing the evidence for attentional biases in depression, Rinck and Becker (2005, p. 63) concluded that “the empirical evidence regarding attentional biases in depression is scarce and heterogeneous, making it very difficult to draw firm conclusions”. Although the evidence is still far from unequivocal, researchers have made important advances since Rinck and Becker’s review, and there is a growing consensus that depression is associated with attentional biases that may play a role in the vulnerability and maintenance of the disorder. Our study has identified a dysphoria-related bias in the allocation of attention distinct from that observed in depressed individuals (Eizenman et al., 2003; Kellough et al., 2008), and this finding may have important theoretical and methodological implications for depression researchers. The other novel result was the identification of a dysphoria-related impairment in the endogenous disengagement of attention from depression-related images. Our research demonstrates that eye-tracking methodology offers significant advantages for the study of selective attention in depressed and dysphoric individuals.

Manuscript received 27 January 2009

Revised manuscript received 22 September 2009

Manuscript accepted 6 October 2009

First published online 17 February 2010

REFERENCES

Beck, A. T. (1976). *Cognitive therapy and the emotional disorders*. New York: International Universities Press.

- Beck, A. T., & Clark, D. A. (1988). Anxiety and depression: An information processing perspective. *Anxiety Research, 1*, 23–36.
- Beck, A. T., & Steer, R. A. (1993). *Beck Anxiety Inventory Manual*. San Antonio, TX: Psychological Corporation.
- Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Beck Depression Inventory Manual* (2nd ed.). San Antonio, TX: Psychological Corporation.
- Bradley, B. P., Mogg, K., & Lee, S. C. (1997). Attentional biases for negative information in induced and naturally occurring dysphoria. *Behavior Research and Therapy, 35*, 911–927.
- Burt, D. B., Zembar, M. J., & Niederehe, G. (1995). Depression and memory impairment: A meta-analysis of the association, its pattern, and specificity. *Psychological Bulletin, 117*, 285–305.
- Calvo, M. G., & Avero, P. (2005). Time course of attentional bias to emotional scenes in anxiety: Gaze direction and duration. *Cognition and Emotion, 19*, 433–451.
- Caseras, X., Garner, M., Bradley, B. P., & Mogg, K. (2007). Biases in visual orienting to negative and positive scenes in dysphoria: An eye movement study. *Journal of Abnormal Psychology, 116*, 491–497.
- Christianson, S. A. (1992). Emotional stress and eyewitness memory: A critical review. *Psychological Bulletin, 112*, 284–309.
- Cox, B. J., Enns, M. W., Borger, S. C., & Parker, J. D. (1999). The nature of the depressive experience in analogue and clinically depressed samples. *Behavior Research and Therapy, 37*, 15–24.
- Dolcos, F., LaBar, K. S., & Cabeza, R. (2005). Remembering one year later: Role of the amygdala and the medial temporal lobe memory system during retrieval of emotional memories. *Proceedings of the National Academy of Sciences, USA, 102*, 2626–2631.
- Dozois, D. J. A., Dobson, K. S., & Ahnberg, J. L. (1998). A psychometric evaluation of the Beck Depression Inventory-II. *Psychological Assessment, 10*, 83–89.
- Eizenman, M., Yu, L. H., Grupp, L., Eizenman, E., Ellenbogen, M., Gemar, M., et al. (2003). A naturalistic vision scanning approach to assess selective attention in major depressive disorder. *Psychiatry Research, 118*, 117–128.
- Ellenbogen, M. A., & Schwartzman, A. E. (2009). Selective attention and avoidance on a pictorial cueing task during stress in clinically anxious and depressed participants. *Behaviour Research and Therapy, 47*, 128–138.

- Flett, G. L., Vredenburg, K., & Lester, K. (1997). The continuity of depression in clinical and nonclinical samples. *Psychological Bulletin*, *121*, 395–416.
- Gotlib, I. H., McLachlan, A. L., & Katz, A. N. (1988). Biases in visual attention in depressed and non-depressed individuals. *Cognition and Emotion*, *2*, 185–200.
- Hamilton, J. P., & Gotlib, I. H. (2008). Neural substrates of increased memory sensitivity for negative stimuli in major depression. *Biological Psychiatry*, *63*, 1155–1162.
- Kellough, J. L., Beevers, C. G., Ellis, A. J., & Wells, T. T. (2008). Time course of selective attention in clinically depressed young adults: An eye tracking study. *Behaviour Research and Therapy*, *46*, 1238–1243.
- Klein, R. M., & Shore, D. I. (2000). Relations among modes of visual orienting. In S. Monsell & J. Driver (Eds.), *Attention and performance XVIII: Control of cognitive processes* (pp. 195–208). Cambridge, MA: MIT Press.
- Koster, E. H. W., De Raedt, R., Goeleven, E., Franck, E., & Crombez, G. (2005). Mood-congruent attentional bias in dysphoria: Maintained attention to and impaired disengagement from negative information. *Emotion*, *5*, 446–455.
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2005). *International Affective Picture System (IAPS): Affective ratings of pictures and instruction manual* (Technical Report A-6). University of Florida, Gainesville, FL.
- Mathews, G. R., & Antes, J. R. (1992). Visual attention and depression: Cognitive biases in the eye fixations of the dysphoric and the non-depressed. *Cognitive Therapy and Research*, *16*, 359–371.
- Matt, G. E., Vazquez, C., & Campbell, W. K. (1992). Mood-congruent recall of affectively toned stimuli: A meta-analytic review. *Clinical Psychology Review*, *12*, 227–255.
- Mogg, K., & Bradley, B. P. (2005). Attentional bias in generalized anxiety disorder versus depressive disorder. *Cognitive Therapy and Research*, *29*, 29–45.
- Neshat-Doost, H. T., Taghavi, M. R., Moradi, A. R., Yule, W., & Dalgleish, T. (1998). Memory for emotional trait adjectives in clinically depressed youth. *Journal of Abnormal Psychology*, *107*, 642–650.
- Ochsner, K. N. (2000). Are affective events richly recollected or simply familiar? The experience and process of recognizing feelings past. *Journal of Experimental Psychology: General*, *129*, 242–261.
- Pashler, H. E. (1998). *The psychology of attention*. Cambridge, MA: MIT Press.
- Posner, M. I. (1980). Orienting of attention. *Quarterly Journal of Experimental Psychology*, *32*, 3–25.
- Ridout, N., Dritschel, B., Mathews, K., McVicar, M., Reid, I. C., & O'Carroll, R. E. (2008). Memory for emotional faces in major depression following judgement of physical facial characteristics at encoding. *Cognition and Emotion*, *23*, 739–752.
- Rinck, M., & Becker, E. S. (2005). A comparison of attentional biases and memory biases in women with social phobia and major depression. *Journal of Abnormal Psychology*, *114*, 62–74.
- Shepard, R. N. (1967). Recognition memory for words, sentences, and pictures. *Journal of Verbal Learning and Verbal Behaviour*, *6*, 156–163.
- Vredenburg, K., Flett, G. L., & Krames, L. (1993). Analogue versus clinical depression: A critical reappraisal. *Psychological Bulletin*, *113*, 327–344.
- Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*, 1063–1070.
- White, C., Ratcliff, R., Vasey, M., & McKoon, G. (2009). Dysphoria and memory for emotional material: A diffusion-model analysis. *Cognition and Emotion*, *23*, 181–205.
- Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1997). *Cognitive psychology and emotional disorders* (2nd ed.). Chichester, UK: Wiley.
- Wright, R. D., & Ward, L. M. (2008). *Orienting of attention*. New York: Oxford University Press.