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# The *Affective Gallery*: A Naturalistic Exploration of the Relationship Between Attentional Bias and Depressive Symptoms

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## Abstract

Eye-movement studies exploring mood disorders and attentional biases have relied heavily on laboratory-based tasks. While this approach has been useful, it may lack ecological validity. The present study aimed to examine attentional bias in a naturalistic setting, exploring how individuals with differing levels of depressive symptomatology look at images in an art gallery. Participants (*N*= 60), college women, were assessed for depressive symptoms prior to being fitted with a portable eye-tracking device and encouraged to browse an exhibition at Al-Fanoun Art Gallery. The exhibition, staged for the purpose of the study, comprised 12 enlarged images from the International Affective Picture System collection; six positive and six negative. Depressive symptomatology was correlated with longer gaze durations for negative images (dysphoric bias) and also with shorter gaze durations for positive images (anhedonic bias). The study is limited by its use of an all-female student sample. However, these findings support previous studies reporting attentional biases associated with low mood and mood disorders. The methodological innovation demonstrated in the present study may prove helpful for interventions aimed at attentional bias modification.

*Key words*: depression, attention, eye-tracking, attentonal bias, affective images.

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### *Novelty and Significance*

*What is already known about the topic?*

- Past research, most of it using desktop computers, has shown that people experiencing depression show biases in the way they look at positive (e.g. child smiling at the beach) and negative (e.g. terminal patient in hospital bed) images.
- The general finding is that people experiencing depression or even high levels of depressive symptoms, tend to spend a longer time looking at negative images, and a shorter time looking at positive images, compared to healthy controls.

*What this paper adds?*

- Most of the past research has been undertake in laboratory settings, with participants sitting at a computer, where images are presented on after another.
- This study used an actual art gallery setting along with mobile eye-tracking devices to extend the real-world validity of past research.
- The expected image viewing biases were observed in this more natural image viewing setting and the findings open up the possibility of using this novel technology as part of a psychological therapeutic technique known as attentional bias modification.

Attentional biases, specifically difficulties disengaging attention from negative stimuli and sustaining it on positive stimuli, are implicated in the onset and maintenance of several psychological complaints. For example, studies using an emotional Stroop paradigm have reported relatively slower response times for colour-naming negative stimuli, such as person-descriptive adjectives (e.g. unlovable, looser, failure) among participants experiencing mood disorders (Bentall & Thompson, 1990; de Ruiter & Brosschot, 1994; Mittershiffthaler *et alii*, 2008; Thomas, Cambell, Altareb, & Ali, 2010; Williams, Mathews, & MacLeod, 1996). Similarly, several studies among depressed and

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manic participants demonstrate a recall bias for negative stimuli on implicit memory tasks, that is, the tendency to remember more negative adjectives than positive ones when given a surprise recall task (for review see Watkins, Mathews, Williamson, & Fuller, 1997). Similar observations are made in the context of anxiety disorders too (for review see Cisler & Koster, 2010). These attentional biases, whether explored in the context of anxiety or mood disorders, are typically interpreted with reference to the vigilance and the maintenance hypotheses. The vigilance hypothesis centres on the idea that certain stimuli are identified faster due to a posited threat detection mechanism. Meanwhile, the maintenance hypothesis rests on the idea of attentional control and difficulties disengaging from emotional stimuli (Cisler & Koster, 2010). These ideas are not mutually exclusive, and they call into focus the concept of "time course". For example, some stimuli might rapidly attract attention early in the deployment process (vigilance), eventually becoming difficult to disengage from (maintenance), perhaps finally, eliciting attentional avoidance.

Much of the experimental research exploring attentional biases has relied upon task-based response times, typically connected with forced-choice key presses on computerised protocols. The emergence of affordable eye-tracking technologies, however, has led to a growing body of attentional bias research examining eye movement (EM) in response to affective stimuli. There are primarily two ways that researchers have operationalised emotion-related attentional bias studies with EM technologies. The first method, known as the search strategy protocol, typically involves asking a participant to search an array of objects (images/words) indicating, as quickly as possible, if a particular target stimulus (e.g. sad face, anxious face) is present or absent. Such search tasks are widely employed in psychological research without EM technology, and typically involve the forced choice (dichotomous) responses (key press) resulting in various response-time and error-rate based metrics. However, including the EM element in search tasks provides additional information, such as the time to first fixation, mean gaze duration, and the EM pathways involved in identifying targets and ruling-out non-targets etc. The second major EM protocol is the free viewing protocol. Free viewing typically abandons the forced choice and response time element in favour of allowing participants to view various stimuli on a computer screen (as if watching TV). This free viewing, however, is usually for a predetermined duration, typically between 1 and 60 seconds per stimulus (Armstrong & Olatunji, 2012).

The majority of EM research exploring attentional biases in depression and anxiety has utilised the free viewing paradigm(Armstrong & Olatunji, 2012). In such tasks, attentional bias is inferred from the gaze behaviour of the participant in response to the on-screen presentation of various stimuli. For example, these stimuli might include, angry or happy faces (Garner, Mogg, & Bradley, 2006), threatening or neutral words (Felmingham, Rennie, Manor, & Bryant, 2011), phobic or non-phobic objects (Rinck & Becker, 2006). Various metrics can be derived from such free viewing tasks; common ones include mean gaze duration (how much time is spent looking/gazing at a particular stimulus) and time to the first fixation (how much time elapses before the participant initially fixates on a particular stimulus). This latter metric is sometimes referred to as an orientating response and is associated with the vigilance hypothesis, while the former (total or mean gaze duration) is associated with the maintenance hypothesis.

In a review of 33 eye-tracking studies exploring depression and anxiety, Armstrong and Olatunji (2012), report that depressed individuals, compared to non-depressed individuals, demonstrated longer gaze duration on dysphoric/unpleasant stimuli. They also demonstrated an "anhedonic bias", in that their duration of gaze on pleasant stimuli was attenuated, compared with that of non-depressed individuals. Similar conclusions were drawn by Carvalho *et alii* (2015) after reviewing EM studies among unipolar and bipolar depressed patients.

Similar findings have emerged from EM studies utilising analogue (non-clinical) samples. EM studies have observed the expected attentional bias in undiagnosed participants with relatively high levels of depressed symptoms (Owens & Gibb, 2017) and also among participants experiencing experimentally induced dysphoric mood (Bodenschatz, Skopinceva, Kersting, Quirin, & Suslow, 2018). Similarly, an EM study exploring negative mood induction and general stress levels among a non-clinical sample found the expected attentional bias for dysphoric stimuli (Macatee, Albanese, Schmidt, & Cougle, 2017). At least one previous EM study has also observed the magnitude of the attentional bias to be positively associated with the severity of the depressive symptoms among depressed patients (Duque & Vázquez, 2015). Finally, bipolar patients studied across all phases of their disorder (euthymic, manic, depressed) uniquely demonstrated an expected EM bias (a decrease in attention to happy images) during the depressive phase (García Blanco, Salmerón, Perea, & Livianos, 2014). These findings point to a gaze-related attentional bias that is associated with a broad spectrum of depressive symptom severity and current mood states.

To date, most of the EM research exploring attentional bias involves lab-based participants passively viewing affective stimuli presented, serially, on computer screens for a predetermined duration (Armstrong & Olatunji, 2012). The few studies that have used mobile eye tracking to explore attention to positive and negative stimuli suggest that allowing participants the freedom to more freely select stimuli can provide further insights into the nature of attentional bias (Isaacowitz, Livingstone, Harris, & Marcotte, 2015; Isaacowitz, Livingstone, Richard, & Seif El-Nasr, 2018). However, even the lab-based studies with fixed eye-trackers have an inherent degree of ecological validity, given the widespread proliferation of personal computers and smartphones in recent decades (Fuller, 2015). Computer use in natural settings, however, generally involves lingering on, returning to and skipping certain images/content at will. The typical lab-based protocol with its unidirectional, serial, presentation of fixed images, and its predetermined exposure durations often lacks these elements. The present study aims to address this limitation and extend the ecological validity of previous findings by having participants walk around an art gallery, wearing a mobile eye-tracking system (Tobii Pro Glasses 2). The gallery in question housed an exhibition of 12 affective images (pleasant and unpleasant) taken from the IAPS collection. In line with previous research, and specifically focused on the maintenance hypothesis of depressive attentional bias, the present study predicted that participants with the highest levels of depressive symptomatology (upper quartile) would demonstrate an attentional bias characterised by a greater gaze duration for unpleasant (negative) images relative to pleasant (positive) ones.

## Method

### *Participants*

Participants ($N$= 60) were an opportunity sample of first-year college women from the college or arts and the college of natural and health sciences at a federal University in the United Arab Emirates. The university operates with a female-only campus, and the language of tuition within the institution is English; all participants were bilingual in Arabic and English. Participants were awarded course credit for their involvement, and each gave informed consent. Before participant recruitment and starting the data collection, the institution's research ethics committee granted ethical approval (ZU10_026_F).

*Instruments*

*Center for Epidemiological Studies-Depression* (CES-D; Radloff, 1977). The CES-D is a 20-item self-report inventory used to assess levels of depressive symptomatology in the general population. Developed by the National Institute of Mental Health, the CES-D has been widely used in large-scale epidemiological studies of depression. The scale's psychometric properties have been evaluated favourably in general community surveys and within psychiatric populations. The scale has good internal consistency, test-retest reliability is and correlates positively with interview-based clinical evaluations of depressive symptoms (Radloff, 1977). The scale was previously translated and validated with Arabic speakers in the UAE. The Arabic version of the CES-D has acceptable reliability and good criterion and discriminative validity (Ghubash, Daradkeh, Al Naseri, Al Bloushi, & Al Daheri, 2000). The scale asks about the frequency of depressive symptoms over the past week, and participants respond from 0 (rarely or none of the time -less than a day) to 3 (most or all of the time-5 to 7 days). Participants' total scores are obtained by summing all responses, with scores ranging from 0 to 60. Example items from the scale include: "I felt lonely", "I felt sad", and "I had crying spells". The original screening cut-off score (16) on the CES-D is criticized for being inadequate within certain populations. For example, Henry, Grant, and Cropsey (2018) proposed an upward revision of the CES-D cutt-off to 23 for women within an ethnically diverse population. Furthermore, in light of previous research showing high rates of depressive symptoms among citizens of Arab Gulf countries (Abdel-Khalek & Alansari, 2004; Alansari, 2005, 2006), the present study will use scores within the upper quartile to represent relatively high levels of depressive symptomatology rather than the traditional screening cutt-off score of 16. The internal consistency for the CES-D in the present study was good, $\alpha$= .91.

*The IAPS Images*. The images for the gallery exhibition were selected from the widely used IAPS (International Affective Picture System) collection (Bradley & Lang, 2007). These images have previously been rated on a scale of 1 to 10 for valence (negative/positive) and arousal (low/high). Based on the existing normative data for this image collection, a computer algorithm was used to select 12 images. These were images among the top 10 for positive valence and among the bottom 10 for negative valence, while ensuring arousal ratings were between 3 and 5 (maximum is 10). Using images with medium to low arousal levels prevented the inclusion of pornographic or violent images. A post selection *T*-test confirmed that the positive and negative images differed significantly on valence, while not differing significantly on arousal levels. The selected images were printed at the size of 59.4 cm x 84.1cm (A1) in full colour. Further details of the gallery images can be found in Table 1 and are available on request from the corresponding author of this paper.

*Affective Gallery*. The IAPS images were exhibited in the Al Fanoun gallery in Abu Dhabi. Al Fanoun is a functioning art gallery regularly hosting exhibitions and installations by local and international artists. For the purpose of the present study, the exhibition was constructed from four wooden dividers (see Figure 1). These were used to create a room or section within the Al Fanoun gallery where the IAPS images were displayed along four walls, with three images on each wall. The image locations were changed between participant viewings, counterbalancing the relative placement of positive and negative images on each wall of the installation.

*Tobii Glasses 2 and Analyzer Software*. The Tobii glasses 2 are a lightweight wearable eye tracker designed to capture natural viewing behaviour in real-world environments. The glasses have two cameras for each eye using Tobii's 3D eye model, extending the technology of traditional screen-based eye trackers. While in operation, the glasses

*Figure 1*. The "affective gallery" comprised an exhibition of positive and negative photographs from the IAPS collection, enlarged and displayed at the Al Fanoun Gallery in Abu Dhabi.

record a video of the visual field and also capture the gaze location and duration in real time. The glasses are combined with Tobii Pro Glasses Analyzer, a dedicated software application for the analysis and visualisation of data generated by the glasses. This software allows the calculation of fixation duration for all objects within the visual field of the person wearing the glasses. In the present study, a fixation was defined as maintaining the gaze on a single location (a gallery image) for at least 100 milliseconds (Salvucci & Goldberg, 2000).

### *Procedure*

Participants each had individual appointment times to arrive at the gallery, and so each participant was tested individually. Upon arrival, the researcher informed participants that this was a study exploring moods and the way people behave in art galleries. Before signing an informed consent sheet, participants received written information detailing the nature of the study; this specified the need to complete a questionnaire assessing mood and the requirement to wear an eye tracking device. It also included information about confidentiality (all data were anonymous) and the right to withdraw from the study at any time. After signing consent forms and completing the CES-D, participants were fitted with the eye-tracking glasses, performed a brief calibration process, and were sent off to look at the installation. All participants received the following standardised instructions "Take your time to look at the exhibition; you have as long as you need. Please behave as you feel you might naturally act in an art gallery". Once the participant exited the gallery, they were debriefed and thanked for their participation.

### *Data Analysis*

Data were analyzed using SPSS version 25. All variables were normally distributed and did not require logarithmic transformation. Correlational analysis was conducted using Pearson's bivariate correlation. Group differences were assessed using an independent samples *T*-Test. Finally, a categorical analysis was conducted using Pearson's Chi Square.

## RESULTS

Participant's ages and mean scores for all the main study variables are given below in Table 1. As anticipated, the CES-D scores were relatively high compared to previous studies reported in Europe and North America, with 79% of the participants scoring above 16, the recommended cut-off for clinically significant depressive symptoms (Radloff, 1977). Despite these relatively high depressive symptom scores, all variables were normally distributed, and all data met the assumptions for bivariate and partial correlational analysis (interval data) and the independent samples *T*-test. Table 1, below, details the means and standard deviations for all key variables.

*Table 1*. Means and standard deviations for all study variables.

| Measure | Range | *Mean* | *SD* |
|---|---|---|---|
| Age | 18-31 | 22.16 | 2.68 |
| CES-D | 0-60 | 24.91 | 8.59 |
| Gaze duration for negative images | - | 29422 | 18987.01 |
| Gaze duration for positive images | - | 29835 | 19512.89 |
| Relative gaze duration | - | 456.88 | 7828.38 |

*Note*: Relative gaze duration= Mean gaze duration for positive images, minus, mean gaze duration for negative images.

The naturalistic, gallery, setting allowed participants to select the images they viewed. Consequently, some participants ignored certain images, while viewing others multiple times. Calculations of the total gaze duration include summing multiple viewings/fixations. Table 2 below presents brief descriptions of the images, positive (P) and negative (N) and the mean gaze duration for each image in milliseconds (ms).

Pearson's bivariate correlations were undertaken between all the study variables (see Table 3). Depression symptoms were also analysed as a dichotomous variable, with scores in the upper quartile (≥ 29) coded as 2 and scores below this threshold coded as 1. These two groupings are used to represent high and low depressive symptom status (D-Status).

*Table 2*. Image description and mean gaze durations in ascending order of time.

| Image description | Valence | *Mean* | *SD* |
|---|---|---|---|
| Distressed girl crying and hiding eyes | N | 3751 | 4275 |
| Two children playing with kittens | P | 3816 | 3479 |
| Distraught boy crying out loud | N | 4326 | 3832 |
| Smiling baby, sitting on a man's stomach | P | 4597 | 3624 |
| Elderly couple smiling at each other | P | 4679 | 4460 |
| Toddler playing with binoculars | P | 4947 | 4329 |
| Smiling old man playing with two toddlers* | P | 5025 | 4661 |
| Young girl cowering in a corner* | N | 5066 | 4060 |
| Desperate looking vagrant drinking from bottle* | N | 5152 | 5108 |
| Severely disabled child showing distress | N | 5168 | 3729 |
| Senior man holding dying wife's hand in a hospital bed | N | 5957 | 4999 |
| Little boy and girl walking on a beach | P | 6767 | 6655 |

*Notes*: N= negative; P= positive; *= Images were never ignored and therefore have minimum scores above zero.

Mean gaze duration for positive and negative images correlated with each other. Therefore a partial correlation was undertaken to explore the relationship between depressive symptom status (high and low) and gaze duration for negative images, controlling gaze duration for positive images as a covariate. The partial correlation revealed that

*Table 3*. Correlations for main study variables at baseline (*N*= *60*).

| | D-Status | CES-D | MGD-Neg | MGD-Pos |
|---|---|---|---|---|
| Age | .013 | .011 | -.021 | .017 |
| D-Status | | .74* | .189 | -.016 |
| CES-D Score | | | .062 | .001 |
| MGD-Neg | | | | .46* |

*Notes*: D-Status= Depression status (high= 2, low= 1); CES-D= Depressive symptoms; MGD-Neg= Mean gaze duration on negative images; MGD-Pos= Mean gaze duration on positive images; *= *p* <.05 Bonferroni correction applied.

the highest levels of depressive symptoms (D-Status) were positively correlated with longer gaze durations for negative images (*r*[58]= .38, *p*= .020). Similarly, participants with the highest depressive symptom scores demonstrated shorter gaze durations for positive images (anhedonia bias) after controlling for negative image gaze duration (*r*[58]= -.33, *p*= .024).

Using an upper quartile comparison, participants with the highest levels of depressive symptomatology (*n*= 15, *M*= 30.12, *SD*= 11.67), were compared with the rest of the group (*n*= 45, *M*= 23.13, *SD*= 7.20). Using an independent samples *T*-test, neither group differed significantly in respect to their overall gaze time or their total gaze time for positive or negative images (see Table 4).

The groups did, however, differ significantly regarding relative gaze durations (mean positive-mean negative gaze duration). The group with the highest levels of depressive symptoms had a relative gaze duration score of -4127.44 (*SD*= 5340.24), this negative number indicates that greater time was spent looking at negative images relative to positive ones. Conversely, the group with lower levels of depressive symptoms spent relatively longer looking at positive images and had a relative gaze duration score of 2185.33 (*SD*= 5104.17). The between groups difference was statistically significant, *t*(59)= 2.56, *p*= . 007, Cohen's *d*= 0.91. See Figure 2 for a graphical illustration of these differences.

*Table 4*. Mean gaze durations by depressive symptom grouping.

| | Highest Depressive Symptoms | | Lower Depressive Symptoms | |
|---|---|---|---|---|
| *Gaze Durations* | Mean | SD | Mean | SD |
| Negative | 28725.81 | 18575.55 | 22570.01 | 12830.76 |
| Positive | 24324.96 | 13762.62 | 24843.67 | 16276.96 |
| Total | 80350.30 | 49885.30 | 68651.03 | 26736.97 |

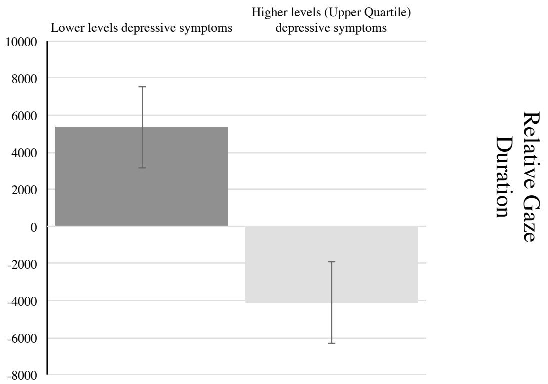


*Figure 2*. Difference between participants with higher and lower depressive symptom levels concerning relative gaze duration. Scores below zero are indicative of more attention being given to negative images; scores above zero represent relatively longer gaze duration on positive images.

Using Pearson's Chi Square test, we categorized participants as demonstrating either a positive bias (looking at positive images for longer than negative images) or a negative bias (looking at negative images longer than positive images). Among the participants with the highest levels of depressive symptoms (*n*= 15), 81% demonstrated a negative bias. Among the participants with lower levels of depressive symptoms (*n*= 45) only 56.8 % demonstrated the negative bias. This difference was statistically significant, $\chi^2$ (2, *N*= 60)= 3.47, *p*= .03.

## Discussion

The present findings support previous research that has observed depressive attentional biases in the context of viewing positive and negative images (Armstrong & Olatunji, 2012; Carvalho *et alii*, 2015; Owens & Gibb, 2017). More specifically, these findings lend further support to the maintenance hypothesis of depressive attentional bias. In the present study, those participants with the highest levels of depressive symptoms spent longer looking at negative images relative to positive ones. Furthermore, the study took place in a novel, naturalistic, setting, thereby extending the ecological validity of previous work in this area, most of which has utilized serial image presentation on computer screens. The use of a functioning art gallery demonstrated that these gaze-related attentional biases can also be observed in relatively naturalistic settings, where images are presented in parallel and the viewer is free too linger, avoid or return to images at will.

This phenomenon of relatively longer gaze durations for negative images associated with depressive symptoms is typically interpreted as difficulty disengaging from negative stimuli (Armstrong & Olatunji, 2012). The difficulty in disengaging might be viewed as a behavioural analogue to depressive rumination –repetitively focusing attention on the causes and consequences of low mood (Nolen-Hoeksema, 1987; Nolen-Hoeksema, Blair, & Lyubomirsky, 2008). It is possible that negative images actually trigger ruminative processes, and while the gaze is directed at the image, attentional resources are also being directed to the ruminative process.

This study also found that, as depressive symptoms increased, the relative gaze duration for positive images decreased. The anhedonic bias, gazing at positive images for relatively shorter durations, as the name suggests, may reflect a diminished interest in pleasure. This reward insensitivity is viewed as leading to less engagement with positive/pleasant stimuli (Armstrong & Olatunji, 2012; Vázquez, Blanco, Sánchez, & McNally, 2016). The anhedonic bias might also be explained as a feature of mood incongruence, that is, positive stimuli failing to initially capture attention when one is in a negative mood state.

These attentional biases (ignoring pleasant stimuli and focusing more on unpleasant stimuli) potentially initiate, maintain and exacerbate low mood. Such biases feature prominently in cognitive (Beck, 1987; Beck, 1995) and metacognitive (Segal, Williams, & Teasdale, 2002) models of major depressive disorder. For example, depression and depressive vulnerability are viewed as arising from a vicious cycle, where dysphoric mood is maintained by a narrow focus of attention on negative information. Over time this pattern can become automatic and habitual, leading to more severe and persistent negative mood states, occasionally culminating in a downward spiral into depression or depressive relapse (Segal *et alii*, 2002).

Within this context, such attentional biases represent a potentially important target for intervention and relapse prevention in the context of depression. Attentional bias modification (ABM), as a potential therapeutic procedure, has already attracted some interest with mixed results (Beard, Sawyer, & Hofmann, 2012; Cristea, Kok, & Cuijpers, 2015; Hakamata *et alii*, 2010). Cristea *et alii* (2015) suggest that some of the inconsistent findings may be attributable to procedural diversity. They also suggest that there is significant room for methodological improvements in attentional bias modification procedures. Using eye-tracking technology might address some of the limitations of past attentional bias modification attempts (Vázquez *et alii*, 2016). The use of the wearable eye-tracking devices in naturalistic settings, as in the present study, might also prove useful in further exploring the therapeutic utility of attentional bias modification. For example, as wearable eye-tracking technology evolves and becomes more affordable the outcomes of clinical or lab-based attentional bias modification attempts might be best assessed in a variety of naturalistic settings.

Despite concurring with previous lab-based explorations of depression related gaze bias, the present study has several important limitations. The use of healthy college students limits the generalizability of this findings. A further limitation was that all participants were females, although, to the best of our knowledge, no previous eye-tracking studies report directional gender differences. The high depressive symptom scores in this sample could also be viewed as a limitation, however, several other studies of depressive symptoms among college women in the Arabian Gulf region report similarly high levels of depressive symptomatology (Abdel-Khalek & Alansari, 2004; Alansari, 2005, 2006; Thomas & Altareb, 2012) A more important limitation, however, is the correlational and cross-sectional nature of the present study. The study's design precludes any inferences concerning temporality or causality, for example, is this bias a cause or consequence of depressive symptoms? Future gallery-based/naturalistic studies might explore EM biases longitudinally with repeated measurement, establishing test re-test reliability and perhaps also utilising mood induction techniques. It might be that, as with dysfunctional attitudes (Teasdale & Cox, 2001), depressive attentional biases become more prominent in those vulnerable to depression after the application of a dysphoric mood induction. In this naturalistic setting it might also be worth exploring the role of experiential avoidance (Giorgio *et alii*, 2010; Thomas, Raynor, & Ribott, 2014). Perhaps participants are viewing negative images, but focusing on elements within the image that cause the least distress.

The present study extends the finding of depressive attentional biases, specifically the maintenance hypothesis, to a novel, naturalistic setting. Both anhedonic (less focus on positive) and dysphoric (greater focus on negative) biases were observed. Future studies might utilise a similar, ecologically robust, methodology to explore attentional bias modification procedures.

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