

# Visual attention to emotion in depression: Facilitation and withdrawal processes

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Attentional biases for sadness are integral to cognitive theories of depression, but do not emerge under all conditions. Some researchers have argued that depression is associated with delayed withdrawal from, but not facilitated initial allocation of attention toward, sadness. We compared two types of withdrawal processes in clinically depressed and non-depressed individuals: (1) withdrawal requiring overt eye movements during visual search; and (2) covert disengagement of attention in a modified cueing paradigm. We also examined initial allocation of attention towards emotion on the visual search task, allowing comparison of withdrawal and facilitation processes. As predicted, we found no evidence of facilitated attention towards sadness in depressed individuals. However, we also found no evidence of depression-linked differences in withdrawal of attention from sadness on either task, offering no support for the theory that depression is associated with withdrawal rather than initial facilitation of attention.

*Keywords:* Depression; Visual attention; Attentional bias; Cognitive bias.

Cognitive theories of depression propose that depressed individuals preferentially attend to and remember negative information and that such cognitive biases constitute important vulnerability and maintenance factors for the disorder (Beck, 1967). While there is robust evidence for depression-linked differences in explicit memory, the evidence for attentional biases in depression is mixed, with attentional biases for sadness emerging under some conditions but not others (Gotlib, Kasch et al., 2004; Williams, Watts, McLeod, & Mathews, 1997; Wisco, 2009). In particular, depression appears not to be associated

with biases in the initial allocation of attention to a stimulus but potentially in the later withdrawal of attention from that stimulus (De Raedt & Koster, 2010; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005; Mogg & Bradley, 2005; Wisco, 2009).

The evidence for this pattern of attentional bias in depression has been examined most frequently in tasks assessing the spatial allocation of attention. Initial allocation and withdrawal processes may operate differently when spatial attention is allocated covertly rather than overtly. Whereas overt allocation of attention requires eye movements, covert

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processes occur on a very short time scale, as fast as 50–100 ms, and without overt eye movements (see Weierich, Treat, & Hollingworth, 2008, for a detailed discussion). The covert allocation of attention has been parsed into shifting, engaging, and disengaging subcomponents (Posner, 1980). Covert engagement and disengagement are conceptually similar to the initial allocation of attention and the withdrawal of attention, but are specific cognitive processes that can be experimentally isolated with tasks that do not allow eye movements (Posner, 1980). The overt allocation of attention cannot be experimentally isolated, because covert shifts always precede overt eye movements. Therefore, all assessments of overt allocation of attention, including visual search tasks or tracking of eye movements, are necessarily influenced by both covert and overt processes. For the purposes of this paper, we use the general terms “initial allocation” and “withdrawal” of attention to refer to circumstances that involve both covert and overt processes. We use the terms “covert engagement” and “covert disengagement” to refer specifically to components of covert orienting.

The theory that depressive biases emerge for withdrawal, but not initial allocation, of attention relies primarily on studies that do not isolate covert processes. Much of evidence comes from the results of studies manipulating stimulus presentation time on the dot-probe task (Peckham, McHugh, & Otto, 2010). Evidence has emerged that depression is associated with a bias for sad faces when stimuli are presented for 1000 ms or longer (Bradley, Mogg, & Lee, 1997; Gotlib, Kasch et al., 2004; Gotlib, Krasnoperova, Yue, & Joormann, 2004; Joormann & Gotlib, 2007; Joormann, Talbot, & Gotlib, 2007; Mogg, Bradley, & Williams, 1995), but not for shorter durations (14 ms to 750 ms; Bradley et al., 1997; Hill & Dutton, 1989; Mogg et al., 1995). This

pattern is interpreted as evidence that depressive biases are found in the withdrawal, but not initial allocation, of attention (Bradley et al., 1997; Mogg & Bradley, 2005). However, a recent meta-analysis found that stimulus presentation duration on the dot probe did not have a statistically significant effect on depression-linked biases (Peckham et al., 2010). Moreover, the dot probe is limited by a number of methodological factors that preclude distinguishing between initial allocation and withdrawal of attention (e.g., Caseras, Garner, Bradley, & Mogg, 2007; Fox, Russo, Bowles, & Dutton, 2001).

Attention to emotion in depression has also been assessed with eye-tracking technology. Depression researchers utilising eye-tracking technology have typically used free-viewing tasks, in which participants are presented with multiple emotional pictures at a time and given few instructions (Caseras et al., 2007; Eizenman et al., 2003; Kellough, Beevers, Ellis, & Wells, 2008; Mathews & Antes, 1992). Eye tracking studies have consistently found that depression is not associated with differences in initial shift of gaze, but is associated with longer fixation times to dysphoric versus neutral stimuli (Caseras et al., 2007; Eizenman et al., 2003; Kellough, Beevers, Ellis, & Wells, 2008; Mathews & Antes, 1992). This pattern of results could be construed as broadly consistent with delayed withdrawal of attention from negative stimuli in depressed individuals.<sup>1</sup> However, a free-viewing task by design does not place any demand on participants to distribute or withdraw their attention in a particular way. Without an incentive to withdraw attention from an object, it is not possible to infer that depression-linked patterns were related to differences in withdrawal processes, rather than other cognitive processes that occur during a fixation.

<sup>1</sup>Other investigators have found a similar pattern of results in nonspatial allocation of attention. Research using negative affective priming tasks has shown that dysphoric individuals are slower to identify a negative target if it was immediately preceded by a trial with a negative distractor, indicating that dysphoric individuals have difficulty ignoring irrelevant, negative information (Joormann, 2004). Although the expected relationship between spatial and nonspatial allocation of attention is unclear, this pattern of results is broadly consistent with current interpretations of the spatial attention literature, namely that depressive biases emerge in the withdrawal, rather than the initial allocation, of attention.

In contrast to dot-probe and free-viewing paradigms, variants of visual search tasks can be used to distinguish initial allocation and withdrawal of attention. In a common visual search paradigm, multiple stimuli are presented on each trial, but trials vary in terms of whether all of the emotions are the same or a single discrepant emotion (a “target” stimulus) is present. The task for participants is to indicate whether a discrepant emotion is present on each trial. The emotion of the discrepant stimulus and the emotion of the stimuli in the background are manipulated, affording independent evaluations of initial allocation and withdrawal of attention. In particular, faster identification of sad versus non-sad targets on target-present trials would indicate facilitation of initial attentional allocation towards sadness. In target-absent trials, increased response times for arrays of sad-face distractors would indicate delayed withdrawal of attention from sadness. On such visual search tasks, depression is not associated with increased facilitation of attention towards sad targets (Karparova, Kersting, & Suslow, 2005; Rinck & Becker, 2005; Suslow et al., 2004). There is some evidence that depression is associated with delayed withdrawal of attention from negative stimuli (Rinck & Becker, 2005), but at least one study failed to replicate this finding (Karparova et al., 2005).

The evidence for delayed withdrawal from sadness on visual search tasks, therefore, is limited to a single study, but this may reflect in part the stimuli used, which were words (Rinck & Becker, 2005) and line drawings of faces (Karparova et al., 2005; Suslow et al., 2004). Pictures are preferable to words for use in tasks assessing top-down influences on attention to emotion, because emotion-relevant pictures are more similar to real-world stimuli and do not require semantic processing (Weierich et al., 2008). Photographs are preferable to drawings of faces, because they may be more ecologically valid and more sensitive to depression-linked differences (e.g., Gotlib, Kasch et al., 2004).

Finally, recent studies have attempted to isolate covert disengagement mechanisms as a means to test the hypothesis of slowed disengagement of attention from sad stimuli in

depressed individuals. Koster and colleagues (Koster et al., 2005; Koster, Leyman, De Raedt, & Crombez, 2006; Koster, De Raedt, Leyman, & De Lissnyder, 2010) used a Posner cueing task to examine covert disengagement in dysphoric individuals. In their version of the task, an emotional word cue was presented on one side of the screen, followed by a target dot in either the same location (50% of the time) or on the opposite side of the screen (50% of the time), and participants reported the location of the dot (i.e., left or right). Koster and colleagues (2005) found no dysphoria-linked differences for sad words with a cue presentation of 250 ms, but a statistical trend for an effect at 500 ms. At the longer stimulus presentation time of 1500 ms, they found evidence of delayed withdrawal of attention from sad words on the cueing task. However, at a presentation time of 1500 ms, the covert-overt distinction is lost, because participants have time to disengage attention from the face and to make an overt eye movement; thus, it is unclear what processes are assessed on this time scale. Koster et al. (2006) reported a failure to replicate depression-linked effects using emotional faces, but Koster et al. (2010) found that dysphoria-linked effects emerged when a 250 ms cue presentation of emotional words was followed by a longer blank (1500 ms rather than 50 ms) prior to the presentation of the target dot. Using a presentation time of 750 ms, Ellenbogen and Schwartzman (2009) found evidence of delayed disengagement from pictures displaying dysphoric themes in clinically depressed individuals. Surprisingly, this finding was not replicated when depressed participants underwent a negative stressor prior to completing the task. These findings suggest that delayed covert disengagement from sadness may be associated with depression, but further investigation is warranted.

Overall, the evidence for depression-linked biases in the allocation of attention to versus withdrawal of attention from sad emotion is equivocal. It is also unclear whether the pattern of findings differs for covert versus overt

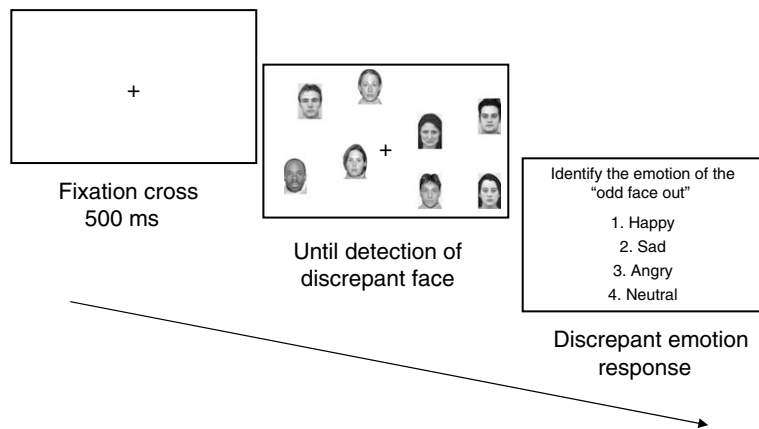


Figure 1. Pictorial representation of visual search task.

allocation of attention. To address these limitations, the present study included two tasks to assess depression-linked attentional biases among clinically depressed and non-depressed individuals. First, we assessed the initial allocation of attention toward and withdrawal of attention from emotional face photographs in a visual-search task, which requires both covert and overt allocation of attention (Figure 1). Second, we assessed covert disengagement in a modified Posner cueing paradigm<sup>2</sup> (Figure 2). Our inclusion of both the search and disengagement tasks allowed for the comparison of withdrawal on the visual search to covert disengagement. We predicted that depression would be associated both with delayed withdrawal from sadness during visual search and with delayed covert disengagement on the disengage task. Because depression-linked biases are thought to be limited to withdrawal processes, we predicted that depression would not be associated with facilitated attention towards sadness on the visual search task.

## METHOD

### Participants

Seventy-four individuals participated in this experiment and were compensated with a payment of thirty US dollars. The sample consisted of 31 men (42%) and 43 women (58%). The age of participants ranged from 18 to 31 with a mean age of 21.4 years ( $SD = 2.9$ ). In terms of race/ethnicity, six participants (8%) identified themselves as Hispanic, 10 (13.5%) as Asian, 10 (13.5%) as African American (non-Hispanic), 1 (1.4%) as a Pacific Islander, 35 (47%) as Caucasian (non-Hispanic), and seven (9.5%) as multiracial. Five participants (6.7%) declined to give racial/ethnic information. There were no significant differences between control and depressed participants in terms of sex or race/ethnicity. There was a significant difference between depressed and control participants in terms of age, such that the depressed group ( $M = 22.3$ ,  $SD = 3.4$ ) was significantly older than the control group ( $M = 20.6$ ,  $SD = 2.2$ ),  $t(72) = 2.5$ ,  $p < .05$ ,  $d = 0.59$ .<sup>3</sup>

<sup>2</sup>We did not examine covert engagement in the current study, because effects of depression on the operation of engagement processes are highly unlikely. While covert disengagement can be influenced by higher order factors, such as semantic relatedness (Stolz, 1996), and trait anxiety (Fox et al., 2001), covert engagement is thought to be “immune to the influences of higher level information” (Stolz, 1996, p. 200). Therefore, we focused on covert disengagement in the current study.

<sup>3</sup>Given the significant difference in age between the two groups, we examined whether statistically controlling for age affected any of the reported results. Entering age into the model did not change any findings. The results reported do not include age as a covariate.

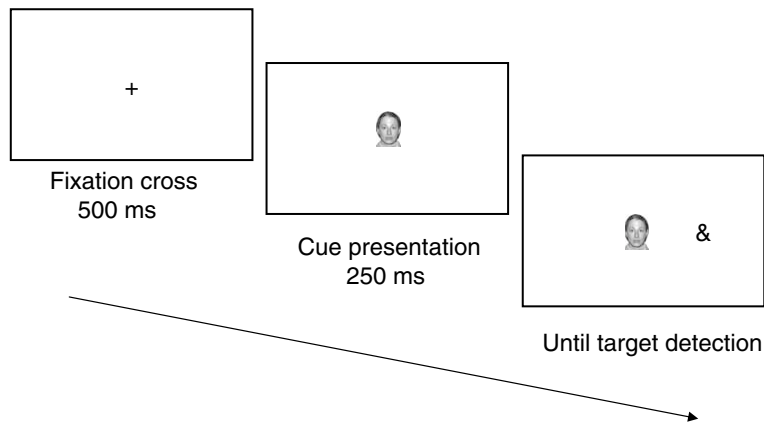


Figure 2. Pictorial representation of disengage task.

### Participant recruitment procedures

Participants were recruited through advertisements posted on the university campus and in the community. We also e-mailed participants from previous experiments in our lab who had expressed interest in future study participation opportunities. Interested participants were asked to complete a pre-screening measure via e-mail. The pre-screener consisted of a modified version of the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996), which included all questions except item 9, assessing suicidal ideation. Using conventional cut-offs (e.g., Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998), individuals who scored below a 9 or above a 16 on the BDI-II were recruited into the study. We further restricted our sample to individuals between the ages of 18 and 31 who reported that they had normal or corrected-to-normal vision. At the time of the experiment, all participants completed the full BDI-II as well as the Major Depression and Dysthymia modules of the Structured Clinical Interview for Diagnosis (First, Spitzer, Gibbon, & Williams, 2002). Of the participants who screened into the study as depressed, only those who met full diagnostic criteria for a current Major Depressive Episode at the time of testing were included in the Currently Depressed group. Of participants who were identified as controls on the pre-screener, only those who had no lifetime

history of either Major Depression or Dysthymia according to the administration of the SCID were included in the Never Depressed Control group. This resulted in a final sample of 39 control and 35 depressed participants. The mean BDI-II score for the control participants was 2.2 ( $SD = 2.4$ ), in the minimal symptom range; the mean score for the depressed participants was 25.5 ( $SD = 8.7$ ), in the moderate symptom range (Beck et al., 1996).

### Overview of cognitive tasks

The order of the visual search (VS) and covert disengage tasks was counterbalanced, and completion of the tasks took approximately 80 minutes. Participants were seated 75 cm from the computer screen, and they rested their chins in a chin rest during the administration of computer tasks. Both tasks were programmed using E-Prime software (Psychology Software Tools, Pittsburgh, PA, 2002) and presented on a 19-inch Dell P991 CRT monitor. Responses were collected by a PST serial response box (Psychology Software Tools, Pittsburgh, PA, 2002).

### Stimuli

A stimulus set was created by selecting pictures from the Karolinska, Ekman, and NIMSTIM sets (Ekman & Friesen, 1976; Lundqvist, Flykt, & Öhman, 1998; Tottenham et al., 2009). All face pictures were black and white, measured 2.54 cm (width) by

6.4 cm (height), and subtended  $3.1^\circ \times 4.6^\circ$  of visual angle. We selected pictures portraying four emotions: happiness, neutrality, anger, and sadness. Stimuli were selected such that photographs of the same actor were available for each of the four emotions. Thus, the same 64 actors portrayed each of the four emotions, resulting in a final stimulus set of 256 pictures. We collected normative data from a sample of undergraduates to ensure that our pictures did clearly present the intended emotions, in the absence of other emotional information. For each stimulus included in our set, at least 30 undergraduates rated how happy, neutral, angry, sad, and fearful the face appeared to them on a scale from 1 to 7, with higher numbers indicating more of the given emotion. Participants rated all 5 emotions for each stimulus, but the stimuli were presented in random order in order to discourage relative ratings of emotion. The stimuli included in our study had mean ratings of greater than 5 for the intended emotion, and less than 3 for each of the other emotions, indicating that our stimuli portrayed the intended emotions effectively.

Our overall picture stimulus set was split into three different sets for testing purposes: one practice set and two experimental sets. We selected the clearest exemplars of the intended emotions for the experimental sets, and selected less desirable pictures for the practice set. The practice picture set included 64 pictures (16 actors displaying each of the four emotions) used only for practice trials during the experiment. Sets A and B were used for the VS and covert disengage tasks, and each consisted of 64 pictures (16 actors displaying each of the four emotions). All participants viewed either set A or B for the first task completed, followed by the other set for the second task completed. The order of picture set presentation was counterbalanced and was fully crossed with task order.

## Procedures

### *Visual search task (VS)*

We selected a VS task for our assessment of initial allocation and withdrawal of attention. We chose this task rather than a free-viewing task because

visual search allows examination of non-strategic allocation of attention. As mentioned in the introduction, free-viewing tasks place few demands upon participants, allowing them to allocate attention freely. On such free-viewing tasks, any biases for negative information could be due either to strategic direction of attention or to relatively automatic processes outside conscious control. VS tasks offer clear task demands encouraging participants to identify the odd face out as quickly as possible. Thus, any depression-linked effects on withdrawal of attention on a visual search task are less likely to be due to strategic influences, because the same speeded strategy is encouraged for all participants. We further minimised the influence of strategic processing by presenting the stimuli in a non-lattice structure in our version of the task, discouraging participants from adopting explicit search strategies such as directing their gaze from top-left to bottom-right.

The VS task presented participants with 192 arrays of eight emotional faces (see Figure 1). In each array, all of the faces displayed the same emotion except for one. Each emotion type (happy, neutral, angry, or sad) was presented in crowds of each other emotion type, creating 12 different combinations (e.g., a single sad face presented in a background of seven neutral faces). Each of the 12 possible combinations was presented a total of 16 times, for a total of 192 arrays, which were presented in random order. In this version of the VS task, a discrepant face was presented on every trial, and participants were instructed to identify the discrepant face, or odd face out, as quickly as possible. This variant of the commonly used VS task increases the number of trials providing informative data regarding initial allocation and withdrawal of attention.

The arrays always consisted of eight different individuals, including four male and four female faces. The specific stimuli used were selected randomly for each trial. The face stimuli appeared within a  $24.8^\circ \times 19.4^\circ$  rectangular region. The position of each face in the array was chosen randomly within this region, with the following constraints. The minimum distance between any two faces was  $5.8^\circ$  (measured from the centre of

each face) and the centre of each face had to be at least  $3.3^\circ$  from the centre of the screen. This latter constraint ensured that no face appeared at fixation when the array appeared. In this task, participants first viewed a fixation cross for 500 ms, followed by an array of faces, which remained on the screen until the participant indicated that s/he had found the odd face out by pressing any button on the response box. Response time was defined as the time from the appearance of the array to the button press. Then the faces disappeared from view and the participant indicated the emotion of the odd face out by pressing one of four buttons on the response box. Accuracy was determined from this response, and the word “incorrect” appeared on the screen following any inaccurate responses. By asking participants first to indicate that they had found the discrepant face, before having to indicate the emotion presented, we were able to distinguish the response time to find the discrepant face from the time needed to execute the button press indicating which of the four emotions was presented. Participants completed 12 practice trials prior to completing 192 experimental trials.

#### *Covert disengage task*

We chose a covert disengagement task designed by Fox and colleagues (2001). For this task, a fixation cross was displayed in the centre of the screen for 500 ms and was replaced by a picture of an emotional face. The face was presented for 250 ms, followed by the appearance of a symbol (& or %), either to the left or the right of the face, 6.84 degrees from the centre of the screen. The symbol and face remained on the screen until response (see Figure 2). The type (% or &) and location (left or right) of the symbol was determined randomly for each trial, with the stipulation that each symbol was presented in each location an equal number of times. Participants were instructed to press one of two buttons identifying the type of symbol presented as quickly as possible. Participants completed 32 practice trials before completing 512 experimental trials.

We chose a basic disengagement task designed by Fox and colleagues (2001), rather than the disengagement paradigm used by Koster and colleagues (2005, 2006, 2010), due to a number of methodological considerations. The stimulus from which attention was to be disengaged was presented at fixation, rather than to the left or right of fixation. This ensured that the participants were attending the relevant stimulus at the beginning of the trial and, due to its foveal presentation, that it was clearly identified. We chose to present the face for 250 ms prior to the presentation of the symbol in order to ensure that participants had sufficient time to process the emotion of the face stimulus before having to disengage attention from it (Calvo & Lundqvist, 2008). Additionally, the face remained visible after symbol onset so that participants would have to disengage attention from a physically present stimulus when they oriented attention to the symbol (see Weierich et al., 2008, for an extended discussion of the design of experiments probing attentional disengagement). Another advantage of this task is that the dependent measure is derived from a discrimination task: participants reported the identity of a target symbol rather than the position of an onset dot. This design feature confers two advantages. First, the discrimination task requires a covert shift of attention away from the emotional face and to the target symbol, because perceptual discriminations among similar stimuli require a focal shift of attention to the stimulus location (e.g., Treisman & Gormican, 1988). Second, the target identity response is not linked to the position of the emotional stimuli, which eliminates the possibility of Simon or motor compatibility effects (which can occur when the target response of left or right overlaps with the left-versus-right location of the presented cue; Kornblum, Hasbroucq, & Osman, 1990; Simon, 1969).

Finally, in order to ensure measurement of covert, rather than overt, disengagement from the face, participants were instructed not to move their eyes from fixation during this task. The experimenter monitored whether participants made any eye movements by viewing a video

monitor connected to a video camera providing a close-up image of the participants' eyes. The experimenter marked trials with eye movements, and gave the participant feedback each time an eye movement was made. This method is used commonly in vision science studies of attention to eliminate saccades and to provide online correction if a saccade is executed. Participants made few eye movements throughout the experimental task ( $M = 12.24$ ,  $SD = 12.19$ ). Trials with eye movements were excluded from the final analyses, resulting in a mean loss of 2.4% of data from the disengage task.

### Data analytic plan

For all cognitive tasks, we excluded practice trials and trials on which the participant provided an incorrect response. Accuracy for both tasks was high, with mean accuracy rates ranging from .87 to .95 on the visual search task, and from .96 to .97 on the covert disengagement task. Following standard practice in vision science for dealing with reaction-time data, we excluded outlying trials on which the participant's RT was 2.5 standard deviations above his or her individual mean RT for that task, which resulted in a loss of less than 3.5% of the data for each of the three tasks. For each task, we examined differences in response time using repeated-measures analysis of variance (ANOVA) with Emotion Type (happy, neutral,

angry, and sad) entered as a within-subjects variable and Depression Status entered as a between-subjects variable.

## RESULTS

Means and standard deviations are presented for response time for each cognitive task (Table 1).

### Order effects

We first examined possible effects of Task Order (VS task followed by covert disengage task, or covert disengage task followed by VS task) and Picture Set Order (picture set A followed by set B, or set B followed by A) on Response Time. We found no significant main effects of either Task Order or Picture Set Order, and no significant interactions of either Task Order or Picture Set Order with Depression Status, on either of the cognitive tasks,  $F_s < 1.5$ ,  $ns$ ,  $\eta_p^2 < .025$ . There were also no significant three-way interactions between Task Order, Depression Status, and Emotion Type or between Picture Set, Depression Status, and Emotion Type for either task,  $F_s < 2.0$ ,  $ns$ ,  $\eta_p^2 < .03$ . Thus, we collapsed across task order and picture set order for all analyses presented below. All statistical tests presented are two-tailed, and alpha levels for all follow-up tests are Bonferroni corrected.

Table 1. Mean response times by group for visual search and disengage tasks

Cognitive task		Group Face type				Average
		Happy	Neutral	Angry	Sad	
VS (Target)	Depressed	3279 (749)	4115 (1027)	4127 (919)	4169 (920)	3922 (859)
	Control	3223 (706)	4151 (1006)	4125 (908)	4261 (916)	3941 (832)
	Average	3250 (722)	4134 (1009)	4126 (907)	4217 (912)	3932 (839)
VS (background)	Depressed	3342 (839)	3705 (916)	4351 (895)	4291 (982)	3922 (859)
	Control	3241 (703)	3760 (893)	4353 (919)	4407 (987)	3941 (832)
	Average	3288 (767)	3734 (898)	4352 (902)	4352 (980)	3932 (839)
Covert disengage	Depressed	548 (93)	555 (102)	554 (96)	552 (93)	552 (95)
	Control	527 (68)	523 (62)	524 (61)	528 (66)	526 (63)
	Average	537 (81)	538 (84)	538 (81)	540 (80)	538 (81)

Note: VS = Visual Search. Mean response times in milliseconds are given for experimental trials, excluding practice trials and trials with incorrect responses. Standard deviations are in parentheses.

## Visual search

No main effect of depression status emerged for response time,  $F(1, 72) < 0.01$ ,  $ns$ ,  $\eta_p^2 < .001$ . On the VS task, both facilitation of attention towards the target emotion (i.e., the discrepant face) and withdrawal of attention from the faces in the “crowd” were assessed.

## Facilitation of attention to target emotion

Facilitation of attention was first examined collapsing across background emotion. A significant effect emerged for Emotion Type of target emotion,  $F(3, 216) = 121.1$ ,  $p < .001$ ,  $\eta_p^2 = .627$ . Bonferroni-corrected follow-up tests revealed that happy targets were identified more quickly than neutral, angry, or sad targets,  $ts(73) > 14$ ,  $ps < .008$ ,  $ds > 1$ . No differences emerged between neutral, angry, or sad targets,  $ts(73) < 2$ ,  $ns$ ,  $ds < 0.1$ . No significant interaction emerged between target Emotion Type and Depression Status,  $F(3, 216) = 0.6$ ,  $ns$ ,  $\eta_p^2 = .008$ . We also examined the effects of target emotion separately for each background emotion type. Four separate repeated-measures ANOVAs were conducted, one for each background emotion type, again with target emotion entered as the within-subjects variable and depression status entered as a between-subjects variable. No interactions between target emotion type and depression status emerged for targets within happy, neutral, angry, or sad backgrounds,  $F_s < 2$ ,  $ns$ ,  $\eta_p^2 < .03$ .

## Withdrawal of attention from background emotion

Withdrawal of attention was first examined collapsing across target emotion. A main effect of Emotion Type emerged,  $F(3, 216) = 168.6$ ,  $p < .001$ ,  $\eta_p^2 = .701$ . Bonferroni-corrected follow-up tests revealed that participants identified targets significantly more quickly within happy than within neutral, angry, or sad backgrounds,  $ts(73) > 8$ ,  $ps < .008$ ,  $ds > 0.5$ , and significantly more quickly within neutral than within angry or sad backgrounds,  $ts(73) > 10$ ,  $ps < .008$ ,  $ds > 0.66$ . Response time did not significantly

differ between angry and sad backgrounds,  $t(73) < 0.01$ ,  $ns$ ,  $d < 0.01$ . No significant interaction emerged between background emotion type and depression status,  $F(3, 216) = 1.3$ ,  $ns$ ,  $\eta_p^2 = .018$ . The effects of background emotion were then examined separately for each target emotion type. No interactions between depression status and background emotion emerged for trials with happy, neutral, angry, or sad targets,  $F_s < 2.5$ ,  $ns$ ,  $\eta_p^2 < .04$ .

## Covert disengagement

No significant effects emerged on the covert disengagement task. No main effects emerged for Depression Status,  $F(1, 72) = 2.02$ ,  $ns$ ,  $\eta_p^2 = .027$ , or Emotion Type,  $F(3, 216) = 0.4$ ,  $ns$ ,  $\eta_p^2 = .006$ . The interaction between Depression Status and Emotion Type was not statistically significant,  $F(3, 216) = 2.5$ ,  $ns$ ,  $\eta_p^2 = .033$ .

## DISCUSSION

In this study, we evaluated attentional biases to emotional faces in depressed and non-depressed individuals. We examined initial allocation and withdrawal of attention requiring overt eye movements in a visual-search paradigm. And we examined the covert process of disengagement of attention in a modified Posner cueing paradigm. The design and implementation of the visual-search and covert-disengagement paradigms were optimised for isolating and understanding attentional processes. Consistent with previous research, we found no evidence of facilitated initial allocation of attention towards sad targets among depressed participants on the visual search task. Contrary to predictions, we also found no evidence of slowed withdrawal or delayed covert disengagement from sadness among depressed participants.

We found no evidence of depression-linked delayed withdrawal of attention from sadness, or facilitated withdrawal from happiness, on the visual search task. This study extends existing literature by using photographs of emotional faces, rather than schematic drawings, which

may provide a more ecologically valid evaluation of the role of withdrawal processes in depression. The choice of face stimuli is also one possible explanation for our failure to find depression-linked effects. The one study that did find evidence of delayed withdrawal of attention from sadness used word stimuli (Rinck & Becker, 2005), whereas studies using schematic faces have not found depression-linked differences in withdrawal from sadness (Karparova et al., 2005; Suslow et al., 2004). This conclusion remains speculative, however, because only one study using word stimuli has found this effect, and because photographs of emotional faces tend to be consistently associated with depression-linked effects on other attention tasks, such as the dot probe (e.g., Gotlib, Kasch et al., 2004).

Interestingly, prior research using free-viewing tasks has demonstrated that depression is associated with longer fixations on sad material and sometimes with shorter fixations on happy material (Caseras et al., 2007; Eizenman et al., 2003; Kellough et al., 2008; Mathews & Antez, 1992). These findings cannot be interpreted unequivocally as reflecting depression-altered attentional withdrawal processes, however, because free-viewing tasks do not place demands on participants' attentional patterns, and several other non-attentional processes are known to influence fixation duration. Thus, it is possible that depressed participants linger on sad information in the absence of clear task demands to do otherwise, potentially secondary to the operation of non-attentional processes, but are able to withdraw attention from sad information quickly when the task requires doing so, such as during visual search.

Contrary to our predictions, we found no evidence that depressed persons show delayed covert disengagement from sadness. The lack of a disengagement effect was observed despite the fact that the disengage paradigm was optimised for observing such an effect: Photographic face stimuli directly exhibited clear examples of each emotion; each face was presented foveally to ensure efficient emotion identification; the target discrimination task required a covert shift of attention away from the

face, unlike detection of the location of a dot, which does not require shifting of attention; the face remained visible after target onset so that participants had to disengage attention from a stimulus that continued to be physically present; and eye movements were controlled to isolate covert orienting. It is possible that our disengagement results may be related to the short face presentation time of 250 ms used in this study, which we selected in order to ensure that we isolated covert disengagement. Some evidence suggests that depression-linked disengagement effects occur only on a longer time scale (Koster et al., 2005). In our task, unlike previous studies, attention was directed to the emotional stimulus from the very beginning of the trial (as it was presented foveally). There was no requirement in our study for participants to shift attention toward an emotional stimulus and then away from that stimulus. Thus, direct comparison of presentation times in our task to times used by Koster and colleagues is difficult. In addition, covert disengagement occurs on a very fast time scale, and should certainly be evident by 250 ms (Weierich et al., 2008). If depression is only associated with biases on such tasks at longer presentation times, processes other than covert disengagement might be implicated. Another consideration is that participants were explicitly instructed not to make eye movements in our version of the disengage task. This design consideration had the advantage of isolating covert processes. However, because previous studies did not include this requirement, our constriction of eye movements could explain the difference between our results and previous findings.

It is important to note the limitations of this study. The sample size was relatively small, thus reducing statistical power to detect small effects. We also did not assess the presence of anxiety disorders. Because anxiety disorders and depression are highly comorbid, depression-linked findings may be driven by symptoms of anxiety rather than depression. It would be useful in future research to compare the role of anxiety and depression in withdrawal processes. Including multiple presentation times on the disengage task would allow us to examine whether depression-linked biases emerge at longer presentation

times. Tracking eye movements during the visual search task also would provide additional indices of facilitation and withdrawal of attention based on fixation frequency and duration. Another potential limitation of the current visual-search paradigm is that we included only target-present trials. This could complicate interpretation of withdrawal findings, because performance as a function of background emotion potentially reflects not only withdrawal of attention but also initial allocation of attention. In future work, inclusion of both target-present and target-absent trials would be helpful to clarify interpretation of any withdrawal findings. Another potential limitation is our use of complicated photographic stimuli, which reduces the ability to control small perceptual differences between stimuli. We used photographs of the same individuals posing with each of the four emotion types, in order to reduce perceptual differences across emotion type as much as possible. We also included multiple stimuli for each emotion type in order to reduce confounding effects of any particular photograph. Photographic stimuli also have the advantage of being more ecologically valid than line drawings of faces. Finally, researchers have recently found that threatening stimuli lead to a slowing of behavioural responses, independent of attentional processes (Mogg, Holmes, Garner, & Bradley, 2008). This complicates interpretation of findings of slowed withdrawal or disengagement from threatening stimuli, such as the angry faces used in the present study, which could be due either to disengagement or slowing of motor response.

In general, we found no evidence to support the theory that depression is related to withdrawal from rather than facilitation of attention to emotion. We found no evidence that depression was related to the speed of withdrawal of attention from sad faces, and no evidence of delayed covert disengagement from sad faces among depressed participants. Future research examining withdrawal of attention in depression, particularly carefully controlled studies distinguishing between overt and covert attentional processes, is indicated. The possible role of task demands in overt attention allocation to emotion and

the time scale of covert disengagement are topics of particular importance.

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