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# Temporal changes in attention to sad and happy faces distinguish currently and remitted depressed individuals from never depressed individuals



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## ABSTRACT

Depression is associated with attentional biases for emotional information that are proposed to reflect stable vulnerability factors for the development and recurrence of depression. A key question for researchers is whether those who have recovered from depression also exhibit attentional biases, and if so, how similar these biases are to those who are currently depressed. To address this question, the present study examined attention to emotional faces in remitted depressed ( $N=26$ ), currently depressed ( $N=16$ ), and never depressed ( $N=33$ ) individuals. Participants viewed sets of four face images (happy, sad, threatening, and neutral) while their eye movements were tracked throughout an 8-s presentation. Like currently depressed participants, remitted depressed participants attended to sad faces significantly more than never depressed participants and attended to happy faces significantly less. Analyzing temporal changes in attention revealed that currently and remitted depressed participants did not reduce their attention to sad faces over the 8-s presentation, unlike never depressed participants. In contrast, remitted depressed participants attended to happy faces similarly to never depressed participants, increasing their attention to happy faces over the 8-s presentation. The implications for cognitive theories of depression and depression vulnerability are discussed.

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## 1. Temporal changes in attention to sad and happy faces distinguish currently and remitted depressed individuals from never depressed individuals

Cognitive theories of depression propose that biased attention to emotional information is an important risk factor associated with the onset, maintenance, and recurrence of depression (Beck, 1987; Beck and Clark, 1988; Gotlib and Joormann, 2010). Two distinct manifestations of biased attention in depressed individuals have been identified (Peckham et al., 2010; Yiend, 2010; Armstrong and Olatunji, 2012). The first is increased attention to depression-relevant themes and stimuli (e.g., negatively valenced words; images related to sadness) relative to never depressed individuals, which is often referred to as a negative attentional bias. The second is decreased attention to positive stimuli (e.g., positively valenced words and images) relative to never depressed individuals. Attentional biases are proposed to be stable, trait-like characteristics, rather than a transient state-like symptom of

depression (e.g., Beck and Clark, 1988; DeRaedt and Koster, 2010; Gotlib and Joormann 2010; Ingram et al., 2008; Koster et al. 2011), and cognitive theories predict that these biases will be present in both currently and remitted depressed individuals. The evidence for these biases in remitted depressed individuals has been mixed, however, and not all researchers agree that attentional biases should be stable (e.g., Just et al., 2001; Mathews and MacLeod, 2005; Scher et al., 2005). One purpose of the present study was to determine if remitted depressed individuals exhibit biased attention to emotional information similar to currently depressed individuals in an eye gaze tracking paradigm known to be especially effective for measuring biased attention (see Armstrong and Olatunji, 2012). In addition, we examined changes in attention over time to determine if remitted and currently depressed individuals differed in their temporal profiles of attention to emotional information.

### 1.1. Attentional biases in currently and remitted depressed individuals

The majority of studies examining depression-related attention biases have focused on currently depressed or dysphoric

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individuals. Researchers have used several tasks to examine attentional biases in these populations, including the dot-probe task (e.g., Joormann and Gotlib, 2007; Joormann et al., 2007; see Peckham et al., 2010, for a review), the emotional Stroop task (see Epp et al., 2012, for a review), the dichotic listening task (e.g., Ingram et al., 2008), visual search tasks (e.g., Wenzlaff et al., 2001), and the deployment of attention task (e.g., McCabe et al., 2000). Although a great deal has been learned about attention in depression using these tasks, most of these tasks use response latencies to infer attentional engagement and are therefore not direct and objective measures of attention (see Yiend, 2010, for a review). Several studies have used eye gaze tracking paradigms to examine attention to emotional images or words in depressed individuals (see Armstrong and Olatunji, 2012, for a review). The major advantage of eye gaze tracking is that it provides a direct and moment-by-moment record of the allocation of attention, because the direction of gaze and the focus of attention are tightly coupled (Wright and Ward, 2008). An additional advantage is that the allocation of attention can be measured over extended intervals, as opposed to the single “snapshot” of attention captured in other attention tasks. This ability to measure changes in attention over time was an important feature of the present study.

A meta-analysis of studies that used eye tracking to assess attention to emotion in currently depressed and dysphoric individuals found evidence of both increased attentional engagement with negative stimuli and decreased engagement with positive stimuli, relative to never depressed individuals (Armstrong and Olatunji, 2012). In contrast to the threat-related attentional bias consistently observed for anxious individuals (Bar-Haim et al., 2007), the bias for negative stimuli for depressed individuals was specific to dysphoric stimuli (i.e., words and images involving themes of sadness or loss) and was not present for threatening stimuli (Armstrong and Olatunji, 2012). For example, Eizenman et al. (2003) used an eye gaze tracking paradigm to compare currently and never depressed individuals' attention to emotional images. Displays of four images (a neutral image, dysphoric image, threatening image, and positive/social image) were presented for 10.5 s while participants' eye movements were tracked and recorded. Eizenman et al. found that depressed participants attended to dysphoric images significantly more than never depressed participants, with no differences for threatening images. In a similar study, with displays of 30 s, Kellough et al. (2008) also found that depressed participants attended to dysphoric images significantly more than never depressed participants (with no differences for threatening images). They also found that depressed participants attended to positive images less than never depressed participants. Similar results were reported by Sears et al. (2010) and Arndt et al. (2014), who compared dysphoric and never depressed participants' attention to positive and negative images. Leyman et al. (2011) compared dysphoric and never depressed participants' attention to happy, sad, angry, and neutral face images and found that dysphoric participants attended to sad faces significantly more than never depressed participants and attended to happy faces significantly less. Note that in none of the studies comparing dysphoric and never depressed individuals were there group differences in attention to threatening stimuli, which further demonstrates the specificity of the negative bias to dysphoric content.

In contrast to the generally consistent findings of eye tracking studies of currently depressed and dysphoric individuals, few studies have used this methodology to examine attention to emotion in remitted depressed individuals, and the results of these studies have not been consistent. Two studies found evidence of attentional biases among remitted depressed participants, although the nature of the bias differed somewhat in the two studies. Sears et al. (2011) showed participants sets of depression-

related, anxiety-related, positive, and neutral images and found that both dysphoric and remitted depressed participants attended to positive images significantly less than never depressed participants. They also found that remitted depressed participants attended to threat-related images significantly more than never depressed participants. Newman and Sears (2015) used a similar methodology and found that remitted depressed participants attended to depression-related images significantly more than never depressed participants (with a trend toward the opposite difference for positive images).

Very different results were reported by Isaac et al. (2014), who showed currently depressed, remitted depressed, and never depressed participants sets of four faces, with angry, sad, neutral, and happy expressions—they found no evidence of emotion-specific attentional biases among remitted depressed participants. Currently and remitted depressed participants attended to all face types more than never depressed participants, but did not show specific biases in overall fixation time to sad or happy expressions. Isaac et al. did find that currently depressed participants had shorter glance durations to happy faces than never depressed participants, whereas the remitted and never depressed participants did not differ. Their results were interpreted as a possible indication that successful treatment of depression may ameliorate reduced processing of positive stimuli. Thus, despite the advantages of eye gaze tracking for measuring biased attention, the results of these studies indicate that there is no consensus at present as to whether the attentional biases characteristic of current depression persist or ameliorate upon remission of a depressive episode. Given the small number of eye tracking studies that have examined attentional biases in remitted depressed individuals, the present study contributes significantly to the literature on attention in remitted depression.

## 1.2. Time course of attention to emotional stimuli in depression

Another important question for depression researchers concerns the temporal pattern of attention to emotion in depression: how does attention to emotional stimuli change over time and do these temporal changes differ among currently depressed, remitted depressed, and never depressed individuals? The answers to these questions will lead to a better understanding of the nature of attentional biases in depression, which aspects of attention to emotion are most relevant for depression vulnerability, and how attentional biases may be effectively altered. In their review of the literature on depression-related attentional biases, Mogg and Bradley (2005) suggested that the biases operate at later, more elaborative stages of stimulus processing. This was based on their observation that studies that employed longer stimulus durations (e.g., 1000 ms) in response latency paradigms such as the dot probe and emotional Stroop task were more likely to observe attentional biases than studies with shorter stimulus durations (e.g., 14–500 ms; Mogg and Bradley, 2005). This would suggest that in contrast to the exogenous capture of attention by threatening stimuli observed with anxious individuals (e.g., Bar-Haim et al., 2007), the bias in depression may be a more controlled and motivated process (Mogg and Bradley, 2005). On the other hand, a subsequent meta-analysis of biased attention in depression found no difference in effect sizes for studies that used stimulus presentations greater than 1000 ms and those that used 500 ms presentations (Peckham et al., 2010).

A major advantage of eye tracking paradigms is that the focus of attention can be tracked continuously over extended periods of viewing, which makes these paradigms optimally suited for examining temporal changes in attention. Surprisingly, only two eye tracking studies have examined temporal changes in attention to emotional stimuli in depressed/dysphoric individuals and never

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