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The role of rumination, attentional biases and stress in psychological distress

Rebecca Morrison and Rory C. O'Connor
Department of Psychology, University of Stirling, UK

This experimental study examines the relationship between rumination and attentional bias. Additionally, the study aims to determine, within a diathesis-stress framework, whether rumination or attentional bias (or both) can prospectively predict psychological distress. Eighty-one participants completed selected measures of rumination and psychological distress at time one, in addition to experimental manipulations of rumination and mood, and measures of mood and attentional bias at time two. Seventy-three participants (90% follow-up) completed final measures of stress and psychological distress approximately 3 weeks later. In combination with negative mood, inducing rumination decreased positive attentional bias, whilst inducing distraction increased positive attentional bias. Rumination and stress interacted to predict change in psychological distress. Negative attentional bias showed a trend towards interacting with rumination and stress to predict dysphoria. The findings supported the proposed diathesis-stress models. In addition, a causal relationship between rumination and positive attentional bias has been empirically established for the first time.

Cognitive theory (Beck, Rush, Shaw & Emery, 1979) posits that certain cognitive vulnerabilities, when 'activated' by stressful or negative life-events, result in psychological distress and diathesis-stress models are often used to illustrate these relationships. There are numerous cognitive vulnerabilities reported in the literature, however, the present research focuses on two specific vulnerabilities, rumination and attentional bias, as both of these have been linked to distress and to each other theoretically (e.g. Bradley, Mogg, & Lee, 1997; Mogg & Bradley, 2005; Beevers & Carver, 2003). Psychological distress can be defined in a number of ways. However, in the current research, it is operationalized as dysphoria, hopelessness and suicidal thinking for the following reasons. High levels of suicidal thinking are currently reported within the UK general population, with one in 38 females and one in 50 males reporting suicidal thoughts each year (Gunnell, Harbord, Singleton, Jenkins & Lewis, 2004). Within the 16–24 years age group, the incidence is even higher (Gunnell *et al.*, 2004)

illustrating the importance of examining potentially related cognitive constructs within a young adult population. As dysphoria and hopelessness are proximal predictors of suicidal thinking (O'Connor & Sheehy, 2000; O'Connor & O'Connor, 2003), examining cognitive constructs associated with these measures of distress may also yield important results.

Attentional bias and distress

Attentional bias can be thought of as a change in the orientation of an individual's attention resulting in the awareness of a specific feature of their environment (Williams, Watts, MacLeod & Mathews, 1988). This change may be conscious, but is more commonly unconscious (Williams *et al.*, 1988). Attentional bias can be measured in a number of ways, including the dot-probe (MacLeod, Mathews & Tata, 1986) and the emotional Stroop tasks (Stroop, 1935).

Attentional bias has been shown to be related to a number of types of distress. For example, attentional bias towards negative stimuli has been found in depressed individuals in some studies (e.g. Beevers & Carver, 2003), but not in others (e.g. MacLeod *et al.*, 1986). Bradley *et al.* (1997) surmise that attentional biases towards negative information are more commonly associated with depression in studies where stimuli are presented for longer durations (500–1000 milliseconds). There is also some evidence to suggest that depressed individuals lack the positive attentional biases displayed by matched controls (Gotlib, McLachlan & Katz, 1988; McCabe & Gotlib, 1995; Suslow, Junghanns & Arolt, 2001).

Attentional biases have also been implicated in suicidal behaviour (Williams & Broadbent, 1986; Becker, Strohbach & Rinck, 1999), but not hopelessness (Becker *et al.*, 1999). However, these findings are limited as the few existing studies used the emotional Stroop, a modified version of the Stroop task (Stroop, 1935), to measure attentional bias (e.g. Williams & Broadbent, 1986; Becker *et al.*, 1999). The emotional Stroop requires participants to read aloud the colour of the ink that emotional words are printed in. Participants are timed on this task and longer timings are thought to represent increased attentional bias. There are, however, two main limitations of research using this method. First, the emotional Stroop is unable to provide any information on the mechanisms of biases measured (e.g. whether interference in the colour naming of words results from attending to negative words or cognitive efforts to suppress negative words – both situations would increase trial lengths; de Ruiter & Brosschot, 1994). Second, the emotional Stroop does not allow a direct comparison of patterns of attentional bias for different stimuli (e.g. larger attentional biases towards negative, in comparison to positive words may result from a bias to attend to negative words, or to suppress negative words). A dot-probe measure (MacLeod *et al.*, 1986) of attentional bias can overcome these weaknesses. Unlike the Stroop, the dot-probe task measures selective attention, two different types of stimuli are presented simultaneously (e.g. negative and positive words) and differing patterns of attention to these stimuli are calculated. Therefore, a re-examination of the relationship between both suicidal ideation and hopelessness and attentional bias, using a more robust measure of attentional bias, is required.

Cognitive theory predicts that the interaction between stress and cognitive vulnerabilities results in future distress. However, much attentional bias research examines the relationship between attentional bias and previous or current ratings of distress (Just, Abramson & Alloy, 2001), meaning that the predictions of cognitive theory

cannot be directly tested. One of the few studies to examine this potential interaction found that increased attentional bias towards negative stimuli, following a negative mood induction procedure, interacted with stress to predict dysphoria at a 7-week follow-up (Beevers & Carver, 2003). Whether this relationship between attentional bias and stress is also predictive of other types of distress remains largely unexplored and is one of the foci of the present study.

Ruminative response style and distress

Similar to attentional bias, a ruminative response style is another cognitive vulnerability linked to distress (O'Connor, O'Connor & Marshall, 2007). A ruminative response style[1] can be thought of as a series of thoughts and behaviours, occurring in response to a sad or negative mood, which result in an individual focusing on the causes and consequences of their emotions, leaving them unable to focus on distracting activities which may alleviate their symptoms (Nolen-Hoeksema, 1991). As a consequence, this perseverative self-focus plays an important role in the maintenance of depression, whereby the process of focusing on depressive symptoms serves to enhance and prolong these symptoms. Indeed, initial levels of rumination have been associated with the maintenance of depressive symptoms after 1 year (Nolen-Hoeksema, McBride & Larson, 1997). A small number of studies have also examined the relationship between a ruminative response style and other types of distress. Specifically, rumination has been cross-sectionally linked with hopelessness (Lam, Schuck, Smith, Farmer & Checkley, 2003) and suicide ideation (Eshun, 2000).

In addition to maintaining distress, ruminative thinking has also been associated with a range of negative thinking styles. Experimental research has shown that participants induced to ruminate were more likely to provide negative explanations for imaginary life-events or interpersonal difficulties, than those in a distraction condition (Lyubomirsky & Nolen-Hoeksema, 1995). In addition, participants induced to ruminate were gloomier about future positive events than those in a distraction condition (Lyubomirsky & Nolen-Hoeksema, 1995). Further experimental work has illustrated that dysphoric participants undergoing a rumination induction recalled more negative autobiographical memories, both in free recall and following prompts, than dysphoric participants undergoing a distraction induction (Lyubomirsky, Caldwell & Nolen-Hoeksema, 1998).

Relationship between rumination and attentional bias

A relationship between rumination and attentional bias has been suggested by some authors (e.g. Bradley *et al.*, 1997; Mogg & Bradley, 2005). Rumination is thought to amplify the effects of negative mood on cognition (Nolen-Hoeksema, 2004). As such, rumination can be seen as symptomatic of more general biases in information processing, such that the accessibility and salience of negative information is heightened (e.g. Lyubomirsky & Nolen-Hoeksema, 1995; Lyubomirsky *et al.*, 1998) and disengaging from negative information is difficult. In addition, there is some evidence that ruminators have difficulty in accessing positive information

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[1] *The terms ruminative response style and rumination are used interchangeably in the literature, so we have adopted the same protocol here.*

(e.g. Lyubomirsky & Nolen-Hoeksema, 1995). These processes provide possible mechanisms to explain a relationship between rumination and attentional biases.

However, a paucity of experimental research has examined the nature of the relationship between these two variables. We are aware of only one study, Williams & Broadbent (1986), which reported a significant positive correlation between rumination and attentional bias for negative stimuli. However, rumination was measured using one item where participants indicated 'how ruminating they felt themselves to be (ruminating was defined as thoughts churning over and over in your mind)' (Williams & Broadbent, 1986, p. 103) and attentional bias was measured using an emotional Stroop task. It is, therefore, necessary to replicate this research using a psychometrically sound measure of rumination and a more robust measure of attentional bias. In order to examine the possibility of causality between rumination and attentional bias, an experimental manipulation of rumination is required. Nolen-Hoeksema and Morrow (1993) have developed a rumination manipulation procedure which allowed for causation between rumination and attentional bias to be examined in the present research. In addition, as the effects of rumination/distraction inductions appear to vary by mood (e.g. Lyubomirsky & Nolen-Hoeksema, 1995), an experimental mood manipulation was also employed.

Aims

In short, two limitations in the current literature were apparent. First, much of the literature to date has failed to utilize a prospective study design to provide a more rigorous test of the diathesis-stress hypothesis. Second, previous research examining the relationship between rumination and attentional bias has not used a psychometrically robust measure of rumination nor directly examined whether this relationship is causal.

Consequently, this research had two main aims intended to address these limitations. The first aim was to explore the nature of the relationship between rumination and attentional bias. In this study, we tested one possible relationship that *change* in rumination would lead to *change* in attentional bias. Specifically, we hypothesized that participants in the negative mood manipulation condition undergoing a rumination induction would increase in negative attentional bias and decrease in positive attentional bias from pre- to post-manipulations. The second aim was to examine whether rumination or attentional bias (or both) could differentially predict distress (i.e. dysphoria, hopelessness and suicide ideation) prospectively within a diathesis-stress framework, after controlling for initial levels of distress.

Method

Participants

Eighty-one healthy young adults were recruited from a Scottish University. Participants were student volunteers recruited via an on-line experiment management system and they were offered course credit in return for participation. All participants were first informed that participation was voluntary and confidential and even after giving initial consent, they were free to withdraw at any stage. Participants were aged between 16 and 48 years with a mean age of 22.09 years ($SD = 6.25$). In total, 58 females and 23 males participated in the study. The majority of participants were not married (91.4%).

The 81 participants who completed the initial self-report measures attended an experimental session between 2 and 20 days later with a median gap of 4 days (time two). Two different manipulations, each with two conditions, mood (negative or positive) and rumination (rumination or distraction), were employed at the experimental session. Participants were randomly assigned to one of four experimental groups (termed negative rumination, positive rumination, negative distraction and positive distraction) covering each permutation of the aforementioned manipulations.

Seventy-three of the original participants went on to complete the final self-report measures at time three, between 14 and 53 days after the experimental session (median gap = 22 days), representing a 90.1% response rate at time three. Participants not completing time three measures did not differ from those who did with regards to age or marital status. However, proportionately more males ($N = 6$) than females ($N = 2$) did not complete time three measures ($\chi^2 = 9.48\,(1)$, $p < .05$) than those who did.

Measures

Rumination

The Response Styles Questionnaire (Short Form) (Short RSQ: Davis & Nolen-Hoeksema, 2000) provided a measure of participants' ruminative tendencies in negative situations (e.g. 'I think about a recent situation, wishing it had gone better'). This 10-item measure has been derived from the original Response Styles Questionnaire. It is preferable to the original measure as it omits a number of items which may reflect 'automatic negative thoughts' (Nolen-Hoeksema, personal communication). Participants were asked to rate each item on a 4-point scale according to the frequency with which they react in this manner when 'sad, down or depressed'. Higher scores reflect a greater ruminative response style in negative situations. The scale has demonstrated significant test–retest reliability over 1 year ($r = .47$, $p < .01$) and construct validity (Just & Alloy, 1997; Nolen-Hoeksema and Morrow, 1991). Internal consistency in this sample was good (Cronbach's $\alpha = .86$).

Hopelessness

The Beck Hopelessness Scale (BHS; Beck, Weissman, Lester & Trexler, 1974) measures pessimism towards the future (e.g. 'It's very unlikely that I will get any real satisfaction in the future'). This 20-item scale asked participants to indicate their agreement or disagreement with each item. Higher scores indicate greater levels of hopelessness. Satisfactory internal consistency was achieved in this sample ($\alpha = .85$ at both administrations).

Dysphoria

The Centre for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977) provided a measure of dysphoria (e.g. 'I felt that I was just as good as other people'). This measured the frequency with which participants experienced depressive symptoms over the past week on a 4-point scale. The CES-D has been established as an appropriate measure to use with a student population (Radloff, 1989). Higher scores on this measure are indicative of increased dysphoria. Internal consistency in this sample was good across each time point (range of $\alpha = .92$–.93).

Suicidal thinking

The Suicide Probability Scale (SPS; Cull & Gill, 1988) provided an 8-item measure of suicidal ideation (e.g. 'In order to punish others, I think of suicide'). Participants were asked to rate how frequently they experienced particular thoughts or feelings in the past week on a 4-point scale. Higher scores on this measure suggest more suicidal ideation. Internal consistency in this sample was good (range $\alpha = .91 - .92$). This measure of suicidal ideation was selected because as well as being predictive of suicide risk (e.g. Larzelere, Smith, Batenhorst & Kelly, 1996; Witte, Fitzpatrick, Joiner, Bradley & Schmidt, 2005), it has demonstrated sensitivity to changes in suicidality (e.g. Rudd, Rajab, Orman, Stulman, Joiner & Dixon, 1996).

Stress

The Perceived Stress Scale (PSS; Cohen, Kamarck & Mermelstein, 1983) is a 14-item measure of global stress (e.g. 'How often have you felt nervous and stressed?'). Participants indicate how they have been feeling over the past 2 weeks on a 4-point scale. Higher scores indicate greater levels of perceived global stress. Internal consistency in this sample was satisfactory (Cronbach's $\alpha = .86$).

Mood

A 10 cm visual analogue scale, anchored at sad and happy, provided a measure of participants' mood. An additional measure of mood was provided by the Profile of Mood States (POMS; McNair, Lorr and Droppleman, 1971). The POMS required participants to rate a series of 65 adjectives on a 5-point scale in accordance with their current feelings. Greater scores are indicative of increased mood disturbance. Internal consistency was confirmed in this sample (range $\alpha = .94 - .95$)

Attentional bias

A dot-probe task was used to provide a measure of attentional bias. The specifics of the dot-probe task used here reflect those of Beevers and Carver (2003). Thus, two words, 3 cm apart were presented on the centre of a computer screen simultaneously for 750 milliseconds. After a 200 millisecond pause, a probe appeared on the screen in the same location as one of the previous words. Participants pressed one of two keys on the keyboard, as quickly as possible, to indicate the location of the probe. The entire task took approximately 4 minutes to complete. Reaction times were recorded and faster reaction times were thought to indicate that the participant was attending to the word in the same spatial location as the probe.

Following Beevers and Carver (2003), 32 word pairs were presented for each participant. Each pairing was randomly assigned one negative and one positive word; the pairs were then displayed in a random sequence. The valence of the word preceding the probe was counterbalanced across trials. Baseline reaction time was measured at the start of the task by eight trials where participants were presented with pairs of 'XXXXX's rather than words. Participants then completed 16 practice trials with neutral word pairs before starting the experimental phase of the task, using valenced words.

Again, following Beevers and Carver (2003), the words used in this task were selected from a standardized list created by John (1988) ensuring the positive and negative words used were comparable in terms of length, frequency of usage and 'emotionality'. The stimuli and procedure remained the same for the second

administration of the task; however, the randomized nature of presentation meant the order in which word pairings occurred varied.

Rumination and distraction manipulations

Both the rumination and distraction manipulations were based on procedures developed by Nolen-Hoeksema and Morrow (1993), adapted by Lavender and Watkins (2004) for use with UK participants. Participants were asked to visualize, focus and concentrate on a series of 45 items in an 8-minute self-paced task. In the rumination condition, these items related to either symptoms, emotions or the self (e.g. 'Think about: the physical sensations you feel in your body'). In the distraction condition, each item was focused externally away from the self and was unconnected to feelings or symptoms (e.g. 'Think about: raindrops sliding down a window pane').

Positive and negative mood manipulations

The mood induction task followed Moore and Oaksford's (2002) procedure where an adaptation of the Velten mood induction procedure (Velten, 1968) was combined with music and a specific request to participants to try to alter their mood state. In the positive condition, music consisted of Mozart's Einekleine Nachtmusik, alongside statements including 'I have complete confidence in myself'. In the negative condition, statements such as 'Just when I think things are going to get better, something else goes wrong' were accompanied by Barber's Adagio for Strings.

Procedure

Prior to the collection of any data, ethical approval was obtained from the University Psychology Department's ethics committee. At time one (T1), participants were asked to complete self-report measures of rumination, dysphoria, hopelessness and suicidal thinking. All participants then attended a laboratory-based session approximately 4 days later (T2). At this laboratory -based session, participants completed a dot-probe task, to provide a baseline measure of attentional bias. Participants were randomly allocated to one of four manipulation groups and these groups were not matched on any of the baseline measures. Participants then rated their current mood before completing the appropriate manipulation procedures. The order of the manipulation procedures was counterbalanced. Following the manipulations, participants re-rated their mood and completed an additional dot-probe task. At the final time point (T3; approximately 3 weeks later), participants were asked to re-complete self-report measures of dysphoria, hopelessness, suicidal thinking and stress.

Results

Effect of manipulations on mood

In order to examine the effect of the manipulations on mood, repeated measures ANOVAs were conducted to examine differences in both the Profile of Mood States (POMS) and visual analogue scores, pre- and post-inductions, between groups. No significant differences on POMS scores were present prior to manipulations. Analysis of the POMS total mood disturbance scores pre- and post-manipulations showed a significant manipulation group $\times$ time interaction ($F(3, 77) = 15.84, p < .001$; Table 1).

Table 1. Mood scores and standard deviations from pre- to post-manipulations by group

Measure	Manipulation group	Pre-manipulation mean (SD)	Post-manipulation mean (SD)
POMS total mood disturbance	Negative rumination	38.90 (38.70)	60.14 (32.70)
	Negative distraction	33.80 (35.03)	36.15 (33.53)
	Positive rumination	27.50 (34.00)	8.40 (20.12)
	Positive distraction	30.25 (33.07)	2.05 (24.91)
Visual analogue scale	Negative rumination	75.52 (12.40)	54.38 (12.93)
	Negative distraction	73.40 (15.78)	55.75 (17.99)
	Positive rumination	79.20 (12.25)	83.45 (9.28)
	Positive distraction	69.65 (11.97)	80.70 (14.18)

Further exploration of this interaction using paired t tests illustrated that the negative rumination group significantly increased in mood disturbance ($t(20) = -2.93, p < .01$) from pre- to post-manipulations. In contrast, the positive rumination ($t(19) = 3.37, p < .001$) and the positive distraction ($t(19) = 6.78, p < .001$) groups decreased in mood disturbance from pre- to post-manipulations. No change in mood disturbance was observed in the negative distraction group from pre- to post-manipulations.

Analysis of the visual analogue scales pre- and post-manipulations showed a significant manipulation group × time interaction ($F(3, 77) = 52.24, p < .001$; Table 1). Further exploration of this interaction using paired t tests illustrated that the negative rumination ($t(20) = 7.75, p < .001$) and negative distraction ($t(19) = 8.99, p < .001$) groups significantly decreased in visual analogue scale (VAS) scores from pre- to post-manipulations. In contrast, the positive distraction group ($t(19) = -6.07, p < .001$) significantly increased in VAS scores from pre- to post-manipulations. Although there was an increase in VAS scores from pre- to post-manipulations for the positive rumination group, this failed to reach significance ($t(19) = -1.99$, ns).

Change in attentional bias

Prior to calculating change in attentional bias, consistent with other studies in the field (e.g. Beevers & Carver, 2003; Bradley *et al.*, 1997), all incorrect responses along with very fast (less than 200 milliseconds) and very slow (more than 2000 milliseconds) responses were identified and excluded from all subsequent analyses. This excluded data accounted for 1.89% of total responses, comparable to other research in this area (e.g. Beevers & Carver, 2003).

In order to calculate change in attentional bias from pre- to post-induction, a standardized change score (Judd & Kenny, 1981) was computed. Unlike raw change scores, standardized change scores have the advantage of controlling for differences in variance in pre- to post-manipulation scores (Campbell & Kenny, 1999). Following Beevers and Carver (2003), change in reaction time was calculated separately for negative, positive and baseline stimuli using the following equation:

$$\text{Change in Dotprobe} = \text{Mean Score Dotprobe T2} - (\text{Mean Score Dotprobe T1}$$

$$\times \text{SD T2 Dotprobe/SD T1 Dotprobe})$$

As the standardized change scores were mean centred, positive scores represent increased reaction time, meaning decreased attentional bias. On the other hand, negative scores reflect a decrease in reaction time and therefore increased attentional bias.

Correlations between variables

As can be seen from Table 2, rumination was significantly positively correlated with each measure of distress at T1 and T3, as well as stress (range of $r = .47 - .78$). However, rumination was not significantly correlated with either change in positive or negative attentional bias.[2] Change in positive or negative attentional bias was not correlated with any measures of distress at T1 or T3, nor did they significantly correlate with each other. Stress was significantly positively correlated with each measure of distress, at T1 and T3, in addition to rumination (range of $r = .43 - .87$).

Change in attentional bias pre- to post-manipulations

To investigate change in attentional bias from pre- to post-manipulations, between groups analysis of variance was conducted, using change in response to baseline stimuli as a covariate, to control for differences in baseline reaction time.[3] With regards to negative attentional bias, the negative rumination group ($M = -92.25$, $SD = 431.46$) show an increase from pre- to post-induction, whilst the negative distraction ($M = 30.272$, $SD = 206.566$), positive rumination ($M = 17.662$, $SD = 287.182$) and positive distraction ($M = 48.925$, $SD = 330.303$) groups all decreased. However, due to the large standard deviations, there were no significant differences between groups ($F(3, 76) = .84$, ns).

With respect to positive attentional bias, the negative distraction group ($M = -147.47$, $SD = 407.51$) showed an increase from pre- to post-inductions, whilst the negative rumination ($M = 84.20$, $SD = 175.14$), positive rumination ($M = 26.246$, $SD = 228.360$) and positive distraction ($M = 32.811$, $SD = 149.187$) groups all decreased. There was a significant main effect of manipulation group on change in attentional bias for positive stimuli ($F(3, 76) = 3.11$, $p < .05$). Further analyses examining differences between specific manipulation groups revealed only the negative rumination and negative distraction groups significantly differed from each other on change in positive attentional bias ($F(1, 38) = 5.55$, $p < .05$). Thus, modifying rumination and mood had differential effects on attentional bias towards positive stimuli. Participants in the negative rumination group showed increased reaction time, therefore decreased attentional bias, towards positive stimuli from pre- to post-manipulations. In contrast, participants in the negative distraction group decreased in reaction time, therefore increasing in attentional bias, towards positive stimuli from pre- to post-manipulations.

Cognitive vulnerabilities as predictors of distress at T3

In order to examine both attentional biases and rumination as cognitive vulnerabilities associated with distress at T3, a series of regression analyses were performed. Analyses

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[2] *Correlations between rumination and positive and negative attentional bias were also examined separately for each group and for positive and negative mood manipulation groups, but no significant correlations were observed.*
[3] *The analyses were conducted to examine the effects of mood manipulation and rumination manipulations independently, however no significant effects were observed. For the sake of brevity only the analyses examining the effect of the mood and rumination manipulations combined are presented here.*

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Table 2. Correlations between rumination, negative attentional bias, positive attentional bias, stress and distress variables at time one (T1) and time three (T3)

	1	2	3	4	5	6	7	8	9
1. Rumination T1	–								
2. Hopelessness T1	.492**	–							
3. Dysphoria T1	.781**	.552**	–						
4. Suicidal thinking T1	.716**	.551**	.736**	–					
5. Hopelessness T3	.466**	.792**	.573**	.559**	–				
6. Dysphoria T3	.598**	.528**	.647**	.611**	.693**	–			
7. Suicidal thinking T3	.554**	.499**	.534**	.812**	.569**	.635**	–		
8. Stress T3	.519**	.434**	.583**	.478**	.564**	.868**	.498**	–	
9. ΔPositive attentional bias	−.049	−.058	−.064	−.090	−.040	−.077	−.087	−.018	–
10. ΔNegative attentional bias	.133	−.074	.099	.133	−.082	.089	.139	.110	−.099

**p < .01.

were conducted separately for each type of distress (i.e. dysphoria, hopelessness and suicidal ideation). In each analysis, the appropriate measure of distress at time three (T3) was entered as the dependant variable. The corresponding measure of distress at time one (T1) was entered as the first step in the regression, along with change in baseline reaction time (to control for individual differences in reaction time) and manipulation group (to control for differences in attentional biases between groups). The second step of the regression analyses contained the main effects of rumination at T1, change in negative and positive attentional bias and perceived stress at T3. The third step contained the appropriate multiplicative terms for each of these main effects. The final step of each analysis contained the appropriate three-way interactions between each of the main effects.

Any significant interaction terms were examined by plotting the regression lines of best fit at high (one standard deviation above the mean) and low (one standard deviation below the mean) levels of the appropriate interaction terms as prescribed by Aiken and West (1991). Where appropriate, the regression lines of best fit were then probed post hoc to examine whether the slopes were significantly different from zero, again consonant with Aiken and West (1991).

Rumination, attentional biases and stress as predictors of distress at T3

Table 3 illustrates the results of the regression analyses predicting distress at T3. Mean hopelessness scores were 3.89 ($SD = 3.73$) at T1 and 3.60 ($SD = 3.67$) at T3. When predicting hopelessness at T3, initial levels of hopelessness ($\beta = 0.59$, $t(58) = 7.27$, $p < .001$), perceived stress at T3 ($\beta = 0.18$, $t(58) = 2.03$, $p < .05$) and the interaction between rumination and stress ($\beta = 0.19$, $t(58) = 2.54$, $p < .05$) were significant predictors in the final step of the analysis. A plot of the lines of best fit for the interaction between rumination and stress can been seen in Figure 1. Post hoc probing of the analysis revealed that the high slope significantly differed from zero ($\beta = 0.24$, $t(58) = 2.03$, $p < .05$), but the low slope just failed to reach significance ($\beta = 0 - .18$, $t(58) = -.1.70$, $p = .094$). Thus, high perceived stress, in combination with higher initial levels of rumination, was predictive of greater hopelessness at T3.

Mean dysphoria scores were 15.28 ($SD = 12.28$) at T1 and 12.04 ($SD = 10.21$) at T3. When predicting dysphoria at T3, perceived stress ($\beta = 0.76$, $t(58) = 10.50$, $p < .001$) and the interaction between rumination and stress ($\beta = 0.22$, $t(58) = 3.69$, $p < .001$) were significant predictors in the final step of the analysis. In addition, rumination ($\beta = 0.17$, $t(58) = 1.87$, $p = .066$) and the interaction between negative attentional bias, rumination and stress ($\beta = 0 - .13$, $t(58) = -1.81$, $p = .075$) also showed a trend towards significance to predict dysphoria. Post hoc probing of this interaction revealed that the high ($\beta = 0.39$, $t(58) = 3.42$, $p < .001$) but not the low slope significantly differed from zero ($\beta = 0 - .06$, $t(58) = -.57$, ns). This demonstrates that high perceived stress in combination with high rumination was predictive of increased dysphoria. As illustrated in Figure 2, the trend towards significance for the three-way interaction between negative attentional bias, rumination and stress suggests that high stress overall was predictive of greater dysphoria. Within this general pattern, however, high stress combined with increased negative attentional bias and high rumination was predictive of higher dysphoria, whilst increased negative attentional bias, combined with low rumination was predictive of lower dysphoria.

Mean suicidal thinking scores were 9.99 ($SD = 3.70$) at T1 and 9.14 ($SD = 2.71$) at T3. When predicting suicidal thinking at T3, only initial levels of suicidal thinking

Table 3. Hierarchical multiple regression analyses to examine attentional biases, rumination and stress as predictors of distress at T3

| Predictor Variable	R	Adj. R^2	ΔR^2	$F(3, 72)$
Dependent variable: Hopelessness T3				
Step 1 Hopelessness T1, ΔBaseline Reaction Time, Manipulation Group	.797	.635		40.089*
Step 2 ΔNegative Attentional Bias, ΔPositive Attentional Bias, Rumination T1, Stress T3	.836	.698	.063	3.396***
Step 3 ΔNegative Attentional Bias × Stress T3, ΔPositive Attentional Bias × Stress T3, ΔNegative Attentional Bias × Rumination T1, ΔPositive Attentional Bias × Rumination T1	.872	.760	.062	3.069***
Step 4 ΔNegative Attentional Bias × Rumination T1 × Stress T3, ΔPositive Attentional Bias × Rumination T1 × Stress T3	.876	.768	.008	.994
Dependent variable: Dysphoria T3				
Step 1 Dysphoria T1, ΔBaseline Reaction Time, Manipulation Group	.658	.433		17.589*
Step 2 ΔNegative Attentional Bias, ΔPositive Attentional Bias, Rumination T1, Stress T3	.892	.796	.363	28.839*
Step 3 ΔNegative Attentional Bias × Stress T3, ΔPositive Attentional Bias × Stress T3, Rumination T1 × Stress T3, ΔNegative Attentional Bias × Rumination T1, ΔPositive Attentional Bias × Rumination T1	.912	.832	.036	2.618***
Step 4 ΔNegative Attentional Bias × Rumination T1 × Stress T3, ΔPositive Attentional Bias × Rumination T1 × Stress T3	.919	.844	.012	2.260
Dependent variable: Suicidal thinking T3				
Step 1 Suicidal Thinking T1, ΔBaseline Reaction Time, Manipulation Group	.820	.672		47.063*
Step 2 ΔNegative Attentional Bias, ΔPositive Attentional Bias, Rumination T1, Stress T3	.836	.699	.027	1.445
Step 3 ΔNegative Attentional Bias × Stress T3, ΔPositive Attentional Bias × Stress T3, Rumination T1 × Stress T3, Rumination T1, ΔPositive Attentional Bias × Rumination T1	.863	.745	.046	2.198
Step 4 ΔNegative Attentional Bias × Rumination T1 × Stress T3, ΔPositive Attentional Bias × Rumination T1 × Stress T3	.864	.747	.002	.194

*p < .001; **p < .01; ***p < .05.
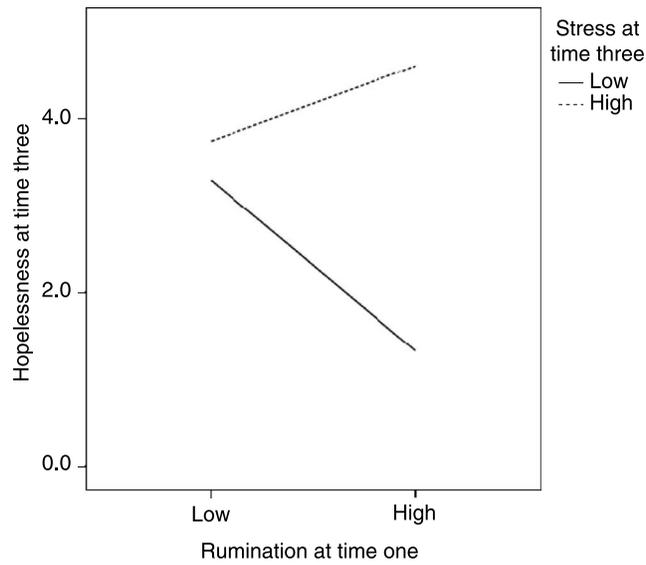
Figure 1. Interaction of high and low levels of rumination and high and low levels of stress to predict hopelessness at time three.
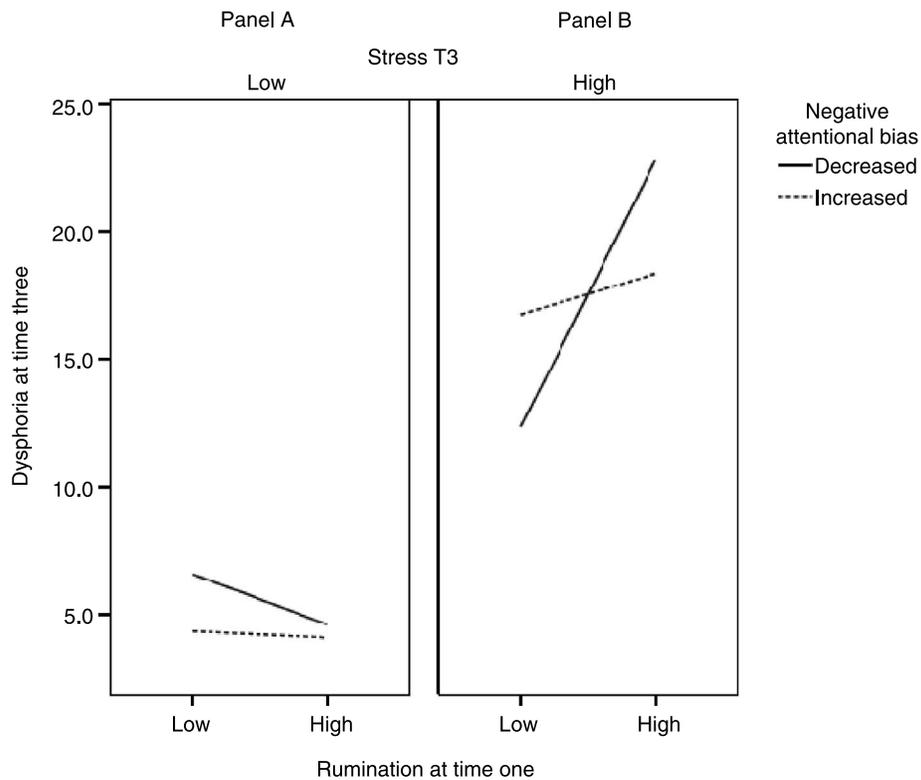

Figure 2. Interaction between high and low levels of negative attentional bias, high and low levels of rumination and high (Panel B) and low levels (Panel A) of stress to predict dysphoria at time three.

($\beta = 0.56$, $t(58) = 4.47$, $p < .001$) and the interaction between rumination and stress ($\beta = 0.26$, $t(58) = 2.93$, $p < .01$) were significant predictors in the final step of the analysis. A plot of the lines of best fit for the interaction between rumination and stress can be seen in Figure 3. Post hoc probing of this interaction found that the low ($\beta = 0 - .24$, $t(58) = -2.10$, $p < .05$), but not the high slope ($\beta = 0.27$, $t(58) = 1.65$, $p = .104$) significantly differed from zero. This suggests that low perceived stress combined with high rumination was predictive of lower levels of suicidal thinking.

Discussion

The first aim of this research was to explore the relationship between rumination and attentional bias. The results indicated there was no significant correlation between rumination and either positive or negative attentional bias. However, the results also illustrated that manipulating rumination between groups had differential effects on positive attentional bias, suggesting a causal relationship between rumination and positive attentional bias.

The second aim of this research was to examine whether rumination or attentional bias (or both) could prospectively predict levels of distress within a diathesis-stress framework, after controlling for initial levels of distress. The results indicated that rumination interacted with stress to prospectively predict hopelessness, dysphoria and suicidal thinking. In addition, the interaction between negative attentional bias, rumination and stress showed a trend towards significance to predict dysphoria. Positive attentional bias was not found to significantly predict any measure of distress.

The finding that manipulating levels of rumination altered positive attentional bias shows, for the first time, a causal relationship between rumination and positive attentional bias. As hypothesized, for those participants completing a negative mood manipulation procedure, inducing rumination was associated with decreased positive
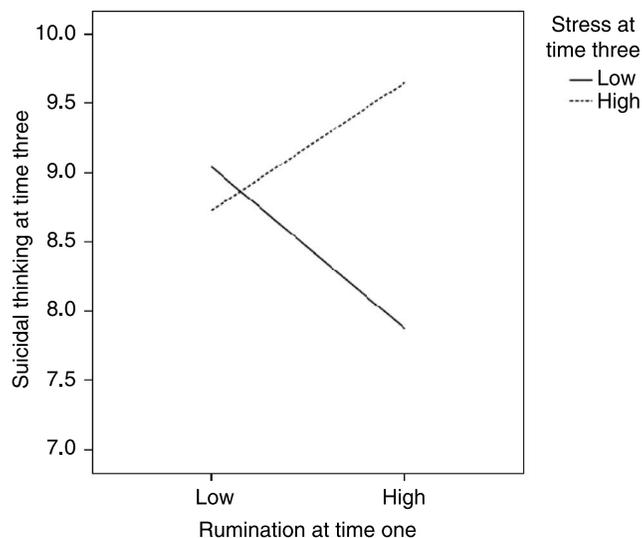

Figure 3. Interaction of high and low levels of rumination and high and low levels of stress to predict suicidal thinking at time three.

attentional bias, whilst inducing distraction was associated with an increase in positive attentional bias. The same pattern was not observed for those participants completing a positive mood manipulation procedure, lending support to Nolen-Hoeksema's (1991) response styles theory which views rumination as a response to negative mood. We had also hypothesized that for those participants completing a negative mood manipulation procedure, inducing rumination would increase negative attentional bias and inducing distraction would decrease negative attentional bias. Although our data are consistent with this pattern, the results did reach conventional levels for statistical significance. These findings suggest that rumination in combination with negative mood, results in a decreasing tendency to focus on positive stimuli, although not necessarily a corresponding increase in attending to negative stimuli. Again, this fits with response styles theory which envisages rumination as a persistent focus on the causes and consequences of emotions, rendering the individual less able to focus on other distracting (positive) activities. More research in this area is necessary to identify the specific mechanism which links rumination to positive attentional bias.

Rumination was found to interact with stress to prospectively predict a number of measures of psychological distress, such that under high stress, increased rumination was predictive of greater dysphoria and hopelessness. In addition, under low levels of stress, increased rumination was predictive of lower levels of suicidal thinking. This extended work by Morrison and O'Connor (2005) where, in a healthy population, rumination interacted with stress to predict social dysfunction, suggesting that this interaction is also observed with other measures of distress. These prospective findings also extend previous cross-sectional research linking rumination with hopelessness (Lam *et al.*, 2003) and suicidal ideation (Eshun, 2000).

Recent work has proposed rumination in response to a specific stressor may have a role in the development of distress (Robinson & Alloy, 2003). This 'stress-reactive rumination' reflects a 'tendency to ruminate on negative inferences following stressful life-events' (Robinson & Alloy, 2003 p. 276). The current findings provide some support for Robinson and Alloy's (2003) notion of 'stress-reactive rumination', as the impact of rumination on distress was moderated by levels of stress. However, it must be noted that the current study used a measure of global stress and more research is necessary to determine whether the same findings would result from measures of stress in response to specific life-events. Nonetheless, the current research indicates that there may be a need for response styles theory to incorporate the role of stress as, in this research, rumination did not always have a detrimental effect on levels of distress.

The trend towards significance for the interaction between negative attentional bias, rumination and stress suggested that increased negative attentional bias (following manipulations), in combination with high stress and high rumination was predictive of higher dysphoria. In contrast, increased negative attentional bias (following manipulations) in combination with low stress and high rumination was predictive of lower dysphoria. Previous research found that change in negative attentional bias interacted with life-stress to predict dysphoria over 7 weeks (Beevers & Carver, 2003). The results for the present study suggest that rumination levels also impact on this interaction between negative attentional bias and stress, as in the present study, the pattern of results observed by Beevers and Carver were only seen in combination with high rumination. The failure to find a relationship between negative attentional bias and hopelessness or suicidal thinking, is consistent with previous research employing an emotional Stroop measure of attentional bias (Williams & Broadbent, 1986; Becker *et al.*, 1999).

In the present research, positive attentional bias was not independently related to distress. Although previous work indicated that the absence of positive attentional biases may be associated with clinical depression (McCabe & Gotlib, 1995; Suslow *et al.*, 2001), we were unable to replicate this finding in a non-clinical sample. Similar to the present results, Becker and colleagues (1999) previously failed to find a relationship between positive attentional biases and hopelessness or previous suicidal behaviour, using an emotional Stroop measure of attentional bias.

The current study had two main limitations. First, the focus of this research was specifically on university students, meaning the results may not be applicable to a clinical population. However, the high levels of distress reported by university students in recent years (Furr, Westefeld, McConnell & Jenkins, 2001) suggests a need for research specifically focusing on this population in order to examine the relationship between distress and potentially modifiable cognitive variables to facilitate the development of methods for intervention. Second, the reliance on self-report measures may be cited as a potential limitation of this research. However, given that interactions emerged from the data, it seems unlikely that social desirability effects confounded the results.

Despite the limitations noted above, this research has a number of implications. First, this research has, for the first time, examined the relationship between attentional bias and a reliable and valid measure of rumination. The findings confirm previous speculation of a relationship between the two and suggest a causal role for rumination in positive attentional bias. Second, the research provided evidence of interactions between rumination and stress to predict a number of measures of distress. This provides support for the suggestion that response styles theory should be extended to include the role of stress and points to a possible role for stress-reactive rumination. Third, the research suggested that negative attentional biases, in combination with rumination and stress may play a role in predicting dysphoria. Increased negative attentional bias, following manipulations, combined with high rumination and high perceived stress, was predictive of the highest levels of dysphoria. This expands previous research in the area and provides further evidence for links between rumination and attentional bias.

The research also raises clinical implications. Increased dysphoria, hopelessness and suicidal thinking in university students were predicted by rumination in combination with higher levels of stress. Additionally, increased dysphoria was also predicted by increased negative attentional bias in conjunction with higher rumination and higher perceived stress levels. As stress is often an unavoidable consequence of academic study, clinical interventions may do better to focus on the potentially modifiable cognitive variables of rumination and attentional bias.

Despite the use of a healthy sample in this research, it is possible to tentatively speculate about the implications of our findings for clinically depressed individuals. The role of cognitive biases in depression has been well established, therefore modifying such biases could form the basis of a cognitive behavioural therapy treatment approach. The findings of our research indicate that the experience of rumination in combination with higher levels of stress was predictive of increased dysphoria, hopelessness and suicidal thinking. This suggests that treatment protocols which focus on reducing ruminative thinking may be beneficial for depressed individuals. Indeed, the results from a recent case series showed that ruminative thinking could be reduced over the course of up to 12 treatment sessions based on cognitive-behavioural methods (Watkins *et al.*, 2007).

To conclude, by focusing on a number of measures of distress, this research has advanced knowledge into the predictors of psychological distress. This research has also increased our theoretical knowledge about rumination and attentional bias and how they relate to each other and to different measures of distress.

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