

Rumination and selective attention: An investigation of the impaired  
disengagement hypothesis

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## Abstract

The primary aim of this thesis was to investigate the relationship between rumination and selective attention, in particular, whether the tendency to ruminate is associated with impaired attentional disengagement from negative information. It is well-established that the tendency to ruminate in response to negative mood is a key vulnerability factor in the development of depression (Nolen-Hoekseman, Wisco, & Lyubomirsky, 2008; Watkins, 2008), but attempts to understand the underlying processes contributing to heightened ruminative disposition have been relatively limited. Recently, a number of researchers have suggested that rumination may be characterised by biased attentional processing of negative information, particularly that individuals with high levels of ruminative disposition may have difficulty disengaging their attention from negative information (e.g., Koster, De Lissnyder, Derakshan, & De Raedt, 2011).

Studies One and Two each investigated the relationship between individual differences in ruminative disposition and selective attention for negative information, using a modified dot-probe task designed by Grafton, Watkins, and MacLeod (2012) to enable the discrete assessment of biases in attentional engagement and disengagement. Study One found that heightened levels of dispositional ruminative brooding, as assessed by both the Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991) and an in-vivo assessment of ruminative disposition, were associated with impaired attentional disengagement from negative relative to positive information. Similarly, Study Two also found that heightened levels of ruminative disposition were associated with impaired attentional disengagement from negative information, particularly for depression relevant stimuli presented for 1000ms.

Study Three sought to extend these findings using an eye-tracking assessment of selective attention to measure the spontaneous allocation of attention between stimuli. However,

ruminative disposition was not significantly associated with any index of attentional bias during the eye-tracking assessment, neither with biased attentional disengagement, nor with biased attentional engagement or maintenance of attention.

Study Four then sought to replicate findings from Study Two using a selected sample of individuals with high and low levels of ruminative disposition. Participants in the high rumination group demonstrated greater attentional bias for depression relevant negative stimuli presented for 1000ms in comparison to those in the low rumination group. However, this between group difference reflected a general attentional preference for negative relative to positive stimuli (i.e., composite of attentional engagement and disengagement bias), but no specific difference in attentional disengagement bias or attentional engagement bias was observed.

Finally, Study Five took a first step towards investigate the causal relationship between rumination and selective attention by investigating the causal effect of rumination on attentional bias. Although there no main effect of induced rumination on attentional bias was observed, the effect of induced rumination on attentional bias was found to be moderated by ruminative disposition. However, contrary to hypotheses, individuals with low levels of ruminative disposition demonstrated an attentional bias for valence-incongruent stimuli, which shifted to a bias for valence-congruent stimuli as ruminative disposition increased.

Overall, there was support across the studies for the primary hypothesis that heightened ruminative disposition is associated with impaired attentional disengagement from negative information. However, the findings do not suggest that ruminative disposition is exclusively associated with attentional disengagement bias, but instead indicate that facilitated attentional engagement may also be involved under some circumstances.

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## CHAPTER ONE: Introduction and Literature Review

It is well-established that the tendency to ruminate in response to negative mood is a key vulnerability factor in the development of depression (Nolen-Hoekseman, Wisco, & Lyubomirsky, 2008; Watkins, 2008). However, although there has been considerable research investigating the negative consequences of rumination, attempts to understand the underlying processes contributing to heightened ruminative disposition have been relatively limited. Recently, a number of researchers have suggested that rumination may be characterised by biased attentional processing of negative information, particularly that individuals with high levels of ruminative disposition may have difficulty disengaging their attention from negative information (e.g., Koster, De Lissnyder, Derakshan, & De Raedt, 2011). The primary aim of this thesis is to further examine the relationship between rumination and attentional bias for negative information, particularly focusing on whether the tendency to ruminate is associated with impaired attentional disengagement from, or enhanced attentional engagement with negative information.

The thesis consists of five studies investigating the relationship between rumination and biased attentional processing of negative information. Chapter One consists of a literature review which focuses on introducing and defining the concepts of rumination and selective attention, outlining theoretical models and empirical evidence indicating a relationship between rumination and selective attention, and finally highlighting the unresolved research questions which the thesis will attempt to address.

Studies One and Two (Chapters Two & Three) each investigated the relationship between individual differences in ruminative disposition and selective attention for negative information,

using a modified dot-probe task designed by Grafton, Watkins, and MacLeod (2012) to enable the discrete assessment of biases in attentional engagement and disengagement. In both studies, ruminative disposition was assessed using both the Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991), but Study One also employed an in-vivo assessment of ruminative disposition designed to mitigate the limitations of retrospective questionnaire measures. Study Three (Chapter Four) sought to extend these studies using an eye-tracking assessment of selective attention, alongside both the RRS and in-vivo assessments of ruminative disposition. In each of these studies, it was hypothesised that heightened levels of ruminative disposition would be associated with more impaired attentional disengagement from negative relative to positive stimuli.

Study Four (Chapter Five) then sought to replicate findings from Study Two using a selected sample of individuals with high and low levels of ruminative disposition. Study Four also assessed general deficits in attentional control using a response-probe variant of the anti-saccade task, in an attempt to investigate whether rumination-linked attentional bias and attentional control deficits are functionally related, or represent separate facets of heightened ruminative disposition.

Study Five (Chapter Six) took a first step towards examining the casual relationship between rumination and selective attention, by investigating the effects of negative rumination and positive basking on attentional bias. It was hypothesised that participants in the negative rumination condition would demonstrate greater attentional bias for negative relative to positive stimuli compared to those in the positive basking condition. Furthermore, Study Five also investigated the hypothesis that the effects of induced rumination would be moderated by ruminative disposition, such that individuals with higher levels of ruminative disposition would

demonstrate a more pronounced bias towards negative stimuli in the negative rumination compared to positive basking condition.

Finally, the general discussion (Chapter Seven) considers the theoretical implications of the thesis findings for attentional processing models of rumination, strengths and limitations of the thesis, and directions for future research.

The literature review will first outline conceptual definitions of rumination, along with evidence for the causal role of rumination in vulnerability to depression, and a brief consideration of the distinction between rumination and worry (Section 1.1). Next, the concept of selective attention will be outlined, followed by a discussion of paradigms for the assessment of selective attention, and evidence for the role of attentional bias in emotional vulnerability (Section 1.2). The literature review will then consider theoretical models proposing an association between rumination and biased attentional processing of negative information (Section 1.3), and outline the empirical evidence in support of these models (Section 1.4). Finally, the literature review will discuss unresolved questions from previous research, which the studies conducted in this thesis will aim to address (Section 1.5).

## **1.1 Rumination**

According to the Response Styles Theory, rumination is conceptualised as a form of recurrent negative thinking, involving “behaviour and thoughts that focus one’s attention on one’s depressive symptoms and on the implications of these symptoms” (Nolen-Hoeksema, 1991, p. 569). In particular, this typically involves dwelling on the causes, meanings and consequences of negative events and feelings. For example, rumination might involve thoughts such as ‘Why do I get depressed when other people don’t?’ (Nolen-Hoeksema, 1991, p. 569). Other theorists have adopted broader conceptualisations of rumination, such as control theory

accounts proposing that rumination is triggered by and involves thoughts focused on perceived discrepancies in progress towards valued goals (Martin & Tesser, 1996; Roberts, Watkins, & Wills, 2013; Watkins, 2008). These theories are not necessarily inconsistent, as failure to achieve or progress towards valued goals is also likely to result in negative affect, and individuals experiencing high levels of negative affect are likely to hold the goal of escaping persistent negative mood, which would result in rumination about negative feelings (McIntosh, 1996).

Nolen-Hoeksema also proposes that the tendency to ruminate in response to negative mood (i.e., ruminative disposition) is a stable, trait-like response style, and is typically assessed using the Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991), which asks participants to indicate how often they engage in a range of ruminative responses during sad or depressed mood. Findings have generally supported the proposal that rumination is a stable, trait-like style of responding to negative mood. Nolen-Hoeksema, Morrow, and Fredrickson (1993) found in a diary study that the majority of participants demonstrated consistent styles of responding to depressed mood. Furthermore, studies have found the RRS to have significant test-retest reliability (Just & Alloy, 1997; Kuehner & Weber, 1999; Nolen-Hoeksema, Parker, & Larson, 1994; Sakamoto, Kambara, & Tanno, 2001), although one study where insufficient test-retest reliability was reported must also be noted (Kasch, Klein, & Lara, 2001). Also, the predictive validity of the RRS has been supported by studies where scores have been found to predict the extent to which participants report engaging in ruminative responses to an episode of depressed mood (Just & Alloy, 1997, marginally significant; Sakamoto et al., 2001), and also ruminative self-focus in general (Moberly & Watkins, 2008). Such findings support both the conceptualisation of rumination as a stable, trait-like response style, and the validity of the RRS as a measure of ruminative disposition.

There is also considerable evidence suggesting that heightened ruminative disposition plays a causal role in both the onset and maintenance of depression (for reviews see Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008; Watkins, 2008). Higher levels of ruminative disposition are associated with greater vulnerability to depression, as demonstrated by studies where the RRS prospectively predicted the onset of depressive episodes in initially non-depressed individuals (Just & Alloy, 1997; Nolen-Hoeksema, 2000; Nolen-Hoeksema, Stice, Wade, & Bohon, 2007), and even mediated the effects of other risk factors in the development of depression (Spasojevic & Alloy, 2001, same sample as Just & Alloy, 1997). More generally, numerous prospective studies have found that the RRS predicts future depressive symptoms after controlling for initial symptoms, in both initially non-depressed participants (Abela, Brozina, & Haigh, 2002; Butler & Nolen-Hoeksema, 1994; Hong, 2007; Nolen-Hoeksema, 2000; Nolen-Hoeksema & Morrow, 1991; Nolen-Hoeksema et al., 1994; Nolen-Hoeksema et al., 2007; Sakamoto et al., 2001; Schwartz & Koenig, 1996; Smith, Alloy, & Abramson, 2006) and patients with clinical depression (Kuehner & Weber, 1999; Nolen-Hoeksema, 2000; Rohan, Sigmon, & Dorhofer, 2003), although one non-replication must be noted (reported in both Kasch et al., 2001; Lara, Klein, & Kasch, 2000). Prospective studies using measures other than the RRS have also supported the finding that rumination predicts future depressive mood, including diary studies (Nolen-Hoeksema et al., 1993; Young & Azam, 2003), ratings of interview transcripts (Nolen-Hoeksema, McBride, & Larson, 1997) and experience sampling (Moberly & Watkins, 2008).

Further support for the causal role of rumination in vulnerability to depression is provided by experimental studies. A ruminative self-focus induction, where participants are instructed to focus on current feelings, is consistently found to exacerbate negative mood relative

to a distraction condition, in dysphoric participants (Lavender & Watkins, 2004; Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998; Lyubomirsky & Nolen-Hoeksema, 1995; Morrow & Nolen-Hoeksema, 1990; Nolen-Hoeksema & Morrow, 1993; Watkins & Teasdale, 2001). Furthermore, relative to distraction, ruminative self-focus has also been found to increase various elements of negative cognition related to depression, including negative interpretations and pessimism about future events (Lyubomirsky & Nolen-Hoeksema, 1995), negative future thinking (Lavender & Watkins, 2004), and negative autobiographical memory recall (Lyubomirsky et al., 1998).

However, it is important to note that subsequent analyses of the RRS have suggested that rather than representing a single, unitary construct, rumination involves distinct subtypes, which appear to influence whether it has maladaptive or adaptive consequences (Watkins, 2008). Factor analysis conducted by Treynor, Gonzalez, & Nolen-Hoeksema (2003), after removing items specifically referring to depressive symptoms, identified two distinct subtypes labelled 'brooding' and 'reflection'. The brooding component was interpreted as "a passive comparison of one's current situation with some unachieved standard" (Treynor et al., 2003, p. 256) and includes items such as thinking "Why do I always react this way?" and "What am I doing to deserve this?" In contrast, the reflection component was interpreted as "a purposeful turning inward to engage in cognitive problem solving to alleviate one's depressive symptoms" (Treynor et al., 2003, p. 256) and includes items such as "Analyze your personality to try to understand why you are depressed" and "Go some place alone to think about your feelings". Brooding might thus be characterised as more passive, judgemental, and evaluative, and reflection as more active and non-judgemental. Also, whereas brooding was found to be associated with both greater concurrent depression and future depression, reflection was associated with greater concurrent

depression, but reduced future depression (Treyner et al., 2003). Subsequent research has also found that brooding, but not reflection, prospectively predicted depressive symptoms in adolescents (Burwell & Shirk, 2007) and was associated with higher mean levels of negative affect (Moberly & Watkins, 2008). Hence, although brooding is considered to be maladaptive, reflection appears to represent a less maladaptive form of rumination, and it is thus important for research to distinguish between these different components.

Rumination is one particular example of repetitive negative thought (see Watkins, 2008 for a review of different forms of repetitive thought), but another similar and likely related type of negative repetitive thought is worry, which has been defined as “a chain of thoughts and images, negatively affect-laden and relatively uncontrollable... on an issue whose outcome is uncertain but contains the possibility of one or more negative outcomes” (Borkovec, Robinson, Pruzinsky, & Depree, 1983, p. 9). These processes are similar in that they both involve repetitive and uncontrollable focus on negative material (Ehring & Watkins, 2008; Watkins, 2008), and there is some debate over the extent to which these concepts can be considered distinct processes (Borkovec, Ray, & Stober, 1998; Segerstrom, Tsao, Alden, & Craske, 2000). Dispositional measures of worry (the Penn State Worry Questionnaire, PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990) are highly correlated with measures of ruminative disposition (Fresco et al., 2002; Hong, 2007; Muris, Roelofs, Meesters, & Boomsma, 2004; Segerstrom et al., 2000), have both been found to be associated with greater levels of depression and anxiety (Borkovec et al., 1983; Chelminski & Zimmerman, 2003; Fresco et al., 2002; Harrington & Blakenship, 2002; Meyer et al., 1990; Nolen-Hoeksema, 2000; Segerstrom et al., 2000; Starcevic, 1995), and in experimental manipulations both worry and rumination increase anxiety and depression (Andrews & Borkovec, 1988; Blagden & Craske, 1996; McLaughlin, Borkovec, & Sibrava,

2007). However, whereas rumination is conceptualised as repetitive thought primarily revolving around past losses and current negative feelings (i.e. depressive content), the content of worry is characterised as being based on potential threats, often future oriented, (i.e. anxious content). Worry and rumination have also been found to have different concurrent and prospective relationships to symptoms after controlling for one another, such that although worry predicts both depression and anxiety, rumination uniquely predicts depression (Hong, 2007; Muris et al., 2004). Although the issue of whether worry and rumination represent the same or distinct processes remains unresolved, the present thesis will primarily investigate the relationship between depressive rumination and selective attention. However, given the potential overlap between anxious worry and depressive rumination, some consideration will be given to relevant literature on the relationship between worry and selective attention, and how this might inform our understanding of the attentional basis of rumination.

## **1.2 Selective Attention**

Selective attention refers to an attentional filtering process involving the allocation of attentional resources to specific stimuli within the internal or external environment. Individuals can be said to have a bias in selective attention if they demonstrate a systematic tendency to attend to a particular type of stimulus over others. It has long been suggested that certain groups of individuals may tend towards attentional biases for particular types of information, notably that those suffering from various emotional disorders may be biased towards mood or concern relevant information, and that this may causally contribute to their emotional vulnerability (e.g., Beck, 1976; Bower, 1981).

Important distinctions have also been drawn between different components of selective attention at which attentional biases might operate (Clarke, MacLeod, & Guastella, 2013; Posner,

1980; Posner & Petersen, 1990). Attentional engagement refers to the selection and initial orienting of attention towards stimuli, whereas attentional disengagement refers to the withdrawal of attentional selection from stimuli. Biased attentional processing of stimuli can involve a systematic bias in either of these attentional components. A bias in attentional engagement would be characterised by faster or more frequent initial orienting of attention towards relevant stimuli. Alternatively, attentional bias might involve impaired disengagement characterised by greater maintenance of attention or difficulty diverting attention away from relevant stimuli.

The following section will first consider various experimental paradigms for the assessment of selective attention, including the separate assessment of attentional engagement and disengagement bias, before considering evidence for the association between selective attention and emotional vulnerability.

### **1.2.1 Paradigms for measuring selective attention**

**Emotional Stroop task.** One early measure that attempted to index selective attention is the emotional Stroop task (Mathews & MacLeod, 1985), where word stimuli are presented in different ink colours, and participants are required to name aloud the colour the word is printed in. The time taken to name the colour is proposed to reflect the extent to which selective attention to the content of the word interfered with colour naming (Stroop, 1935). As such, an attentional bias can be inferred from relative latencies to name the colours of words of different emotional valences. For example, longer naming latencies for negative relative to neutral words would indicate greater attentional interference from negative information. However, it is not clear that such effects are necessarily a result of attentional bias, as there are other factors that may influence colour naming latencies on the Emotional Stroop task (Algom, Chajut, & Lev,

2004; de Ruiter & Brosschot, 1994). In particular, slower colour naming for negative words could result from either general response slowing (e.g. startle effect) or attentional avoidance of negative words. Therefore, many researchers do not consider the emotional Stroop task as an unambiguous measure of selective attention (Algom et al., 2004; de Ruiter & Brosschot, 1994).

**Response probe paradigms.** A more robust and commonly used paradigms for measuring selective attention is the dot-probe (or attention probe) task developed by MacLeod and colleagues (MacLeod, Mathews, & Tata, 1986). In this paradigm, two stimuli are simultaneously presented on a computer screen (e.g., negative and neutral words), followed by a probe appearing in the same spatial location as of one of the stimuli. The participant is then required to press a button as fast as possible in response to this probe. Early versions of this paradigm involved a probe detection task, where participants were simply required to press the response button as soon as the probe was detected (e.g. MacLeod et al., 1986), but later versions have incorporated differentiation tasks, where participants are required to press different buttons depending on either the location or identity of the probe displayed (see Mogg & Bradley, 1999; Saleminck, van den Hout, & Kindt, 2007). It is assumed that participants' reaction times in response to the probes will be dependent on the spatial allocation of attention (i.e. faster responding to probes appearing in an attended as opposed to unattended location; see Posner, Snyder, & Davidson, 1980), as determined by the previously presented stimuli. An attentional bias can therefore be inferred based on participants response latencies to probes replacing different types of stimuli. For example, faster responses to probes appearing in the location of threatening words relative to probes replacing neutral words would suggest greater attention for threatening relative to neutral stimuli, thus indicating an attentional bias for threatening information.

A key strength of the dot-probe task is that unlike the emotional Stroop task, any observed differences in attentional bias for different types of stimuli cannot be accounted for by alternative explanations (MacLeod et al., 1986). Firstly, since participants are required to execute a neutral response (button pressing) to a neutral stimulus (the probe), this eliminates the possibility of response biases. Secondly, since the two stimuli to be compared are presented simultaneously, this means that it controls for the potential influence of response slowing in the presence of emotional stimuli (Mogg, Holmes, Garner, & Bradley, 2008). Thus, differences in reaction times must indicate enhanced attentional processing of one stimulus relative to another.

However, although the dot-probe paradigm provides a clear and unambiguous measure of selective attention, one limitation of the original version is that it cannot distinguish between attentional engagement and disengagement bias (Clarke et al., 2013; Koster, Crombez, Verschuere, & de Houwer, 2004; Mogg et al., 2008; Yiend, 2010). Faster responding to probes appearing in the same location as the prior emotional stimuli could potentially result from either enhanced attentional engagement with such stimuli or greater difficulty disengaging attention from them once it has been allocated. Consequently, selective attention as indexed by the original dot-probe task will reflect the combined influence of any bias in attentional engagement and disengagement (Grafton et al., 2012). Thus, researchers wishing to discriminate between these two types of attentional bias must use alternative paradigms.

Another similar paradigm which is often claimed to be able to distinguish between engagement and disengagement bias is the exogenous cuing task based on the Posner paradigm (Posner et al., 1980). In this paradigm, a single cue is presented in one of two locations on a computer screen, followed by a probe in either location, to which participants must execute a response. In order to measure selective attention, response latencies for probes following

emotional and neutral cues are compared (e.g. Fox, Russo, Bowles, & Dutton, 2001; Yiend & Mathews, 2001). Attentional engagement is inferred by comparing response latencies on valid trials (i.e. the probe appears in the same location as the cue), with faster responses being argued to indicate facilitated engagement. In contrast, attentional disengagement is inferred by comparing response latencies on invalid trials (i.e. the probe appears in the opposite location to the cue), with slower responses supposedly indicating impaired disengagement.

However, subsequent researchers have identified two limitations which significantly compromise the ability of the exogenous cuing task to differentiate between attentional engagement and disengagement bias (Clarke et al., 2013; Grafton & MacLeod, 2014; Grafton et al., 2012; Mogg et al., 2008). Firstly, in order to infer bias in attentional disengagement using invalid trials, it is necessary that attention is initially engaged with the cue stimuli to an equivalent degree regardless of valence or participant group. Otherwise, any observed difference in response latencies to probes presented distally to different types of stimuli may be a result of variations in initial engagement with the cue stimuli, rather than relative speed of disengagement. Since the exogenous cueing task allows for such variations in initial engagement, measures of disengagement bias will be confounded by any existing bias in attentional engagement. Secondly, this paradigm fails to control for the generic influence of particular stimuli on response latencies, because attentional bias is inferred by comparing trials where emotional stimuli are presented with those where they are not. This criticism is particularly relevant, since Mogg et al. (2008) demonstrated that anxious participants do in fact show general response slowing following the presentation of threatening stimuli. Thus, any relative slowing in responses to probes appearing distally to threatening cues observed in this group could be accounted for by this general slowing effect, without invoking impairments in attentional

disengagement. Simultaneously, such response slowing could also obscure any bias in engagement with threatening stimuli, which would otherwise be indicated by speeded processing of probes cued by negative relative to neutral stimuli. As a result of these two important limitations, the exogenous cuing task fails to provide a clear distinction between attentional engagement and disengagement bias. Furthermore, due to the second limitation regarding the potential confound of response slowing, it also does not provide an unambiguous measure of selective attention.

Some researchers have also attempted to address the issue of attentional engagement and disengagement biases using a modified version of the dot-probe task where response latencies to emotion congruent and incongruent probes replacing emotional-neutral stimulus pairs are compared with response latencies following neutral-neutral pairs (Koster et al., 2004; Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006; Salemink et al., 2007). However, this approach is subject to the same limitations as the exogenous cuing task outlined above, meaning that this also cannot provide an adequate measure of engagement and disengagement bias.

Recently however, Grafton et al. (2012) have developed a new version of the dot-probe task which avoids these limitations, and is therefore able to clearly distinguish between attentional engagement and disengagement bias (see Figures 2.1 & 3.1). In this version of the task, on each trial the participant is first informed by an arrow display where to initially allocate their attention between two locations on the screen. A cue then appears in this location, followed by a pair of stimuli (e.g. an emotional and a neutral word) in each of the two locations, and then finally a probe in either of the two locations. The participant must then perform a probe differentiation task, to indicate whether the probe is the same or different to the cue. Since participants must attend to the cue in order to accurately perform the task, this ensures that

participants' attention is secured in a designated location prior to the presentation of the stimulus pair. Disengagement bias is measured using trials where attention is initially secured in the same location as the subsequent emotional stimulus, with slower responding to probes appearing away from the emotional stimulus (i.e., the neutral stimulus) relative to probes appearing in the location of the emotional stimulus, indicating impaired disengagement from emotional stimuli. In contrast, engagement bias is measured using trials where attention is initially secured away from the subsequent emotional stimulus, with faster responding to probes appearing in the location of the emotional stimulus relative to the location of the neutral stimulus indicating facilitated attentional engagement with the emotional stimuli. The task also allows for general response slowing to be controlled for through comparison with response latencies for both probes presented away from emotional stimuli and following neutral-neutral stimulus pairs.

**Eye-tracking paradigms.** A limitation of all attention probe tasks using reaction time data is that they can only provide 'snapshots' of attention at the time of probe presentation, meaning that we cannot know the patterns of attentional distribution before or after probing (Mogg & Bradley, 2005; Yiend, 2010). This is a particular problem for the investigation of later stages of selective attention and studies using longer stimulus presentation durations, as attention may shift multiple times before the presentation of the probe (Yiend, 2010). Thus, although reaction time data from attention probe tasks may be a suitable measure of early selective attention, they are less useful for assessing the maintenance of attention over time. Furthermore, reaction time data may be less accurate for participants with slow or variable motor responses, which may be the case for many clinical populations, particularly individuals suffering from depression (Mogg & Bradley, 2005).

An alternative approach that is able to overcome these limitations is the measurement of attentional distribution via eye-tracking. Eye-movements are closely linked to attention, as individuals typically direct their gaze towards stimuli that attract their attention (Jonides, 1981), and there is a mandatory shift in attention prior to every eye-movement (Kowler, Anderson, Doshier, & Blaser, 1995). Eye-tracking technology allows for the continuous assessment of attention allocation, thus allowing for a more accurate and relatively direct assessment of patterns of attentional distribution throughout the entire stimulus presentation duration. Eye-movements are also less likely to be influenced by motor-slowness deficits, allowing for more accurate measurement in groups at risk of this confound (Mogg & Bradley, 2005).

There are a variety of experimental tasks that can incorporate eye-tracking to measure selective attention. One common approach involves the free-viewing of simultaneously presented stimuli of differing valences (e.g. Eizenman et al., 2003; Kellough, Beevers, Ellis, & Wells, 2008), with selective attention indexed by the amount of time spent fixated on particular types of stimuli. This is arguably a particularly ecologically valid index of selective attention, because it assesses where participants naturally allocate their attention between a range of competing stimuli. Some researchers have also combined eye-tracking with experimental cueing tasks such as the dot-probe and exogenous cueing tasks (e.g. Mogg, Millar, & Bradley, 2000; Sears, Thomas, LeHuquet, & Johnson, 2010). Similar to the approach adopted in Grafton et al.'s (2012) modified dot-probe task, these paradigms can be modified to assess attentional engagement and disengagement bias depending on where attention is secured prior to stimulus presentation (Clarke et al., 2013). When attention is initially secured in a location distal to emotional stimuli, attentional engagement can be inferred by latency to fixate on emotional stimuli relative to neutral stimuli, whereas when attention is initially secured in a location

proximal to emotional stimuli, attentional disengagement can be inferred from latency to saccade away from emotional stimuli relative to neutral stimuli.

**Visuals search tasks.** Another common paradigm for measuring selective attention is visual search tasks, where participants are required to detect target stimuli embedded within an array of distracting stimuli (e.g., sad facial expression within an array of neutral faces; Öhman, Flykt, & Esteves, 2001; Rinck, Becker, Kellermann, & Roth, 2003). There are two main ways in which such tasks can be used to assess attentional bias. Firstly, attentional bias can be inferred from relative speed to detect emotional (e.g., happy or sad faces) compared to neutral targets (e.g., neutral faces) within arrays of neutral distractors (i.e., detection paradigm), reflecting the degree to which attention is drawn towards emotional stimuli, with greater attentional bias for emotional stimuli indicated by faster detection latencies for emotional relative to neutral targets. Alternatively, attentional bias can be inferred from relative speed to detect neutral targets within arrays of emotional relative to neutral distractors (i.e., distraction paradigm), reflecting the degree to which attention is held by emotional stimuli, with greater attentional bias for emotional stimuli indicated by slower detection latencies for targets within emotional relative to neutral arrays of distractors. Some researchers have also combined visual search tasks with eye-tracking, such that latency to fixate on emotional targets is measured during detection paradigms, whereas latency to fixate on neutral targets is measured during distraction paradigms (e.g., Rinck, Reinecke, Ellwart, Heuer, & Becker, 2005).

Some researchers have proposed that these two variants of the visual search task can be used to distinguish between attentional engagement and disengagement bias (e.g., Pineles, Shipherd, Mostoufi, Abramovitz, & Yovel, 2009; Pineles, Shipherd, Welch, & Yovel, 2007), such that the detection paradigm assesses attentional engagement bias, whereas the distraction

paradigm reflects attentional disengagement bias. However, as pointed out by Clarke et al. (2013), these variants of the visual search paradigm do not meet the necessary criteria to adequately distinguish between attentional engagement and disengagement bias, as distraction paradigms will be susceptible to behavioural freezing effects, and detection latencies will be dependent on both attentional engagement with and disengagement from distracting stimuli.

**Internal shift task.** Whereas response probe and visual search paradigms assess selective attention for external stimuli, some researchers have proposed a distinction between attention for external visual-spatial stimuli and internal information, such as thoughts, feelings, and internal representations of stimuli in working memory (Chun, Golomb, & Turk-Browne, 2011). As a result, De Lissnyder, Koster, and De Raedt (2012a) developed the internal shift task (IST) which assesses ability to shift internal attentional focus between emotional and neutral representations of stimuli. In the IST, participants are required to perform a mental count task based on either the emotional expression of facial stimuli (e.g., count the number of negative and neutral faces; emotional condition) or non-emotional features of facial stimuli (e.g., count the number of male and female faces; non-emotional condition). As such, participant's internal focus of attention is directed towards either emotional or non-emotional features of stimuli. Depending on the experimental condition, the IST can be used to assess both general attentional switching abilities and valence-specific bias in attentional switching. General attentional switching abilities can be inferred from switching costs (i.e., performance on switch relative to no-switch trials) in the non-emotional condition. In contrast, attentional bias can be inferred from relative switching costs within the emotional condition, by comparing performance when switching from the processing of emotional to neutral stimuli (e.g., switching from counting a negative face to counting a neutral face), and vice-versa. Greater attentional bias for negative information would be

indicated by greater relative impairment switching from the processing of negative to neutral information. However, although the IST has the advantage of assessing attentional bias for internal representations of information, it is not clear to what extent this is a pure measure of selective attention. It is possible that biases in other aspects of cognition, such as memory and inhibition may influence performance on the IST.

**Emotional flanker task.** In the emotional flanker task (Fenske & Eastwood, 2003), participants are required to identify the valence of a centrally presented emotional target stimulus, whilst ignoring flanker stimuli, which can be either congruent (i.e., same valence as the target), incongruent (i.e., opposite valence to the target), or neutral. The degree to which response latencies are slower in the presence of incongruent stimuli (interference effect) or faster in the presence of congruent stimuli (facilitation effect) indicates attentional interference from flanker stimuli. Thus, attentional bias can be inferred from the relative degree of interference and facilitation effects from different emotional stimuli. However, as with the IST, it is not clear whether the emotional flanker task is a pure measure of attentional bias, as performance on this task may be influenced by biases other aspects of cognition, such as inhibition, working memory and priming.

**Attentional bias modification.** Each of the paradigms discussed so far can be used to measure selective attention, but it is also possible to manipulate attentional biases using attentional bias modification (ABM), in order to investigate the causal effects of attentional bias. ABM techniques typically involve modifying tasks originally used to measure attentional bias, such that the contingencies of an attentional task are manipulated in order to induce biased attention either towards or away from emotional stimuli (Hertel & Mathews, 2011). One of the most common ABM approaches involves manipulating the contingencies of the dot-probe task

(e.g., MacLeod, Rutherford, Campbell, Ebsworthy & Holker, 2002; Mathews & MacLeod, 2002), such that target probes disproportionately appear in the location of particular stimuli. For example, if target probes mostly appear in the location of negative stimuli, then faster responding can be achieved by preferentially directing attention towards the location of negative stimuli, thus encouraging an attentional processing bias towards negative stimuli. In contrast, if target probes mostly appear in the location distal to negative stimuli, faster responding can be achieved by preferentially directing attention away from the location of negative stimuli, so attentional bias towards negative stimuli is discouraged. Visual search tasks have also been used to modify attentional bias, by manipulating the types of stimuli participants are required to search for (e.g., Dandeneau, Baldwin, Baccus, Sakellaropoulo, & Pruessner, 2007). For example, whereas instructing participants to search for negative stimuli among non-negative distractors induces attentional bias towards negative stimuli, instructing participants to search for non-negative stimuli among negative distractors reduces attentional bias for negative stimuli. Such ABM techniques have generally been shown to be effective at changing attentional bias, as assessed by the standard tasks described above (see Clarke, Notebaert, & MacLeod, 2014 for review)

### **1.2.2 Selective attention and emotional vulnerability**

There is strong converging evidence from studies using the experimental methodologies outlined above indicating that selective attention for negative information is associated with emotional vulnerability. In particular, there is strong evidence relating anxiety to an attentional bias for threatening information (for reviews see Armstrong & Olatunji, 2012; Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007; Cisler & Koster, 2010; Dalgleish & Watts, 1990; Mogg & Bradley, 2005). Initial studies using the dot-probe task found that clinically anxious participants were consistently faster to respond to probes that appeared in the

prior location of threatening words relative to neutral words, whereas normal controls showed the opposite pattern of results, and were faster to respond to probes appearing away from threatening stimuli (MacLeod et al., 1986). Multiple studies have since found a similar bias for threatening stimuli using the dot-probe task in both clinically anxious (Bradley, Mogg, White, Groom, & de Bono, 1999; Mathews, Ridgeway, & Williamson, 1996; Mogg, Bradley, & Williams, 1995; Musa, Lepine, Clark, Mansell, & Ehlers, 2003; Taghavi, Neshat-Doost, Moradi, Yule, & Dalgleish, 1999; Tata, Leibowitz, Prunty, Cameron, & Pickering, 1996) and high-trait anxious participants (Bradley, Mogg, Falla, & Hamilton, 1998; Koster, Verschuere, Crombez, & Van Damme, 2005; MacLeod & Mathews, 1988; Mogg & Bradley, 1999; Tata et al., 1996), and also that higher levels of state anxiety are associated with greater bias for threat within non-clinical samples (Bradley, Mogg, & Millar, 2000; Mogg, Bradley, de Bono, & Painter, 1997). Furthermore, recent studies using Grafton et al.'s (2012) modified dot-probe task to assess attentional engagement and disengagement bias have found that heightened levels of anxiety vulnerability are associated with both facilitated attentional engagement with, and impaired attentional disengagement from threatening stimuli (Grafton & MacLeod, 2014; Rudaizky, Basanovic, & MacLeod, 2014). One study has also suggested that there may be an interaction between state and trait anxiety, as high-trait anxious participants demonstrated a greater increase in bias for concern-relevant threatening stimuli during a period of elevated state anxiety relative to low-trait anxious participants (MacLeod & Mathews, 1988).

Findings from eye-tracking studies have supported and extended the evidence for an attentional bias towards threat in anxiety, demonstrating that anxious participants initially orient towards threatening stimuli more frequently and more quickly than non-anxious controls during free-viewing and dot-probe tasks (Armstrong, Olatunji, Sarawgi, & Simmons, 2010; Calvo &

Avero, 2005; Felmingham, Rennie, Manor, & Bryant, 2011; Gamble & Rapee, 2010; Mogg et al., 2000; Mogg, Garner & Bradley, 2007; Rinck & Becker, 2006), consistent with threat-vigilance models of attention in anxiety (see Armstrong & Olatunji, 2012, for review and meta-analysis). Similarly, eye-tracking during visual search tasks has demonstrated that anxious individuals are typically faster to fixate on threat stimuli embedded in neutral distractors than non-anxious individuals (Miltner, Krieschel, Hecht, Trippe & Weiss, 2004; see Armstrong & Olatunji, 2012, for review and meta-analysis).

Evidence for selective attention in depression, however, has typically been more mixed (for reviews see Dalglish & Watts, 1990; Mogg & Bradley, 2005; Peckham, McHugh & Otto, 2010). Various dot-probe studies found no evidence of selective attention in depression (Hill & Dutton, 1989; MacLeod et al., 1986; Mogg et al., 2000; Neshat-Doost, Moradi, Taghavi, Yule, & Dalglish, 2000) and some have even suggested that co-morbid depression may suppress attentional biases towards threat in anxiety (Musa et al., 2003; Taghavi et al., 1999). However, other studies have found evidence of selective attention towards negative information in depressed and dysphoric participants using the dot-probe task (Bradley, Mogg, & Lee, 1997; Donaldson, Lam, & Mathews, 2007; Gotlib et al., 2004a; Gotlib, Krasnoperova, Yue, & Joormann, 2004b; Joormann & Gotlib, 2007; Mathews et al., 1996; Mogg et al., 1995; Shane & Peterson, 2007).

These inconsistencies may be explained by considering the particular circumstances under which attentional biases are found in depression (Mogg & Bradley, 2005). Firstly, the relevance of particular stimuli to the disorder of interest may be important, as many of the studies failing to find a bias for negative information in depression only used threatening stimuli, which are likely to be more relevant to anxiety disorders and less relevant to depression. Studies

directly comparing selective attention for different types of stimuli in depression have found biases for socially but not physically threatening words (Mathews et al., 1996), depression-related but not anxiety-related words (Bradley et al., 1997), and sad but not angry faces (Gotlib et al., 2004a; Gotlib et al., 2004b). In addition, a number of studies have suggested that stimulus exposure duration may be relevant, finding that depressed participants only demonstrate a bias on the dot-probe task at exposure durations of at least 1000ms (Bradley et al., 1997; Donaldson et al., 2007), suggesting that selective attention in depression may operate at later stages of processing than in anxiety. The extent to which particular dot-probe studies converge with these experimental conditions is able to account for many, although not all of the inconsistent findings in depression (Mogg & Bradley, 2005). Thus, there is evidence to suggest that depression may be specifically associated with attentional bias for depression relevant stimuli presented for longer exposure durations.

Converging evidence from eye-tracking studies has also supported the existence of an attentional bias in depression, finding that depressed participants demonstrate increased maintenance of gaze on dysphoric stimuli during free viewing (Arndt, Newman, & Sears, 2014; Eizenman et al., 2003; Kellough et al., 2008; Leyman, De Raedt, Vaeyens, & Philippaerts, 2011; see Armstrong & Olatunji, 2012 for meta-analysis), and that dysphoric participants are slower to disengage attention from dysphoric stimuli when required (Sanchez, Vazquez, Marker, LeMoult, & Joormann, 2013; Sears et al., 2010). In contrast, eye-tracking studies have not found evidence of an orienting bias for negative stimuli in depression (Kellough et al., 2008; Mogg et al., 2000; Sears et al., 2010; see Armstrong & Olatunji, 2012 for meta-analysis). Thus, the eye-tracking evidence suggests that selective attention for negative stimuli in depression involves the

maintenance and impaired disengagement of attention from dysphoric stimuli, which is consistent with explanations for the discrepant findings from dot-probe studies.

Selective attention appears not only to be a correlate of depressed mood, but also seems to be a factor associated with vulnerability to depression. Previously depressed individuals have been found to demonstrate biased attention for negative stimuli similar to the bias observed in currently depressed individuals (Joorman & Gotlib, 2007; Sears, Newman, Ference, & Thomas, 2011). Other studies have suggested that there may be an interaction between trait and state variables, such that individual differences in selective attention during sad or depressed mood may be associated with vulnerability for depression. Individuals identified as at risk of developing depression (children of mothers with recurrent depression) have been found to show greater bias for negative facial expressions following a negative mood induction relative to controls (Joormann, Talbot, & Gotlib, 2007). Furthermore, the extent to which participants demonstrate biased attention for negative information following a negative mood induction has been found to interact with life-stress to prospectively predict future dysphoria (Beevers & Carver, 2003). Such findings suggest that the attentional patterns that an individual adopts in response to negative mood may be associated with vulnerability to depression, rather than the presence of a consistent bias for negative stimuli regardless of mood state.

Experimental studies employing ABM have also supported the causal role that selective attention might play in emotional vulnerability. Initial studies utilising modified dot-probe tasks by MacLeod and colleagues (MacLeod et al., 2002; Mathews & MacLeod, 2002) found that healthy participants trained to attend to negative stimuli reported stronger negative reactions to a stressor than those trained to attend to neutral stimuli. Similarly, participants trained to attend away from negative stimuli using a home-based training program have reported reduced anxiety

in response to a real-life stressor, as well as reduced trait anxiety in comparison to no-training controls (See, MacLeod, & Bridle, 2009). Various studies using ABM programs have also been successful in reducing symptoms in anxious populations (Amir, Beard, Burns, & Bomyea, 2009a; Amir et al., 2009b; Hazen, Vasey, & Schmidt, 2009; Li, Tan, Qian, & Liu, 2008; Schmidt, Richey, Buckner, & Timpano, 2009; see Hakamata et al., 2010 for meta-analysis), and also in reducing anxiety in response to a public-speaking challenge in socially anxious participants (Amir, Weber, Beard, Bomyea, & Taylor, 2008). There is also some research successfully utilising ABM to reduced depressive symptoms in dysphoric individuals (Wells & Beevers, 2010; Yang, Ding, Dai, Peng, & Zhang, 2015). Such studies suggest selective attention plays a causal role in the development and maintenance of emotional disorders, and suggest that ABM may have some therapeutic value as an intervention.

### **1.3 Theoretical Models of an Association between Rumination and Attentional Processing Bias**

Since rumination primarily involves processing of negative content, we might expect heightened ruminative disposition to be related to selective processing of negative material, including an attentional bias towards negative information (e.g., Watkins, 2008). Initial conceptualisations of rumination characterised it as a particular ‘behavioural-attentional style’ (Nolen-Hoeksema, 1991, p. 569), where attention is focused on depressive symptoms. Moreover, given the close correspondence between rumination and depression, one might expect rumination to also be associated with the negative attentional biases found in depression, especially those involving depression-related material and longer presentation times. Attentional bias researchers have also suggested that the evidence for maintained processing of negative material in depression is consistent with evidence of ruminative thinking styles (e.g., Mogg & Bradley,

2005), and that deficits in the inhibition of negative material may explain rumination due to more difficulty discarding negative thoughts from working memory (Joormann, 2010). In the following section, three principal models implicating an association between rumination and attentional processing bias will be considered.

### **1.3.1 The Impaired Disengagement Account of Rumination**

According to the impaired disengagement hypothesis put forward by Koster and colleagues (Koster, De Lissnyder, Derakshan, & De Raedt, 2011), difficulty disengaging attention away from negative information is an underlying process contributing to heightened levels of ruminative disposition. This model of rumination highlights that the experience of negative life events or mood states typically triggers negative ruminative thoughts, termed ‘cued rumination’. In this sense, engaging in cued rumination is considered normal and non-pathological, but when rumination becomes more repetitive and persistent this is characteristic of pathological rumination. The disengagement hypothesis suggests that when an individual experiences such negative ruminative thoughts, this will generally lead to cognitive conflict followed by the recruitment of attentional control resources to disengage from these thoughts and reduce this conflict. If the disengagement of attention from negative information is disrupted then negative thoughts will be maintained resulting in persistent rumination. Thus, impaired attentional disengagement from negative information contributes to a greater tendency to engage in persistent, repetitive rumination in response to negative events and mood. This impaired attentional disengagement model is illustrated in Figure 1.1.

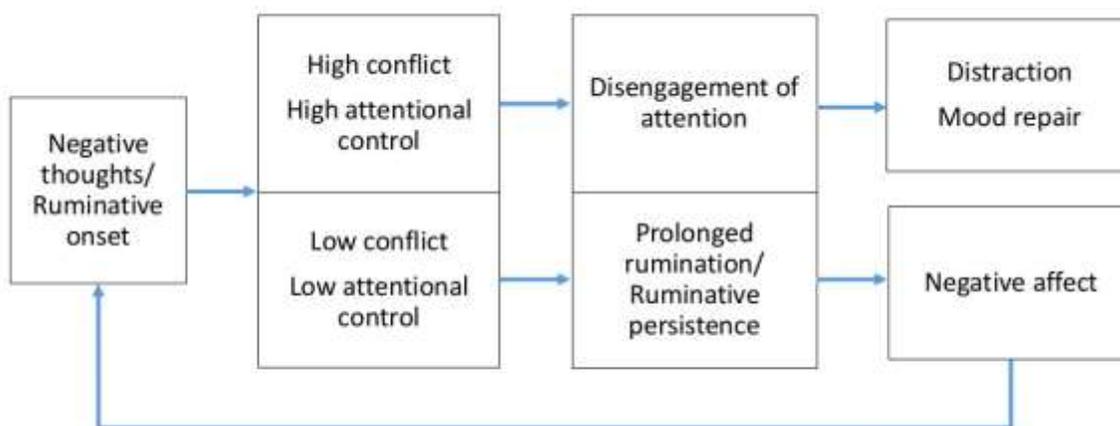


Figure 1.1. Outline of Koster et al.'s (2011) impaired disengagement model of rumination.

Koster et al. (2011) propose two main mechanisms through which attentional disengagement from negative thoughts can be disrupted. The first is impaired conflict signalling, which can occur when individuals have negative self-schemas, meaning that negative thoughts are consistent with self-schemas, and thus do not elicit cognitive conflict. In this case, there will be reduced attempts to disengage attention from negative thoughts, resulting in sustained attentional focus on negative thoughts.

The second mechanism is through intact conflict signalling, but impaired attentional control. Attentional control refers to the ability to selectively attend to relevant information, and inhibit the attentional processing of irrelevant information. Thus, if attentional control is impaired, individuals will have greater difficulty terminating negative thoughts, leading to more persistent rumination. In this case, greater attentional bias for negative information is at least in part a direct result of deficits in attentional control.

It is important to note that whilst Koster et al.'s (2011) model emphasises the role of impaired attentional disengagement in contributing to heightened levels of rumination, it does

not explicitly discuss the potential role of attentional engagement in rumination. A strong interpretation of this model would therefore suggest that, as far as selective attention is concerned, only attentional disengagement bias contributes to ruminative disposition, and that attentional engagement bias is not associated with ruminative disposition. Alternatively, a more open interpretation would suggest that attentional engagement bias could be an additional, unspecified factor contributing to heightened ruminative disposition.

### **1.3.2 Joormann's (2010) Cognitive Inhibition Model**

Joormann's (2010) cognitive inhibition model of depression proposes a number of ways in which deficits in the inhibition of negative material is associated with increased risk for depression, including how inhibition impairments might be associated with increased tendency to ruminate during negative mood. Inhibition is broadly defined as an executive control process that limits the access of information to working memory, and removes no longer relevant information (Hasher, Zacks, & May, 1999). With regard to rumination, it is proposed that impaired inhibition in the form of greater difficulty removing negative material from working memory is associated with increased tendency to ruminate during negative mood.

Similar to Koster et al. (2011), it is acknowledged that the experience of negative events leads to negative mood and the activation of negative cognitions, which are usually transient and quickly replaced by cognitions facilitating mood repair. However, if the removal of negative material from working memory is impaired, this will result in sustained attentional focus on negative cognitions, leading to persistent rumination. Thus, Joormann's (2010) model also predicts that higher levels of ruminative disposition will be associated with impaired attentional disengagement from negative information. However, whereas Koster et al.'s (2011) model focuses specifically on impairments in attentional control and disengagement, Joormann's (2010)

model incorporates these impairments within broader inhibition deficits in the removal of negative material from working memory.

### **1.3.3 The Attentional Scope Model of Rumination**

An alternative attentional processing account of individual differences in ruminative disposition is the attentional scope model of rumination (Whitmer & Gotlib, 2013). According to the attentional scope model, heightened levels of ruminative disposition are associated with a more narrowed attentional scope. A more narrowed attentional scope reduces the array of information available for attentional selection, resulting in more constricted and less flexible attentional processing. Thus, when negative ruminative thoughts are activated by negative mood, individuals with a more narrowed attentional scope will have a more limited array of alternative thoughts and actions available to divert attention away from negative thoughts, thus increasing the likelihood of repetitive, persistent rumination. In contrast, individuals with a broader attentional scope will more easily shift their attention towards a wider array of thoughts and activities, thus facilitating the termination of negative thoughts through distraction.

According to this account, heightened ruminative disposition is not directly associated with an attentional bias for negative information. Instead, rumination-linked attentional bias in depressed individuals is a product of a narrowed attentional scope which exacerbates the effects of depressed mood on attentional bias. Negative mood states typically result in mood-congruent attentional bias (Beevers & Carver, 2003), which is exaggerated by a narrowed attentional scope, due to a reduced array of mood-incongruent information available for attentional selection. Thus, rumination-linked attentional bias effects are context dependent, such that heightened levels of ruminative disposition will only be associated with an attentional bias for negative information during negative mood states.

The attentional scope model is not necessarily inconsistent with the impaired disengagement model. A more narrowed attentional scope could conceivably contribute to greater difficulty in disengaging attention from mood-congruent information during negative mood states. However, whereas the attentional scope model implies that ruminative disposition will only be associated with attentional bias for negative information during negative mood states, the impaired disengagement model allows for a relationship between ruminative disposition and attentional bias regardless of mood state. Since previous research has mostly only investigated the relationship between ruminative disposition and attentional bias within depressed participants, it is currently difficult to determine whether this association is dependent on mood state, and thus whether rumination-linked attentional bias may be a product of narrowed attentional scope or impaired attentional disengagement.

## **1.4 Evidence in Support of Attentional Processing Models of Rumination**

### **1.4.1 Rumination and Attentional Bias for Negative Information**

A number of studies have found evidence that heightened levels of ruminative disposition are associated with an attentional bias for negative stimuli using the dot-probe task, thus explicitly relating rumination to a bias in selective attention. Donaldson, Lam, and Mathews (2007) found that in a sample of depressed participants, RRS scores were positively correlated with greater attentional bias for depression relevant negative words presented for 1000ms, but not 500ms, relative to neutral words. Similarly, Joormann, Dkane, and Gotlib (2006) found a relationship between ruminative disposition and an attentional bias for sad faces presented for 1000ms relative to neutral faces, but not happy or angry faces, in depressed individuals. The relationship was also only significant for the brooding component of rumination, and not for reflective pondering, suggesting that the relationship with attentional bias for negative

information may be specific to more negative styles of ruminative thinking. Hilt and Pollak (2013) also found that adolescents that engaged in rumination in response to a laboratory stressor displayed a reduced attentional bias for happy faces presented for 1,500ms relative to neutral faces. Thus, heightened levels of ruminative disposition appear to be associated with greater attentional bias for depression relevant negative information presented for longer stimulus exposure durations, similar to patterns of attentional bias associated with depression.

The association between ruminative disposition and attentional bias does not, however, appear to be simply a by-product of relationship between depression and attentional bias. Instead, the relationship between ruminative disposition and attentional bias has been shown to remain significant after controlling for current depressive symptoms (Donaldson et al., 2007; Hilt & Pollack, 2013; Joormann, Dkane & Gotlib, 2006), indicating that this association is independent of depression.

Such findings that heightened ruminative disposition is independently associated with increased attentional bias provide good initial support for models proposing that rumination is associated with sustained attentional processing of negative material, as a result of impaired attentional disengagement from negative information (Joormann, 2010; Koster et al., 2011). However, as outlined above (see Section 1.2.1), the standard dot-probe task used these studies is not capable of adequately distinguishing between attentional engagement and disengagement bias. Evidence of biased attention only for stimuli presented for longer exposure durations may suggest that this bias operates at later stages of processing involving the disengagement of attention, but it is unclear whether biases at longer exposure durations necessarily indicate impaired attentional disengagement. Thus, based on present findings, heightened ruminative

disposition could involve either impaired attentional disengagement from negative information, facilitated attentional engagement with negative information, or a combination of both.

It also worth noting that a couple of studies have examined the relationship between ruminative disposition and attentional bias on the exogenous cuing task, but findings from these studies have been mixed. LeMoult, Arditte, D'Avanzato, and Joormann (2013) found that individuals who reported higher levels of rumination in response to a laboratory stressor allocated more attention to emotional relative to neutral information on invalid trials (i.e., trials where the probe appears distal to cue stimuli), which was interpreted as evidence of impaired attentional disengagement from emotional information. In contrast, Vanderhasselt, Koster, Goubert, and De Raedt (2012) found that higher levels of ruminative reflection in response to life stress was associated with less attentional allocation to emotional relative to neutral information, whereas ruminative brooding was not associated with biased attentional processing of emotional information. However, as discussed earlier in this chapter (see Section 1.2.1), the exogenous cuing task does not provide an unambiguous measure of selective attention and cannot adequately distinguish between attentional engagement and disengagement bias (Clarke et al., 2013).

However, it is notable that these studies have primarily only investigated the relationship between ruminative disposition and attentional bias within depressed samples. It is therefore not yet clear whether findings extend to non-clinical populations. According to the attentional scope model (Whitmer & Gotlib, 2013), individual differences in ruminative disposition will only be associated with attentional bias for negative information during negative mood states, due to narrowed attentional scope exacerbating the effects of negative mood on attentional bias. Since previous research has mostly only investigated the relationship between ruminative disposition

and attentional bias within depressed participants, it is currently difficult to determine whether this association is dependent on mood state, and thus whether rumination-linked attentional bias may be a product of narrowed attentional scope.

There is also promising initial evidence to support the prediction that biased attentional processing of negative information is an underlying process causally contributing to increased tendency to ruminate. Yang et al. (2015) conducted a randomised control trial investigating the effectiveness of ABM as a treatment for depression, in which ABM training attentional bias away from negative stimuli was compared to a placebo training and assessment only controls. Both depressive symptoms and ruminative disposition were reduced in the ABM relative to control conditions. Furthermore, changes in ruminative disposition mediated the effects of ABM on depressive symptoms, such that greater decreases in rumination were associated with greater reductions in depressive symptoms. However, this study was limited by a relatively small non-clinical sample of college students. Further replication of the causal effect of attentional bias on ruminative disposition, and extension to clinical samples is therefore required to provide converging support for this finding.

#### **1.4.2 Rumination and Inhibition of Negative Information**

A number of studies have also linked heightened ruminative disposition to deficits in the inhibition and control of negative material. Higher levels of ruminative disposition have been associated with impaired inhibition of previously relevant negative material when switching between task settings (De Lissnyder, Koster, Derakshan, & De Raedt, 2010). Using the internal shift task (IST), it has also been demonstrated that higher levels of ruminative disposition are associated with greater impairments in shifting away from the processing of negative information (De Lissnyder et al., 2012a; De Lissnyder, et al., 2012b; Koster, De Lissnyder, & De Raedt,

2013). Furthermore, heightened ruminative disposition has been found to be associated with both impairments in preventing irrelevant negative information from accessing working memory (Joormann, 2006; Zetsche & Joormann, 2011), and difficulty in removing no longer relevant negative information from working memory (Joormann & Gotlib, 2008; Zetsche, D'Avanzato, & Joormann, 2012). Similarly, higher levels of ruminative disposition have also been found to be associated with greater interference from negative distractors on an emotional flanker task (Pe, Vandekerckhove, & Kuppens, 2013). Such findings demonstrate that heightened ruminative disposition is associated with a deficit in controlling the processing of negative material, consistent with an attentional bias for negative information. Yet, since inhibition involves multiple information processing components, it is unclear from these findings whether impaired inhibition of negative material reflects a bias in selective attention, or other aspects of information processing such as working memory.

### **1.4.3 Rumination and General Attentional Control Deficits**

The impaired disengagement hypothesis suggests that rumination-linked attentional bias for negative information may at least in part be a result of general deficits in attentional control. In support of this proposal, there is considerable evidence for a relationship between heightened ruminative disposition and impairments in attentional control. Davis and Nolen-Hoeksema (2000) found that individuals with higher levels of ruminative disposition were more likely to persist in performing a task according to an old rule after the rule had changed, despite being given feedback their responses were incorrect. Similarly, heightened dispositional ruminative brooding has been found to be related to impaired inhibition of previous task settings (De Lissnyder et al., 2010; Whitmer & Banich, 2007) and impaired switching between different task settings on the IST (De Lissnyder et al., 2010; De Lissnyder, et al., 2012b; Demeyer, De

Lissnyder, Koster, & De Raedt, 2012). One study also found that ruminative brooding was related to difficulty inhibiting orienting responses towards an abrupt cue on an anti-saccade task (De Lissnyder, Derakshan, De Raedt, & Koster, 2011), indicating impairments in the control of visual-spatial attention.

However, although research has clearly demonstrated a relationship between heightened ruminative disposition and attentional control impairments, such research has yet to assess attentional bias and attentional control within the same study. As a result, it is not yet clear whether rumination-linked attentional bias and attentional control deficits are functionally associated with each other, or whether impaired attentional control and biased attentional processing of negative information represent separate cognitive characteristics contributing to higher levels of ruminative disposition. In addition to assessing the correlation between rumination-linked attentional control deficits and attentional bias, further research investigating the effect of manipulating attentional control on attentional bias and rumination will be necessary to test prediction that attentional control deficits causally contribute to attentional bias and heightened ruminative disposition.

#### **1.4.4 Selective Attention and Worry**

Another key line of evidence comes from the worry literature, as since both worry and rumination involve repetitive negative thought, it is reasonable to expect that similar processes may be involved in each. Aside from the substantial evidence described above implicating attentional bias for threat in anxious participants (who are also known to demonstrate elevated worry), some studies have also specifically demonstrated a relationship between tendency to worry (measured by the PSWQ) and biased attentional processing. Gole, Köchel, Schäfer, and Schienle (2011) used an emotional ‘go/no-go’ task to index selective attention, where participants were required to make go/no-go decisions (i.e. button press, or withhold press) based

on either the semantic meaning of the stimuli (i.e. aversive or neutral) or the syntactic features of the word (i.e. upper or lower case letters). Participants in the high worry group had shorter reaction times (argued to indicate enhanced attentional engagement), larger commission errors (i.e. incorrectly responding to a no-go stimulus, argued to indicate attentional disengagement), and fewer omission errors (i.e. failure to respond to a go stimulus, argued to indicate enhanced sensitivity), when go stimuli were threat words, relative to neutral words. However, although bias in selective attention may be involved in performance on this task, other types of processing bias may also be involved which could account for this effect, such as impaired inhibition.

Another study by Verkuil, Brosschot, Putman, and Thayer (2009) used an exogenous cueing task to demonstrate that high trait worry in combination with high trait anxiety was associated with reduced inhibition of return (IOR; the tendency to respond faster to invalidly cued relative to validly cued trials when stimuli are presented for relatively long periods of time, see Posner & Cohen, 1984) for angry faces following an experimentally induced period of worry, which has been suggested to indicate impaired attentional disengagement from threat.

Furthermore, a number of studies have suggested that modifying attentional biases can influence worry. Krebs, Hirsch, and Mathews (2010) manipulated selective attention using a modified dot-probe task, and found that participants with excessive worry trained to attend to threat words reported more negative thought intrusions following a worry period compared to participants trained to attend to neutral words, although only when given explicit instructions to attend to threat during training. Similarly, Hayes, Hirsch, and Mathews (2010) found that high trait worry participants trained to attend away from threatening words and towards neutral words using both a modified dot-probe task and a dichotic listening task reported less negative thoughts than those who received no training. Unfortunately, because two attention training procedures

were used in this study, it is not possible to tell whether either or both contributed to the reduction in worry. Yet, such findings are useful because they suggest that attentional biases may causally influence repetitive thought.

Hirsch et al. (2011) used a different paradigm to modify selective attention, specifically targeting whether participants engaged or disengaged with the meanings of different types of words. Participants were required to make lexical decisions based on either the valence (i.e. aversive or neutral) or structure (i.e. upper or lower case) of various threatening or non-threatening words. The contingencies of the task were then set up to either encourage or discourage attentional engagement or disengagement from the meanings of threatening words. Participants encouraged to engage with threat reported more negative thoughts following the worry task than those discouraged from engaging with threat. However, procedures designed to influence disengagement from threat did not produce any differences in worry. Thus, this procedure sheds some doubt on the suggestion that difficulty disengaging attention from relevant information influences repetitive thought.

Given the conceptual differences between worry and rumination, particularly in terms of their primary content, it is not entirely clear to what extent associations between worry and attentional bias will extend to rumination. Overall though, these findings from generally provide further support for the proposal that biased attentional processing of negative material is associated with negative repetitive thought.

### **1.5 Unresolved Questions**

Despite theoretical accounts implicating attentional bias for negative information in rumination, the empirical evidence for this relationship is currently limited. Much of the research used to support the disengagement hypothesis has focused on general and valence-specific

deficits in inhibition and attentional control, and can be explained without necessarily invoking a specific bias in selective attention. Findings that ruminative disposition is associated with impaired inhibition of negative material (De Lissnyder et al., 2010; Joormann, 2006) could be explained by greater sensitivity to priming from negative stimuli, whereas greater difficulty in removing negative material from working memory (Joormann & Gotlib, 2008) could be explained by memory biases. Only a few studies to date have demonstrated a relationship between ruminative disposition and an unambiguous measure of selective attention by using the dot-probe task (Donaldson et al., 2007; Hilt & Pollak, 2013; Joormann et al., 2006). Thus, although there is some evidence for a relationship between elevated ruminative disposition and attentional bias for negative material, this finding requires further replication to improve confidence in its reliability. Similarly, further replication of the finding that this rumination-linked attentional bias specifically involves bias for depression relevant stimuli presented for longer stimulus exposure durations is also required.

Of particular importance to the impaired disengagement hypothesis, research demonstrating a link between ruminative disposition and attentional bias for negative information has yet to establish whether this bias involves impaired attentional disengagement from, or facilitated attentional engagement with negative stimuli. As outlined above (see Section 1.2.1), neither the standard dot-probe task nor the exogenous cueing task used in previous studies are capable of adequately distinguishing between attentional engagement and disengagement bias. Studies utilising the standard dot-probe task found biased attention for stimuli presented for longer exposure durations (1000ms or longer; Donaldson et al., 2007; Hilt & Pollak, 2013; Joormann et al., 2006), which may suggest that this bias operates at later stages of processing involving the disengagement of attention. However, it is unclear whether biases at longer

exposure durations necessarily indicate impaired attentional disengagement. Thus, based on present findings, heightened ruminative disposition could involve either impaired attentional disengagement from negative information, facilitated attentional engagement with negative information, or a combination of both. Also, some findings from the worry literature suggest a bias in attentional engagement but not disengagement might causally influence this type of repetitive thought (Hirsch et al., 2011).

Clarke et al. (2013) have outlined methodological criteria that must be met by research seeking to distinguish between attentional engagement and disengagement bias. In order to assess attentional disengagement bias, attention must initially be secured in the location of emotional stimuli, followed by assessment of latency to direct attention away from emotional stimuli. In order to assess attentional engagement bias, attention must initially be secured in a location distal to emotional stimuli, followed by assessment of latency to direct attention towards emotional stimuli. Grafton et al., (2012) developed a modified dot-probe paradigm fulfilling these methodological criteria, enabling the independent assessment of attentional engagement and disengagement bias. Thus, this modified dot-probe task provides an ideal paradigm for investigating the hypothesis that heightened levels of ruminative disposition are associated with impaired attentional disengagement from negative information.

In addition, in previous studies investigating the attentional basis of rumination, individual differences in ruminative disposition have primarily been assessed using the RRS questionnaire measure. However, there are two problems with exclusive reliance on such an assessment approach. Firstly, this questionnaire measure does not control for variability in the levels of exposure to negative events that respondents may have experienced. Thus, it is possible that a high score on the RRS could reflect more frequent, extended or intense exposure to

negative events capable of evoking rumination, rather than an increased tendency for rumination to be evoked by such negative events. Secondly, the RRS requires participants to draw on their long-term memory of past ruminative experience, across an extended period of time, and it is well known that retrieval from long-term memory can be highly susceptible to biases, such as mood-congruency and recency effects (Kihlstrom, Eich, Sandbrand, & Tobias, 2009; Trull & Ebner-Priemer, 2009). Such memory biases may influence participant's RRS responses in ways that compromise sensitive assessment of variability in ruminative disposition, thereby obscuring the association between individual differences in ruminative disposition and attentional bias to negative information. Thus, whatever association between ruminative disposition, as assessed by the RRS, and attentional bias is observed, it is important to seek converging evidence for this association from alternative measures of ruminative disposition which mitigates the problems of this assessment approach.

Furthermore, research has primarily only investigated the relationship between ruminative disposition and attentional bias within depressed samples. It is therefore not yet clear whether findings extend to non-clinical populations. Addressing this issue is particularly important with regard to the implications of the attentional scope model of rumination. According to the attentional scope model, individual differences in ruminative disposition will only be associated with attentional bias for negative information during negative mood states, due to narrowed attentional scope exacerbating the effects of negative mood on attentional bias. If the relationship between ruminative disposition and attentional bias is demonstrated within non-depressed individuals not currently experiencing negative mood, this would suggest that narrowed attentional scope cannot fully account for rumination-linked attentional bias. In

contrast, if this relationship is only apparent during negative mood states, this would indicate that rumination-linked attentional bias may be a product of narrowed attentional scope.

Further research is also required to investigate the role of attentional control in rumination-linked attentional bias. The impaired disengagement hypothesis suggests that difficulties disengaging attention from negative information may be caused by deficits in attentional control (Koster et al., 2011). Yet, although research has clearly demonstrated a relationship between heightened ruminative disposition and attentional control impairments (Davis & Nolen-Hoeksema, 2000; De Lissnyder et al., 2010; De Lissnyder et al., 2011; De Lissnyder, et al., 2012b; Demeyer et al., 2012; Whitmer & Banich, 2007), such research has yet to distinguish attentional control from attentional bias within the same study. As a result, it is not clear whether rumination-linked attentional bias and attentional control deficits are functionally associated with each other, or whether impaired attentional control and biased attentional processing of negative information represent separate cognitive characteristics contributing to higher levels of ruminative disposition.

Finally, the majority of research investigating the relationship between ruminative disposition and attentional bias has been purely correlational, meaning that the causal relationship remains unclear. Koster et al.,'s (2011) disengagement hypothesis suggests that impaired disengagement of attention from negative information is an underlying process contributing to greater tendency to ruminate. However, an equally persuasive case has been made that rumination may causally influence biased attentional processing of negative information. There is considerable evidence that rumination exacerbates the effects of negative mood on information processing biases, including interpretation bias, memory bias, and negative future thinking (Lavender & Watkins 2004; Lyubomirsky & Nolen-Hoeksema, 1995; Lyubomirsky et al., 1998). If individuals habitually ruminate during negative mood states, as

would be the case for those with high levels of ruminative disposition, such information processing biases could become increasingly ingrained and pervasive. Thus, the previously observed relationship between ruminative disposition and attentional bias for negative information could be at least partly explained by the effects of rumination on cognitive processing biases.

The aim of this thesis will be to further examine the relationship between ruminative disposition and attentional bias, in particular whether the tendency to ruminate is associated with impaired attentional disengagement from, or enhanced attentional engagement with negative information. Whereas previous research investigating the relationship between ruminative disposition and attentional bias has not used attentional assessment paradigms that can distinguish between biased attentional engagement and disengagement, this thesis will employ attentional assessment tasks fulfilling methodological criteria outlined by Clarke et al. (2013) for the independent assessment of attentional engagement and disengagement bias. These paradigms will include variants of Grafton et al.'s (2012) modified dot-probe task (Studies One, Two, & Four) and an eye-tracking assessment of attentional bias (Study Three). Consistent with Koster et al.'s (2011) impaired disengagement model, it is hypothesised that heightened levels of ruminative disposition will be associated with more impaired attentional disengagement from negative information. The thesis will also seek to investigate this relationship within non-depressed samples of participants, in order to determine whether the relationship between ruminative disposition and attentional bias extends to non-depressed populations. Attentional control will also be assessed alongside attentional bias, in an attempt to determine whether these represent separate or functionally associated facets of heightened ruminative disposition (Study Four). Finally, the thesis will take a first step towards examining the causal relationship between

rumination and selective attention, by investigating the effect of induced rumination on attentional bias (Study Five).

## CHAPTER TWO: Study One

### 2.1 Preface

The paper reported in the main section of this chapter has been accepted for publication at *Cognition and Emotion*, and is currently in press.

The primary aim of Study One was to examine the relationship between ruminative disposition and attentional bias using an attentional assessment paradigm capable of distinguishing between attentional engagement and disengagement bias. The impaired disengagement hypothesis (Koster, De Lissnyder, Derakshan, & De Raedt, 2011) suggests that heightened levels of ruminative disposition are associated with impaired attentional disengagement from negative information. However, previous studies demonstrating a relationship between heightened ruminative disposition and attentional bias for negative information (e.g., Donaldson, Lam, & Mathews, 2007; Joormann, Dkane, & Gotlib, 2006) were limited by their use of the standard dot-probe task, which cannot distinguish between attentional engagement and disengagement bias (Clarke, MacLeod, & Guastella, 2013). Thus, it is not yet clear whether this bias involves impaired attentional disengagement from, or facilitated attentional engagement with negative stimuli. Study One addressed this limitation by employing a modified dot-probe task designed to independently assess attentional engagement and disengagement bias (Grafton, Watkins, & MacLeod, 2012).

Secondly, Study One aimed to address the limitation that previous research demonstrating a relationship between rumination disposition and attentional bias, has exclusively relied on the Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991) questionnaire measure to assess individual differences in ruminative disposition. However, such

questionnaire measures are vulnerable to confounds such as individual differences in exposure to negative events and memory biases. Such confounds may influence participant's RRS responses in ways that compromise sensitive assessment of variability in ruminative disposition, thereby obscuring the association between individual differences in ruminative disposition and attentional bias to negative information. Thus, Study One sought to reduce these limitations by also assessing ruminative disposition using an in-vivo measure of increases in rumination in response to a controlled negative event.

Consistent with predictions from the impaired disengagement account of rumination (Koster et al., 2011), it was hypothesised that heightened levels of ruminative disposition, as assessed by both the RRS and an in-vivo measure, would be associated with more impaired attentional disengagement from negative relative to positive stimuli.

Heightened ruminative disposition is associated with impaired attentional disengagement from negative relative to positive information: Support for the “impaired disengagement” hypothesis

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## 2.2 Abstract

Information processing accounts of rumination propose that impaired attentional disengagement from negative information may underpin heightened disposition to experience ruminative brooding in response to negative mood. The present study examined the relationship between individual differences in ruminative disposition and selective attention, using a paradigm capable of distinguishing between biases in the engagement and disengagement of attention. Results showed that higher dispositional ruminative brooding, as measured by both the brooding subscale of the RRS and an in-vivo assessment of ruminative disposition, was associated with greater relative impairment disengaging attention from negative compared to positive stimuli. These findings thus provide support for the “impaired disengagement” account of ruminative brooding.

Keywords: rumination, brooding, attention, disengagement bias, engagement bias

### 2.3 Introduction

During their lives, bad things will happen to most people. For almost everyone, exposure to a bad event will elicit an increase in negative mood state. However, the severity of such negative emotional reactions is predicted by individual differences in the degree to which people tend to engage in rumination, a form of repetitive negative thinking that involves dwelling on the causes, meanings, and consequences of such events and feelings (Nolen-Hoeksema, McBride, & Larson, 1997). This observation that heightened negative emotional reactions to events can be predicted by elevated disposition to engage in rumination, has motivated researchers to investigate the cognitive factors that underpin ruminative disposition (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Investigators often seek to assess individual differences in ruminative disposition using questionnaire measures, most commonly the Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991). Factor analysis of the RRS has identified two distinct sub-types of rumination, termed 'brooding' and 'reflection'. The former is considered a maladaptive form of rumination that involves passively experiencing unpleasant thoughts concerning negative events and feelings, whereas the latter is considered a more adaptive form of rumination that involves an active attempt to problem solve in order to overcome negative mood (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). There is considerable evidence from prospective longitudinal studies, and from experimental studies, which suggests that the heightened disposition to engage in ruminative brooding, in particular, may play a critical role in the etiology and maintenance of depression (c.f. Nolen-Hoeksema et al., 2008; Watkins, 2008). Hence, it becomes crucial to delineate the cognitive processes that contribute to this maladaptive form of rumination.

Many investigators contend that biases in the selective attentional processing of negative relative to non-negative information underpin individual differences in the disposition to engage in ruminative brooding (Joormann, 2010; Siegle, Steinhauer, & Thase, 2004), and discriminate two facets of attentional selectivity that may be important in this regard (LeMoult, Arditte, D'Avanzato, & Joormann, 2013). The first is increased attentional engagement with negative information, reflecting a disproportionate tendency for attention to become more readily focused on distal information that is negative in emotional tone, and the second is impaired attentional disengagement from negative information, reflecting a disproportionate tendency for attention to be more firmly held by proximal information that is negative in emotional tone. The phenomenological experience of ruminative brooding suggests that it is characterised by difficulty in terminating negative thinking, and so it has been hypothesized that individual differences in ruminative brooding may specifically be underpinned by impaired attentional disengagement from negative information, rather than by increased attentional engagement with negative information (Koster, De Lissnyder, Derakshan, & De Raedt, 2011). According to this impaired disengagement hypothesis, the heightened tendency to experience the persistence of negative thoughts, which characterizes dispositional ruminative brooding, reflects difficulty disengaging attention from negative information.

Some researchers have used the emotional flanker task (Fenske & Eastwood, 2003) to assess attentional bias to negative information in rumination. In this approach, participants are required to execute a central task in the presence of flanker stimuli that are either negative or non-negative in emotional tone. The degree to which participants are slowed to complete the central task in the presence of negative flankers, relative to non-negative flankers, reveals attentional bias towards the former information compared to the latter. It has been demonstrated

that participants who report high levels of ruminative disposition on the RRS show relatively increased slowing of central task performance in the presence of negative flankers compared to non-negative flankers, consistent with the operation of a rumination-linked attentional bias to negative information (Pe, Vandekerckhove, & Kuppens, 2013).

Other researchers have instead employed the dot-probe task (MacLeod, Mathews, & Tata, 1986) to assess attentional bias to negative information in rumination. In this task, participants are briefly exposed to stimulus pairs comprising one negative member and one non-negative member, and are required to quickly discriminate the identity of a probe that is subsequently displayed in the location of either one of the two stimulus pair members. The degree to which participants are speeded to discriminate probes that appear in the locus of the negative information, relative to probes that appear in the locus of the non-negative information, reveals attentional bias towards negative compared to non-negative information. It has been shown that participants who score higher in ruminative disposition, as assessed by the RRS, are disproportionately speeded to discriminate probes in the locus of negative information, compared to those in the locus of positive information, suggesting that the distribution of their attention favors the locus of negative information (Donaldson, Lam, & Mathews, 2007; Joormann, Dkane, & Gotlib, 2006). In these studies, this association between ruminative disposition and attentional bias was independent of concurrent levels of depression.

The findings from these previous studies indicate that heightened ruminative disposition is characterised by an attentional bias to negative information. However, these studies are constrained by three significant limitations that leave them unable to shed light on the hypothesis that heightened ruminative brooding, in particular, is characterized specifically by impaired attentional disengagement from negative information. First, these studies have typically not

sought to distinguish variation in the disposition to engage in ruminative brooding from variation in the disposition to engage in ruminative reflection. Second, they have employed attentional assessment tasks that do not enable the independent assessment of biased attentional engagement with, and biased attentional disengagement from, negative information. Third, they have relied exclusively on the RRS questionnaire measure to assess individual differences in ruminative disposition. In the following, we consider each limitation in turn, and illustrate how each can be overcome.

To date, only one study has sought to investigate whether heightened dispositional ruminative brooding, in particular, is characterised by an attentional bias to negative information. Specifically, using the dot-probe task, Joormann et al. (2006) found that, compared to participants with lower levels of ruminative brooding, those with higher levels of ruminative brooding displayed greater attentional bias to negative information. In contrast, compared to participants with lower levels of ruminative reflection, those with higher levels of ruminative reflection did not show greater attentional bias to negative information. Hence, these findings provide support for the idea that the heightened disposition to engage in ruminative brooding, in particular, is characterised by an attentional bias to negative information. However, Joormann et al. (2006) used a conventional variant of the dot-probe task that it not designed to independently measure attentional engagement and disengagement bias (Clarke, MacLeod & Guastella, 2013; Mogg, Holmes, Gardner, & Bradley, 2008; Yiend, 2010). Thus, this study cannot shed light on the hypothesis that the heightened disposition to engage in ruminative brooding is characterised specifically by impaired attentional disengagement from negative information.

Independent assessment of the tendency for attention to be disproportionately captured by initially distal negative information (engagement bias), and to be disproportionately held by

initially proximal negative information (disengagement bias) requires that, on each trial, participants have their initial attentional focus respectively secured in a locus distal to where differentially valenced information is presented, or in a locus proximal to where differentially valenced information is presented (Grafton & MacLeod, 2014; Rudaizky, Basanovic, & MacLeod, 2014). Selective attention can then be assessed in the usual way, by comparing discrimination latencies to probes appearing in either the same or opposite location of this emotional information. Using this approach, trials on which negative information, relative to non-negative information, is presented distal to initial attentional focus enable the assessment of biased attentional engagement with negative information, whereas trials on which negative, relative to non-negative information, is presented proximal to initial attentional focus enable the assessment of biased attentional disengagement from negative information.

Unfortunately, the approach most commonly used to assess engagement bias and disengagement bias, a variant of the Posner cuing task (e.g., LeMoult et al., 2013), does not involve systematically anchoring the initial attentional focus of participants in a location either distally to, or proximally from, differentially valenced information, and so cannot enable independent assessment of these two facets of selective attention (Grafton & MacLeod, 2014; Rudaizky et al., 2014). Specifically, in this task, participants are instructed to initially attend to a central fixation cue. A single differentially valenced stimulus (negative or positive) is then briefly presented, either to the left or right of this initial attentional focus. Next, a target probe, to which the participant must rapidly execute a discriminatory response, appears in either the same or opposite location to where the single stimulus was just displayed. There are two problems with this approach. The first problem is that nothing requires, or verifies, that participants consistently follow the instruction to initially attend to the central fixation cue, which raises

serious concerns about whether attention is actually secured in this intended initial location. The second problem is that the differentially valenced information is then always presented in a location distal to the intended initial focus of attention. Thus, on every trial, the first attentional response made by participants would be influenced by the degree to which attention is captured by this initially distal information when it is negative compared to positive in emotional tone, and so the assessment of disengagement bias would be systematically contaminated by engagement bias.

To overcome the problems of such variants of the Posner cuing task, Grafton, Watkins, and MacLeod (2012) developed a modified dot-probe task that satisfies the methodological requirement that the initial attentional focus of participants is secured either distally to, or proximally from, differentially valenced information, thus enabling the independent assessment of selective attentional engagement with, and selective attentional disengagement from, negative information. Specifically, in this task, participants are initially instructed to attend to an upper or lower screen location. An anchor probe is then presented in this attended locus (for 150ms), and the participant is required to apprehend its identity. Immediately thereafter, a stimulus pair comprising an emotional letter string (negative or positive in emotional tone) and a non-emotional letter string is briefly displayed, one member appearing in each of the two critical screen locations, with equal frequency. Thus, the emotional letter string appears either proximally to where the participant is initially attending, or distally from this initial attentional focus. A target probe then appears in the location of either one of the two screen loci, and the participant is required to determine whether the identity of the target probe matches that of the anchor probe. The degree to which speeding to target probes in the locus of the emotional letter strings compared to non-emotional letter strings is greater when the emotional letter string is

negative compared to positive in emotional tone provides an index of attentional bias to negative information. On trials where the emotional letter string appears distal to initial attentional focus, this index of attentional bias to negative information reveals increased attentional engagement with negative compared to positive information. In contrast, on trials where the emotional letter string appears proximal to initial attentional focus, this index of attentional bias to negative information reveals reduced attentional disengagement from negative compared to positive information. The capacity of this approach to independently assess engagement bias and disengagement bias has been validated in a number of recent studies investigating the attentional basis of elevated anxiety vulnerability (Grafton & MacLeod, 2014; Grafton, et al., 2012; Rudaizky, et al., 2014). Hence, in the present study, we will deliver a dot-probe task, closely based on the procedure introduced by Grafton et al. (2012), in order to separately assess these two facets of attentional selectivity in rumination.

Finally, in previous studies investigating the attentional basis of rumination, individual differences in ruminative disposition have only been assessed using the RRS questionnaire measure. There are two problems with exclusive reliance on such an assessment approach. The first problem is that this questionnaire measure does not control for variability in the levels of exposure to negative events that respondents may have experienced. Thus, it is possible that a high score on the RRS could reflect more frequent, extended or intense exposure to negative events capable of evoking rumination, rather than an increased tendency for rumination to be evoked by such negative events. The second problem is that the RRS requires participants to draw on their long-term memory of past ruminative experience, across an extended period of time, and it is well known that retrieval from long-term memory can be highly susceptible to biases, such as mood-congruency and recency effects (Kihlstrom, Eich, Sandbrand, & Tobias,

2009; Trull & Ebner-Priemer, 2009). Such memory biases may influence participant's RRS responses in ways that compromise sensitive assessment of variability in ruminative disposition, thereby obscuring the association between individual differences in ruminative disposition and attentional bias to negative information. Thus, whatever association between ruminative disposition, as assessed by the RRS, and attentional bias is observed, it is important to seek converging evidence of this association effect when ruminative disposition is assessed in a manner that mitigates the potential problems associated with this questionnaire measure. Hence, in the present study, we also employed an in-vivo procedure to assess individual differences in ruminative disposition. Specifically, this involved exposing participants to a standardized event in the laboratory capable of eliciting an increase in negative mood state, and assessing their levels of rumination immediately before and immediately after this event. An index of ruminative disposition, reflecting the degree to which this controlled event served to evoke rumination, was obtained by computing the degree to which rumination was elevated post-compared to pre- this negative event. Higher levels of ruminative disposition will be revealed by greater increases in rumination following exposure to this negative event, relative to before such exposure. By ensuring that participants received equivalent exposure to the same negative event, under tightly controlled laboratory conditions, and minimizing reliance on long-term memory by assessing levels of rumination in very close temporal proximity to this event, we were able to minimize the problems associated with the RRS questionnaire measure of ruminative disposition.

In summary, the purpose of the current study was to empirically test the disengagement bias hypothesis put forward by Koster et al. (2011), according to which heightened ruminative brooding is characterised by impaired attentional disengagement from negative relative to positive information. To do this, we delivered a variant of the dot-probe task, which was closely

based on the approach introduced by Grafton et al. (2012), to participants who differed widely in terms of their disposition to engage in ruminative brooding. To assess this ruminative disposition we employed both the conventional RRS questionnaire measure, and an in-vivo assessment procedure, the latter mitigating the potential problems associated with the former approach.

## **2.4 Method**

### **2.4.1 Participants**

Participants were 63 students (17 male, 46 female; mean age = 20.2) from the University of Exeter, recruited from the psychology department or via a database of individuals who wished to be informed of opportunities to participate in research in the department. Participants were screened for depressive symptoms using the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996). Given that the study employed a stressor designed to induce negative mood state, for ethical reasons, individuals who scored 20 or above on the BDI, reflecting the standard cut-off for moderate levels of depression (Beck et al., 1996), were required to be excluded from participation in the study by our institutional review board. Overall, participants displayed a low level of depressive symptoms ( $M = 3.30$ ,  $SD = 3.69$ ). All participants spoke English as a first language.

### **2.4.2 Assessment of Ruminative Disposition**

#### **Questionnaire Measure of Ruminative Disposition: Ruminative Responses Scale.**

The Ruminative Response Scale questionnaire (RRS; Nolen-Hoeksema & Morrow, 1991) was employed as our questionnaire measure of ruminative disposition. The RRS is a 22-item retrospective report measure, which requires participants to indicate the degree to which they engage in particular ruminative responses when in a negative mood, on a 4-point Likert scale (1 = Almost Never, 4 = Almost Always). Of importance to the present study, this questionnaire

yields two subscales; ruminative brooding and ruminative reflection. Both of these subscales show acceptable reliability and consistency (Treyner et al., 2003). In each case, a higher score indicates a greater tendency to engage in each form of rumination in response to negative mood state.

**In-Vivo Measure of Ruminative Disposition: Elevation in Ruminative Thinking in Response to a Standardized Negative Event.** Ruminative disposition was also measured using an in-vivo approach that involved assessing levels of ruminative thinking immediately before, and immediately after, exposure to a controlled negative event in the laboratory. As described in detail below, this negative event was an anagram failure task. To assess levels of ruminative thinking at each of these two assessment points, we adapted the breathing focus task originally developed by Hirsch, Hayes, and Mathews (2009). In this task, participants were asked to try and focus on their breathing for 5 minutes. Throughout this 5 minute period, a tone sounded 12 times at random intervals of between 20 and 30 seconds. Whenever the tone sounded, participants were required to report whether they were currently focused on their breathing or were focused on a thought. If they were focused on a thought, they were required to give this thought a one or two word label, and classify it as negative, positive, or neutral in emotional tone <sup>1</sup>.

At the end of the 5 minute breathing period, the participant rated each recorded negative thought on five key dimensions relevant to rumination. Specifically, each negative thought was rated from 0 to 4 in terms of frequency (i.e., how often the thought came to mind), duration (i.e., how long they were thinking about the subject of the thought), repetitiveness (i.e., how much

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<sup>1</sup> In addition to having participants rate the negativity of their own thought content, an independent rater also verified the participants' valence ratings. Specifically, a blind assessor rated the valence of a random sample of 10% of participants' thoughts. These ratings showed that the assessor evidenced a high level of agreement with participants' own negative valence ratings (86%), thereby establishing convergent validity of the participants' ratings.

thoughts kept coming back to the same idea), severity (i.e., how upsetting or distressing the thought was), and control (i.e., how difficult it was to stop or move on to other thoughts; see Appendix One for full rating questions and response options). The ratings for each negative thought reported during the 5 minute breathing period were averaged across the total number of negative thoughts to yield a rumination score for that period. Using this rumination score data, an in-vivo index of ruminative disposition was obtained by computing the residuals from a simple linear regression predicting rumination scores post-anagram task from rumination scores pre-anagram task. A higher score on this index reflected a greater tendency to respond to the negative event by increasing ruminative thinking, and so indicated heightened ruminative disposition.

**Visual Analogue Assessment of Negative Mood.** To assess the impact of the anagram failure task on negative mood state, when each tone sounded during the breathing focus tasks, participants also completed two visual analogue mood rating scales, each 100 mm in length, that assessed state levels of sadness (scale labelled “sad and “happy” at each extreme) and anxiety (scale labelled “anxious” and “confident” at each extreme). Responses were scored on a scale ranging from 0 to 100. An index of negative mood reactivity to the anagram failure task was obtained by computing the residuals from a simple linear regression predicting negative mood scores post-anagram task from negative mood scores pre-anagram task.

**Anagram Failure Task.** In this anagram task, participants were given three minutes to solve 30 supposed anagrams. They were told that the anagram task predicted academic success, and that they should expect to solve five or six anagrams. Fifteen of the anagrams were soluble, in that their letters could be rearranged to form a legitimate English word, though these anagrams had been rated as very difficult to solve. The remaining 15 anagrams were insoluble, as the

letters of these anagrams could not be rearranged to form a legitimate English word. Most participants were unable to solve any of the anagrams (mean correct = 0.84,  $SD = 1.26$ ). One participant did, however, successfully solve more than five anagrams, and so was excluded from the analysis. At the end of the 3 minutes, participants were given their score, together with the feedback that this score was below average.

**Beck Depression Inventory (BDI-II; Beck et al., 1996).** The BDI-II is a 21-item self-report measure designed to assess the severity of depressive symptoms. Participants indicate on a 4-point scale how much they have experienced depressive symptoms over the past two weeks. We used a 20-item version of the BDI-II, with the item about suicidal feelings or ideation removed at the request of our institutional review board. Higher scores represent greater severity of depressive symptoms. This measure has shown good reliability and validity (Beck et al., 1996).

### **2.4.3 Apparatus**

A 22-inch computer monitor and a standard two-button mouse were used to present stimuli and record participant responses.

### **2.4.4 Experimental Stimuli**

In the present study, we required 64 word pairs each comprising an emotional word and neutral word, which were matched in terms of word length and frequency. The emotional word stimuli were taken from Grafton et al. (2012; see Appendix Two for full list of emotional word stimuli). Half of the emotional words were intended to be negative terms likely to be implicated in ruminative thinking (e.g. hopeless, lonely, sluggish), while the other half were intended to be positive terms unlikely to be implicated in ruminative thinking (e.g. pleased, calm, fun). These emotional word stimuli were rated by 4 graduate psychologists in terms of emotional valence,

likelihood of being implicated in ruminative thinking, and arousal. These ratings confirmed that our intentions were satisfied. Specifically, the negative words were rated as more negative than the positive words, and more likely to be involved in ruminative thinking (both  $p$ 's < .001). The negative words and positive words did not differ in terms of word length, frequency, or arousal (all  $p$ 's > .05).

#### **2.4.5 Attentional Bias Assessment Task**

Each trial began with the appearance of an upper and lower string of asterisks, indicating the two critical screen regions, centralised horizontally on the computer screen and separated by a distance of 3cm. Between the asterisks was a row of arrows, all pointing to the upper string, or all pointing to the lower string, with equal frequency. The arrows directed the participant which of the two screen regions to initially fixate attention upon. After one second, the screen was cleared, and an anchor probe was briefly presented (150ms) in this attended region. This anchor probe was a small (2mm) red line sloping upwards 45° to either the left or right, with equal frequency. Immediately thereafter, a word pair was presented, with one word appearing in each of the two critical screen regions. On half the trials the emotional member of the word pair appeared distal to the initially attended region (permitting the assessment of the biased attentional engagement with negative information), and on the remaining half of the trials the emotional member of the word pair appeared proximal to the initially attended region (permitting the assessment of biased attentional disengagement with negative information). The word pair was displayed for either 500ms or 1000ms, with equal frequency. A target probe stimulus then appeared in either of the two critical regions, with equal frequency. The target probe stimulus was again a small (2mm) red line sloping upwards 45° to either the left or right. Participants were required to indicate whether the slope direction of this target probe stimulus matched that

of the anchor probe, which was the case on 50% of trials. Participants responded by pressing either the right or left mouse buttons, to indicate a match and a non-match, respectively. The latency, and accuracy, to make this discrimination response was recorded. Upon detection of the participant's response the screen was cleared, and the next trial began after a 1000ms inter-trial interval. This sequence of events is summarized in the example trials shown in Figure 2.1.

The task consisted of 256 trials in total, split into two equal blocks of 128 trials, with a 30 second break in between. Across the task, each of the 64 word pairs was presented four times in a random order, with the constraint that each pair was presented once before any were presented a second time, and each was repeated once before any were displayed for a third time, and so on.

**Calculating Bias Indices.** In this task, selective attention to the emotional word members of the word pairs is revealed by relative speeding to make discrimination responses to target probes appearing in the locus of emotional words compared to target probes appearing in the locus of neutral words. Thus, an index of attentional bias to negative information relative to positive information can be computed by expressing the degree to which this relative speeding to discriminate probes in the locus of emotional words compared to probes appearing in the locus of neutral words, is greater when this word was negative, rather than positive, in emotional tone.

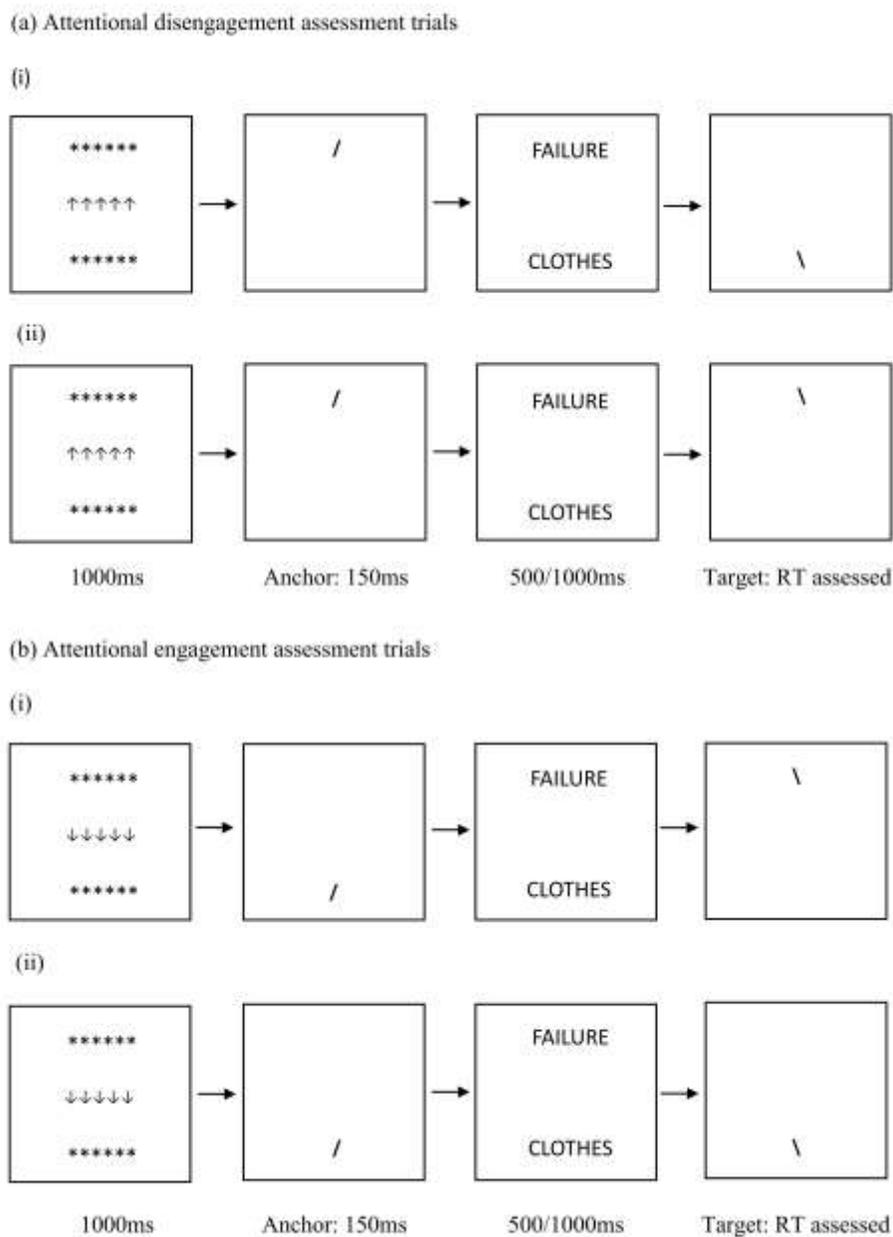


Figure 2.1. Examples of stimulus presentation locations; (a) (i) anchor proximal to emotional word, target distal to emotional word, (ii) anchor proximal to emotional word, target proximal to emotional word, (b) (i) anchor distal to emotional word, target proximal to emotional word, (ii) anchor distal to emotional word, target distal to emotional word. On attentional disengagement assessment trials the anchor appears in the location of the emotional word, whereas on attentional engagement assessment trials the anchor appears in the location of the neutral word.

Of most importance, the current task permits us to compute this negative attentional bias index under two conditions, in order to separately index facilitated attentional engagement with, and impaired attentional disengagement from, negative information. Specifically, an Engagement Bias Index can be computed by using the RT data from trials on which the emotional member of the word pair appeared distal to initial attentional focus (i.e. from trials on which the anchor probe appeared in the locus of the neutral word). Higher scores on this engagement bias index indicate that attention was captured to a greater degree by this distal information when it was negative rather than positive in emotional tone, and can be expressed using the following formula:

Attentional Engagement Bias Index = (RT anchor distal negative word, target distal negative word – RT anchor distal negative word, target proximal negative word) – (RT anchor distal positive word, target distal positive word – RT anchor distal positive word, target proximal positive word).

A Disengagement Bias Index can be computed by using the RT data from trials on which the emotional member of the word pair appeared proximal to initial attentional focus (i.e. from trials on which the anchor probe appeared in the locus of the emotional word). Higher scores on this disengagement bias index indicate that attention was held to a greater degree by this proximal emotional information when it was negative rather than positive in emotional tone, and can be expressed using the following formula:

Attentional Disengagement Bias Index = (RT anchor proximal negative word, target distal negative word – RT anchor proximal negative word, target proximal negative word) – (RT anchor proximal positive word, target distal positive word – RT anchor proximal positive word, target proximal positive word).

Probe discrimination latencies can only indicate attentional distribution if the response is made accurately, hence only RTs from accurate responses were used, and we eliminated any participants with an overall accuracy score that was atypically low using a 95% confidence interval. Following the approach adopted in prior research (Rutherford, MacLeod, & Campbell, 2004; Ratcliff, 1993), we used participants' median RT under each condition in these computations, to minimise the influence of outlying RTs <sup>2</sup>.

#### **2.4.6 Procedure**

Prior to commencing the experimental session, participants were told that the study was investigating the links between personality, mood, and cognitive abilities, and were given a basic description of each task. Participants then completed the BDI-II and RRS questionnaire measure. They were then seated approximately 40cm from the computer screen, and were given written instructions for the attentional assessment task. Next, they completed a brief practice task consisting of 16 trials using only neutral stimuli. Following this, they completed the attentional assessment task. Participants then practiced focusing on their breathing for a one minute period, before completing the in-vivo assessment of ruminative disposition.

### **2.5 Results**

Five participants who displayed atypically low accuracy on the attention probe task (using 95% confidence interval), and four who did not complete the full set of emotional assessment measures, were removed prior to analysis. The remaining participants displayed a high level of accuracy on the attention probe task, averaging less than 11% errors. There was no

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<sup>2</sup> Analyses were also conducted using mean RTs, rather than median RTs. Consistent with the argument that median RTs are more sensitive than means to the detection of RT (Ratcliff, 1993), there was no evidence of a relationship between our measures of ruminative brooding and attentional disengagement bias using this approach (all  $p$ 's > .05).

association between accuracy on the attentional bias assessment task and any of the measures of ruminative disposition (all  $p$ 's > .70).

Table 2.1. Descriptive statistics of participant characteristics, attentional bias indices, and in-vivo mood and rumination assessments (pre- and post-failure).

	Mean ( <i>SD</i> )	Range
BDI-II	3.30 (3.69)	0 - 14
RRS	42.5 (9.79)	25 - 67
Brooding	9.47 (2.84)	5 - 15
Reflection	10.3 (3.13)	5 - 18
Engagement Bias Index	-7.74 (109.1)	-322.0 - 196.4
Disengagement Bias Index	-15.70 (109.2)	-228.4 – 213.0
Pre-Failure Assessment		
Sadness	29.30 (12.60)	4.00 – 49.00
Anxiety	31.68 (14.07)	3.00 – 55.00
Rumination	0.98 (1.99)	0.00 – 7.00
Post-Failure Assessment		
Sadness	37.47 (14.88)	3.00 – 68.00
Anxiety	39.32 (14.75)	4.00 – 66.00
Rumination	4.70 (4.22)	0.00 – 15.40

Note: Note: BDI-II = Beck Depression Inventory II, RRS = Ruminative Responses Scale

### **2.5.1 Association between RRS Questionnaire Measure of Ruminative Disposition and Attentional Engagement and Disengagement Bias Indices**

To determine whether the heightened disposition to engage in ruminative brooding, in particular, is characterized specifically by impaired attentional disengagement from negative information, bivariate correlations were computed between the RRS ruminative brooding scores, the RRS ruminative reflection scores, and our two indices of attentional bias to negative information. The results of these correlational analyses are shown in Table 2.2. As can be seen, there was a significant positive correlation between ruminative brooding scores and disengagement bias scores,  $r(53) = .30, p = .032$ , reflecting the fact that higher ruminative brooding scores were associated with higher disengagement bias scores. This association remained evident, albeit at trend level, when controlling for BDI-II scores,  $r(50) = .25, p = .076$ , suggesting that the observed association between ruminative brooding and disengagement bias was independent of depression. No significant correlation was observed between ruminative brooding scores and engagement bias scores,  $r(53) = .08, p = .588$ . Further, the ruminative reflection scores were not significantly correlated with either measure of attentional bias to negative information (in both cases  $p > .30$ ). Hence, in keeping with the disengagement hypothesis proposed by Koster et al. (2011), the obtained pattern of results suggest that heightened ruminative brooding, in particular, is characterized by impaired attentional disengagement from negative relative to positive information.

Table 2.2. Bivariate correlations between RRS and in-vivo ruminative disposition scores, and attentional bias indices.

	Engagement Bias		Disengagement Bias	
	<i>r</i> (53)	<i>p</i>	<i>r</i> (53)	<i>p</i>
RRS Brooding	.08	.588	.30	.032*
RRS Reflection	-.13	.347	-.04	.773
In vivo-ruminative disposition	.11	.441	.33	.016*

Note: \*  $p < .05$

### 2.5.2 Association between In-Vivo Measure of Ruminative Disposition and Attentional Engagement and Disengagement Bias Indices

The anxiety and sadness scores obtained from the analogue mood scales delivered immediately before and immediately after the anagram failure task are shown in Table 1. A two-way repeated measures ANOVA that considered the within-group factors Mood Assessment Point (Pre-Anagram Mood Assessment vs. Post-Anagram Mood Assessment) and Mood Scale Type (Sadness vs. Anxiety) was used carried out on these data. The only effect to emerge from the analysis was a significant main effect of Mood Assessment Point,  $F(1, 52) = 46.18, p < .001, \eta_p^2 = .47$ , reflecting the fact that, in general, the level of negative mood indicated by the analogue mood scale scores was significantly higher at post-anagram assessment ( $M = 76.79, SD = 28.70$ ) compared to pre-anagram assessment ( $M = 60.98, SD = 25.35$ ). Thus, this confirms that the anagram failure task did serve to elevate negative mood state, as intended.

Next, a one-way repeated measures ANOVA that considered the within-group factor Rumination Assessment Point (Pre-Anagram Rumination Assessment vs. Post-Anagram Rumination Assessment) was carried out on the rumination scores obtained immediately before

and immediately after the anagram failure task. This analysis revealed a significant main effect of Rumination Assessment Point,  $F(1, 52) = 40.50, p < .001, \eta_p^2 = .44$ , reflecting the fact that participants displayed higher rumination scores at post-anagram assessment ( $M = 4.70, SD = 4.22$ ) compared to pre-anagram assessment ( $M = .98, SD = 1.99$ ). Thus, this confirms that the anagram failure task did serve to elicit an increase in rumination, as intended.

Of course, in the present study, our main interest was in individual differences in the degree to which rumination was elevated following this anagram failure experience. Hence, we went on to compute our in-vivo index of ruminative disposition, as described in the Method section. Correlation analysis revealed a significant positive association between these in-vivo ruminative disposition scores and RRS brooding scores,  $r(53) = .33, p = .016$ . In contrast, no such association was observed between these in-vivo ruminative disposition scores and RRS reflection scores,  $r(53) = .19, p = .166$ . Thus, this pattern of results indicates that our in-vivo measure of ruminative disposition reflects variation in the tendency for ruminative brooding to be elicited by a negative event, rather than variation in the tendency for ruminative reflection to be elicited by a negative event.

To determine whether converging evidence for the hypothesis that heightened ruminative brooding is characterized by reduced attentional disengagement from negative information would be obtained when such ruminative disposition was indexed by our in-vivo assessment procedure, rather than by the RRS, we computed bivariate correlations between our in-vivo ruminative brooding scores and our two indices of attentional bias to negative information. Consistent with the pattern of results obtained using the RRS, the present analysis revealed that in-vivo ruminative brooding scores were significantly positively associated with disengagement bias index scores,  $r(53) = .33, p = .016$ , and there was no evidence that in-vivo ruminative

brooding scores were significantly associated with engagement bias index scores,  $r(53) = .11, p = .441$ . Thus, this pattern of findings provides powerful converging support for the hypothesis that heightened ruminative brooding is characterized specifically by impaired attentional disengagement from negative relative to positive information.

Given that increased rumination tends to predict elevated negative mood state, we expected that our in-vivo ruminative brooding scores would be positively correlated with our negative mood reactivity scores, and this expectation was confirmed,  $r(53) = .69, p < .001$ . Also not surprising was our observation that disengagement bias index scores tended to predict variance in negative mood reactivity scores, albeit at a trend level,  $r(53) = .24, p = 0.08$ . To test whether this tendency for disengagement bias scores to marginally predict negative mood reactivity scores reflected the mediating influence of ruminative disposition scores, we employed the Sobel test to compute the significance of this indirect effect. The outcome confirmed that the observed association between disengagement bias scores and negative mood reactivity scores was indeed mediated by ruminative brooding scores, Sobel test = 2.28,  $p < .05$ . In contrast, the observed association between disengagement bias scores and ruminative brooding scores was not significantly mediated by negative mood reactivity scores, Sobel test = 1.71, *ns*. This pattern of findings invites the inference that variation in disengagement bias scores directly impacted on in-vivo ruminative brooding scores, which in turn exerted an influence on negative mood reactivity scores.

## 2.6 Discussion

The present study sought to investigate the relationship between the disposition to engage in ruminative brooding and negative attentional bias, using a paradigm capable of distinguishing between bias in attentional engagement and disengagement. Our current results show that, when

assessed using the RRS questionnaire measure, heightened ruminative brooding, but not heightened ruminative reflection, is associated with impaired attentional disengagement from negative information. Of critical importance, this association between heightened ruminative brooding and disengagement bias was also evident when such rumination was measured using an in-vivo assessment approach, which mitigates the problems that otherwise compromise questionnaire assessment of this disposition. In contrast, there was no evidence of a significant association between ruminative brooding and attentional engagement bias, either when such rumination was assessed using the RRS questionnaire measure or our in-vivo measure of rumination. Of course, it is always important to exercise caution when interpreting null results. Nevertheless, the currently observed findings are fully consistent with the proposal that heightened ruminative brooding is characterized by impaired attentional disengagement from negative information relative to positive information.

The present results provide support for the impaired disengagement hypothesis (Koster et al., 2011) by demonstrating that higher levels of dispositional ruminative brooding are associated specifically with impaired attentional disengagement from negative information relative to positive information. Of course, because the current design contrasted attentional disengagement from negative information against disengagement from positive information, this effect could, in principle, reflect either reduced attentional disengagement from negative information, increased attentional disengagement from positive information, or both. Future research could resolve this issue by deploying variants of our current attentional assessment task that present word pairs comprising two emotionally neutral members. Designs of this type would enable investigators to tease apart rumination-linked variation in speed to disengage from negative compared to neutral words, and to disengage from positive compared to neutral words. However, what is clear from

the present study is that heightened ruminative brooding involves bias in attentional disengagement from negative relative to positive information. To our knowledge, only one other study has investigated associations between rumination and attentional biases using a task that is capable of adequately distinguishing between engagement and disengagement bias (Grafton, Southworth, Watkins, & MacLeod, in press). While this study also showed that impaired attentional disengagement was characteristic of heightened ruminative brooding, it suffered from the exclusive use of questionnaire assessment of rumination.

Indeed, a particular strength of the current study was the assessment of individual differences in the disposition to engage in ruminative brooding using not only the RRS questionnaire measure, but also an in-vivo approach, which involved exposing participants to a negative event in the laboratory, and assessing the degree to which such rumination was elevated immediately after this event, relative to before the event. Previous work investigating the relationship between ruminative disposition and attentional bias has relied exclusively on the RRS questionnaire measure to assess such disposition. As mentioned, this questionnaire approach to the assessment of ruminative disposition does not control for inter-individual variability in levels of exposure to negative events. Moreover, it requires respondents to draw upon their long-term memory of potentially quite distant past episodes of rumination, and so permit contamination by biases in the operation of long-term memory (Kihlstrom et al., 2009; Trull & Ebner-Priemer, 2009). The present in-vivo assessment approach mitigates these limitations as participants are all equally exposed to the same standardized negative event, to reveal individual differences in the degree to which this serves to elevate ruminative thinking. Participants report only the ruminative thinking they experienced in recent minutes, reducing distortion by biases in the operation of long-term memory. We believe this in-vivo approach may

be of value to future researchers wishing to move beyond exclusive reliance on questionnaire measures to assess individual differences in ruminative disposition.

The present findings confirm that heightened ruminative brooding is characterised by attention being more firmly held in the locus of proximal negative compared to positive information. Future research could usefully seek to discriminate two alternative hypotheses concerning how this effect arises. One possibility is that this effect reflects the reduced ability of participants high in ruminative brooding to rapidly move attention from the locus of negative information when a probe distal to such information appears. But an alternative possibility is that this effect could reflect the reduced tendency of such participants to move attention from the locus of negative information prior to probe onset (thus decreasing their probability of being in the probe locus upon onset). Attentional probe tasks cannot distinguish between these alternative hypothetical accounts, as they only provide a 'snapshot' of attentional distribution at a specific point following stimulus onset. Future research that employs eye-movement procedures (c.f. Findlay & Gilchrist, 2003) would be capable of discriminating between these two possibilities, however, as such measures can provide a more continuous assessment of attentional distribution across the entire duration of stimulus presentation.

It has been proposed that an attentional bias to negative information may functionally underpin heightened ruminative brooding (Koster et al., 2011). However, because the present study involved a correlational design, we cannot draw any conclusions concerning the causal nature of the observed relationship between attentional disengagement bias and such ruminative disposition. To directly investigate the causal nature of observed associations, it would be of value to determine whether attention bias modification procedures (c.f. MacLeod & Mathews, 2012), designed to specifically modify bias in attentional disengagement from negative

information, can serve to significantly alter the tendency to engage in ruminative brooding. Such a finding would indicate that such attentional disengagement bias makes a functional contribution to variation in such ruminative disposition.

A growing body of research suggests that heightened tendency to engage in ruminative brooding is also associated with deficits in the ability to direct attention in accordance with task relevant attentional objectives (Koster et al., 2011). However, researchers have not yet investigated whether ruminative brooding-linked attentional control deficits, and impaired attentional disengagement from negative information, represent independent facets of such rumination, or whether these two attentional anomalies might be functionally related. If the latter is true, then it may be that attentional control deficits causally contribute to impaired attentional disengagement from negative information, or alternatively that difficulty disengaging attention from negative information may directly compromise attentional control. Future research could address this issue by examining whether one ruminative brooding-linked attentional anomaly mediates the other, or by seeking to determine whether the direct experimental manipulation of one attentional anomaly has a subsequent impact on the other, as would be the case if a causal relationship exists between them.

Although it is well established that heightened ruminative brooding is associated with increased vulnerability to depression, the cognitive processes that underlie the elevated disposition to engage in ruminative brooding are only now becoming clear. Illuminating these underlying processes may pay dividends in terms of enhancing both the treatment and prevention of depression, as this understanding is translated into interventions aimed at reducing dispositional ruminative brooding, which itself is thought to underpin depressive vulnerability. For the moment, however, the present study has advanced understanding of the attentional basis

of heightened ruminative brooding, by showing that the heightened tendency to engage in ruminative brooding, whether indexed by the RRS brooding subscale or by in-vivo assessment, is characterized by impaired attentional disengagement from negative information.

## 2.7 Appendix A: Additional Analyses Investigating Difference in the Strengths of the Relationships between Ruminative Disposition, and Attentional Engagement and Disengagement Bias

In addition to the analyses reported in the submitted paper, additional analyses were conducted for the thesis. The analysis reported in the main section of this chapter demonstrated that higher dispositional ruminative brooding (as measured by both the RRS and an in-vivo assessment) was significantly associated with biased attentional disengagement from negative relative to positive stimuli, but not with bias attentional engagement with such stimuli. However, this finding does not necessarily warrant the conclusion that dispositional ruminative brooding is *exclusively* associated with attentional disengagement bias, rather than a general attentional processing bias involving both biased attentional engagement and disengagement. In order to infer attentional bias specificity, dispositional ruminative brooding must be demonstrably more strongly associated with attentional disengagement bias than with attentional engagement bias.

In order to investigate whether the relationship between RRS brooding and attentional disengagement bias was significantly stronger than the relationship between RRS brooding and attentional engagement bias, attentional bias indices were subjected to a repeated measures ANCOVA that considered attentional bias type (engagement bias, disengagement bias), with RRS brooding scores entered as a continuous variable. There was no significant interaction between RRS brooding and attentional bias type,  $F(1, 51) = 1.62, p = .208, \eta_p^2 = .03$ , indicating that the relationship between RRS brooding and attentional bias was not significantly stronger for attentional disengagement bias than attentional engagement bias.

The same ANCOVA was conducted again, but with in-vivo ruminative disposition indices entered as a continuous variable instead of RRS brooding scores. There was no

significant interaction between in-vivo ruminative disposition and attentional bias type,  $F(1, 51) = 1.65, p = .205, \eta_p^2 = .03$ , indicating that the relationship between in-vivo ruminative disposition and attentional bias was also not significantly stronger for attentional disengagement bias than attentional engagement bias.

Thus, there was no evidence that dispositional ruminative brooding was more strongly associated with attentional disengagement bias than with attentional engagement bias, meaning that evidence of bias specificity was limited.

## **2.8 Appendix B: Analyses Investigating the Moderating Effects of Stimulus Domain and Exposure Duration**

Previous research has identified additional conditions that may determine whether rumination-linked attentional bias is observed. Firstly, rumination may particularly be associated with an attentional bias for depression-relevant negative information, rather than negative information more generally. Joormann et al. (2006) investigated attentional bias for negative images related to both depression and anxiety, and found that the rumination-linked attentional bias for negative stimuli was only observed for depression relevant images. Secondly, there is evidence that the observation of rumination-linked attentional bias may be dependent on stimulus presentation duration. Donaldson et al. (2007) varied the stimulus presentation duration between 500ms and 1000ms, and only found a relationship between ruminative disposition and attentional bias for negative stimuli when stimuli were presented for 1000ms. Taken together, there is evidence to suggest that rumination may specifically be related to attentional bias for depression-relevant negative information, and that this bias may only be apparent under conditions allowing for extended stimulus processing duration.

Thus, additional analyses were conducted to investigate whether the relationship between ruminative disposition and attentional bias was moderated by stimulus domain and exposure duration. Emotional word stimuli (negative/positive words) were rated on the basis of their emotional domain relevance and included a mix of both depression relevant (sad/happy) and anxiety relevant (anxious/relaxed) words, giving rise to a within-subjects stimulus domain factor (see Grafton et al., in press, Chapter Three for further details). Additionally, as noted in the main text, throughout the attentional bias assessment task, word pairs were displayed for either 500ms or 1000ms, giving rise to a within-subjects exposure duration factor. It was hypothesised that

higher levels of ruminative disposition would be particularly associated with attentional bias for depression relevant stimuli presented for 1000ms.

### 2.8.1 Results and Discussion

The disengagement bias index scores were subjected to three repeated measures ANCOVAs that considered the two within-subject factors stimulus domain (sad/happy words, anxious/relaxed words), and exposure duration (500ms, 1000ms). In each ANCOVA, one of the measures of ruminative disposition (i.e., RRS brooding scores, RRS reflection scores, and in-vivo ruminative disposition indices) was entered as a continuous variable (i.e., they were each entered as a covariate in the SPSS repeated measures ANCOVA). There were no significant interactions between any of measures of ruminative disposition and the within-subjects factors (all  $p$ 's > .20; see Table 2.3), indicating that the relationship between ruminative disposition and attentional disengagement bias was not moderated by either stimulus domain or exposure duration.

The engagement bias index scores were subjected to the same repeated measures ANCOVAs. There were no significant interactions between RRS brooding or reflection scores and any of the within subjects factors (all  $p$ 's > .20; see Table 2.3). However, there was a significant two-way interaction between in-vivo ruminative disposition indices and exposure duration,  $F(1, 51) = 4.10, p = .048, \eta_p^2 = .07$ , which was subsumed within a trend-level three-way interaction between in-vivo ruminative disposition indices, exposure duration, and stimulus domain,  $F(1, 51) = 3.61, p = .063, \eta_p^2 = .07$ . Further analyses were conducted to investigate the nature of these interactions.

Table 2.3 Interactions between indices of ruminative disposition and within-subject factors from ANCOVAs with attentional engagement bias and attentional disengagement bias as dependent variables.

	Stimulus Domain		Exposure Duration		Stimulus Domain x Exposure Duration	
	<i>F</i> (1, 51)	<i>p</i>	<i>F</i> (1, 51)	<i>p</i>	<i>F</i> (1, 51)	<i>p</i>
<i>Engagement Bias</i>						
Brooding	0.67	.417	1.54	.220	0.48	.493
Reflection	0.05	.827	1.04	.312	0.57	.454
In-vivo ruminative Disposition	0.42	.521	4.10	.048*	3.61	.063 <sup>^</sup>
<i>Disengagement Bias</i>						
Brooding	0.10	.748	0.03	.869	0.68	.415
Reflection	0.62	.436	0.08	.780	0.99	.324
In-vivo ruminative Disposition	1.62	.209	0.19	.662	0.00	.994

Note: <sup>^</sup>  $p < .10$ ; \*  $p < .05$

The three-way interaction reflected the fact that the two-way interaction between in-vivo ruminative disposition indices and exposure duration was significant under the sad/happy stimulus domain condition,  $F(1, 51) = 7.52$ ,  $p = .008$ ,  $\eta_p^2 = .13$ , but not under anxious/relaxed stimulus domain condition,  $F(1, 51) = 0.01$ ,  $p = .922$ ,  $\eta_p^2 < .01$ . This two-way interaction within the sad/happy stimulus domain condition reflected the fact that in-vivo ruminative disposition indices were significantly associated with attentional engagement bias for sad/happy words

presented for 1000ms, such that higher levels of ruminative disposition were associated with greater attentional engagement with sad relative to happy words,  $r(53) = .33, p = .016$ , but not with attentional engagement bias for anxious/relaxed words presented for 1000ms,  $r(53) = -.18, p = .20$ .

Thus, there was some evidence that heightened levels of ruminative disposition were associated with facilitated attentional engagement with negative information, but only for depression relevant stimuli presented for 1000ms. This finding is consistent with previous evidence suggesting that heightened ruminative disposition is specifically associated with attentional bias for depression relevant stimuli presented for longer exposure durations (Donaldson et al., 2007; Joormann et al., 2006).

There was no evidence that the relationship between ruminative disposition and attentional disengagement bias was moderated by stimulus domain or exposure duration. However, given the relatively small sample size of the present study ( $N = 53$ ) it is possible that this null effect was a result of low statistical power. Power analyses conducted in G-Power revealed that the present study achieved a power of only .11 to detect small effect sizes ( $r = .10$ ) at the .05 level, and a power of .61 to detect medium effect sizes ( $r = .30$ ), both of which are below the recommended level of .80. Whilst these levels of power apply to both main effects and interactions, on the reasonable assumption that the predicted interactions may have smaller effect sizes than the main effects, then for the same sample size, the ability to detect moderation would be less than that for main effects. Thus, a larger sample size may be required to detect a moderating effect of stimulus domain and exposure duration on the relationship between ruminative disposition and attentional disengagement bias.

In conclusion, findings from Study One supported the hypothesis that heightened levels of ruminative disposition are associated with impaired attentional disengagement from negative relative to positive information. In addition, there was some evidence that under particular circumstances heightened ruminative disposition may also be associated with facilitated attentional engagement with negative relative to positive information, specifically when stimuli are relevant to depression and are presented for longer exposure durations.

## CHAPTER THREE: Study Two

### 3.1 Preface

The paper reported in the main section of this chapter has been accepted for publication at *Emotion*, and is currently in press.

The primary aim of Study Two was to investigate the relationship between ruminative disposition and attentional bias, using a modified dot-probe task designed to independently assess attentional engagement and disengagement bias (Grafton, Watkins, & MacLeod, 2012). The impaired disengagement hypothesis (Koster, De Lissnyder, Derakshan, & De Raedt, 2011) suggests that heightened levels of ruminative disposition are associated with impaired attentional disengagement from negative information. Consistent with this account, Study One found that higher levels of ruminative disposition were associated with more impaired attentional disengagement from negative relative to positive stimuli, and Study Two sought to replicate this finding.

It is important to note, that the modified dot-probe task used in Study Two differed slightly from the task used in Study One. In Study One, emotional word stimuli (negative or positive words) were presented opposite neutral word stimuli. One limitation of this design is that since there are no trials where only neutral information is presented, it is not possible to independently assess attentional bias for negative relative to neutral information and positive relative to neutral information. Thus, the finding from Study One that higher levels of ruminative disposition are associated with impaired attentional disengagement from negative relative to positive stimuli could, in principle, reflect either more impaired attentional disengagement from

negative information, facilitated disengagement from positive information, or a combination of both.

However, in Study Two word stimuli (positive, negative, or neutral words) were presented opposite non-word letter strings. The inclusion of trials where only neutral stimuli were presented meant that it was possible to separately index attentional engagement and disengagement bias for negative relative to neutral stimuli and positive relative to neutral stimuli. The paper reported in the main section of this chapter investigated the relationship between ruminative disposition and attentional bias for negative relative to positive stimuli, but analyses using separate indices of attentional bias for negative relative to neutral and positive relative to neutral stimuli are reported in Appendix B (Section 3.8).

The addition of neutral word trials increased the length of the attentional assessment task, but the procedure and design of the tasks used in Studies One and Two were otherwise identical, and the same set of positive, negative, and neutral word stimuli was used. Attentional bias for negative relative to positive stimuli was also calculated using the same procedure, with regard to the locations of probe stimuli relative to positive and negative words. Thus, the indices of attentional bias for negative relative to positive stimuli obtained in Study Two were functionally identical to the attentional bias indices in Study One.

Study Two also sought to investigate whether the relationship between ruminative disposition and attentional bias is dependent on stimulus domain and presentation duration. Joormann, Dkane, and Gotlib (2006) investigated attentional bias for negative images related to both depression and anxiety, and found that the rumination-linked attentional bias for negative stimuli was only observed for depression relevant images. Donaldson, Lam, and Mathews (2007) varied the stimulus presentation duration between 500ms and 1000ms, and only found a

relationship between ruminative disposition and attentional bias for negative stimuli when stimuli were presented for 1000ms. Taken together this evidence suggests that rumination may specifically be related to attentional bias for depression-relevant negative information, and that this bias may only be apparent under conditions allowing for extended stimulus processing duration.

Study One did not find evidence that that the relationship between ruminative disposition and attentional disengagement bias was moderated by stimulus domain and presentation duration. There was, however, some evidence that the relationship between ruminative disposition and attentional engagement bias was moderated by stimulus domain and presentation duration, such that heightened ruminative disposition was specifically associated with facilitated attentional engagement with depression relevant negative stimuli presented for 1000ms. Thus, although there was some support for the hypothesis that the relationship between ruminative disposition and attentional bias is dependent on stimulus domain and presentation duration, this may only be the case for attentional engagement bias, and not attentional disengagement bias. However, Study One was limited by a relatively small sample size ( $N = 53$ ), which may have restricted statistical power to detect moderation effects. On the basis of power analysis conducted in G-Power, it was determined that Study One achieved a power of only .11 to detect small effect sizes ( $r = .10$ ) at the .05 level, and .61 to detect medium effect sizes ( $r = .30$ ), both of which are below the recommended level of .80. Assuming smaller effect sizes for interactions than main effects, this may disproportionately affect ability to detect moderation. Study Two used a larger sample size ( $N = 136$ ), thus increasing statistical power to detect small effect sizes to .21 and medium effect sizes to .95. Although the achieved statistical power to detect small effects was still low, the power to detect medium effect sizes was adequate, including for the main effects

observed, thus increasing the likelihood of detecting any potential moderation effects for attentional disengagement bias.

Consistent with findings from Study One, it was predicted that higher levels of ruminative disposition would be associated with more impaired attentional disengagement from negative relative to positive stimuli. Furthermore, consistent with previous findings (Donaldson et al., 2007; Joormann et al., 2006) it was expected that this attentional disengagement bias would be specifically for depression relevant stimuli presented for longer exposure durations (1000ms).

Stuck in a sad place: Biased attentional disengagement in rumination

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In press, *Emotion*.

### 3.2 Abstract

Previous research has demonstrated that heightened ruminative disposition is characterized by an attentional bias to depressogenic information at 1000ms exposure durations. However, it is unknown whether this attentional bias reflects facilitated attentional engagement with depressogenic information, or impaired attentional disengagement from such information. The present study was designed to address this question. In keeping with recent theoretical proposals, our findings demonstrate that heightened ruminative disposition is associated only with impaired attentional disengagement from depressogenic information, and does not involve facilitated attentional engagement with such information. In addition to resolving this key issue, the present study provided converging support for the previous claim that rumination-linked attentional bias is specific to depressogenic information, and also lends weight to the contention that rumination-linked attentional bias may be evident only when controlled attentional processing is readily permitted by using stimulus exposure durations of 1000ms. We discuss the theoretical implications of these findings, and highlight key issues for future research.

Keywords: rumination, attentional bias, disengagement, engagement, attentional-probe task

### 3.3 Introduction

Rumination is a form of repetitive negative thinking that typically is focused on the causes and implications of distressing situations or events (Watkins, 2008). People differ in the degree to which rumination is elicited by negative mood state, and this variation in ruminative disposition most commonly has been assessed using the Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991). Heightened ruminative disposition is associated with increased vulnerability to depression, as evidenced by the fact that individuals who score higher on the RRS have a greater probability of depressive onset (Just & Alloy, 1997; Nolen-Hoeksema, 2000; Nolen-Hoeksema, Parker, & Larson, 1994; Spasojevic & Alloy, 2001), and also tend to experience greater persistence of depressive symptoms (Kuehner & Weber, 1999; Nolen-Hoeksema, Morrow, & Fredrickson, 1993). Given that heightened ruminative disposition may play a role in the development and maintenance of depression, investigators have called for research to illuminate the cognitive factors that underpin this disposition (e.g. Koster, De Lissnyder, Derakhshan, & De Raedt, 2011; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). One cognitive factor that has been of particular interest to researchers is selective attention.

Investigators have been motivated by the hypothesis that an attentional bias to negative information may underlie heightened ruminative disposition (c.f. Koster et al., 2011). The attentional-probe task (MacLeod, Mathews, & Tata, 1986) has been used to assess this attentional bias. In this task, participants are briefly exposed to stimulus pairs that usually comprise one negative member and one non-negative member. A probe subsequently appears in the location where either member of the stimulus pair was just displayed, and participants are required to quickly make a discriminatory response to this probe. The degree to which discrimination responses are speeded to probes appearing in the locus of the negative member compared to the non-negative member of the stimulus pair is taken as an index of attentional

bias to negative information. To date, two studies have investigated the association between variability in this attentional bias and in ruminative disposition, and these are considered in turn below.

Using this attentional-probe task, Donaldson, Lam, and Mathews (2007) sought to determine whether heightened ruminative disposition is characterized by an attentional bias to negative information. The investigators were also interested in the role that automatic vs. controlled attentional processes may play in the expression of such bias. Hence, they exposed stimulus pairs for either 500ms or 1000ms, reasoning that controlled attentional processes would exert a greater impact on attentional selectivity at the longer exposure duration compared to the shorter exposure duration, while automatic processes would have as great an influence at the shorter exposure duration as at the longer exposure duration (Kim & Cave, 1999; Lamy & Egeth, 2003; McNally, 1995; Mogg & Bradley, 2005; Theeuwes, Atchley, & Kramer, 2000). It was found that participants who scored higher in ruminative disposition, as assessed by the RRS, were disproportionately speeded to discriminate probes in the locus of negative information compared to those in the locus of positive information, but only at the longer 1000ms exposure duration. This association between ruminative disposition and attentional bias remained evident when participant's concurrent levels of depression were statistically accounted for. Thus, these findings are consistent with the hypothesis that heightened ruminative disposition is characterized by an attentional bias to negative information, while also suggesting that this pattern of attentional selectivity may reflect the operation of controlled attentional processes.

Joormann, Dkane, and Gotlib (2006) also employed the attentional-probe task to investigate the attentional basis of rumination. These researchers sought to determine whether rumination-linked attentional bias is specific to depression-related information, or reflects increased attention to negative information in general. On each trial of their assessment task,

participants were exposed for 1000ms to stimulus pairs that comprised one emotional member (either negative or positive), and one member that was devoid of emotional meaning. In some stimulus pairs, the emotional member was more related to depression, and in others it was more related to anxiety. It was found that participants who reported heightened ruminative disposition on the RRS showed greater attentional bias to negative information, but only when this negative information was specifically related to depression. Again, this association between ruminative disposition and attentional bias remained evident when participant's concurrent levels of depression were statistically controlled for. In addition, unlike Donaldson et al. (2007), these researchers also examined the association between this attentional bias and two subscales of the RRS, the ruminative brooding subscale and the ruminative reflection subscale, originally distinguished by Treynor, Gonzalez, & Nolen-Hoeksema (2003). The results showed that the observed attentional bias effect was more a function of the former subscale than the latter. Taken together, these findings are consistent with the hypothesis that heightened ruminative disposition is characterized by an attentional bias that operates to specifically favor the processing of depressogenic information, and also invite speculation that this bias might differentially implicate ruminative brooding and ruminative reflection.

However, as has recently been pointed out by LeMoult, Arditte, D'Avanzato, and Joormann (2013), these studies cannot illuminate whether this rumination-linked attentional bias reflects enhanced attentional engagement with this negative information, or impaired attentional disengagement from such information. The present study was designed to resolve this issue. Specifically, we sought to determine whether this rumination-linked attentional bias involves increased attentional engagement with negative information, reflecting a disproportionate tendency for attention to be captured by attentionally distal information that is emotionally negative in content, or whether it involves reduced attentional disengagement

from negative information, reflecting a disproportionate tendency for attention to be more firmly held by attentionally proximal information that is negative in content. Some researchers have argued, on theoretical grounds, that the attentional bias associated with heightened ruminative disposition may specifically involve only impaired attentional disengagement from negative information (Koster et al., 2011). As others have pointed out, however, existing findings could equally well reflect facilitated attentional engagement with negative information, meaning that investigators must directly evaluate the validity of these alternative possibilities (Grafton & MacLeod, 2013). Determining the attentional characteristics of heightened ruminative disposition is of particular importance given the key role that rumination appears to play in increasing susceptibility to depression.

To determine which facet of attentional selectivity characterizes heightened ruminative disposition requires a task that can yield separate measures of selective attentional engagement with, and selective attentional disengagement from, negative information. It is generally accepted that the conventional attentional-probe task cannot provide independent measures of these two facets of attentional selectivity (Mogg, Holmes, Gardner, & Bradley, 2008; Yiend, 2010). Hence, a number of investigators have sought to develop tasks capable of independently measuring engagement bias and disengagement bias (e.g. Fox, Russo, Bowles, & Dutton, 2001; Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006; Yiend & Mathews, 2001). Unfortunately, as pointed out in recent critiques, the attentional assessment tasks used in most previous attempts to differentiate engagement bias and disengagement bias cannot fully satisfy the methodological criteria that must be met to yield discrete measures of these two facets of attentional selectivity (Clarke, MacLeod, & Guastella, 2013; Grafton & MacLeod, 2014; Mogg et al., 2008; Rudaizky, Basanovic, & MacLeod, 2014). As noted in these critiques, because selective attentional engagement reflects a disproportionate tendency for attention to become focused on initially distal

negative information, assessment tasks designed to specifically index bias in attentional engagement with negative compared to non-negative information must present this differentially valenced information distal from the location in which participants' attentional focus is initially secured. In contrast, because selective attentional disengagement reflects a disproportionate tendency for attention to remain focused on initially proximal negative information, assessment tasks designed to specifically index bias in attentional disengagement from negative compared to non-negative information must present this differentially valenced information in the location where participants' attentional focus is initially secured. Selective attention to alternative categories of emotional information can then be assessed in the usual manner, by comparing relative latencies to respond to target probes appearing in either the same or opposite locus of this emotional information. The degree to which attention moves towards negative compared to positive information presented distally from initial attentional focus indexes the capacity of negative information to capture attention more readily than positive information, and so provides a measure of heightened attention to negative information as a result of engagement bias. The degree to which attention remains in the locus of negative compared to positive information presented proximally to initial attentional focus indexes the capacity of negative information to hold attention more firmly than positive information, and so provides an index of heightened attention to negative information as a result of disengagement bias.

Grafton, Watkins, and MacLeod (2012) introduced a variant of the attentional-probe task that fulfils these methodological criteria, and so yields separate measures of selective attentional engagement with, and selective attentional disengagement from, negative information. Each trial of this task begins with the presentation of an anchor probe, and ends with the presentation of a target probe. Participants are required to respond only to the target probe, by indicating whether its identity matches that of the anchor probe. Intervening

between these two probe presentations, a pair of letter strings is displayed, one of which is an emotionally toned word. By configuring the position of the anchor probe, the word member of the letter string pair, and the final target probe, this task permits the discrete assessment of variability in selective engagement with emotional information distal to initial attentional focus, and in selective disengagement from emotional information proximal to initial attentional focus. Specifically, because the participant must apprehend the orientation of the briefly presented anchor probe, this secures their initial attentional focus in a predetermined screen location. The pair of letter strings that then appears, for either 500ms or 1000ms, contains an emotionally toned word of either negative or positive valence, and a length matched non-word, devoid of emotional meaning. Thus, the emotional word can be shown in the opposite screen location to the anchor probe, meaning that this emotional information appears distally from initial attentional focus, or in the same location as the anchor probe, meaning that this emotional information appears proximally to initial attentional focus. The target probe is then presented in either screen location, with equal frequency, with relative discrimination latencies for the target probes shown in each location serving to index the distribution of attention following letter string offset. The degree to which speeding to target probes in the locus of the words compared to non-words is greater when these words are negative compared to positive in emotional tone, provides an index of heightened attentional bias to negative information. The tendency for attention to become captured by distal negative information (i.e. engagement bias) is revealed by this measure of heightened attention to negative, relative to positive, emotional words, when these words were presented distally from initial attentional focus. In contrast, the tendency for attention to remain held by proximal negative information (i.e. disengagement bias) is revealed by this measure of heightened attention to negative, relative to positive, emotional words, when these words

were presented proximally to initial attentional focus. Examples of these trials are shown in Figure 3.1.

Grafton et al. (2012) and others have validated the capacity of this task to separately assess bias in attentional engagement with, and attentional disengagement from, negative information (Grafton & MacLeod, 2014; Rudaizky et al., 2014). Using this task, it has been demonstrated that elevated anxiety vulnerability is characterized both by facilitated attentional engagement with, and impaired attentional disengagement from, anxiety-related negative information, and that these two attentional biases are quite unrelated to one another. However, as yet, this methodological approach has not been employed to shed light on the present question, concerning whether the attentional bias to negative information that characterizes heightened ruminative disposition reflects facilitated attentional engagement with, or impaired attentional disengagement from, negative information<sup>3</sup>.

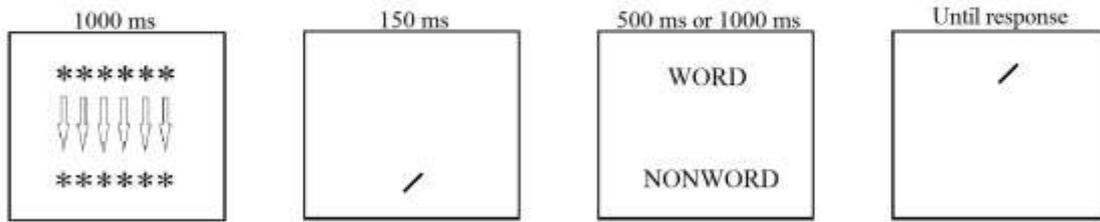
Hence, in the present study, we delivered a variant of the attentional-probe task, closely based on the approach introduced by Grafton et al. (2012), to participants who varied widely in their ruminative disposition, as assessed by the RRS, to determine whether heightened ruminative disposition is characterized by facilitated attentional engagement with negative information, or by impaired attentional disengagement from negative information. We followed the approach of Donaldson et al. (2007) by employing both a 500ms and a 1000ms exposure duration, which enabled us to investigate whether observed patterns of attentional selectivity were more evident at the longer exposure duration, suggesting the involvement of controlled attentional processes in rumination-linked attentional bias. We followed the lead of Joormann et al. (2006) by employing both depression- and anxiety-related emotional information, which enabled us to investigate whether observed rumination-

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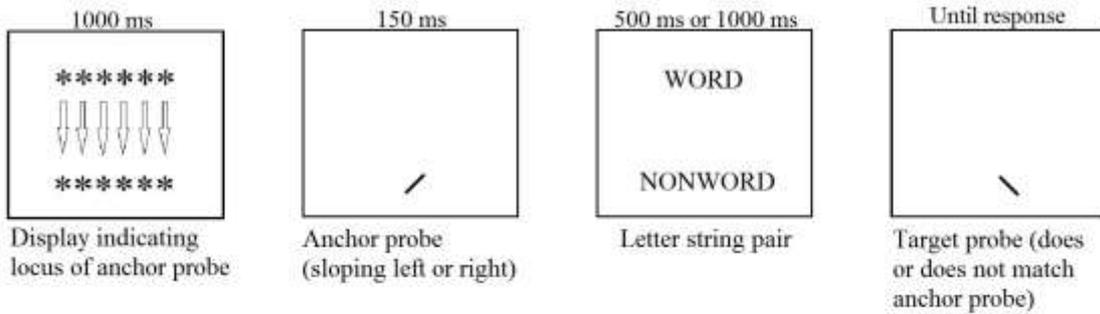
<sup>3</sup> Note that the paper reported in this chapter had been accepted for publication before Study One (Chapter Two), hence the claim that this methodological approach has not yet been used to investigate the relationship between ruminative disposition and attentional bias.

a) Illustrative examples of engagement bias assessment trial (word member of letter string pair **always** appears **distal** to initial attentional focus)

i) Target probe in same locus as word member of letter string pair

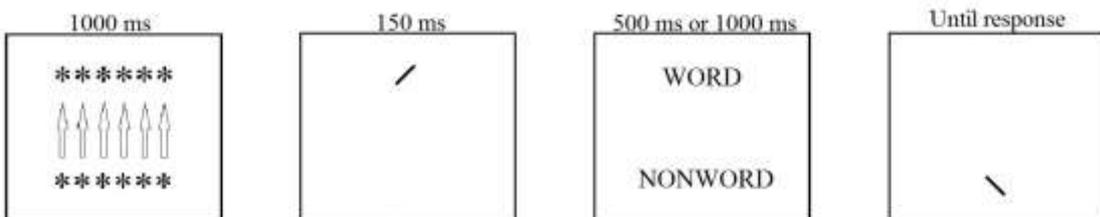


ii) Target probe in locus opposite to word member of letter string pair



b) Illustrative examples of disengagement bias assessment trial (word member of letter string pair **always** appears **proximal** to initial attentional focus)

iii) Target probe in locus opposite to word member of letter string pair



iv) Target probe in same locus as word member of letter string pair

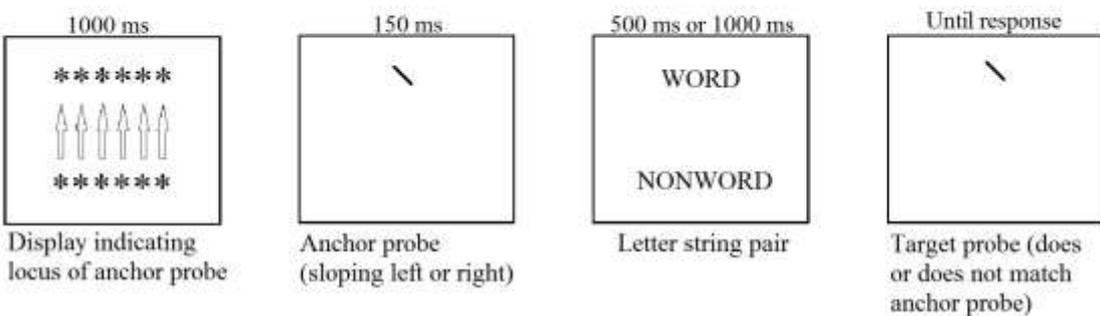


Figure 3.1. Illustrative examples of sequence of events on attentional engagement bias assessment trial (panel a), and on attentional disengagement bias assessment trial (panel b).

linked bias in attentional engagement or disengagement is specific to depression-related material, or instead reflects biased attentional responding to negative information more generally. Also, like Joormann et al., we investigated whether any pattern of attentional bias associated with heightened ruminative disposition, as assessed by the total RRS score, differentially implicated ruminative brooding vs. ruminative reflection, as assessed by their respective RRS subscales. Finally, like Donaldson et al. and Joormann et al., we assessed participant's levels of depression to determine whether any observed association between ruminative disposition and attentional bias remains evident when controlling for concurrent variation in depression.

### 3.4 Method

#### 3.4.1 Participants

Participants were 144 (24 male) undergraduate psychology students from the University of Western Australia, and from the University of Exeter, ranging in age from 17 to 47 years ( $M = 18.85$ ,  $SD = 2.75$ ). At recruitment, the mean score of these participants on the Ruminative Response Scale (RRS) was  $M = 42.92$  ( $SD = 12.87$ ;  $Min = 23$ ;  $Max = 76$ ; Interquartile Range = 17.75).

#### 3.4.2 Questionnaire Measures

**Ruminative Responses Scale.** Ruminative disposition was assessed using the Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991), which requires participants to rate their tendency to experience each of 22 particular ruminative symptoms when in a negative mood. The RRS has both high internal reliability and validity (c.f. Luminet, 2004). Investigators also have distinguished two RRS subscales: ruminative brooding and ruminative reflection. Both of these subscales show acceptable reliability and consistency (Treyner et al., 2003).

**Beck Depression Inventory – II.** Depression was assessed using the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996), which requires participants to respond to 21 statements describing various depressive symptoms, on a scale ranging from 0 – 3. The BDI-II has good reliability (Wiebe & Penley, 2005) and validity (Storch, Roberti, & Roth, 2004).

### 3.4.3 Experimental Stimuli

In the present study, we required 64 letter string pairs each comprising an emotional word, either negative or positive in emotional tone, and a length matched non-word devoid of emotional meaning. The words were selected from a larger initial pool of 400 candidate words, on the basis of ratings obtained from six clinical psychologists, who rated the candidate words on two dimensions. One rating concerned the emotional valence of the word, which was judged on a 7 point scale ranging from -3 (extremely negative) to +3 (extremely positive). The other rating concerned the degree to which the candidate words were related either to the emotional domain associated with variation in depression (ranging from sad to happy experiences), or to the emotional domain associated with variation in anxiety (ranging from anxious to relaxed experiences), and was judged on a 7 point scale ranging from 3x (extremely associated to sad/happy domain) to 3y (extremely associated to anxious/relaxed domain).

Half of the experimental words (32 words) were chosen on the basis of receiving highly negative ratings, while half were chosen because they had received highly positive ratings. This gave rise to a Stimulus Valence factor (Negative Words vs. Positive Words). Half of the negative words and half of the positive had been judged more closely related to the sad/happy domain, and half had been judged to more closely related to the latter anxious /relaxed domain. This gave rise to a Stimulus Domain factor (Sad/Happy Words vs. Anxious/Relaxed Words).

A two-way ANOVA, which considered the factors Stimulus Valence (Negative Words vs. Positive Words) and Stimulus Domain (Sad/Happy Words vs. Anxious/Relaxed Words), was carried out on the valence ratings. This analysis confirmed a significant main effect of Stimulus Valence,  $F(1, 60) = 3357.61, p < .001, \text{partial } \eta^2 = .98$ . Neither the main effect of Stimulus Domain,  $F(1, 60) = 1.88, p = .18, \text{partial } \eta^2 = .03$ , nor the interaction between the two factors,  $F(1, 60) = 1.60, p = .21, \text{partial } \eta^2 = .03$ , was significant. Hence, stimulus valence differed as required as a function of the Stimulus Valence factor, and was not confounded with the domain distinction. An equivalent two-way ANOVA carried out on the domain ratings confirmed a significant main effect of Stimulus Domain,  $F(1, 60) = 642.80, p < .001, \text{partial } \eta^2 = .92$ . Neither the main effect of Stimulus Valence,  $F(1, 60) = .49, p = .49, \text{partial } \eta^2 = .01$ , nor the interaction between the two factors,  $F(1, 60) = .91, p = .34, \text{partial } \eta^2 = .02$ , was significant. Thus, stimulus domain rating differed as a function of the Stimulus Domain factor as required, and was not confounded with the valence distinction. Additional ANOVAs carried out on word frequency (according to Kucera & Francis, 1967) and on word length (expressed in terms of letters) revealed no significant differences as a function of Stimulus Valence, Stimulus Domain, or their interaction. The full set of experimental words is provided in the Appendix Two.

### **3.4.4 Attentional Assessment Task**

Each trial commenced with the 1000ms presentation of an upper and lower string of asterisks that demarcated the two critical screen regions. These asterisk strings were centralized horizontally on the screen, and separated vertically by a distance of 3cm. Between them was an arrow display pointing either towards the upper or the lower region with equal frequency. Participants were required to direct their attention to the screen region (demarcated by the row of asterisks) indicated by the arrow direction. The screen was then cleared, and an anchor probe was briefly exposed (150ms) in this attended region. The anchor

probe was a small (2 mm) red line, sloping upwards 45 degrees to either the left or right, with equal probability. A letter string pair was then presented, one member appearing in each of the two screen regions. On half of the trials, the word member of this pair appeared in the locus distal to that where the participant was already attending (Attentional Engagement Bias Assessment Trials), and on the remaining half of trials, the word appeared in the locus where the participant was already attending (Attentional Disengagement Bias Assessment Trials). This letter string pair was exposed for either 500ms or 1000ms with equal frequency. The screen was then cleared, and a target probe appeared in either of the two screen regions with equal probability. This target probe also was a small (2 mm) red line, sloping upwards 45 degrees to either the left or to the right. Participants were required to quickly indicate whether the slope direction of the target probe matched that of the anchor probe, which was the case on 50% of trials. They registered their response by pressing either the right or left mouse button, to respectively indicate that the slope of the target probe either did or did not match that of the anchor probe. The latency to make this discrimination response to the target probe was recorded, as was its accuracy. Following detection of the response, the screen was cleared for 1000ms, before the next trial began. This sequence of events is summarized in the example trials illustrated in Figure 3.1.

The attentional assessment task delivered 256 trials. Across these trials, each of the 64 letter string pairs were presented, in a random order, once before any were presented a second time, and each was repeated once before any were exposed for a third time, and so on. Hence, over the task, each letter string pair was presented a total of 4 times. On two of these occasions, the word member of the letter string pair was presented proximal to initial attentional focus, and on the other two of these occasions the word member was presented distal to initial attentional focus. In each case, the target probe appeared once in the locus of the word member, and once in the locus of the non-word member, of the letter string pair.

### 3.4.5 Procedure

Participants were tested individually. Each participant was seated approximately 60 cm from the computer screen, and given instructions for the attentional assessment task. These instructions emphasised that the participant should ensure accurate identification of whether the target probe matched the slope of the anchor probe, but should respond as quickly as possible without compromising accuracy. A short practice comprising 20 trials that employed only neutral stimuli was given. Then the participant completed the attentional assessment task, before being thanked and debriefed.

## 3.5 Results and Discussion

### 3.5.1 Computation of Engagement and Disengagement Bias Index Scores

Probe discrimination latencies can only indicate attentional distribution when probe discrimination responses are accurate, thus we eliminated participants whose overall accuracy was atypically low using a 95% confidence interval. Eight participants displayed high error rates meeting the exclusion criteria. The remaining 136 participants averaged less than 12% errors. There was no association between accuracy and RRS rumination scores,  $r(134) = .02$ ,  $p = .83$ .

To compute the Engagement Bias Index scores, and the Disengagement Bias Index scores, we first calculated participants' latencies to correctly discriminate probes under each experimental condition, following the recommendations of Leys, Ley, Klein, Bernard, and Licata (2013). Specifically, we eliminated probe discrimination latencies that fell further than 2.5 times the median absolute deviation from the participant's median RT under each experimental condition, then calculated each participant's median probe discrimination latencies for each condition. These latency data were then used to compute an index of engagement bias and disengagement bias, as follows.

The Engagement Bias Index, reflecting degree to which attention selectively moved to the locus of negative information compared to positive information that was presented distally from the initial locus of attentional focus, was calculated using probe discrimination latency data from those trials on which the emotional words were presented distally from initial attentional focus, following the equation:

$$\text{Engagement Bias Index} = (\text{Anchor probe distal to negative word in letter string pair: RT for target probe distal to negative word} - \text{RT for target probe proximal to negative word}) - (\text{Anchor probe distal to positive word in letter string pair: RT for target probe distal to positive word} - \text{RT for target probe proximal to positive word}).$$

The Disengagement Bias Index, reflecting degree to which attention was selectively held by negative information compared to positive information that was presented in the same locus as initial attentional focus, was calculated using probe discrimination latency data from those trials on which the emotional words were presented proximally to initial attentional focus, following the equation:

$$\text{Disengagement Bias Index} = (\text{Anchor probe proximal to negative word in letter string pair: RT for target probe distal to negative word} - \text{RT for target probe proximal to negative word}) - (\text{Anchor probe proximal to positive word in letter string pair: RT for target probe distal to positive word} - \text{RT for target probe proximal to positive word}).$$

The indices of engagement bias and disengagement bias are shown in Table 3.1. Scores on these two bias indices will be higher to the extent that participants display relatively greater attention to the negative words compared to the positive words, with the two indices respectively reflecting the specific involvement of engagement bias and disengagement bias in such attentional selectivity.

### 3.5.2 Analysis of Engagement Bias Index Scores

The Engagement Bias Index scores were subjected to a repeated measures ANCOVA that considered the two within-subject factors Stimulus Domain (Sad/Happy Words vs. Anxious/Relaxed Words), and Exposure Duration (500ms Exposure vs. 1000ms Exposure). The RRS rumination scores were entered as a continuous variable (i.e., they were entered as a covariate in the SPSS repeated measures ANCOVA). This analysis did not reveal evidence of any significant effects (all  $p$ 's > .09). Of most relevance, the main effect of RRS Score,  $F(1, 134) = .01, p = .92, \text{partial } \eta^2 = 0$ , the two-way interaction of Stimulus Domain x RRS Score,  $F(1, 134) = .01, p = .92, \text{partial } \eta^2 = 0$ , the two-way interaction of Exposure Duration x RRS Score,  $F(1, 134) = 1.96, p = .16, \text{partial } \eta^2 = .01$ , and the three-way interaction of Stimulus Domain x Exposure Duration x RRS Score,  $F(1, 134) = 2.83, p = .10, \text{partial } \eta^2 = .02$ , all failed to reach statistical significance. Hence, there was no evidence to suggest that heightened ruminative disposition is characterized by facilitated attentional engagement with negative information.

Table 3.1. Mean (and *SD*) of Engagement and Disengagement Bias Indices obtained under each experimental condition.

Attentional Bias Type	500ms Exposure Duration		1000ms Exposure Duration	
	Sad/Happy Stimulus Domain	Anxious/Relaxed Stimulus Domain	Sad/Happy Stimulus Domain	Anxious/Relaxed Stimulus Domain
Engagement Bias Index	-9.04 (248.45)	-12.32 (236.13)	-23.77 (264.71)	-40.04 (317.16)
Disengagement Bias Index	-47.44 (294.55)	-2.58 (270.62)	3.04 (280.01)	12.01 (332.95)

### 3.5.3 Analysis of Disengagement Bias Index Scores

The Disengagement Bias Index scores were subjected to the same repeated measures ANCOVA. This analysis revealed a significant main effect of Stimulus Domain,  $F(1, 134) = 5.28, p = .02, \text{partial } \eta^2 = .04$ , that was subsumed within a significant two-way interaction of Stimulus Domain x RRS Score,  $F(1, 134) = 4.33, p = .04, \text{partial } \eta^2 = .03$ . This two-way interaction was itself subsumed within a three-way interaction involving Stimulus Domain x Exposure Duration x RRS Score,  $F(1, 134) = 4.76, p = .03, \text{partial } \eta^2 = .03$ , which was the only other significant effect to emerge from the analysis. Hence, it is necessary to examine the nature of this higher-order interaction to reveal the pattern of biased attentional disengagement from negative information that characterizes heightened ruminative disposition.

This three-way interaction reflected the fact that the simple two-way interaction of Stimulus Domain x RRS Score was significant under the 1000ms exposure condition,  $F(1, 134) = 8.45, p = .01, \text{partial } \eta^2 = .06$ , but not under the 500ms exposure condition,  $F(1, 134) = .002, p = .97, \text{partial } \eta^2 = 0$ . This supports the idea that rumination-linked attentional bias may involve relatively controlled, rather than automatic, attentional processes. Given existing evidence that rumination-linked attentional bias may be particularly evident on depressogenic material, it would be expected that the rumination-linked attentional bias, evident under the 1000ms exposure condition, would be more evident on stimuli from the Sad/Happy domain, rather than the Anxious/Relaxed domain. Consistent with such expectation, RRS scores showed a significant positive association with Disengagement Bias Index scores, obtained under this exposure condition, only for stimuli from the Sad/Happy domain,  $r(134) = .21, p = .01$ <sup>4</sup>, as shown in Figure 3.2, with no such positive association being evident for stimuli

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<sup>4</sup> Two outlying bias scores, identified in Figure 2 by the square outlines, were detected using box-and-whisker plots. The correlation between these two variables remained positive and significant when these outliers were excluded,  $r(134) = .18, p = .04$ .

from the Anxious/Relaxed domain,  $r(134) = -.14$ ,  $p = .10$ . Hence, this pattern of findings indicates that heightened ruminative disposition is characterized by impaired attentional disengagement only from negative relative to positive information on the sadness-happiness dimension, and only at the longer 1000ms exposure duration.

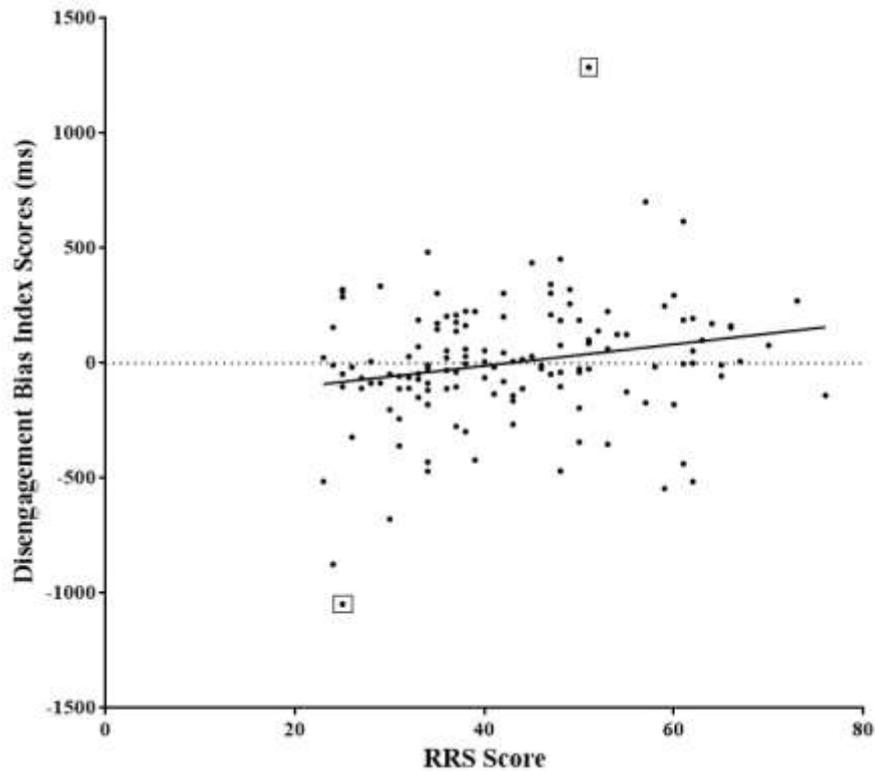


Figure 3.2. Scatterplot showing the association between RRS scores and Disengagement Bias Index scores when stimuli came from the Sad/Happy domain at the 1000ms exposure duration.

To determine whether ruminative brooding and ruminative reflection, as assessed by their respective RRS subscales, were differentially implicated in the observed attentional disengagement bias, we separately computed the association between scores from the RRS brooding and RRS reflection subscales, and the Disengagement Bias scores on stimuli from

the Sad/Happy domain at the 1000ms exposure duration. These Disengagement Bias Index scores had a significant positive association with both RRS brooding scores,  $r(134) = .17, p = .05$ , and with RRS reflection scores,  $r(134) = .16, p = .05$ . The magnitude of these two correlations did not significantly differ from one another,  $Z = .06, p = .95$ . Hence, there was no evidence to suggest that ruminative brooding and ruminative reflection were differentially implicated in the observed disengagement bias effect.

As previously noted, heightened ruminative disposition is often accompanied by heightened depression and indeed, in our present sample, RRS scores were positively correlated with BDI-II scores,  $r(133) = .46, p < .001$ . Thus, it was important to determine whether the observed impairment in disengaging attention from depressogenic information at the 1000ms exposure duration was a specific characteristic of heightened ruminative disposition, rather than a characteristic of the elevated depression that accompanied this ruminative disposition. We entered both RRS scores and BDI-II scores simultaneously into a multiple regression in which the Disengagement Bias scores on stimuli from the Sad/Happy domain, at the 1000ms exposure duration, was the dependent variable. The regression model was significant,  $F(2, 132) = 3.28, p = .04$  and, of most importance to the issue under consideration, the RRS rumination scores predicted independent variance in the disengagement bias scores,  $\beta = .24; t(132) = 2.50, p = .01$ , while the BDI-II depression scores did not,  $\beta = -.06; t(132) = -.62, p = .54$ . Thus, these results indicate that there was a direct association between heightened ruminative disposition and the observed impairment in attentional disengagement from depressogenic information.

### **3.6 General Discussion**

Previous research has demonstrated that heightened ruminative disposition is characterized by an attentional bias to negative information. The purpose of the present study was to determine whether this rumination-linked attentional bias to negative information

reflects facilitated attentional engagement with, or impaired attentional disengagement from, negative information. Our findings show that heightened ruminative disposition is associated with impaired attentional disengagement from negative information, and there was no evidence to suggest that such ruminative disposition is associated with facilitated attentional engagement with negative information. Of course, appropriate caution should always be exercised when interpreting null results, and it will be important for future researchers to replicate the current findings. Nevertheless, our results are fully consistent with the hypothesis that heightened ruminative disposition is characterized specifically by impaired attentional disengagement from negative information.

In addition to resolving this key issue, the present study provided converging support for the previous claim that rumination-linked attentional bias is specific to depressogenic information (Joormann et al., 2006), by showing that heightened ruminative disposition was associated with impaired attentional disengagement from negative information only when this was depression-relevant. Our results also lend weight to the contention that rumination-linked attentional bias may be evident only when controlled attentional processing is readily permitted (Donaldson et al., 2007), as we found that heightened ruminative disposition was associated with impaired attentional disengagement from negative information only when stimuli were exposed for 1000ms, and not when they were exposed for 500ms. It is common to assume that attentional effects observed only at longer stimulus exposure intervals reflect the operation of controlled processing (McNally, 1995; Mogg & Bradley, 2005), inviting the inference that controlled attentional processes may play an important role in the attentional disengagement bias associated with heightened ruminative disposition. However, it should be acknowledged that 500ms exposure durations do permit sufficient time to enable the operation of controlled attentional processes, albeit to a lesser extent that would be possible at longer exposures (Holender, 1986; Mogg, Bradley, & Williams, 1995). It could be that

evidence of biased disengagement from negative information was more evident 1000ms after stimulus onset, compared to 500ms after stimulus onset, only because attentional disengagement from these stimuli necessarily must temporally follow engagement, and differences in disengagement bias, as a function of ruminative disposition and stimulus valence, could be detected only when sufficient time was permitted for such disengagement to occur. Future researchers could seek to determine the relative involvement of automatic and controlled processes in the presently observed rumination-linked disengagement bias by using a secondary load to disrupt controlled attentional processing (Sternberg, 1966; van Dillen, Papiés, & Hofmann, 2012). If the restriction of rumination-linked biased attentional disengagement to the 1000ms exposure duration, in the present study, does reflect the fact that this bias results from patterns of controlled attentional processing, then it would be expected that this bias would be attenuated under secondary load conditions.

The current findings also indicate that the observed disengagement bias effect was a function of ruminative disposition in general, as there was no evidence to suggest that this effect differentially implicated ruminative brooding and ruminative reflection. Further, although ruminative disposition was correlated with depression, as expected, this pattern of biased attentional disengagement was found to be a direct function of ruminative disposition, rather than an indirect function of accompanying heightened depression.

The pattern of results obtained in our current study are in keeping with the theory recently put forward by Koster et al. (2011), according to which heightened ruminative disposition is caused in part by specific difficulty disengaging attention from depressogenic information. The current study cannot shed light on the causal nature of the observed association between such disengagement bias and heightened ruminative disposition. Using an attentional-probe task variant configured to systematically modify attentional response to negative information, Yang, Ding, Dai, Peng, and Zhang (2015) have recently shown that

experimentally induced change in attentional bias can serve to influence subsequent rumination, consistent with the possibility that such attentional selectivity causally contributes to rumination. It will be now be important for researchers to directly interrogate the causal role of impaired attentional disengagement from depressogenic information in heightened ruminative disposition, using training variants of the conventional attentional-probe task specifically configured to directly modify attentional disengagement from depressogenic information. Of course, the finding that impaired attentional disengagement from depressogenic information makes a causal contribution to ruminative disposition would not preclude the possibility that such disposition also may causally influence this attentional bias in a reciprocal manner. Future research addressing this issue could make a valuable contribution to the literature.

Attentional bias is not the only information processing anomaly that has been found to be associated with heightened ruminative disposition. There is evidence that such ruminative disposition is characterized by enhanced recall of negative information (McFarland & Buehler, 1998), an increased tendency to impose negative interpretations on situations (Lyubomirsky & Nolen-Hoeksema, 1995), and a reduced expectancy for positive future events (Pyszczynski, Holt, & Greenberg, 1987). Moreover, within the domain of attentional processing there is growing evidence that heightened ruminative disposition may be characterized by deficient attentional control (Koster et al., 2011). The pattern of biased attentional disengagement observed in the present study, and such a deficit in attentional control, may represent two quite independent characteristics of rumination. However, a more intriguing possibility is that this impaired attentional disengagement from depressogenic information may result from deficient attentional control. The nature of the relationship between each attentional anomaly and variation in ruminative disposition should now be investigated by measuring disengagement bias, using the current attentional assessment task,

while also including an established measure of attentional control such as the anti-saccade task (e.g. Derakhshan, Ansari, Hansard, Shoker, & Eysenck, 2009), within the same studies. This would reveal whether the presently observed association between disengagement bias and ruminative disposition is direct, or is mediated by rumination-linked variation in attentional control.

There are, of course, some limitations associated with the current study. For one thing, our participants were not selected on the basis of displaying the excessively high ruminative disposition characteristic of pathological ruminators. Hence, it remains to be seen whether clinical patients exhibiting such pathological rumination would exhibit only impaired attentional disengagement from depressogenic information, as observed in the present participants. One intriguing possibility worthy of future consideration is that the attentional characteristics of pathological rumination might differ from the pattern of attentional selectivity presently found to be associated with high ruminative disposition in a non-clinical sample. Specifically, while the latter individuals only showed evidence of impaired attentional disengagement from negative information, it may be the case that the former individuals could show both impaired attentional disengagement from, and facilitated attentional engagement with, depressogenic information.

For the moment, we can conclude that heightened ruminative disposition, as assessed by the RRS, is characterized by impaired attentional disengagement from negative information, relative to positive information, that this attentional bias appears to specifically favour the processing of depression-relevant information, and that it is only evident when stimuli are exposed for 1000ms, rather than 500ms, exposure durations. We hope that this work, and the suggestions we have made concerning how future research can build upon this foundation, will be of value to investigators seeking to better understand the attentional basis of rumination.

### **3.7 Appendix A: Additional Analyses Investigating Whether the Relationship between Ruminative Disposition and Attentional Bias was Moderated by Attentional Bias Type**

In addition to the analyses reported in the submitted paper, additional analyses were conducted for the thesis. The analyses reported in the main section of this chapter demonstrated that higher levels of ruminative disposition were associated with impaired attentional disengagement from negative relative to positive stimuli, specifically for depression relevant stimuli presented for 1000ms. There was no evidence of a significant relationship between ruminative disposition and attentional engagement bias, regardless of stimulus domain or exposure duration. However, this finding does not necessarily warrant the conclusion that ruminative disposition is *exclusively* associated with attentional disengagement bias, rather than a general attentional processing bias involving both biased attentional engagement and disengagement. In order to infer attentional bias specificity, there must be evidence that the relationship between ruminative disposition and attentional bias is moderated by attentional bias type.

The attentional bias index scores were subjected to a repeated measures ANCOVA that considered the three within-subject factors attentional bias type (engagement bias, disengagement bias), stimulus domain (sad/happy words, anxious/relaxed words), and exposure duration (500ms, 1000ms), with RRS scores entered as a continuous variable. There were no significant interactions between RRS scores and attentional bias type (all  $p$ 's > .10), indicating that the relationship between RRS scores and attentional bias was not moderated by attentional bias type.

Since the analyses reported in the main section of this chapter found that RRS scores were particularly associated with attention disengagement bias for depression relevant words presented for 1000ms, analyses were also conducted to investigate whether the relationship between RRS scores and attentional bias for depression relevant stimuli presented for 1000ms

was moderated by attentional bias type. Attentional bias indices for depression relevant stimuli presented for 1000ms were subjected to a repeated measures ANCOVA that considered attentional bias type (engagement bias, disengagement bias), with RRS scores entered as a continuous variable. There was no significant interaction between RRS scores and attentional bias type,  $F(1, 134) = 2.59, p = .110, \eta_p^2 = .02$ , indicating that the relationship between RRS scores and attentional bias for depressive stimuli presented for 1000ms was not significantly stronger for attention disengagement bias than for attentional engagement bias ( $r(136) = .01, p = .892$  for attentional engagement bias;  $r(136) = .21, p = .014$  for attentional disengagement bias).

Thus, there was no evidence to suggest that the relationship between ruminative disposition and attentional bias was moderated by attentional bias type, meaning that evidence that rumination was exclusively associated with attentional disengagement bias was limited.

### **3.8 Appendix B: Analyses Investigating the Relationships between Ruminative Disposition, and Attentional Disengagement Bias for Both Negative Relative to Neutral and Positive Relative to Neutral Stimuli**

The index of attentional disengagement bias employed in the main section of this chapter compared attentional disengagement from negative relative to positive stimuli. Thus, the finding that heightened levels of ruminative disposition were associated with more impaired attentional disengagement from negative relative to positive stimuli could, in principal, reflect more impaired attentional disengagement from negative relative to neutral stimuli (i.e., increased negative attentional bias), facilitated attentional disengagement from positive relative to neutral stimuli (i.e., reduced positive attentional bias), or a combination of both. In order to distinguish between these possible interpretations, further analyses were conducted investigating the relationships between ruminative disposition, and attentional disengagement bias for both negative and positive stimuli relative to neutral stimuli separately.

The procedure for calculating attentional disengagement bias indices for emotional relative to neutral stimuli was similar to the procedure for calculating attentional disengagement bias indices for negative relative to positive stimuli, and can be expressed using the following equation:

Disengagement Bias Index = (Anchor probe proximal to emotional word in letter string pair: RT for target probe distal to emotional word – RT for target probe proximal to emotional word) – (Anchor probe proximal to neutral word in letter string pair: RT for target probe distal to neutral word – RT for target probe proximal to neutral word).

The analyses conducted in the main section of this chapter indicated that ruminative disposition was specifically associated with attentional disengagement bias for depression relevant stimuli (i.e., sad relative to happy words) presented for 1000ms. Thus, bivariate

correlations investigated the relationship between RRS scores, and attentional disengagement bias for sad relative to neutral words (negative attentional bias) and happy relative to neutral words (positive attentional bias) presented for 1000ms. There was a significant correlation between RRS scores and negative attentional disengagement bias, such that higher levels of ruminative disposition were associated with more impaired attentional disengagement from sad relative to neutral stimuli,  $r(136) = .22, p = .010$ . In contrast, there was no significant relationship between ruminative disposition and positive attentional disengagement bias,  $r(136) = -.04, p = .640$ . Thus, these findings indicate that heightened levels of ruminative disposition are associated with more impaired attentional disengagement from negative relative to neutral information.

In conclusion, the findings from Study Two indicate that heightened levels of ruminative disposition are associated with biased attentional disengagement from depression relevant stimuli presented for 1000ms, and that this attentional disengagement bias is characterized by impaired attentional disengagement from sad relative to neutral information.

## CHAPTER FOUR: Study Three

### 4.1 Introduction

Many investigators contend that biases in the selective attentional processing of negative relative to non-negative information underpin individual differences in ruminative brooding (Joormann, 2010; Siegle, Steinhauer, & Thase, 2004). Studies have found that heightened levels of ruminative disposition are associated with greater attentional bias for negative relative to non-negative information (Donaldson, Lam, & Mathews, 2007; Joormann, Dkane, & Gotlib, 2006; Pe, Vandekerckhove, & Kuppens, 2013). Furthermore, researchers have distinguished two facets of attentional selectivity that may be important in this regard (LeMoult, Arditte, D'Avanzato, & Joormann, 2013). The first is increased attentional engagement with negative information, reflecting a disproportionate tendency for attention to become more readily focused on negative information. The second is impaired attentional disengagement from negative information, reflecting a disproportionate tendency for attention to be more firmly held by negative information. Since the phenomenological experience of ruminative brooding suggests that it is characterised by persistent negative thinking, it has been hypothesized that individual differences in ruminative brooding may specifically be underpinned by impaired attentional disengagement from negative information, rather than by increased attentional engagement with negative information (Koster, De Lissnyder, Derakshan, & De Raedt, 2011).

Studies One and Two supported the impaired disengagement account of ruminative brooding by providing evidence that heightened ruminative disposition is associated with greater relative impairment in disengaging attention from negative compared to non-negative stimuli. These studies used variants of the dot-probe task developed by Grafton, Watkins, and MacLeod (2012) that enables the discrete assessment of selective attentional engagement

with, and selective attentional disengagement from, negative information. In this task, the participant's attention is initially fixed in either an upper or lower screen location using an anchor probe. Immediately thereafter, a stimulus pair comprising an emotional letter string, and a non-emotional letter string, is briefly displayed. A target probe then appears in the location of either one of the two screen loci, and the participant is required to determine whether the identity of the target probe matches that of the anchor probe. The degree to which speeding to target probes in the locus of the emotional letter strings compared to non-emotional letter strings is greater when the emotional letter string is negative, relative to positive in emotional tone, provides an index of attentional bias to negative information. On trials where the emotional letter string appears distal to initial attentional focus, this index of attentional bias to negative information reveals increased attentional engagement with negative compared to positive information. In contrast, on trials where the emotional letter string appears proximal to initial attentional focus, this index of attentional bias to negative information reveals reduced attentional disengagement from negative compared to positive information. Using this attentional assessment task, Study One found that heightened disposition for ruminative brooding, as measured by both a retrospective questionnaire and an in-vivo assessment, was associated with slower attentional disengagement from negative relative to positive stimuli. Study Two extended this finding by indicating that this rumination-linked bias in attention disengagement was specific to depression relevant stimuli, and not anxiety relevant stimuli.

However, evidence that ruminative disposition was exclusively associated with attentional disengagement bias was limited. Study One found that in-vivo ruminative disposition indices were associated with attentional engagement bias, although only for depression relevant stimuli presented for longer durations. Furthermore, neither study found

any evidence that ruminative disposition was more significantly associated with attentional disengagement bias than attentional engagement bias.

One limitation of response probe assessments of attentional bias, which may have contributed to unclear findings, is that they can only provide a 'snapshot' of attention at the time of probe presentation, meaning that we cannot know the patterns of attentional distribution before or after probing (Mogg & Bradley, 2005; Yiend, 2010). This potentially has implications for the sensitivity of attentional bias assessments, as any biases in selective attention that occur either before or after probe presentation will be missed. In addition, there may be multiple shifts in the allocation of attention before probe presentation, particularly at longer stimulus presentation durations (Yiend, 2010). This may be particularly problematic for assessment tasks seeking to distinguish between biases in the engagement and disengagement of attention, as there could potentially be some degree of cross-contamination between these separate measures. For example, if on trials intended to assess attentional engagement with emotional stimuli, there is sufficient time for participants to engage with and then disengage attention from initially distal stimuli, biases detected by this measure could in part reflect attentional disengagement as well as attentional engagement. Such limitations to sensitivity and opportunity for cross-contamination could potentially explain the lack of a significant difference in the strength of the relationship between rumination and biases in attentional engagement and disengagement in Studies One and Two.

Furthermore, response probe assessments are unable to fully delineate the nature of the attentional mechanisms that underpin any observed biases in attentional disengagement. A bias in attentional disengagement as assessed by the modified dot-probe task could reflect either a reduced ability to disengage attention from negative information, a reduced tendency to disengage attention from negative information, or a combination of both these mechanisms. It is possible that the task constraints imposed by the response probe task might

lead to strategic differences in the distribution of attention, which determine whether an attentional bias is expressed. For example, participants may have pre-emptively disengaged attention from its initial location prior to probe onset, in order to facilitate rapid responding to the probe, in which case a deficit in the ability to disengage attention from negative stimuli would result in an attentional disengagement bias, which might not otherwise have been apparent. Alternatively, it is possible that participants with high levels of ruminative disposition may have an increased tendency to maintain attention for negative stimuli, such that they preferentially sustain attentional focus on negative information even in the absence of explicit demands upon attention. In this case, an attentional bias for negative stimuli would be apparent regardless of the presence of a response probe. Response probe assessments of attentional bias are unable to distinguish between these two accounts, as it is unclear whether an attentional bias would still be expressed in the absence of the task demands imposed by the response probe.

An alternative methodology that can overcome these limitations is the measurement of attentional distribution via eye-movements. Eye-movements are closely linked to attention, as individuals typically direct their gaze towards stimuli that attract their attention (Jonides, 1981), and there is a mandatory shift in attention prior to every eye-movement (Kowler, Anderson, Doshier, & Blaser, 1995). Eye-tracking technology allows for the continuous assessment of attention allocation throughout the entire stimulus presentation duration, thus allowing for any biases in selective attention to be detected regardless of when during stimulus presentation that they occur. Also, attentional assessment via eye-tracking is not necessarily reliant on the presence of a response probe, or any other task constraints. By presenting material without a response probe, which may require some ability to shift attention in order to execute a response, eye tracking can assess spontaneous patterns of attentional distribution, which are assumed to be more likely to reflect tendencies in

attentional distribution, rather than ability to distribute attention. Thus, eye-tracking can assess tendencies in biased attentional allocation that are less influenced by abilities to shift attention in response to task constraints.

Various previous studies have used eye-tracking to investigate attentional biases in depression. The majority of these studies have employed free-viewing tasks, in which participants' attention is initially secured on a central fixation point, before viewing an array of stimuli of differing emotional valence, without any restrictions on gaze behaviour. Such studies have typically found evidence of a dwell bias for dysphoric stimuli, such that depressed individuals spent more time viewing dysphoric stimuli relative to non-depressed individuals, and less time viewing positive stimuli (Eizenman et al., 2003; Kellough, Beevers, Ellis, & Wells, 2008; Leyman, De Raedt, Vaeyens, & Philippaerts, 2011; see Armstrong & Olatunji, 2012 for meta-analysis). Investigators have suggested that this dwell bias may reflect greater elaborative processing of dysphoric information, consistent with higher levels of rumination (Armstrong & Olatunji, 2012). However, it is important to note that although such dwell biases are consistent with the possibility of impaired attentional disengagement in depression, free-viewing tasks which initially secure attention in a location distal to emotional stimuli cannot specifically assess biases in attentional disengagement. In order to adequately assess attentional disengagement using eye-movements, attention must initially be secured in the locus of an emotional or neutral stimulus, in order to assess how the valence of this attentionally proximal information influences latency to shift eye-gaze away from it (Clarke, MacLeod, & Guastella, 2013).

A couple of studies have, however, employed eye-tracking assessments, which adequately assessed biases in attentional disengagement, indicating that depression is associated with impairments disengaging attention from dysphoric information (Sanchez, Vazquez, Marker, LeMoult, & Joormann, 2013; Sears, Thomas, LeHuquet, & Johnson,

2010). Sears et al. (2010) utilised a task where participants were occasionally required to direct their attention away from sequentially presented emotional images, towards the direction of an arrow probe, as quickly as possible. It was found that dysphoric participants were slower than non-dysphoric participants to direct their attention towards the required location when the probed image was depression-related, indicating impaired disengagement from depression-related information. Sanchez et al. (2010) employed a 'wait for fixation' design, which would initially involve free-viewing of an emotional and neutral face pair. After a period of time, participants would be prompted to shift their attention towards the opposing stimulus only once their attention was fixated on a designated location. On trials assessing attentional disengagement, a shift in attention was prompted once participants had fixated on the emotional face, whereas on trials assessing attentional engagement, a shift in attention was prompted once participants had fixated on the neutral face. Attentional engagement and disengagement were both indexed by latency of the first shift in gaze towards the opposite stimulus following this prompt. Sanchez et al. (2010) found that depressed participants were slower than control participants to disengage their attention from sad faces relative to neutral faces, but did not differ in latencies of attentional engagement with sad faces relative to neutral faces. Furthermore, individual differences in attentional disengagement from sad faces in the depressed group predicted lower recovery from sad mood in response to a stress induction.

Although eye-tracking assessments have found evidence of impaired attentional disengagement from negative stimuli in depression, research has yet to use eye-tracking to investigate the relationship with ruminative disposition. In the present study, we developed an eye-tracking task designed to measure biases in attentional engagement with and disengagement from negative information. We adapted the Grafton et al. (2012) attentional assessment task used in Studies One and Two, where attention is initially secured in a

designated location prior to the presentation of an emotional and non-emotional letter string pair. However, since we were interested in determining whether rumination-linked attentional disengagement bias involves tendency to maintain attention for negative information, the response probe appearing after stimulus presentation was removed, in order to assess the spontaneous allocation of attention between stimuli. Instead, in order to secure attention in the designated location, participants were required to respond to an anchor stimulus presented prior to an emotional and non-emotional letter-string pair. Subsequently, attentional distribution was assessed by measuring eye-movement during free-viewing of the letter-string pair. On trials assessing attentional engagement with emotional stimuli, attention was initially secured in the location of the non-emotional letter string, and attentional engagement was indexed using latency to fixate on the emotional letter string. On trials assessing attentional disengagement from emotional stimuli, attention was initially secured in the location of the emotional letter string, and attentional disengagement was indexed using latency to saccade away from the emotional letter string. In addition, we also assessed maintenance of attention on emotional stimuli on all trials, using the total fixation duration on the emotional letter string throughout the entire duration of stimulus presentation.

Lastly, in the majority of prior studies investigating the attentional bias of rumination, variation in ruminative disposition has only been assessed using the RRS questionnaire measure. There are two problems with exclusive reliance on such an assessment approach. The first problem is that this questionnaire measure does not control for variability in the levels of exposure to negative events that respondents may have experienced. Thus, it is possible that a high score on the RRS could reflect more frequent, extended or intense exposure to negative events capable of evoking rumination, rather than an increased tendency for rumination to be evoked by such negative events. The second problem is that the RRS requires participants to draw on their long-term memory of past ruminative experience,

across an extended period of time, and it is well known that retrieval from long-term memory can be highly susceptible to biases, such as mood-congruency and recency effects (Kihlstrom, Eich, Sandbrand, & Tobias, 2009; Trull & Ebner-Priemer, 2009). Such memory biases may influence participant's RRS responses in ways that compromise sensitive assessment of variability in ruminative disposition, thereby obscuring the association between individual differences in ruminative disposition and attentional bias to negative information.

In Study One, we addressed this issue by developing an in-vivo assessment of the tendency to engage in rumination in response to negative mood. Specifically, this involved exposing participants to a standardised negative event in the laboratory, and assessing their levels of rumination immediately before and immediately after this event. An index of ruminative disposition, reflecting the degree to which this controlled event served to evoke rumination, was obtained by computing the degree to which rumination was elevated post-compared to pre- this negative event. Higher levels of ruminative disposition were revealed by greater increases in rumination following exposure to this negative event, relative to before such exposure. By ensuring that participants received equivalent exposure to the same negative event, under tightly controlled laboratory conditions, and minimising reliance on long-term memory by assessing levels of rumination in very close temporal proximity to this event, we were able to reduce the problems associated with the RRS questionnaire measure of ruminative disposition. This alternative measure of ruminative disposition provided converging support for the relationship between rumination and impaired attentional disengagement from negative information, as both the RRS brooding subscale and this new in-vivo measure of ruminative disposition were found to be associated with slower disengagement from negative relative to positive stimuli.

The purpose of the current study was to further test the impaired disengagement account of rumination, in particular whether heightened ruminative disposition is associated

with reduced tendency to disengage attention from negative information, rather than impaired ability to disengage attention from negative information. To do this, we delivered an eye-tracking assessment of bias in attentional engagement and disengagement, to participants who differed widely in terms of their disposition to engage in ruminative brooding. The eye-tracking assessment of attentional bias involved unconstrained, free-viewing of emotional stimuli, in order to assess bias is the spontaneous distribution of attention, thereby reducing the likelihood that any observed attentional disengagement bias can be attributed to impaired ability to disengage attention from negative stimuli. To assess ruminative disposition, we employed both the conventional RRS questionnaire measure, which requires retrospective report concerning the degree to which past experience of negative mood have served to elicit rumination, and an in-vivo assessment of variation in the degree to which a standardized stressor serves to elicit rumination. It was hypothesised that higher levels of dispositional ruminative brooding would be associated with slower disengagement from negative relative to positive stimuli (attentional disengagement bias), but would not be associated with a bias in attentional engagement with negative relative to positive stimuli. The association between dispositional ruminative brooding and dwell bias (i.e., total time spent viewing stimuli) was also investigated. It was predicted that higher levels of dispositional ruminative brooding would be associated with greater dwell bias for negative relative to positive stimuli.

## **4.2 Method**

### **4.2.1 Participants**

Participants were 60 students (17 male, 43 female; mean age = 19.9,  $SD = 1.40$ ) from the University of Exeter, recruited via the university participant recruitment system.

Participants with glasses, contact lenses, or other eye-problems (e.g., astigmatism) were excluded from the study. All participants spoke English as a first language.

#### 4.2.2 Materials and Measures

**Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996).** The BDI-II is a 21-item self-report measure designed to assess the severity of depressive symptoms. Participants indicate on a 4-point scale how much they have experienced depressive symptoms over the past two weeks. We used a 20-item version of the BDI-II, with the item about suicidal feelings or ideation removed at the request of our institutional review board. Higher scores represent greater severity of depressive symptoms. This measure has shown good reliability and validity (Beck et al., 1996).

**Ruminative disposition assessment: Questionnaire measure.** The Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991) was employed as our questionnaire instrument of ruminative disposition. The RRS is a 22-item self-report measure, which requires participants to indicate the degree to which they engage in particular ruminative responses when in a negative mood on a 4-point Likert scale (1 = Almost Never, 4 = Almost Always). This questionnaire yields two subscales: ruminative brooding and ruminative reflection. Both of these subscales show acceptable reliability and consistency (Treyner et al., 2003). In each case, a higher score indicates a greater tendency to engage in rumination in response to negative mood.

**Ruminative disposition assessment: In-vivo measure.** Ruminative disposition was also measured using an in-vivo approach, identical to the procedure used in Study One (see section 2.4.2), that involved assessing levels of ruminative thinking immediately before, and immediately after, exposure to a controlled negative event in the laboratory. As described in detail below, this negative event was an anagram failure task. To assess levels of ruminative thinking at each of these two assessment points, we adapted the breathing focus task originally developed by Hirsch, Hayes, and Mathews (2009). In this task, participants were asked to try and focus on their breathing for 5 minutes. Throughout this 5 minute period, a

tone sounded 12 times at random intervals of between 20 and 30 seconds. Whenever the tone sounded, participants were required to report whether they were currently focused on their breathing or were focused on a thought. If they were focused on a thought, they were required to give this thought a one or two word label, and classify it as negative, positive, or neutral in emotional tone.

At the end of the 5 minute breathing period, the participant rated each recorded negative thought on five key dimensions relevant to rumination. Specifically, each negative thought was rated from 0 to 4 in terms of frequency (i.e., how often the thought came to mind), duration (i.e., how long they were thinking about the subject of the thought), repetitiveness (i.e., how much thoughts kept coming back to the same idea), severity (i.e., how upsetting or distressing the thought was), and control (i.e., how difficult it was to stop or move on to other thoughts; see Appendix One for full rating questions and response options). The ratings for each negative thought reported during the 5 minute breathing period were averaged across the total number of negative thoughts to yield a rumination score for that period. Using this rumination score data, an in-vivo index of ruminative disposition was obtained by computing the residuals from a simple linear regression predicting rumination scores post-anagram task from rumination scores pre-anagram task. A higher score on this index reflected a greater tendency to respond to the negative event by increasing ruminative thinking, and so indicated heightened ruminative disposition.

**Mood assessment.** During the breathing focus tasks, for each tone, participants also completed two visual analogue mood rating scales, each 100mm in length, that assessed momentary levels of sadness (scale labelled “sad and “happy” at each extreme) and anxiety (scale labelled “anxious” and “confident” at each extreme), each scored on scales from 0 to 10, with higher scores indicating more negative mood.

**Anagram failure task.** In this anagram task, participants were given three minutes to solve 30 supposed anagrams. They were told that the anagram task predicted academic success, and that they should expect to solve five or six anagrams. Fifteen of the anagrams were soluble in that their letters could be rearranged to form a legitimate English word, though these anagrams had been rated as very difficult to solve even for a university population. The remaining 15 anagrams were insoluble, as the letters of these anagrams could not be rearranged to form a legitimate English word. Most participants were only able to solve one or two anagrams (mean correct = 1.19,  $SD = 1.21$ ), and no participants solved more than four. At the end of the 3 minutes, participants were given their score, together with the feedback that this score was below average.

#### **4.2.3 Attentional Bias Assessment**

**Apparatus.** Eye movements were recorded by an EyeLink 2000 eye-tracking system, which uses infrared video-based tracking technology. Head location was fixed using a chin rest 57cm from the display monitor, and a camera on the desk tracked the position of the pupils as they moved. The stimulus display was presented on a 17 inch 1024 x 768 monitor, and 1 cm on the stimulus display corresponded to 1° visual angle. Both stimulus presentation and eye-movements recording were controlled by E-prime 2.0 software, with the eye-tracking system automatically synchronised to the program at the beginning of each trial. Only eye-movements from the right eye were recorded, which were tracked continuously throughout each trial. The EyeLink 2000 system automatically parsed eye-movement data into fixations and saccades. The parser computed instantaneous velocity and acceleration, and compared these to pre-determined thresholds. Fixations were defined as time periods where both velocity and acceleration were under these thresholds. Start latency, end latency, and average position for each fixation were recorded.

The eye-tracker was calibrated before the start of each assessment block in order to ensure accurate measurement of gaze direction. The calibration procedure involved the sequential presentation of nine targets (5mm white circles) in pre-determined locations on the screen, which the participants were instructed to direct their gaze towards. During the first presentation sequence, gaze direction was determined by matching pupil position to the location of each target. The presentation sequence was then repeated a second time, and the difference in visual angle between the estimated fixation position and actual target position was recorded for each target. The calibration was accepted if average discrepancy was below  $0.7^\circ$  and maximum discrepancy was below  $1.5^\circ$ , otherwise the calibration procedure was repeated until an acceptable level of accuracy was obtained.

**Experimental stimuli.** In the present study, we required 96 word pairs each comprising a word (negative, positive, or neutral), and a length matched non-word (see Appendix Two for list of word stimuli). The word stimuli were taken from Grafton et al. (2012). These words had been selected from a pool of 400 candidate words on the basis of emotional tone ratings provided by clinical psychologists. The sets of negative, positive and neutral words, did not differ in terms of word length, frequency, or arousal ratings (all  $p$ 's  $> .05$ ). Emotional words (negative/positive words) were also rated on the basis of their emotional domain relevance, such that half of the words were depression relevant (sad/happy) and half were anxiety relevant (anxious/relaxed), giving rise to the stimulus domain factor. Emotional tones ratings did not significantly differ between depression and anxiety relevant stimuli, confirming that stimulus emotionality was not confounded by stimulus domain (see Study Two, section 3.4.3 for further details).

**Attentional bias assessment task.** Each trial began with the appearance of an upper and lower string of asterisks for 1000ms, centralised horizontally on the screen, demarcating the two critical screen regions. The critical regions were separated vertically by a distance of

4.3 cm, which corresponded to a visual angle of  $4.32^\circ$  to ensure the elicitation of eye movements<sup>5</sup>. Immediately afterwards, a cue stimulus appeared in one of the two critical regions, with equal frequency. The cue stimulus was a small red line, sloping upwards either the left or to the right, with equal frequency. Participants were required to indicate the direction of the cue stimulus, by pressing either the left or right mouse button. Immediately after the response was executed, a word/non-word stimulus pair was presented for 2000ms, one member appearing in each of the critical screen regions. Thus, the word appeared in the region either proximal or distal to the initial focus of attention, with equal frequency. This sequence of events is summarized in the example trials shown in Figure 4.1.

The task consisted of a total of 384 trials, split into 4 blocks, with a 30 second break in between each block. The eye-tracker was calibrated before the start of each block in order to ensure accurate measurement of gaze direction. Each of the 96 stimulus pairs was presented 4 times; twice with the word in the locus of initial attention, and twice with the word distal to the focus of initial attention, and in each case with the word appearing once in the upper region and once in the lower region. Presentation of stimuli was balanced across the blocks, such that each word pair was presented once per block, and that an equal number of each word type was presented in each of the four location conditions.

**Data preparation.** For the purpose of analysis, the upper and lower screen regions were defined as two areas each measuring 8cm horizontally, by 3cm vertically. Both were centralised horizontally, and the centre of each was distanced 2.15cm vertically from the screen centre.

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<sup>5</sup>  $4.32^\circ$  visual angle falls within the parafoveal field of vision (between  $2^\circ$  and  $5^\circ$  visual angle; Rayner, 1998). Word stimuli appearing within the parafoveal field of vision will receive some semantic processing, but it will be necessary to make an eye-movement to achieve full semantic processing (Liversedge & Findlay, 2000).

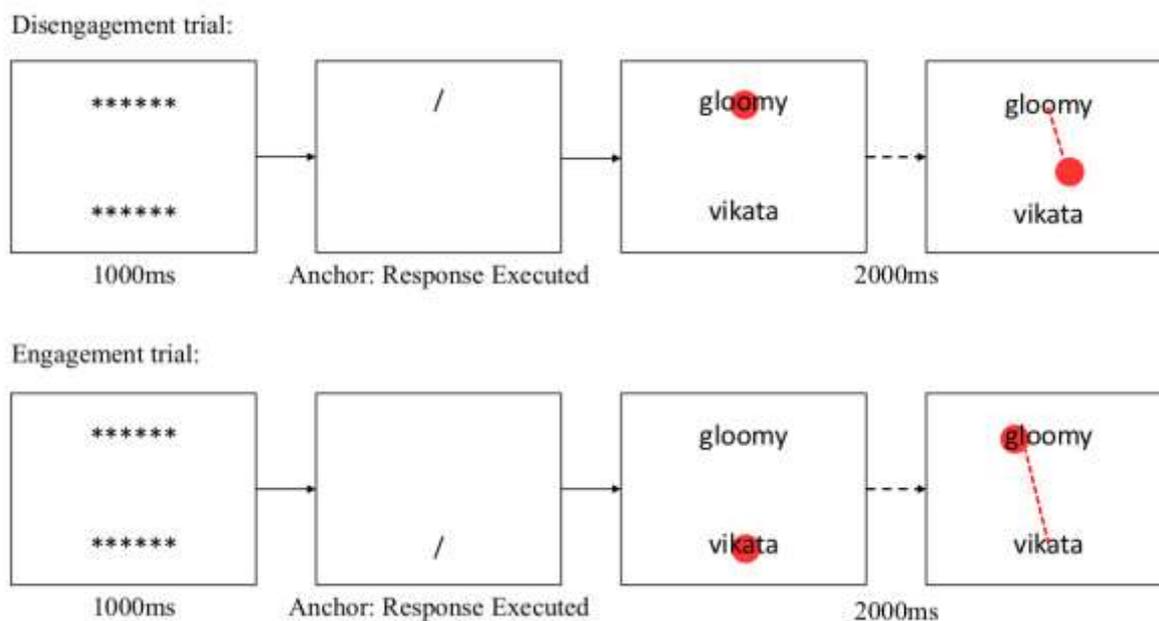


Figure 4.1. Examples of stimulus presentation on engagement and disengagement trials. On disengagement trials the cue appears in the location of the word stimulus, and latency to saccade away from the word stimulus is assessed. On engagement trials the cue appears in the location of the non-word, and latency to fixate on the word stimulus is assessed.

Trials were categorised as valid and included for analysis if (a) participants were fixated on the region containing the cue stimulus immediately prior to the onset of the stimulus pair, and (b) they remained fixated on this region for at least 100ms after stimulus onset, indicating that they were attending to the cue as intended.

The percentage of valid trials for each block was calculated, and blocks with less than 75% valid trials were excluded from analysis, as a high percentage of invalid trials can indicate poor calibration of the eye-tracker. Participants with less than 2 valid blocks were excluded from analysis.

Following the approach adopted in prior research (Rutherford, MacLeod, & Campbell, 2004; Ratcliff, 1993) to minimise the influence of outliers, we used median latencies under each condition per person to calculate each of the bias indices.

**Engagement bias.** Trials where attention was initially fixated on the non-word stimulus were used to calculate engagement bias. Engagement speed was defined as latency to fixate on the word stimulus following onset (i.e., start latency of the first fixation within the region of the word stimulus). Engagement bias was calculated by subtracting engagement speed for negative words from engagement speed for positive words, so that a larger bias index indicated faster engagement with negative relative to positive words.

**Disengagement bias.** Trials where attention was initially fixated on the word stimulus were used to calculate disengagement bias. Disengagement speed was defined as latency to saccade away from the word stimulus following onset (i.e., end latency of the fixation prior to the first fixation outside the region of the word stimulus). Disengagement bias was calculated by subtracting disengagement speed for positive words from disengagement speed for negative words, so that a larger bias index indicated slower disengagement from negative relative to positive words.

**Dwell bias.** Total fixation durations to the region of the word stimuli for the entire presentation duration were summed, in order to measure dwell time for the word stimuli. Dwell bias was calculated by subtracting dwell time for positive words from dwell time for negative words, so that a larger bias index indicated longer dwell time for negative relative to positive words.

#### **4.2.4 Procedure**

Prior to commencing the experimental session, participants were told that the study was investigating links between personality, and variations in attention and cognitive abilities, and were given a basic description of each task. After being given the opportunity to ask questions, participants signed the study consent form. Participants then completed the BDI-II and RRS questionnaire measures. They were then seated approximately 57cm from the display monitor, and completed a brief practice of the attentional assessment task

consisting of 16 trials utilising only neutral stimuli. Following this, they completed the attentional assessment task. Participants then practiced focusing on their breathing for a one minute period, before completing the in-vivo assessment of ruminative disposition. Finally, participants were fully debriefed and completed a final mood assessment to check for any persisting signs of distress.

### 4.3 Results

Nine participants who had less than two valid blocks in the attentional assessment task, and three who did not complete the full set of emotional assessment measures, were removed prior to analysis. The remaining participants displayed a high level of accuracy on the attentional assessment task, averaging 85% valid trials. There was no association between percentage of valid trials and any of the measures of ruminative disposition (all  $p$ 's > .20).

In order to check that the anagram failure task had the intended effect on mood and state rumination, repeated measures ANOVAs were used to investigate the effect of the anagram failure task on mood and rumination. Both sadness and anxiety ratings were higher during the post-failure assessment than during the pre-failure assessment ( $F(1, 47) = 42.10, p < .001, \eta_p^2 = .472$  for sadness;  $F(1, 47) = 33.38, p < .001, \eta_p^2 = .415$  for anxiety; see Table 4.1 for means), confirming that the anagram failure experience was effective at eliciting negative mood. Participants also obtained higher state rumination scores during the post-failure assessment than during the pre-failure assessment,  $F(1, 47) = 17.43, p < .001, \eta_p^2 = .271$  (see Table 4.1 for means), confirming that the anagram failure task was effective at eliciting rumination, as intended.

In-vivo ruminative disposition scores were not significantly correlated with RRS scores,  $r(48) = .23, p = .116$ , or with either the brooding or reflection subscales ( $r(48) = .21, p = .157$  for brooding;  $r(48) = .08, p = .589$  for reflection). However, this in-vivo measure

has previously been found to be positively associated with ruminative brooding scores (Study One).

Table 4.1. Descriptive statistics of participant characteristics, and in-vivo mood and rumination assessments (pre- and post-failure).

	Mean ( <i>SD</i> )	Range
BDI-II	6.00 (5.16)	0 - 20
RRS	46.29 (10.94)	25 - 69
Brooding	10.10 (3.43)	5 - 18
Reflection	11.52 (3.41)	5 - 20
Pre-Failure Assessment		
Sadness	28.27 (15.64)	0.00 - 62.60
Anxiety	34.31 (16.43)	4.20 – 62.40
Rumination	3.96 (5.03)	0.00 – 16.00
Post-Failure Assessment		
Sadness	39.14 (17.01)	8.30 – 85.40
Anxiety	44.27 (16.81)	10.20 – 84.70
Rumination	7.17 (5.69)	0.00 – 20.00

Note: BDI-II = Beck Depression Inventory II, RRS = Ruminative Responses Scale

Table 4.2. Mean attentional engagement and disengagement latencies, and total dwell times for positive and negative stimuli, along with mean bias indices (*SDs* in parentheses).

	<i>Latency/dwell time (ms)</i>		
	<i>Negative words</i>	<i>Positive words</i>	<i>Bias index</i>
Attentional engagement latency	965.8 (374.9)	956.3 (440.5)	-9.50 (276.2)
Attentional disengagement latency	555.1 (214.9)	528.0 (235.2)	27.16 (138.5)
Total dwell time	700.6 (128.2)	732.6 (162.8)	-32.06 (146.6)

#### **4.3.1 Association between Ruminative Disposition Questionnaire Assessment Scores and Attentional Bias Indices**

Bivariate correlations were computed between RRS scores, the brooding and reflection subscales, and our indices of attentional bias to negative information (engagement, disengagement, and dwell bias). The results of these correlations are shown in Table 4.3. There were no significant correlations between any of the questionnaires measures of ruminative disposition and the indices of attentional bias (all  $p$ 's > .30).

We went on to investigate whether any of the relationships between questionnaire measures of ruminative disposition and attentional biases were moderated by stimulus domain. Each of the attentional bias indices were subjected to repeated measures ANCOVAs with stimulus domain as the within-subjects factor (depression vs. anxiety relevant words), and questionnaire measures of ruminative disposition as the covariates (separate analyses conducted for each questionnaire measure). There were no significant interactions between stimulus domain and ruminative disposition for any of the attentional bias indices (all  $p$ 's > .10). Thus, there was no evidence that any of the relationships between ruminative disposition and attentional biases differed depending on stimulus domain.

Table 4.3. Bivariate correlations between RRS and in-vivo ruminative brooding scores and attentional bias indices.

	<i>Engagement</i>		<i>Disengagement</i>		<i>Dwell Bias</i>	
	<i>Bias</i>		<i>Bias</i>			
	<i>r</i> (48)	<i>p</i>	<i>r</i> (48)	<i>p</i>	<i>r</i> (48)	<i>P</i>
RRS	.03	.819	-.13	.375	-.02	.882
Brooding	.15	.322	.00	.990	.14	.349
Reflection	-.05	.737	-.07	.629	-.00	.984
In-vivo ruminative brooding	-.24	.097	.10	.510	.00	.981

Note: RRS = Ruminative Responses Scale

#### 4.3.2 Association between In-Vivo Ruminative Disposition Scores and Attentional Bias Indices

We went on to investigate the association between our in-vivo measure of ruminative disposition, and the attentional bias index scores using bivariate correlations. There were no significant correlations between in-vivo ruminative disposition scores and any of the indices of attentional bias (all  $p$ 's > .05; see Table 4.3). We also investigated whether the relationship between in-vivo ruminative disposition scores and each of the attentional bias indices was moderated by stimulus domain. Each of the attentional bias indices were subjected to a repeated measures ANCOVA with stimulus domain as the within-subjects factor (depression vs. anxiety relevant words), and in-vivo ruminative disposition scores as the covariate. There were no significant interactions between stimulus domain and in-vivo ruminative disposition for any of the attentional bias indices (all  $p$ 's > .50). Thus, there was no evidence that the relationship between in-vivo ruminative disposition and any of the indices of attentional biases differed depending on stimulus domain.

#### 4.4 Discussion

The aim of the present study was to empirically test the impaired disengagement account of ruminative brooding, using an eye-tracking assessment of attentional bias to assess spontaneous allocation of attention to emotional stimuli. Response probe assessments of attentional disengagement bias used in previous studies could involve either ability or tendency to disengage attention from negative stimuli. By employing an eye-tracking assessment of attentional bias involving free-viewing of emotional stimuli, the present study was able to investigate whether ruminative disposition is associated with individual differences in the spontaneous tendency to disengage attention from negative stimuli. It was hypothesised that higher levels of dispositional ruminative brooding, as measured by both the RRS and an in-vivo measure, would be associated with slower attentional disengagement from negative relative to positive stimuli. However, there was no evidence of a relationship between ruminative disposition and attentional disengagement bias. Neither the RRS nor the in-vivo assessment of ruminative disposition were correlated with biases in attentional disengagement from negative relative to positive stimuli. There was also no evidence of a relationship between ruminative disposition and biases in either engagement or maintenance of attention.

The lack of any evidence for a relationship between ruminative disposition and attentional bias contrasts with previous studies using response probe assessments of attentional bias, which have demonstrated that higher levels of ruminative disposition are associated with greater attentional bias for negative information (Donaldson et al., 2007; Joormann et al., 2006) and more specifically with impaired attentional disengagement from negative information (Studies One & Two). One possible explanation for this discrepancy is that rumination-linked attentional bias is only apparent under conditions that explicitly require a shift in the direction of attention allocation. In the present study, attentional

distribution was assessed via eye-movements during free-viewing of emotional stimuli. Such attentional assessment tasks arguably reflect biases in tendency to allocate attention to emotional stimuli, whereas response probe assessments of attentional bias could reflect biases in either attentional tendency or ability. In response probe assessments of attentional bias, participants will be required to disengage their attention from the location of emotional stimuli on trials where the probe appears distal to this location. The task demands imposed by the response probe may have influenced the allocation of attention during stimulus presentation to facilitate rapid responding to the target probe, such that participants pre-emptively disengaged attention from its initial location prior to probe onset. If rumination-linked attentional biases involve reduced ability to disengage attention from negative information, then such biases might only be apparent when participants are explicitly required to disengage their attention from the location of emotional stimuli, as is the case in response probe tasks. Hence, it is possible that rumination-linked impairments in disengagement of attention from negative information could particularly involve a reduced ability to disengage attention when required, but not a reduced tendency to spontaneously disengage attention.

Another possible explanation for the present findings may involve the fact that eye-movements can only detect overt shifts in attention (i.e., attentional selection performed via eye-movements; Armstrong & Olatunji, 2012). In between eye-movements, covert shifts in attention allocation can occur without redirecting gaze. If the rumination-linked attentional biases observed in previous studies do not translate into shifts in overt attention, but instead only involve shifts in covert attention, then eye-tracking assessments of attentional bias would be incapable of detecting this. This explanation seems unlikely, as in naturalistic viewing, eye-movements are the primary method of attentional selection, with covert

attention generally guiding eye-movements (Findlay & Gilhchrist, 2003; Hayhoe & Ballard, 2005), but cannot be completely ruled out by the present methodology.

There are also other methodological differences worth noting between the eye-tracking and response probe attentional assessment task, which could potentially have influenced the present findings. Firstly, the distance between the critical screen regions was increased from 3cm in the response probe assessment to 4.3cm in the eye-tracking assessment, in order to ensure that the distance between the critical regions was sufficient to necessitate eye-movements when shifting attention between critical regions. Secondly, whereas stimulus presentation duration in the response probe assessment varied between 500ms and 1000ms, stimulus presentation duration was increased to 2000ms in the eye-tracking assessment. Whereas the ‘snapshot’ nature of response probe assessments of attentional bias means that longer stimulus presentations durations risk missing any early bias in selective attention, the continuous nature of eye-tracking assessments means that biases in attentional distribution can be detected regardless of when they occur. Thus increasing the stimulus presentation duration maximises the opportunity to detect bias in attentional distribution at multiple stages. Since both these methodological changes were adopted in order to maximise eye-tracking sensitivity, it seems unlikely that either of these differences can account for the null findings within the present paradigm.

In addition, the null findings in this study could simply be a result of low statistical power, due to small sample size ( $N = 48$ ). Power analyses conducted in G-Power revealed that the present study achieved a power of only .10 to detect small effect sizes ( $r = .10$ ) at the .05 level, and a power of .57 to detect medium effect sizes ( $r = .30$ ), both of which are below the recommended level of .80. However, the observed effect sizes for the relationship between ruminative brooding and attentional disengagement bias were very small ( $r = .00$  for

the RRS brooding subscale;  $r = .10$  for the in-vivo measure of ruminative disposition), indicating that any genuine relationship is likely to be weak.

In order to better understand the reasons for the discrepancy between the present study and previous research investigating the link between ruminative disposition and attentional biases for emotional stimuli, future research could combine the use of eye-tracking assessments of selective attention with attentional response probe tasks. If this combined approach were to produce evidence of a relationship between ruminative disposition and attentional disengagement bias on the response probe measure, but without a simultaneous bias in disengagement of attention via eye-movements, then this would indicate that the discrepant results can be accounted for by differences in the ability to detect covert shifts in attention. However, if simultaneous biases in attentional disengagement were found using both measures, then the role of the response probe in eliciting this bias could be further investigated. A mixture of assessment trials both with and without the response probe would enable the determination of whether the task constraints imposed by the response probe are necessary for rumination-linked biased in attentional disengagement to become apparent. Such research would have theoretical implications for the nature of the rumination-linked attentional disengagement bias, particularly the distinction between biases in ability and spontaneous tendency to disengage attention. Specifically, if a an attentional bias for negative information performed via eye-movements was observed in the presence of the response probe, but not during free-viewing of stimuli in the absence of a response probe, this would indicate that this rumination-linked attentional bias principally involved impaired ability to inhibit attentional processing of negative information, rather than a spontaneous tendency to preferentially direct attention towards negative information.

If rumination-linked attentional disengagement bias does involve a reduced ability to disengage attention from negative information, then this would emphasise the role of

attentional control deficits in contributing to this attentional bias. According to the impaired disengagement hypothesis, deficits in attentional control may underpin impaired disengagement of attention from negative thoughts in rumination (Koster et al., 2011), and previous studies have already demonstrated a relationship between ruminative disposition and impaired attentional control (De Lissnyder, Derakshan, De Raedt, & Koster, 2011; De Lissnyder, Koster, Derakshan, & De Raedt, 2010; Whitmer & Banich, 2007). It is possible that deficits in attentional control could specifically be associated with impaired ability to disengage attention from negative information, and not biases in tendencies to spontaneously disengage attention from negative information. Further research assessing ruminative disposition, attentional bias and attentional control will also be required to determine whether such attentional disengagement bias and attentional control deficits are functionally related, or represent separate facets of ruminative disposition.

In summary, the present study did not find any evidence of a relationship between ruminative disposition and attentional bias for negative information, in contrast to previous research demonstrating that higher levels of rumination are associated with impaired attentional disengagement from negative information. Further research will be necessary to illuminate the potential explanations for these discrepant findings, particularly the possible distinction between bias in the tendency and ability to disengage attention from negative information.

## CHAPTER FIVE: Study Four

### 5.1 Introduction

According to the impaired disengagement hypothesis put forward by Koster and colleagues (Koster, De Lissnyder, Derakshan, & De Raedt, 2011), high levels of rumination are caused by difficulties disengaging attention away from negative information. The disengagement hypothesis suggests that when an individual experiences maladaptive negative thoughts, this will generally lead to cognitive conflict followed by the recruitment of attentional control resources to disengage from these thoughts. However, if the disengagement of attention from negative information is disrupted (either through impaired conflict signalling or impaired attentional control) then negative thoughts will be maintained resulting in persistent rumination. Thus, rumination occurs because of a failure to disengage attention from negative thoughts.

Previous research has supported the impaired disengagement hypothesis by demonstrating that higher levels of ruminative disposition are associated with an attentional bias for negative relative to non-negative stimuli (Donaldson, Lam, & Mathews, 2007; Joormann, Dkane, & Gotlib, 2006; Pe, Vandekerckhove, & Kuppens, 2013). Studies One and Two extended this evidence using a modified dot-probe task to distinguish between bias in attentional engagement and disengagement of attention, demonstrating that this rumination-linked attentional bias involved impaired attentional disengagement from negative stimuli. However, evidence that ruminative disposition was exclusively associated with attentional disengagement bias was limited, as neither study found any evidence that ruminative disposition was more strongly associated with attentional disengagement bias than attentional engagement bias.

Previous research has also identified additional conditions that may determine whether rumination-linked attentional bias is observed. Firstly, rumination may specifically be associated with an attentional bias for depression-relevant negative information, rather than negative information more generally. Joormann et al. (2006) investigated attentional bias for negative images related to both depression and anxiety, and found that the rumination-linked attentional bias for negative stimuli was only observed for depression relevant images. Study Two supported this finding, demonstrating that rumination was associated with impaired disengagement from depression-relevant, but not anxiety-relevant negative words. Secondly, there is evidence that the observation of rumination-linked attentional bias may be dependent on stimulus presentation duration. Donaldson et al. (2007) varied the stimulus presentation duration between 500ms and 1000ms, and only found a relationship between ruminative disposition and attentional bias for negative stimuli when stimuli were presented for 1000ms. Similarly, Study Two found that the rumination-link bias in attentional disengagement was specific to stimuli presented for 1000ms, and not 500ms. Such evidence that rumination-linked attentional bias is only expressed under conditions where processing time is less restricted, may indicate that rumination-linked attentional bias may be a result of strategic (or controlled), as opposed to automatic processes (McNally, 1995; Mogg & Bradley, 2005). Strategic processing is considered controlled and effortful, as opposed to automatic processing, which is effortless, unconscious, and involuntary. Therefore, heightened ruminative disposition may be specifically associated with individual differences in the operation of controlled attentional processing bias.

Taken together, there is evidence to suggest that rumination may specifically be related to attentional bias for depression-relevant negative information, and that this bias may only be apparent under conditions allowing for extended stimulus processing duration. Interestingly, Study One also found evidence that ruminative disposition was associated with

an attentional engagement bias for negative information, but only for depression-relevant stimuli presented for 1000ms. However, it is important to note that Study One did not find evidence that the relationship between ruminative disposition and attentional disengagement differed depending on either stimulus domain relevance or presentation duration.

One limitation of previous studies, which may have contributed to unclear findings regarding the specificity of rumination-linked attentional bias, is that ruminative disposition was measured continuously using unselected non-clinical samples. In such non-clinical samples, variation in ruminative disposition may be relatively restricted, meaning that sensitivity in the measurement of the relationship with selective attention may be low. Another more sensitive approach would be to selectively recruit participants with high and low levels of ruminative disposition, to increase the potential ability to detect differences in selective attention. Furthermore, research comparing individuals with high and low levels of ruminative disposition would be more relevant and generalizable to the more extreme patterns of ruminative responding observed in clinical populations (e.g., patients with major depression).

In addition to investigating the link between rumination and biased attentional processing of emotional information, another key aspect of the impaired disengagement hypothesis is the role of individual differences in general attentional control. The impaired disengagement hypothesis suggests that difficulties disengaging attention from negative information may be caused by deficits in attentional control (Koster et al., 2011). If attentional control is impaired, then strategic attempts to disengage attention from negative information may be compromised, resulting in slower attentional disengagement from negative information. Consistent with this theory, whereas studies using response probe assessments of attentional bias have typically found that heightened ruminative disposition is associated with an attentional bias for negative information, Study Three found no evidence

of a relationship between ruminative disposition and attentional bias assessed via eye-movements during free-viewing of emotional stimuli. These findings raise the possibility that heightened ruminative disposition may particularly be associated with a reduced ability to disengage attention from negative information, such that attentional disengagement bias is only expressed under conditions that explicitly require the disengagement of attention from negative information. If rumination-linked attentional disengagement bias does involve reduced ability to disengage attention from negative information when required, this would strengthen the case that impaired attentional control might contribute to this attentional bias.

Previous research has provided empirical support for the relationship between rumination and attentional control deficits in the processing of non-emotional information, using a variety of paradigms to assess attentional control. Davis and Nolen-Hoeksema (2000) found that participants with high compared to low levels of ruminative disposition were more likely to persist in performing a task according to a prior rule, despite being given feedback that their responses were incorrect. Similarly, heightened ruminative disposition has been found to be related to impaired inhibition of previous task settings (De Lissnyder, Koster, Derakshan, & De Raedt, 2010; Whitmer & Banich, 2007), impaired switching between different task settings (De Lissnyder et al., 2010; De Lissnyder, et al., 2012b; Demeyer, De Lissnyder, Koster, & De Raedt, 2012), and greater difficulty inhibiting orienting responses on the antisaccade task (De Lissnyder, Derakshan, De Raedt, & Koster, 2011).

However, although research has demonstrated a relationship between ruminative disposition and both impaired attentional control and attentional bias for negative information, all three have yet to be investigated within the same study. As a result, it is not clear whether rumination-linked attentional biases and attentional control deficits are functionally associated with each other, or whether impaired attentional control and biased

attentional processing of negative information represent separate cognitive characteristics contributing to higher levels of ruminative disposition.

One well established method for assessing individual differences in attentional control is the antisaccade task, which assesses the ability to control the allocation of visual-spatial attention. The antisaccade task involves the abrupt presentation of a peripheral stimulus, which participants are instructed either to direct their attention towards (prosaccade trials) or away from (antisaccade). The sudden appearance of a peripheral stimulus triggers a reflexive saccade in the direction of the stimulus, meaning that on antisaccade trials participants must inhibit this automatic response in order to direct attention away from the stimulus (Hutton & Ettinger, 2006; Munoz & Everling, 2004). Accordingly, participants are typically faster to direct their attention towards the stimulus on prosaccade than on antisaccade trials (Munoz & Everling, 2004). Furthermore, the difference between prosaccade and antisaccade latencies (i.e., antisaccade cost) is thought to reflect the degree of inhibitory attentional control.

Studies assessing attentional control using the antisaccade task have typically measured antisaccade and prosaccade latencies directly via the tracking of eye-movements (e.g, Chen, Clarke, Watson, MacLeod, & Guastella, 2015; De Lissnyder et al., 2011). However, it is also possible to assess antisaccade cost indirectly via response probes located either proximally (prosaccade trials) or distally (antisaccade trials) to the stimulus. Since participants will be required to direct their attention towards the location of the target in order to execute a correct response, response latencies will partly reflect latencies to direct attention towards the location of the target. It is also possible to control for any non-attentional influences on response latencies, by comparing response latencies on prosaccade and antisaccade trials to response latencies for centrally presented targets. As such, a prosaccade index can be calculated by subtracting response latencies for central targets presented simultaneously with a central stimulus from response latencies on prosaccade trials, whereas

an antisaccade index can be calculated by subtracting response latencies for central targets presented without a stimulus from response latencies on antisaccade trials. Antisaccade cost can then be indexed by the difference between prosaccade and antisaccade indices. This approach has the advantage of being more time and resource efficient than eye-tracking assessments, and has been successfully used in previous research investigating the role of attentional control in anxiety, which demonstrated that heightened levels of anxiety were associated with deficits in attentional control (Basanovic & Grafton, in prep).

The purpose of the present study was to attempt to replicate and extend findings from Study Two, where it was found that higher levels of ruminative disposition were associated with greater attentional disengagement bias for depressive stimuli presented for 1000ms. The attentional bias assessment task delivered to participants was identical to that used in Study Two, but in order to maximise sensitivity, participants with high and low levels of ruminative disposition were selectively recruited for this study. It was hypothesised that participants in the high rumination group would demonstrate greater attentional bias for negative relative to positive stimuli than participants in the low rumination group. Furthermore, it was hypothesised that this bias would involve slower attentional disengagement from negative relative to positive words, and that there would be no between group differences in attentional engagement bias. It was also hypothesised that this attentional bias would be specific to depression relevant stimuli presented for 1000ms.

The present study also investigated the relationship between ruminative disposition and attentional control using a response probe version of the antisaccade task to assess attentional control. The anti-saccade task was selected to assess attentional control, as like the modified dot-probe task used to assess attentional bias, this task involves the assessment of visual spatial attention. The present antisaccade task was also designed to be visually consistent with the attentional bias assessment task, in that since the stimuli in the attentional

bias assessment task consisted of word and non-word stimuli, stimuli in the present antisaccade task consisted of letter strings (i.e., strings of either X's or O's). Consistent with well-established patterns of attentional distribution during the antisaccade task, it was expected that participants would generally be slower to direct their attention towards target probes on antisaccade compared to pro saccade trials (i.e., antisaccade cost). Furthermore, consistent with previous findings demonstrating that heightened ruminative disposition is associated with deficits in attentional control (e.g., De Lissnyder et al., 2011; De Lissnyder et al., 2010; Whitmer & Banich, 2007), it was hypothesized that participants in the high rumination group would demonstrate greater antisaccade cost relative to participants in the low rumination group, reflecting greater impairments in attentional control. If, as expected, both rumination-linked differences in attentional bias and attentional control were observed, further analyses would be conducted to determine whether these represented related or independent factors associated with levels of ruminative disposition.

## **5.2 Method**

### **5.2.1 Participants**

745 students from the University of Western Australia were screened using a shortened 10-item version of the Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991; see below), which measures disposition to ruminate in response to negative mood. Participants scoring in the top and bottom tertiles were invited to participate in the study, giving rise to high and low rumination groups. 43 participants allocated to the low rumination group and 45 allocated to the high rumination group completed the experimental session. All participants spoke English as a first language.

Participants also completed the full 22-item RRS during the experimental session. Participants were again grouped into high and low ruminators, based on a median-split performed on these in-session RRS scores. In order to ensure reliability and consistency of

ruminative disposition, participants with a discrepancy between screening and in-session rumination group allocation (i.e., allocated to the low rumination group based on screening scores, and the high rumination group based on in-session scores, and vice versa) were excluded from data analysis. Eighteen participants (8 initial low rumination, 10 initial high rumination) were excluded from analysis on this basis. A further six participants were excluded from analysis because they did not complete the full set of attentional assessment tasks (2 low rumination, 4 high rumination), and five because they displayed low accuracy on the attentional bias assessment task (1 low rumination, 4 high rumination; see Results section).

There was no significant difference between the rumination groups in either age or gender (both  $p$ 's  $> .80$ ), but there was a significant difference in BDI-II and in-session RRS scores, such that the high rumination group displayed higher levels of depressive symptoms and ruminative disposition (both  $p$ 's  $< .001$ ; see Table 5.1 for descriptive and test statistics).

### 5.2.2 Materials and Measures

**Beck Depression Inventory (BDI-II; Beck et al., 1996).** The BDI-II is a 21-item self-report measure designed to assess the severity of depressive symptoms. Participants indicate on a 4-point scale how much they have experienced depressive symptoms over the past two weeks. We used a 20-item version of the BDI-II, with the item about suicidal feelings or ideation removed at the request of our institutional review board. Higher scores represent greater severity of depressive symptoms. This measure has shown good reliability and validity (Beck et al., 1996).

Table 5.1. Gender frequencies and mean participant age, BDI-II and in-session RRS scores in the high and low rumination groups (*SDs* in parentheses), along with tests of between-group differences.

	<i>Low Rumination</i> ( <i>N</i> = 32)	<i>High Rumination</i> ( <i>N</i> = 27)	<i>Statistics</i>
Gender	9 male, 23 female	8 male, 19 female	$\chi^2 = 0.02, p = .899$
Age	19.88 (6.36)	19.96 (6.67)	$t(57) = 0.06, p = .956$
BDI-II	5.69 (4.42)	16.96 (9.96)	$t(57) = 5.77, p < .001$
RRS	35.03 (5.88)	59.00 (7.94)	$t(57) = 13.30, p < .001$

Note: BDI-II = Beck Depression Inventory II, RRS = Ruminative Responses Scale

**Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991).** The RRS is a 22-item self-report measure, which requires participants to indicate the degree to which they engage in particular ruminative responses when in a negative mood on a 4-point Likert scale (1 = Almost Never, 4 = Almost Always). A higher score indicates a greater tendency to engage in rumination in response to negative mood. The RRS has been shown to have both high internal reliability and validity (Luminet, 2004). The shortened 10-item version of the RRS used in screening consisted of items from the brooding and reflection subscales (Treynor et al., 2003), which also show acceptable reliability and consistency.

**Apparatus.** A 22-inch computer monitor and a standard two-button mouse were used to present stimuli and record participant responses for both the attentional bias and attentional control assessment tasks.

### 5.2.3 Attentional Bias Assessment

The attentional bias assessment task was identical to that used in Study Two.

**Experimental stimuli.** In the present study, we required 96 word pairs each comprising a word (negative, positive, or neutral), and a length matched non-word (see Appendix Two for list of word stimuli). The emotional word stimuli were taken from Grafton et al. (2012). These words had been selected from a pool of 400 candidate words on the basis of emotional valence ratings provided by clinical psychologists. The sets of negative, positive and neutral words did not differ in terms of word length, frequency, or arousal ratings (all  $p$ 's  $> .05$ ). Emotional words (negative/positive words) were also rated on the basis of their emotional domain relevance and included a mix of both depression relevant (sad/happy) and anxiety relevant (anxious/relaxed) words, giving rise to the within-subjects stimulus domain factor. Emotional valence ratings did not significantly differ between depression and anxiety relevant stimuli, confirming that stimulus emotionality was not confounded by stimulus domain (see Study Two, section 3.4.3 for further details).

**Attentional bias assessment task.** Each trial began with the appearance of an upper and lower string of asterisks, indicating the two critical screen regions, centralised horizontally on the computer screen and separated by a distance of 3cm. Between the asterisks was a row of arrows, all pointing to the upper string, or all pointing to the lower string, with equal frequency. The arrows directed the participant which of the two screen regions to initially fixate attention upon. After one second, the screen was cleared, and an anchor probe was briefly presented (150ms) in this attended region. This anchor probe was a small (2mm) red line sloping upwards  $45^\circ$  to either the left or right, with equal frequency. Immediately thereafter, a letter string pair was presented, with one letter string appearing in each of the two critical screen regions. On half the trials the word member of the letter string pair appeared distal to the initially attended region (permitting the assessment of the biased

attentional engagement with negative information), and on the remaining half of the trials the word member of the letter string pair appeared proximal to the initially attended region (permitting the assessment of biased attentional disengagement with negative information). The letter string pair was displayed for either 500ms or 1000ms, with equal frequency, giving rise to the within-subjects exposure duration factor. A target probe stimulus then appeared in either of the two critical regions, with equal frequency. The target probe stimulus was again a small (2mm) red line sloping upwards  $45^\circ$  to either the left or right. Participants were required to indicate whether the slope direction of this target probe stimulus matched that of the anchor probe, which was the case on 50% of trials. Participants responded by pressing either the right or left mouse buttons, to indicate a match and a non-match, respectively. The latency, and accuracy, to make this discrimination response was recorded. Upon detection of the participant's response the screen was cleared, and the next trial began after a 1000ms inter-trial interval.

The task consisted of 384 trials in total, split into four equal blocks of 96 trials, with a 30 second break in between. Across the task, each of the 96 letter string pairs was presented four times in a random order, with the constraint that each pair was presented once before any were presented a second time, and each was repeated once before any were displayed for a third time, and so on.

**Calculating bias indices.** In this task, selective attention to the word members of the letter string pairs is revealed by relative speeding to make discrimination responses to target probes appearing in the locus of words compared to target probes appearing in the locus of non-words. Thus, an index of attentional bias to negative information relative to positive information can be computed by expressing the degree to which this relative speeding to discriminate probes in the locus of words compared to probes appearing in the locus of non-

words, is greater when this word was negative, rather than positive, in emotional tone. This index of negative attentional bias can be expressed as follows:

$$\text{Negative Attentional Bias Index} = (\text{RT to target probes opposite negative word loci} - \text{RT to target probes in negative word loci}) - (\text{RT to target probes opposite positive word loci} - \text{RT to target probes in positive word loci})$$

Of most importance, the current task permits us to compute this negative attentional bias index under two conditions, in order to separately index facilitated attentional engagement with, and impaired attentional disengagement from, negative information. Specifically, an Engagement Bias Index can be computed by using the RT data from trials on which the word member of the letter string pair appeared distal to initial attentional focus (i.e. from trials on the anchor probe appeared in the locus of the non-word). Higher scores on this engagement bias index indicate that attention was captured to a greater degree by this distal information when it was negative rather than positive in emotional tone. A Disengagement Bias Index can be computed by using the RT data from trials on which the word member of the letter string pair appeared proximal to initial attentional focus (i.e. from trials on the anchor probe appeared in the locus of the word). Higher scores on this disengagement bias index indicate that attention was held to a greater degree by this proximal emotional information when it was negative rather than positive in emotional tone.

Probe discrimination latencies can only indicate attentional distribution if the response is made accurately, hence only RTs from accurate responses were used, and we eliminated any participant with an overall accuracy score that was atypically low using a 95% confidence interval. Following the approach adopted in prior research (Rutherford, MacLeod, & Campbell, 2004; Ratcliff, 1993), we used participants' median RT under each condition in these computations, to minimise the influence of outlying RTs.

### 5.2.4 Attentional Control Assessment

The attentional control assessment was a response probe variant of the antisaccade task. Antisaccade and prosaccade trials involved the presentation of peripheral letter strings (either X's or O's), along with a target probe presented either proximally (prosaccade trials) or distally (antisaccade trials) to the letter string. The abrupt presentation of the letter string is assumed to trigger a reflexive saccade in the direction of the letter string, which participants will be required to inhibit on antisaccade trials. Relative speed to direct attention towards target probes on antisaccade compared to prosaccade trials, as reflected by response latencies, is assumed to represent degree of attentional control. In order to control for non-attentional influences on response latencies, control trials involving the presentation of centrally located target probes and letter strings were also included. The present task also included 'dual string' trials, designed to assess general abilities to direct attention towards a desired location, but these trials were not used to index attentional control in the present study. The stimulus display presentation for antisaccade, prosaccade, and control trials are illustrated in Figure 5.1.

**Stimulus presentation sequence.** Each trial began with the appearance of a fixation cross in the centre of the screen. Participants were instructed to look directly at the fixation cross, and then press the 'spacebar'. Immediately after this, a stimulus display was presented, which included a target probe appearing in different locations relative to letter string stimuli (see 'stimulus display conditions' section below). There were three critical screen regions (an upper, a lower, and a central region), within which the letter strings and target probes would appear. All screen regions were centralised horizontally on the computer screen, and the upper and lower regions were each separated vertically from the centre by a distance of 1.5cm. The target probe was a small grey arrow (2mm), pointing to either the left or the right, with equal frequency. Participants were required to indicate the direction of this arrow, using

the left and right mouse buttons. The latency, and accuracy, to make this discrimination response was recorded. Upon detection of the participant's response the screen was cleared, and the next trial began after a 1000ms inter-trial interval.

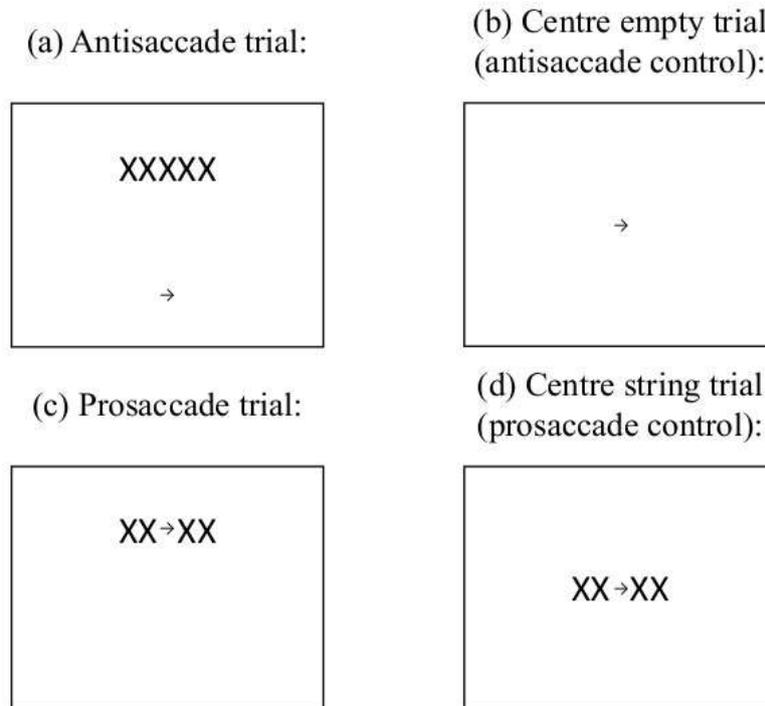


Figure 5.1. Attentional control assessment task stimulus displays for (a) antisaccade trials, (b) centre empty trials (antisaccade control), (c) prosaccade trials, and (d) centre string trials (prosaccade control).

**Stimulus display conditions.** The stimulus display containing the target probe and letter strings varied depending on seven different conditions. These different stimulus display conditions were presented in blocks of eight trials. At the beginning of each block participants were given instructions telling them where the probe would appear relative to the letter strings. The stimulus display and instructions for each condition were as follows:

- **Prosaccade.** A string of either X's or O's appeared in either the upper or lower region. The target probe was located amongst the letter string. Participants were

instructed to attend to the location of the letter string, consistent with the direction of reflexive saccades towards the letter string.

- ***Antisaccade.*** A string of either X's or O's appeared in either the upper or lower region. The target probe was located in the region distal to the letter string. Participants were instructed to attend to the location distal to the letter string, which required the inhibition of reflexive saccades in the direction of the letter string.
- ***Centre string (attend X).*** A string of X's appeared in the centre of the screen. The target probe was located amongst the letter string. Participants were instructed to attend to the centre of the screen.
- ***Centre string (attend O).*** A string of O's appeared in the centre of the screen. The target probe was located amongst the letter string. Participants were instructed to attend to the centre of the screen.
- ***Centre empty.*** No letter string was presented. The target probe was located on its own, in the centre of the screen. Participants were instructed to attend to the centre of the screen.
- ***Dual string (attend 'X').*** A string of X's and a string of O's both appeared, one in the upper and one in the lower region. The target probe was located amongst the string of X's. Participants were instructed to attend to the location of the string of X's.
- ***Dual string (attend O).*** A string of X's and a string of O's both appeared, one in the upper and one in the lower region. The target probe was located amongst the string of O's. Participants were instructed to attend to the location of the string of O's.

Each stimulus display block was presented four times, with each presented once before being repeated. Every seven blocks, participants were given an opportunity to take a short break.

**Calculating attentional control indices.** Response latencies on prosaccade and antisaccade trials were used to assess attentional control. In order to control for non-attentional effects on response latencies, RTs from relevant centre trials were subtracted. The prosaccade index was calculated by subtracting RTs for ‘centre string’ trials from RTs for prosaccade trials. The antisaccade index was calculated by subtracting RTs for ‘centre empty’ trials from RTs for antisaccade trials. Antisaccade cost was then calculated by subtracting prosaccade indices from antisaccade indices, with higher antisaccade cost representing more impaired attentional control.

Probe discrimination latencies can only indicate attentional distribution if the response is made accurately, hence only RTs from accurate responses were used. Following the approach adopted in prior research (Rutherford et al., 2004; Ratcliff, 1993), we used participants’ median RT under each condition in these computations, to minimise the influence of outlying RTs.

### **5.2.5 Procedure**

Prior to starting the experiment participants were given the rationale that the study was investigating individual differences in verbal and visual information processing, and given basic descriptions of the tasks they would be completing. Participants then completed the BDI-II and RRS self-report measures. They were then given written instructions for the attentional bias assessment task, and completed a practice task consisting of 16 trials using only neutral stimuli. Following this, they completed the attentional assessment task. Participants were then given written instructions for the attentional control assessment task,

and completed 14 demonstration trials, outlining the different instructions for each of the seven block types. Finally, participants completed the attentional control assessment task.

### 5.3 Results

Five participants who displayed atypically low accuracy on the attentional bias assessment task (using 95% confidence interval) were removed prior to analysis. The remaining participants displayed a high level of accuracy on the attentional bias assessment task, averaging less than 6% errors. Participants also displayed a high level of accuracy on the attentional control assessment task, averaging less than 3% errors. There was no significant difference between the rumination groups in accuracy on either attentional assessment task (both  $p$ 's > .50).

#### 5.3.1 Between Group Differences in Attentional Bias

**Omnibus analysis.** A four-way mixed design ANOVA was conducted, with attentional bias as the dependent variable, rumination group (high rumination, low rumination), as the between-subjects factor, and bias type (attentional engagement bias, attentional disengagement bias), stimulus domain (depression relevant, anxiety relevant), and exposure duration (500ms, 1000ms) as within-subject factors. There was a significant two-way interaction between rumination group and stimulus domain,  $F(1, 57) = 4.92, p = .031, \eta_p^2 = .08$ , which was subsumed within a significant three-way interaction between rumination group, stimulus domain, and exposure duration,  $F(1, 57) = 7.37, p = .009, \eta_p^2 = .11$ , indicating that the main-effect of rumination group differed depending on stimulus domain and exposure duration. There were no significant interactions involving both rumination group and bias type (all  $p$ 's > .80), indicating that the main-effect of rumination group did not differ depending on attentional bias type.

Further analyses were conducted to investigate the nature of the interaction between rumination group, stimulus domain and exposure duration. This three-way interaction

reflected the fact that the two-way interaction between rumination group and stimulus domain was significant under the 1000ms exposure condition,  $F(1, 57) = 12.96, p = .001, \eta_p^2 = .19$ , but not under the 500ms exposure condition,  $F(1, 57) = 0.16, p = .687, \eta_p^2 < .01$ . Consistent with previous findings, there was a significant main-effect of rumination group for depressive stimuli presented for 1000ms,  $F(1, 57) = 5.17, p = .027, \eta_p^2 = .08$ , such that participants in the high rumination group were more biased towards negative relative to positive stimuli than the participants in the low rumination group (see Table 5.2 and Figure 5.2a for descriptive statistics). There was no significant interaction between rumination group and bias type,  $F(1, 57) = 0.09, p = .765, \eta_p^2 < .01$ , indicating that the main-effect of rumination group on attentional bias for depressive stimuli presented for 1000ms did not differ depending on bias type. There was also a significant main-effect of rumination group for anxiety relevant stimuli presented for 1000ms,  $F(1, 57) = 5.03, p = .029, \eta_p^2 = .08$ , such that participants in the low rumination group were more biased towards negative relative to positive stimuli than participants in the high rumination group (see Table 5.2 and Figure 5.2b for descriptive statistics). There was no significant interaction between rumination group and bias type,  $F(1, 57) = 0.00, p = .960, \eta_p^2 = .00$ , indicating that the main-effect of rumination group on attentional bias for anxiety relevant stimuli presented for 1000ms did not differ depending on bias type. There was no significant main-effect of rumination group on either depression or anxiety relevant stimuli presented for 500ms (both  $p$ 's  $> .30$ ).

**Attentional disengagement bias.** An a priori three-way mixed design ANOVA was conducted, with attentional disengagement bias as the dependent variable, rumination group (high rumination, low rumination), as the between-subjects factor, and stimulus domain (depression relevant, anxiety relevant) and exposure duration (500ms, 1000ms) as within-subject factors. There was no significant main-effect of rumination group on disengagement

bias,  $F(1, 57) = 0.55$ ,  $p = .462$ ,  $\eta_p^2 = .01$ , or significant interactions between rumination group and the within-subjects factors (all  $p$ 's  $> .10$ ).

Table 5.2. Attentional bias indices in the high and low rumination groups.

<i>Bias Type</i>	<i>Stimulus domain</i>	<i>Exposure Duration (ms)</i>	<i>Low Rumination</i>		<i>High Rumination</i>	
			<i>M</i>	<i>(SD)</i>	<i>M</i>	<i>(SD)</i>
Attentional	Depression	500	-20.34	(184.39)	-65.33	(249.99)
Engagement		1000	-23.09	(125.96)	70.54	(241.38)
	Anxiety	500	-33.01	(182.11)	-47.93	(191.66)
		1000	92.13	(230.88)	-10.94	(149.64)
Attentional	Depression	500	-11.92	(164.44)	-51.30	(266.53)
Disengagement		1000	-42.19	(239.61)	25.04	(243.25)
	Anxiety	500	37.59	(217.97)	12.37	(210.43)
		1000	68.64	(225.76)	-38.41	(306.31)

Since previous research has found that ruminative disposition is particularly associated with attentional bias for depressive stimuli presented for 1000ms, a one-way between-subjects ANOVA was also conducted with attentional disengagement bias for depressive stimuli at 1000ms as the dependent variable. There was no significant main-effect of rumination group on attentional disengagement bias for depressive stimuli at 1000ms,  $F(1, 57) = 1.14$ ,  $p = .291$ ,  $\eta_p^2 = .02$ .

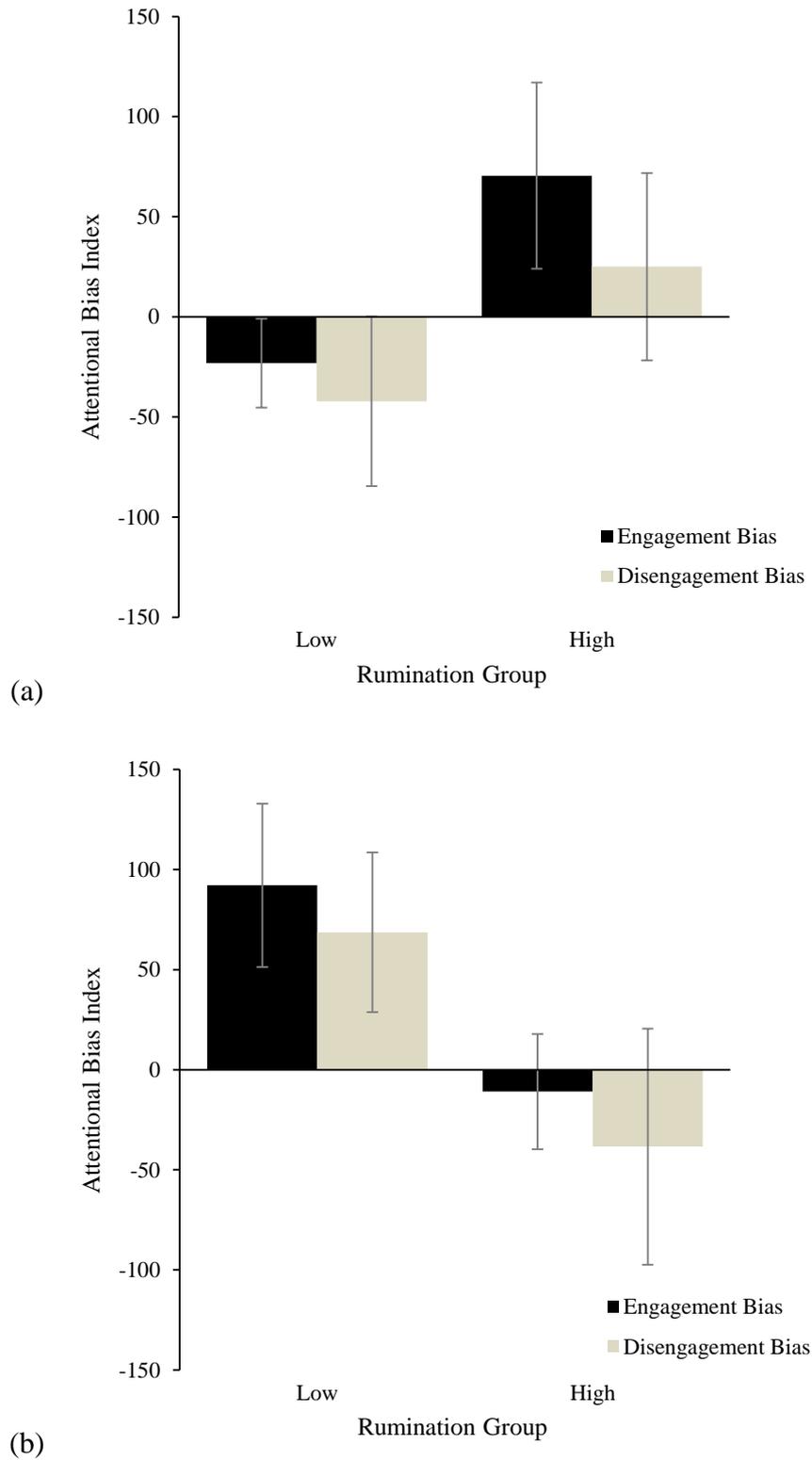


Figure 5.2. Mean and *SE* attentional engagement and disengagement bias indices in each rumination group for (a) depression relevant stimuli presented for 1000ms and (b) anxiety relevant stimuli presented for 1000ms.

**Attentional engagement bias.** A three-way mixed design ANOVA was conducted, with attentional engagement bias as the dependent variable, rumination group (high rumination, low rumination), as the between-subjects factor, and stimulus domain (depression relevant, anxiety relevant) and exposure duration (500ms, 1000ms) as within-subject factors. There was no significant main-effect of rumination group on engagement bias,  $F(1, 57) = 0.69, p = .410, \eta_p^2 = .01$ . There was also no significant two-way interaction between rumination group and either stimulus domain or exposure duration (both  $p$ 's  $> .10$ ). There was, however, a trend towards a significant three-way interaction between rumination group, stimulus domain, and exposure duration,  $F(1, 57) = 3.04, p = .087, \eta_p^2 = .05$ .

To further investigate this interaction, separate two-way mixed design ANOVAs were conducted on attentional engagement bias for stimuli presented for 500ms and 1000ms. There was a significant interaction between rumination group and stimulus domain under the 1000ms exposure condition,  $F(1, 57) = 5.98, p = .018, \eta_p^2 = .10$ , but this same interaction was not significant under the 500ms exposure condition,  $F(1, 57) = 0.12, p = .726, \eta_p^2 = .00$ . Separate one-way between-subjects ANOVAs were then conducted on attentional engagement bias for anxiety and depression relevant stimuli presented for 1000ms. There was a trend towards a significant main-effect of rumination group on attentional engagement bias for depression relevant stimuli at 1000ms,  $F(1, 57) = 3.65, p = .061, \eta_p^2 = .06$ , such that participants in the high rumination group were more biased towards negative relative to positive stimuli than the low rumination group (see Table 5.2 for means). There was also a marginally significant main-effect of rumination group on attentional engagement bias for anxiety relevant stimuli at 1000ms,  $F(1, 57) = 3.97, p = .051, \eta_p^2 = .07$ , such that participants in the low rumination group were more biased towards negative relative to positive stimuli than the high rumination group (see Table 5.2 for means). There was no significant main-

effect of rumination group on attentional engagement bias for either depression or anxiety relevant stimuli presented for 500ms (both  $p$ 's > .40).

### 5.3.2 Between Group Differences in Attentional Control

A central assumption of the antisaccade task is that the abrupt presentation of a peripheral stimulus will trigger a reflexive saccade in the direction of the stimuli, which participants must inhibit on antisaccade trials, resulting in increased latency to direct attention towards the target. Thus, in order to validate the attentional control task, within-subjects differences between prosaccade and antisaccade indices were investigated. A paired samples  $t$ -test found a highly significant difference between prosaccade and antisaccade indices,  $t(58) = 13.3$ ,  $p < .001$ . However, contrary to hypotheses, prosaccade indices were larger than antisaccade indices ( $M = 190.0$ ,  $SD = 61.3$  for prosaccade index;  $M = 88.3$ ,  $SD = 51.0$  for antisaccade index). Thus, participants were slower to direct their attention towards the target probe on prosaccade trials than on antisaccade trials, violating a central assumption of the antisaccade task, and calling into question the validity of the attentional control task.

Regardless, we went on to investigate between-subjects differences in attentional control. A one-way between subjects ANOVA was conducted, with rumination group (high rumination, low rumination) as the between subjects variable, and antisaccade cost as the dependent variable. There was no significant difference in antisaccade cost between rumination groups,  $F(1, 57) = 0.43$ ,  $p = .513$ ,  $\eta_p^2 = .01$  (see Table 5.3 for means). In addition, a one-way between subjects MANOVA was conducted, with rumination group (high rumination, low rumination) as the between-subjects variable, and prosaccade and antisaccade indices as dependent variables. There was no significant overall main-effect of rumination group,  $F(2, 56) = 0.54$ ,  $p = .586$ ,  $\eta_p^2 = .02$ , and no significant main-effect on either prosaccade index,  $F(1, 57) = 1.10$ ,  $p = .299$ ,  $\eta_p^2 = .02$ , or antisaccade index,  $F(1, 57) = 0.24$ ,  $p = .625$ ,  $\eta_p^2 = .00$  (see Table 5.3 for means). Thus, there was no evidence of differences

in attentional control between high and low ruminators, subject to the proviso made earlier re the antisaccade task.

Table 5.3. Attentional control indices in the high and low rumination groups.

<i>Attentional Control Index</i>	<i>Low Rumination</i>		<i>High Rumination</i>	
	<i>M</i>	<i>(SD)</i>	<i>M</i>	<i>(SD)</i>
Prosaccade index	182.3	(61.2)	199.1	(61.3)
Antisaccade index	85.2	(53.0)	91.8	(49.4)
Antisaccade cost	-97.1	(60.5)	-107.3	(57.5)

#### 5.4 Discussion

The first aim of the present study was to attempt to replicate and extend findings from Study Two (Grafton, Southworth et al., in press), where it was found that higher levels of ruminative disposition were associated with greater attentional disengagement bias for depressive stimuli presented for 1000ms. It was hypothesised that participants in the high rumination group would demonstrate greater attentional bias for negative relative to positive stimuli in comparison to participants in the low rumination group. Consistent with the impaired disengagement account of rumination (Koster et al., 2011), it was also hypothesised that this attentional bias would involve more impaired attentional disengagement from negative stimuli, rather than facilitated attentional engagement with negative stimuli. Furthermore, it was hypothesised that this attentional bias would be specific to depression relevant stimuli presented for 1000ms.

Consistent with previous findings (Donaldson et al., 2007; Joormann et al., 2006; Study Two), higher levels of ruminative disposition were found to be associated with greater attentional bias for negative relative to positive stimuli, specifically for depression relevant

stimuli presented for 1000ms. However, in contrast to the findings of Studies One and Two, there was no significant difference between rumination groups in attentional disengagement bias, either for negative stimuli in general or specifically for depression relevant stimuli presented for 1000ms. Instead, this rumination-linked difference in attentional bias was only significant for a composite attentional bias consisting of both attentional engagement and disengagement bias, although there was also a trend towards a significant between-group difference in attentional engagement bias for depression relevant stimuli presented for 1000ms. There was also no significant interaction between attentional bias type (i.e., engagement vs. disengagement bias) and rumination group for attentional bias for depressive stimuli presented for 1000ms. Thus, the rumination-linked attentional bias for depression-relevant stimuli presented for 1000ms appears to reflect a composite of both facilitated engagement with and impaired disengagement from negative stimuli.

Indeed, although previous research found a significant relationship between ruminative disposition and attentional disengagement bias (Studies One & Two), these studies also failed to find evidence that the relationship between ruminative disposition and attentional bias differed on the basis of attentional engagement or disengagement. Thus, taken together these findings begin to suggest that higher levels of ruminative disposition may be associated with an attentional bias that involves a combination of both facilitated engagement with and impaired disengagement from negative information.

One limitation which may potentially account for these inconsistencies between different studies is the previously observed low reliability of attention probe tasks. Reliability refers to the extent to which a measure's variance reflects true score variance, as opposed to measurement error. Low reliability is thus associated with increased error variance and reduced statistical power (Kopriva & Shaw, 1991; Waechter & Stolz, 2015), and has been demonstrated to result in lower levels of replicability (LeBel & Paunonen, 2011). Previous

studies have consistently reported low internal reliability of multiple different commonly used versions of the attention probe task (Schmukle, 2005; Staugaard, 2009; Waechter, Nelson, Wright, Hyatt, & Oakman, 2014; Waechter & Stolz, 2015), therefore it is likely that this low reliability will also extend to the modified attention probe task used in the present studies. As such, this low reliability may account for some effects not being replicated in all studies, such that genuine effects are statistically significant in some studies but not others.

In addition, it is also possible that the findings not replicated in the present study are a result of low statistical power, due to small sample size ( $N = 59$ ). Power analyses conducted in G-Power revealed that the present study achieved a power of only .12 to detect small effect sizes ( $\eta_p^2 = .01$ ) at the .05 level, and a power of .48 to detect medium effect sizes ( $\eta_p^2 = .06$ ), both of which are below the recommended level of .80. The study did, however, achieve a power of .86 to detect large effect sizes ( $\eta_p^2 = .14$ ). As a result, larger sample sizes may be required to detect all genuine effects, particularly considering the potential low reliability of the dot-probe task, although the study was adequately powered to detect larger effect sizes such as the consistent relationship observed between rumination and attentional bias at longer stimulus presentation.

Another limitation of response probe assessments of attentional bias is that they can only provide a 'snapshot' of attention at the time of probe presentation, meaning that we cannot know the patterns of attentional distribution before or after probing (Mogg & Bradley, 2005; Yiend, 2010). This potentially has implications for the sensitivity of attentional bias assessments, as any biases in selective attention that occur either before or after probe presentation will be missed. In addition, there may be multiple shifts in the allocation of attention before probe presentation, particularly at longer stimulus presentation durations (Yiend, 2010). This may be particularly problematic for assessment tasks seeking to distinguish between biases in the engagement and disengagement of attention, as there could

potentially be some degree of cross-contamination between these separate measures. For example, if on trials intended to assess attentional engagement with emotional stimuli, there is sufficient time for participants to engage with and then disengage attention from initially distal stimuli, biases detected by this measure could in part reflect attentional disengagement as well as attentional engagement. Such limitations to sensitivity and opportunity for cross-contamination could potentially explain the lack of a clear difference in the relationship between rumination and bias in attentional engagement and disengagement. Further research applying eye-tracking to the present attentional bias assessment task may help clarify these findings, as the continuous assessment of attention allocation throughout the entire stimulus presentation duration can rule out cross-contamination between measures of attentional engagement and disengagement, and may increase sensitivity by allowing for any biases in selective attention to be detected regardless of when during stimulus presentation that they occur. Although Study Three did not find evidence of a relationship between ruminative disposition and attentional bias assessed via eye-tracking, methodological differences in the attentional bias assessment task (i.e., free-viewing, as opposed to response probe assessment) may have accounted for these null findings.

The present findings do, however, appear to suggest a reliable relationship between ruminative disposition and attentional bias specifically for depression relevant stimuli presented for 1000ms. Previous research has already suggested that heightened ruminative disposition is specifically associated with attentional bias favouring depression relevant, but not anxiety relevant negative stimuli (Joormann et al., 2006; Study Two), and for stimuli presented for 1000ms, but not 500ms (Donaldson et al., 2007; Study Two), and these findings were replicated in the present study.

One unexpected finding in the present study was that higher levels of ruminative disposition were also found to be associated with reduced attentional bias for anxiety relevant

negative stimuli presented for 1000ms, as previous research has typically found that heightened ruminative disposition is associated with greater attentional bias for negative information. However, similar findings have also been observed in research investigating attentional bias in anxiety. Although anxious individuals exhibit an attentional bias towards threat at shorter stimulus presentation durations, they also demonstrate a reduced attentional bias for threat stimuli at longer presentation durations (e.g., Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006; Koster, Verschuere, Crombez, & Van Damme, 2005; Mogg, Bradley, Miles, & Dixon, 2004), suggesting that heightened anxiety is associated with initial vigilance for threatening stimuli, followed by subsequent avoidance. It has been suggested that emotion regulation strategies may underlie this attentional avoidance of threatening information in anxiety (Cisler & Koster, 2010). Thus, one possible explanation for the present findings may be that individuals with high levels of ruminative disposition demonstrate strategic avoidance of threatening information, similar to individuals with elevated anxiety.

Some researchers have suggested that evidence of attentional biases specifically at longer stimulus exposure durations may indicate more strategic rather than automatic processing, as strategic processes are more likely to be evident when processing time is extended (McNally, 1995; Mogg & Bradley, 2005). Thus, the present findings are consistent with the proposal that heightened ruminative disposition is associated with a bias in the operation of controlled attentional processing. However, it is important to note that 500ms exposure duration is sufficient to enable the operation of strategic processes, although to a lesser extent than would be possible at longer durations (Holender, 1986; Mogg, Bradley, & Williams, 1995). It is possible that the restriction of rumination-linked attentional biases to 1000ms stimulus exposure duration could simply be attributed to the time taken for attentional engagement or disengagement to take place, rather than to the strategic nature of

this bias. Thus, further research will be required to determine whether rumination-linked attentional biases involve strategic or automatic processes. One possibility for future research may involve participants completing a variant of the current attentional bias assessment task, in which some trials will require participants to process a secondary load in order to disrupt strategic processing (Sternberg, 1966; van Dillen, Papiers, & Hofmann, 2012). If rumination-linked attentional biases for negative information do reflect strategic processing, then evidence of this bias would be attenuated under secondary load conditions.

The present study also investigated rumination-linked deficits in attentional control. Previous research has already demonstrated a relationship between ruminative disposition and attentional control (e.g., De Lissnyder et al., 2011; De Lissnyder et al., 2010; Whitmer & Banich, 2007), but not addressed whether this is causally associated with rumination-linked attentional biases for negative information, or contributes separately to higher levels of ruminative disposition. In the present study we assessed attentional control using a response-probe version of the antisaccade task, which was designed to closely match our attentional bias assessment task. Contrary to previous findings, there were no differences between rumination groups in attentional control. However, unusual response latencies cast some doubt over the validity the present antisaccade task as a method of measuring attentional control. It is well established that participants are typically slower to direct attention towards stimuli on antisaccade than on prosaccade trials, assumedly because on antisaccade trials they must inhibit the automatic saccade in the direction of the stimulus (Hutton & Ettinger, 2006; Munoz & Everling, 2004). However, in the present study, participants were slower to identify probes on prosaccade than on antisaccade trials. This response pattern was highly reliable within the present study, which strongly contradicts previous research on the antisaccade task. The precise explanation for this result is unclear, although previous research has successfully used a response probe version of the antisaccade task to investigate attentional

control in anxiety (Basanovic & Grafton, in prep), suggesting that the problem is not inherent to response probe variants of the antisaccade task. Instead, whereas the antisaccade task in the present study used letter string stimuli, the antisaccade task used by Basanovic and Grafton (in prep) used pictorial shape stimuli, indicating that the problem may be related to the use of letter strings. In the absence of a clear explanation, the atypical pattern of response latencies means that we cannot be sure of the validity of the present antisaccade task as a measure of attentional control. As such, further research using a more clearly valid measure of attentional control will be necessary to adequately investigate the relationship between rumination-linked deficits in attentional control and biased attentional processing of negative information.

In summary, the present findings provide reliable support for the relationship between higher levels of ruminative disposition and greater attentional bias for negative relative to positive information, specifically for depression relevant stimuli presented for 1000ms. The present findings also suggest that this rumination-linked attentional bias may involve facilitated engagement with negative information as well as impaired disengagement from negative information. However, due to the limitations of response probe assessments of attentional bias, further research assessing attentional bias using both response latencies and more direct measures of attentional distribution, such as eye-tracking, will be necessary to better clarify the potential distinction between bias in attentional engagement and disengagement. In addition, higher levels of ruminative disposition were found to be associated with reduced attentional bias for anxiety relevant stimuli presented for 1000ms, indicating that heightened levels of rumination may also be associated with strategic avoidance of threat. The nature of the relationship between rumination-linked attentional biases and deficits in attentional control also requires further investigation.

## CHAPTER SIX: Study Five

### 6.1 Introduction

Previous research has indicated that higher levels of ruminative disposition are associated with an attentional bias for negative relative to non-negative stimuli (Donaldson, Lam, & Mathews, 2007; Joormann, Dkane, & Gotlib, 2006; Pe, Vandekerckhove, & Kuppens, 2013). According to the impaired disengagement hypothesis put forward by Koster, De Lissnyder, Derakshan, and De Raedt (2011), higher levels of ruminative disposition may particularly be associated with impaired disengagement of attention from negative information. Studies One, Two, and Four addressed this hypothesis, by using a modified dot-probe task to distinguish between biases in attentional engagement and disengagement of attention. Findings from Studies One and Two supported the impaired disengagement hypothesis by demonstrating that higher levels of ruminative disposition were associated with slower disengagement from negative relative to positive stimuli. However, the strength of the relationships between ruminative disposition and both engagement and disengagement bias did not significantly differ from each other. Furthermore, Study Four did not find a significant relationship between ruminative disposition and attentional disengagement bias, but did find that ruminative disposition was associated with a composite index of both attentional engagement and disengagement bias. Thus, ruminative tendencies may be associated with both greater engagement with and impaired disengagement from negative information.

So far research investigating the relationship between rumination and selective attention has primarily involved correlational studies. Thus, it is not yet possible to draw firm conclusions about the causal relationship. Koster et al's (2011) disengagement hypothesis suggests that impaired disengagement of attention from negative information is an underlying

process contributing to greater tendency to ruminate. However, an equally persuasive case has been made that rumination may causally influence biased attentional processing of negative information. According to Nolen-Hoeksema's (1991) response style theory, rumination exacerbates the effects of negative mood on information processing biases, as focusing on negative feelings heightens the accessibility of negative information (Nolen-Hoeksema, 1991; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). If individuals habitually ruminate during negative mood states, as would be the case for those with high levels of ruminative disposition, such information processing biases could become increasingly ingrained and pervasive. Thus, the previously observed relationship between ruminative disposition and attentional bias for negative information could be at least partly explained by the effects of rumination on cognitive processing biases.

Previous research has supported the causal influence of rumination on negative biases in a number of aspects of cognition. Typically, rumination has been induced by instructing participants to focus on current feelings during negative mood states (Nolen-Hoeksema & Morrow, 1993). Using this rumination induction, induced ruminative self-focus on negative mood relative to distraction has been found to be associated with more negative interpretations (Lyubomirsky & Nolen-Hoeksema, 1995), increased negative future thinking and pessimism about future events (Lavender & Watkins 2004; Lyubomirsky & Nolen-Hoeksema, 1995), and greater negative autobiographical memory recall (Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998). Thus, rumination does appear to have a causal influence on some aspects of cognitive processing biases in favour of negative information.

A couple of studies have also investigated the effects of induced rumination on attentional bias for negative information, but findings have been inconsistent. In a sample of healthy participants, Morrison and O'Connor (2008) utilised Nolen-Hoeksema and Morrow's (1993) rumination induction procedure combined with a negative mood induction, followed

by assessment of attentional bias using a standard dot-probe task. Participants who ruminated on negative mood demonstrated an increase in attentional bias for negative relative to positive word stimuli, whereas participants who were distracted from negative mood showed a decrease in attentional bias for negative relative to positive word stimuli. In contrast, Donaldson et al. (2007) used the same rumination induction procedure in currently depressed participants, followed by assessment of attentional bias using a similar dot-probe task, but did not find any effect of either induced rumination or distraction on attentional bias for negative word stimuli. Thus, further investigation of the causal effects of rumination on attentional biases for negative information is required.

One limitation of rumination inductions used in previous studies, which may have contributed to inconsistent results, is that they specifically involve instructing participants to focus on existing mood states. Thus, these inductions require voluntary and deliberate attempts at rumination, which may not be a particularly ecologically valid representation of real-world rumination, which often occurs involuntarily. In addition, since such induced rumination requires deliberate focus on negative mood, rumination may not persist once participants are given another task, which may act as a form of distraction, such as the response probe paradigms commonly used to assess attentional bias. Furthermore, in non-depressed samples, negative mood must be separately induced prior to rumination, which may vary in effectiveness and persistence, thus increasing the risk that rumination will not persevere throughout any subsequent attentional assessment tasks.

An alternative approach to inducing rumination, which may be more robust to distraction from attentional assessment tasks, is the unresolved goal cueing paradigm (Roberts, Watkins, & Wills, 2013). According to control theory, rumination is triggered by and primarily involves thoughts revolving around ideal-actual goal-discrepancies (Martin & Tesser, 1996; Watkins, 2008). That is, when individuals detect a discrepancy between ideal

levels of progress towards a valued goal and actual progress made, this will instigate rumination focused around this discrepancy. Consistent with this account, cueing of an unresolved goal by instructing participants to identify a problem or difficulty that had recently been causing them to feel stressed has been found to result in persistent rumination about this identified problem (Roberts et al., 2013), relative to cueing of a resolved goal. Such rumination occurs involuntarily, and appears to be persistent even throughout prolonged cognitive tasks (Roberts et al., 2013). In contrast, cueing of a resolved goal by instructing participants to identify a recent success or achievement does not result in persistent rumination, and thus provides a robust experimental control. This goal-cueing approach can be combined with Nolen-Hoeksema and Morrow's (1993) instructed rumination procedure, by specifically instructing participants to spend a period of time focusing on their feelings in relation to their identified goal. In this study, the manipulation of goal-cueing (resolved versus unresolved) was paired with instructions to repetitively focus on the failure versus on the success, so as to maximise the difference between the experimental conditions, i.e., to compare a positive rumination condition versus a negative rumination condition, rather than a ruminative condition versus a non-ruminative condition. It was hypothesised that the two ruminative conditions would have contrasting effects on attentional bias.

Another interesting question yet to be investigated is whether the effects of rumination on attentional biases might interact with ruminative disposition. According to the attentional scope model of rumination (Whitmer & Gotlib, 2013), individuals with heightened levels of ruminative disposition demonstrate a more narrowed attentional scope, such that attentional processing is generally more constricted and less flexible. Individuals with a more narrowed attentional scope will find it more difficult to direct their attention away from mood-congruent information, thus exacerbating mood-congruent effects of negative mood on attentional bias in individuals with heightened ruminative disposition.

Similarly, to the extent that rumination results in valence-congruent attentional bias, it follows that this narrowed attentional scope may also exacerbate the effects of rumination on attentional bias in individuals with heightened levels of ruminative disposition relative to individuals with lower levels of ruminative disposition. Thus, individuals with higher levels of ruminative disposition may also demonstrate greater attentional bias for negative relative to positive stimuli in response to negative rumination triggered by focus on unresolved goals, relative to resolved goals.

The aim of the present study was to investigate the causal effect of rumination on attentional bias. Rumination was induced using an unresolved goal cueing paradigm known to produce robust and durable rumination (Roberts et al., 2013), which involved instructing participants to focus on their feelings in relation to either a problem/difficulty (i.e., unresolved goal; negative rumination condition) or success/achievement (i.e., resolved goal; positive basking condition). Attentional bias was then assessed using a version of the modified dot-probe task introduced by Grafton, Watkins, and MacLeod (2012) to assess attentional engagement and disengagement bias. It was hypothesised that the rumination inductions would have valence-congruent effects on attentional bias, such that attention would be more biased towards negative relative to positive stimuli in the negative rumination condition, in comparison to the positive basking condition.

The hypothesis that the effects of the rumination inductions on attentional bias would be moderated by ruminative disposition was also investigated. One possibility was that higher levels of ruminative disposition would be more strongly associated with greater valence-congruency bias, reflected in greater attentional bias for negative relative to positive stimuli in the negative compared to the positive rumination condition. Alternatively, effects of the rumination inductions on attentional bias would not differ depending on ruminative

disposition, meaning that the relationship between ruminative disposition and attentional bias would not differ between rumination induction conditions.

Consistent with previous studies, the possibility that effects were moderated by bias type (engagement vs. disengagement), stimulus domain (depression relevant vs. anxiety relevant) or exposure duration (500ms vs. 1000ms) was also investigated.

## 6.2 Method

### 6.2.1 Participants

Participants were 78 students (16 male, 62 female; mean age = 18.9) from the University of Exeter, recruited from the psychology department or via a database of individuals who wished to be informed of opportunities to participate in research in the department. All participants spoke English as a first language. Participants received either course credits (first year psychology undergraduates) or payment for their time.

Participants were screened for depressive symptoms at the beginning of the study using the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996). Given that the study employed a rumination induction expected to induce a negative mood state, for ethical reasons, individuals who scored 20 or above on the BDI, reflecting the standard cut-off for moderate levels of depression (Beck et al., 1996), were required to be excluded from participation in the study by our institutional review board. One participant (BDI-II = 24) was excluded on this basis, and did not complete the remainder of the experiment.

Participants were randomly allocated to either the positive or negative rumination condition (39 positive basking, 39 negative rumination).

### 6.2.2 Questionnaire Measures

**BDI-II (Beck et al., 1996).** The BDI-II is a 21-item self-report measure designed to assess the severity of depressive symptoms. Participants indicate on a 4-point scale how

much they have experienced depressive symptoms over the past two weeks. We used a 20-item version of the BDI-II, with the item about suicidal feelings or ideation removed at the request of our institutional review board. Higher scores represent greater severity of depressive symptoms. This measure has shown good reliability and validity (Beck et al., 1996).

**RRS (Nolen-Hoeksema & Morrow, 1991).** The Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991) was employed as our measure of ruminative disposition. The RRS is a 22-item self-report measure, which requires participants to indicate the degree to which they engage in particular ruminative responses when in a negative mood on a 4-point Likert scale (1 = Almost Never, 4 = Almost Always). This questionnaire yields two subscales: ruminative brooding and ruminative reflection. Both of these subscales show acceptable reliability and consistency (Treynor et al., 2003). In each case, a higher score indicates a greater tendency to engage in rumination in response to negative mood.

**Mood ratings.** Two visual analogue mood rating scales, each 100mm in length, were used to assess momentary levels of sadness and anxiety. The scale for measuring sadness was labelled '*sad*' at one end and '*happy*' at the other, whilst the scale for anxiety was labelled '*anxious*' at one end and '*confident*' at the other. Participants indicated their current mood by placing a cross (*x*) on each scale. Mood was measured with a millimetre ruler according to the position of the cross placed on each scale, with scores ranging from 0 (happy or confident) to 100 (sad or anxious), with higher scores indicating more negative mood.

### 6.2.3 Rumination Induction

Consistent with theories suggesting that rumination is triggered by and involves thoughts focused on goal discrepancies (Martin & Tesser, 1996), rumination was induced using a modified goal cuing paradigm (Roberts et al., 2013). The modified goal cuing paradigm consistent of two parts; first a goal identification procedure, then a period of

ruminative thought. For the goal identification procedure, participants were instructed to identify an ongoing personally relevant goal. In the negative rumination condition, participants were instructed to identify a problem or difficulty (i.e., unresolved goal), whereas in the positive basking condition participants were instructed to identify a success or achievement (i.e., resolved goal). The period of ruminative thought was based on Nolen-Hoeksema and Morrow's (1993) rumination induction, where participants are instructed to focus on current feelings using a list of ruminative statements. However, in the present study participants used the same ruminative statements to focus on their feelings in relation to their previously identified goal.

**Goal identification.** All participants were asked to identify a recent or ongoing goal that was personally important to them. Participants in the negative rumination condition were instructed that this should be a goal that they had recently failed to accomplish or relating to an area of their life that they did not feel was going well (i.e., a problem or difficulty), and that had been causing them to feel negative, sad, down or stressed over the past week. In contrast, participants in the positive basking condition were instructed that this should be a goal that they had recently accomplished or relating to an area of their life that they felt was going well (i.e., a success or achievement), and that had been causing them to feel positive, happy or fulfilled over the past week. Participants were also given some examples of suitable goals.

Once participants confirmed that they had thought of a suitable goal, they were asked to write down a brief outline of goal. They were also asked to rate their identified goal on 10-point Likert scales; how much they had been thinking about the goal over the past week (1 = 'Not at all, 10 = 'Very often'), how important the goal was to them (1 = 'Not at all', 10 = 'Very'), how negative they had been feeling about the goal over the past week (1 = 'Not at all

negative', 10 = 'Extremely negative'), and how positive they had been feeling about the goal over the past week (1 = 'Not at all positive', 10 = 'Extremely positive').

**Ruminative thought.** Participants were instructed to spend 8-minutes focusing on the previously identified goal, how it made them feel, and on the meanings and implications of the goal. Participants were given a list of items from Nolen-Hoeksema and Morrow's (1993) rumination induction procedure, which focus attention on emotions and self (e.g., 'Think about why you react the way you do'), and asked to focus on each of the items in relation to their identified goal. Nolen-Hoeksema and Morrow's original induction contains 45 items, but 15 items were removed for the current study, as it was deemed that they would not be appropriate in the context of focusing on goals rather than current feelings, such as items involving physical sensations (e.g., possible explanation for your physical sensations) or which might only relate to specific goals (e.g. how you feel about your friendships). They were instructed to read each item slowly and silently to themselves, and spend a few moments concentrating on each of the ideas in relation to the goal. The researcher explained the instructions for the rumination task verbally, then left the room for 8-minutes whilst the participants completed the task.

**Manipulation checks.** Following the rumination task, participants were asked to rate their thoughts about their identified goal during the 8-minutes on 10-point Likert scales; how much they were thinking about the goal (1 = 'Not at all', 10 = 'The whole time'), how negative their thoughts about the goal were (1 = 'Not at all negative', 10 = 'Extremely negative'), and how positive their thoughts about the goal were (1 = 'Not at all positive', 10 = 'Extremely positive'). Then, following the attentional bias assessment task (see below) participants were asked to rate their thoughts and mood during the attention task on further 10-point Likert scales; the extent to which they continued thinking about their identified goal (1

= 'Not at all', 10 = 'The whole time'), and the extent to which thinking about the identified goal continued to influence their mood (1 = 'Not at all', 10 = 'The whole time').

#### **6.2.4 Attentional Bias Assessment**

**Apparatus.** A 22-inch computer monitor and a standard two-button mouse were used to present stimuli and record participant responses.

**Experimental stimuli.** In the present study, we required 64 word pairs each comprising an emotional word, either negative or positive in emotional tone, and a length matched neutral word (see Appendix Two). The emotional word stimuli were taken from Grafton et al. (2012). These words had been selected from a pool of 400 candidate words on the basis of emotional tone ratings provided by clinical psychologists. Emotional words were also rated on the basis of their emotional domain relevance and included a mix of both depression relevant (sad/happy) and anxiety relevant (anxious/relaxed) words, giving rise to the within-subjects stimulus domain factor. The set of negative words, and the set of positive words, did not differ in terms of word length, frequency, or arousal (all  $p$ 's > .05). Each emotional word was paired with a neutral word that was matched for word length and frequency.

**Attentional bias assessment task.** Each trial began with the appearance of an upper and lower string of asterisks, indicating the two critical screen regions, centralised horizontally on the computer screen and separated by a distance of 3cm. Between the asterisks was a row of arrows, all pointing to the upper string, or all pointing to the lower string, with equal frequency. The arrows directed the participant which of the two screen regions to initially fixate attention upon. After one second, the screen was cleared, and an anchor probe was briefly presented (150ms) in this attended region. This anchor probe was a small (2mm) red line sloping upwards 45° to either the left or right, with equal frequency. Immediately thereafter, a word pair was presented, with one word appearing in each of the

two critical screen regions. On half the trials the emotional member of the word pair appeared distal to the initially attended region (permitting the assessment of the biased attentional engagement with negative information), and on the remaining half of the trials the emotional member of the word pair appeared proximal to the initially attended region (permitting the assessment of biased attentional disengagement with negative information). The word pair was displayed for either 500ms or 1000ms, with equal frequency, giving rise to the within-subjects exposure duration factor. A target probe stimulus then appeared in either of the two critical regions, with equal frequency. The target probe stimulus was again a small (2mm) red line sloping upwards  $45^\circ$  to either the left or right. Participants were required to indicate whether the slope direction of this target probe stimulus matched that of the anchor probe, which was the case on 50% of trials. Participants responded by pressing either the right or left mouse buttons, to indicate a match and a non-match, respectively. The latency, and accuracy, to make this discrimination response was recorded. Upon detection of the participant's response the screen was cleared, and the next trial began after a 1000ms inter-trial interval. This sequence of events is summarized in the example trials shown in Figure 2.1 (see Chapter Two).

The task consisted of 256 trials in total, split into two equal blocks of 128 trials, with a 30 second break in between. Across the task, each of the 64 word pairs was presented four times in a random order, with the constraint that each pair was presented once before any were presented a second time, and each was repeated once before any were displayed for a third time, and so on.

**Calculating bias indices.** In this task, selective attention to the emotional word members of the word pairs is revealed by relative speeding to make discrimination responses to target probes appearing in the locus of emotional words compared to target probes appearing in the locus of neutral words. Thus, an index of attentional bias to negative

information relative to positive information can be computed by expressing the degree to which this relative speeding to discriminate probes in the locus of emotional words compared to probes appearing in the locus of neutral words, is greater when this word was negative, rather than positive, in emotional tone. This index of negative attentional bias can be expressed as follows:

Negative Attentional Bias Index = (RT to target probes opposite negative word loci - RT to target probes in negative word loci) - (RT to target probes opposite positive word loci - RT to target probes in positive word loci)

Of most importance, the current task permits us to compute this negative attentional bias index under two conditions, in order to separately index facilitated attentional engagement with, and impaired attentional disengagement from, negative information. Specifically, an Engagement Bias Index can be computed by using the RT data from trials on which the emotional member of the word pair appeared distal to initial attentional focus (i.e. from trials on the anchor probe appeared in the locus of the neutral word). Higher scores on this engagement bias index indicate that attention was captured to a greater degree by this distal information when it was negative rather than positive in emotional tone. A Disengagement Bias Index can be computed by using the RT data from trials on which the emotional member of the word pair appeared proximal to initial attentional focus (i.e. from trials on the anchor probe appeared in the locus of the emotional word). Higher scores on this disengagement bias index indicate that attention was held to a greater degree by this proximal emotional information when it was negative rather than positive in emotional tone.

Probe discrimination latencies can only indicate attentional distribution if the response is made accurately, hence only RTs from accurate responses were used, and we eliminated any participant with an overall accuracy score that was atypically low using a 95% confidence interval. Following the approach adopted in prior research (Rutherford, MacLeod,

& Campbell, 2004; Ratcliff, 1993), we used participants' median RT under each condition in these computations, to minimise the influence of outlying RTs.

### **6.2.5 Procedure**

Prior to starting the experiment, participants were given the rationale that the study was investigating the links between personality, goals, and cognitive abilities, and given basic descriptions of the tasks they would be completing. Participants then completed the BDI-II and RRS self-report measures. They were then given written instructions for the attentional bias assessment task, and completed a practice task consisting of 16 trials using only neutral stimuli. Participants then completed their first mood ratings using visual analogue scales, to provide a baseline measure of mood prior to the rumination induction. They then completed the goal identification procedure, immediately followed by further mood ratings. They then completed the rumination task, followed by another set of mood ratings and the first set of manipulation checks. Participants then immediately completed the full attentional bias assessment task, followed by the final set of manipulation checks.

## **6.3 Results**

Two participants who displayed atypically low accuracy on the attention probe task (using 95% confidence interval) were removed prior to analysis. The remaining participants displayed a high level of accuracy on the attention probe task, averaging less than 10% errors. There was no association between accuracy on the attentional bias assessment task and ruminative disposition (full RRS, brooding, and reflection; all  $p$ 's > .10), or difference in accuracy between rumination conditions,  $t(74) = 0.22$ ,  $p = .824$ . There were also no differences between rumination conditions in gender, age, depressive symptoms or ruminative disposition (all  $p$ 's > .30; see Table 6.1 for descriptive and test statistics).

Table 6.1. Gender frequencies and mean participant age, BDI-II, RRS, brooding and reflection in each rumination condition (*SDs* in parentheses), along with tests of between-group differences.

	<i>Positive Basking</i> ( <i>N</i> = 38)	<i>Negative Rumination</i> ( <i>N</i> = 38)	<i>Statistics</i>
<i>Gender</i>	9 male, 29 female	7 male, 31 female	$\chi^2 = 0.32, p = .574$
<i>Age</i>	18.92 (1.82)	18.84 (1.13)	$t(74) = 0.23, p = .821$
<i>BDI-II</i>	5.87 (4.50)	5.16 (4.16)	$t(74) = 0.72, p = .477$
<i>RRS</i>	45.08 (13.17)	43.42 (9.24)	$t(74) = 0.64, p = .527$
<i>Brooding</i>	10.84 (4.03)	10.11 (2.92)	$t(74) = 0.91, p = .364$
<i>Reflection</i>	10.97 (3.69)	10.16 (3.30)	$t(74) = 1.02, p = .313$

Note: BDI-II = Beck Depression Inventory II, RRS = Ruminative Responses Scale

### 6.3.1 Between Group Differences in Goal Characteristics, Goal Thoughts, and Mood

Self-report ratings of goal characteristics and thoughts during the inductions were used as manipulation checks to assess the suitability of the rumination inductions. There were no differences between the rumination conditions in self-reported thought about the goal during the past week, goal importance, thought about the goal during the induction, thought about the goal during the attention probe task, or influence of the goal on mood during the attention task (all  $p$ 's > .30; see Table 6.2 for descriptive and test statistics). Thus, the rumination conditions were not confounded by differences in goal characteristics or extent of prior rumination about the goal. Yet, as intended, there were highly significant differences between the rumination conditions in negative feelings about the goal over the past week, positive feelings about the goal over the past week, thought negativity during the induction, and thought positivity during the induction (all  $p$ 's < .001; see Table 6.2 for descriptive and

test statistics). Thus, the rumination conditions differed sufficiently in both goal and thought valence in the intended direction.

Table 6.2. Mean goal characteristics and thought ratings in each rumination condition (*SDs* in parentheses), along with tests of between-group differences.

	<i>Positive Basking</i> ( <i>N</i> = 38)	<i>Negative Rumination</i> ( <i>N</i> = 38)	<i>Statistics</i>
<i>Thought past week</i>	7.58 (1.59)	7.34 (1.36)	<i>t</i> (74) = 0.70, <i>p</i> = .487
<i>Importance</i>	8.55 (1.16)	8.26 (1.70)	<i>t</i> (74) = 0.87, <i>p</i> = .389
<i>Negative feelings past week</i>	2.74 (1.48)	6.58 (1.29)	<i>t</i> (74) = 12.06, <i>p</i> < .001
<i>Positive feelings past week</i>	7.74 (1.31)	3.53 (1.37)	<i>t</i> (74) = 13.70, <i>p</i> < .001
<i>Thought during induction</i>	7.26 (1.70)	7.50 (1.31)	<i>t</i> (74) = 0.68, <i>p</i> = .499
<i>Thought negativity during induction</i>	3.47 (1.83)	6.29 (1.77)	<i>t</i> (74) = 6.83, <i>p</i> < .001
<i>Thought positivity during induction</i>	7.66 (1.24)	4.24 (1.85)	<i>t</i> (74) = 9.47, <i>p</i> < .001
<i>Thought during attention probe</i>	2.76 (1.97)	2.68 (1.61)	<i>t</i> (74) = 0.19, <i>p</i> = .849
<i>Influence on mood during attention probe</i>	3.58 (2.38)	3.26 (2.00)	<i>t</i> (74) = 0.63, <i>p</i> = .533

Effects of the rumination induction procedures on self-reported mood were also analysed. Two-way mixed-design ANOVAs were conducted with rumination condition (positive basking, negative rumination) as the between-subjects factor, time (baseline, post-goal identification, post-rumination induction, post-attention probe task) as the within-subjects factor, and sadness and anxiety as the dependent variables in each analysis. There was a highly significant rumination condition by time interaction for both sadness and anxiety ( $F(3, 222) = 27.36, p < .001, \eta_p^2 = .27$  for sadness;  $F(3, 222) = 17.45, p < .001, \eta_p^2 = .19$  for anxiety), indicating that the rumination conditions differentially influenced mood throughout the experimental session. Pair-wise contrasts comparing mood ratings at baseline with each subsequent time point individually all found significant rumination condition by time interactions (all  $p$ 's  $< .05$ ). Subsequent between-subjects  $t$ -tests comparing mood ratings at each time point confirmed that there were highly significant differences between conditions in both sadness and anxiety at all time points except baseline (see Table 6.3 for descriptive and test statistics), such that participants in the negative rumination condition reported higher levels of sadness and anxiety post-baseline than participants in the positive rumination condition. Thus, there is evidence of discrepant effects of the rumination inductions on self-reported mood, which were maintained throughout the attention task, confirming that the inductions were successful.

Table 6.3. Mean sadness and anxiety ratings at different time points in each rumination condition (*SDs* in parentheses), along with tests of between-group differences.

	<i>Positive Basking (N = 38)</i>	<i>Negative Rumination (N = 38)</i>	<i>Statistics</i>
<i>Baseline</i>			
Sadness	26.74 (17.08)	31.00 (15.58)	$t(74) = 1.14, p = .259$
Anxiety	35.76 (14.76)	39.54 (14.50)	$t(74) = 1.07, p = .290$
<i>Post-goal identification</i>			
Sadness	21.95 (13.84)	46.47 (14.93)	$t(74) = 7.43, p < .001$
Anxiety	28.42 (15.54)	50.47 (17.26)	$t(74) = 5.86, p < .001$
<i>Post-rumination induction</i>			
Sadness	25.34 (16.55)	51.02 (17.45)	$t(74) = 6.58, p < .001$
Anxiety	30.34 (15.68)	52.45 (18.01)	$t(74) = 5.71, p < .001$
<i>Post-attention probe</i>			
Sadness	30.24 (15.43)	40.74 (12.72)	$t(74) = 3.24, p = .002$
Anxiety	32.21 (12.52)	43.37 (12.31)	$t(74) = 3.92, p < .001$

### 6.3.2 Between Group Differences in Attentional Bias

In order to investigate between group differences in attentional bias, a four-way mixed-design ANOVA was conducted with rumination condition (positive basking, negative rumination) as the between-subjects factor, bias type (engagement bias, disengagement bias), stimulus domain (depression relevant words, anxiety relevant words), and exposure duration (500ms, 1000ms) as within-subjects factors, and attentional bias as the dependent variable.

There was no significant main-effect of rumination condition,  $F(1, 74) = 0.53, p = .468, \eta_p^2 =$

.01, indicating that there was no difference between rumination conditions in overall attentional bias (see Table 6.4 for means). There was also no significant interaction between rumination condition and bias type,  $F(1, 74) = 0.23, p = .634, \eta_p^2 = .00$ , and subsequent one-way between-subjects ANOVAs confirmed that there were no significant differences between rumination conditions in either engagement or disengagement bias ( $F(1, 74) = 0.87, p = .355, \eta_p^2 = .01$ , for engagement bias;  $F(1, 74) = 0.01, p = .939, \eta_p^2 = .00$  for disengagement bias; see Table 6.4 for means). There were also no other higher-order interactions between rumination condition and any of the within-subjects factors (all  $p$ 's  $> .20$ ), indicating that the main-effect of rumination condition did not differ depending on bias type, stimulus domain or exposure duration. Thus, there was no evidence of any general effects of the rumination inductions on attentional bias.

Table 6.4. Mean engagement bias, disengagement bias, and overall attentional bias in each rumination condition (*SDs* in parentheses).

	<i>Positive Basking (N = 38)</i>	<i>Negative Rumination (N = 38)</i>
<i>Overall Attentional Bias</i>	-1.14 (71.0)	-14.24 (84.8)
<i>Engagement Bias</i>	-0.73 (122.4)	-24.51 (98.8)
<i>Disengagement Bias</i>	-1.56 (135.4)	-3.97 (138.8)

### 6.3.3 Moderating Effect of Ruminative Disposition

In order to investigate whether the effect of the rumination inductions was moderated by ruminative disposition, ruminative disposition (RRS scores) was added as a covariate to the four-way ANOVA used to investigate between-group differences in attentional bias (see above). The interaction between ruminative disposition and rumination condition was included as an additional between-subjects factor. There was a trend towards a significant

interaction between ruminative disposition and rumination condition,  $F(1, 72) = 3.56, p = .063, \eta_p^2 = .05$ , indicating that the effects of the rumination inductions on attentional bias might be moderated by ruminative disposition. Examining Figure 6.1, contrary to hypotheses, individuals with low levels of ruminative disposition demonstrated a bias towards valence-incongruent stimuli, such that individuals in the positive basking condition demonstrated greater bias for negative relative to positive stimuli compared to individuals in the negative rumination condition. In contrast, as levels of ruminative disposition increased to high levels, there was a shift to a bias towards valence-congruent stimuli, such that individuals in the positive basking condition demonstrated greater bias for positive relative to negative stimuli compared to individuals in the negative rumination condition.

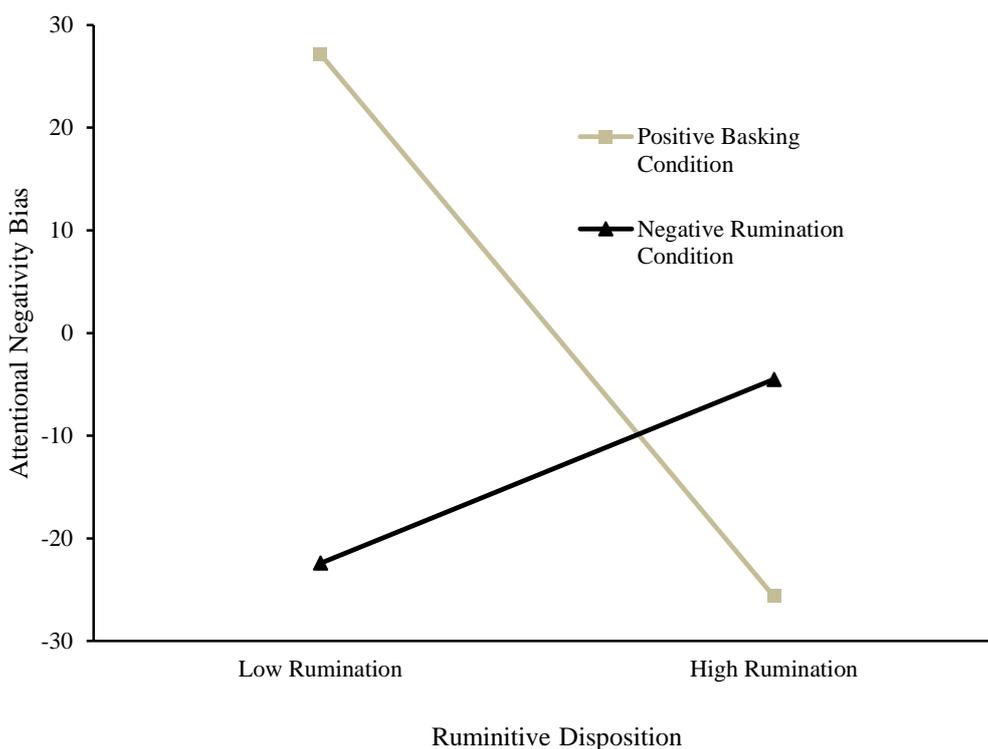


Figure 6.1 Mean attentional negativity bias in each rumination condition for high compared to low ruminators ( $\pm 1 SD$ ).

Bivariate correlations were then conducted to investigate the relationship between ruminative disposition and attentional bias in each rumination condition separately. There was a highly significant correlation between ruminative disposition and attentional bias in the positive basking condition, with higher ruminative disposition associated with reduced bias for negative relative to positive stimuli,  $r(38) = -.43, p = .007$ , but no significant relationship between ruminative disposition and attentional bias in the negative rumination condition,  $r(38) = .09, p = .608$  (see Figure 6.2 for plots).

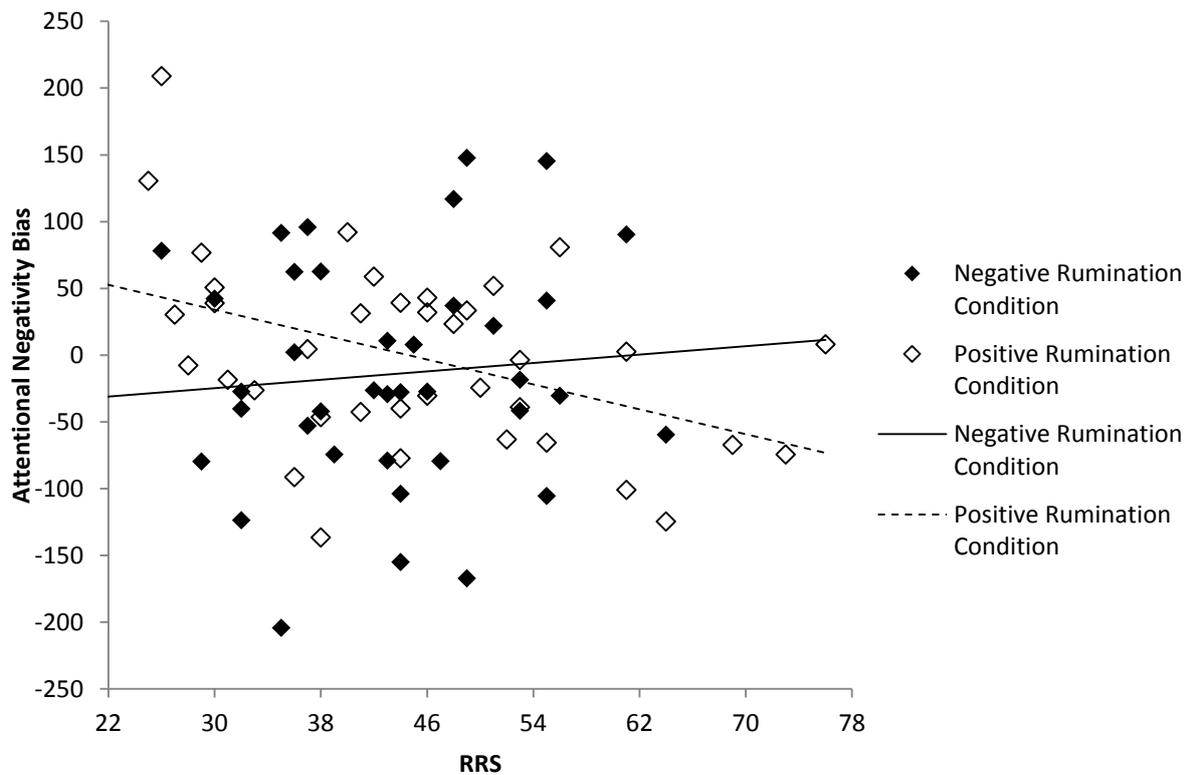


Figure 6.2. Graph showing correlation between ruminative disposition (RRS) and attentional bias in each rumination condition.

There was no significant three-way interaction between ruminative disposition, rumination condition and bias type,  $F(1, 72) = 0.04, p = .838, \eta_p^2 = .00$ , indicating that the moderating effect of ruminative disposition was not specific to either engagement or

disengagement bias. Similarly, there were also no interactions between ruminative disposition and bias type within either of the rumination conditions ( $F(1, 36) = 0.09, p = .762, \eta_p^2 = .00$  in the positive basking condition;  $F(1, 36) = .00, p = .987, \eta_p^2 = .00$  in the negative rumination condition), indicating that the relationship between ruminative disposition and attentional bias in each condition was not moderated by bias type (see Table 6.5 for bivariate correlations).

Table 6.5. Bivariate correlations between ruminative disposition (RRS, brooding and reflection) and attentional biases in each rumination condition.

	<i>Positive Basking</i> ( $N = 38$ )	<i>Negative Rumination</i> ( $N = 38$ )
<i>RRS</i>		
Overall Attentional Bias	$r = -.43, p = .007$	$r = .09, p = .608$
Engagement Bias	$r = -.21, p = .215$	$r = .07, p = .670$
Disengagement Bias	$r = -.27, p = .105$	$r = .05, p = .747$
<i>Brooding</i>		
Overall Attentional Bias	$r = -.41, p = .010$	$r = -.17, p = .303$
Engagement Bias	$r = -.17, p = .299$	$r = .00, p = .998$
Disengagement Bias	$r = -.28, p = .095$	$r = -.21, p = .207$
<i>Reflection</i>		
Overall Attentional Bias	$r = -.47, p = .003$	$r = .12, p = .463$
Engagement Bias	$r = -.21, p = .199$	$r = -.04, p = .828$
Disengagement Bias	$r = -.30, p = .069$	$r = .18, p = .291$

Note: RRS = Ruminative Responses Scale

There were also no other higher-order interactions between ruminative disposition, rumination condition and any of the within-subjects factors (all  $p$ 's  $> .30$ ), indicating that the moderating effect of ruminative disposition was also not further moderated by stimulus domain or exposure duration.

Similar analyses were also conducted using brooding and reflection as covariates instead of the full RRS. Both brooding and reflection were found to be strongly associated with attentional bias in the positive basking condition, with higher rumination associated with reduced bias for negative relative to positive stimuli in each case ( $r(38) = -.41, p = .010$  for brooding;  $r(38) = -.47, p = .003$  for reflection), but no significant relationships were found in the negative rumination condition (both  $p$ 's  $> .30$ ). However, although there was a significant interaction between rumination condition and reflection,  $F(1, 72) = 5.84, p = .018, \eta_p^2 = .08$ , there was no interaction between rumination condition and brooding,  $F(1, 72) = 0.18, p = .669, \eta_p^2 = .00$ , indicating that the effects of the ruminations inductions was not moderated by brooding. Thus, although there was only a significant relationship between brooding and attentional bias in the positive basking condition, higher brooding may have been associated with reduced bias for negative relative to positive stimuli in both rumination conditions. There were no higher-order interactions between either brooding or reflection, rumination condition and any of the within-subjects factors (all  $p$ 's  $> .10$ ), indicating that the moderating effects of brooding and reflection were not further moderated by bias type, stimulus domain or exposure duration (see Table 6.5 for bivariate correlations with engagement and disengagement biases).

## 6.4 Discussion

The aim of the present study was to investigate the causal effect of induced rumination on attentional bias for negative information. It was hypothesised that negative rumination would result in greater attentional bias for negative relative to positive stimuli in

comparison to positive basking. However, there was no significant overall difference in attentional bias between rumination conditions. The between-group difference in attentional bias was also not moderated by bias type (engagement vs. disengagement bias), emotional domain (depression vs. anxiety relevant stimuli), or stimulus exposure duration (500ms vs. 1000ms).

The present study also investigated whether the effect of induced rumination on attentional bias would interact with ruminative disposition. It was hypothesised that individuals with heightened levels of ruminative disposition may demonstrate greater attentional biases for negative relative to positive stimuli in response to negative rumination, in comparison to positive basking. As predicted, the effect of induced rumination on attentional bias was moderated by ruminative disposition, such that individuals with higher levels of ruminative disposition demonstrated greater valence-congruency bias relative to individuals with lower levels of ruminative disposition. However, contrary to predictions, individuals with low levels of ruminative disposition demonstrated a bias for valence-incongruent stimuli, such that individuals in the positive basking condition demonstrated greater bias for negative relative to positive stimuli compared to individuals in the negative rumination condition. In contrast, individuals with high levels of ruminative disposition demonstrated a bias for valence-congruent stimuli, such that individuals in the positive basking condition demonstrated greater bias for positive relative to negative stimuli compared to individuals in the negative rumination condition.

When the relationship between ruminative disposition and attentional bias was examined separately in each rumination condition, surprisingly, greater levels of ruminative disposition were associated with more bias for positive relative to negative stimuli in the positive basking condition. In contrast, ruminative disposition was not significantly associated with attentional bias in the negative rumination condition. The finding that higher

levels of ruminative disposition were associated with greater bias for positive stimuli was unexpected, since previous research has typically found evidence that rumination is associated with greater bias for negative stimuli. However, as far as we are aware, this is the first study to investigate the relationship between ruminative disposition and attentional bias following both negative rumination and positive basking. Previous research has only ever examined this relationship in the absence of a rumination induction, and often in patients currently suffering from depression. One possible explanation for the present findings is that individuals with heightened ruminative disposition have a greater tendency to attend to information that is similar to recent thought contents, resulting in more biased attention towards valence congruent information. Since this is the first study to investigate the link between ruminative disposition and attentional bias in the context of positive repetitive thought, replication of the present findings and further research investigating the valence congruency hypothesis will be necessary.

However, the valence congruency hypothesis would also predict that higher levels of ruminative disposition would also be associated with greater bias for negative information in the negative rumination condition, but there was no significant relationship between ruminative disposition and attentional bias in the negative rumination condition. It is worth noting though, that although the relationship was not statistically significant, higher levels of ruminative disposition were associated with greater bias for negative stimuli in the negative rumination condition, which is consistent with the valence congruency hypothesis. Power analyses conducted in G-Power revealed for correlations within each condition ( $N = 38$ ), the present study achieved a statistical power of only .08 to detect the observed effect size ( $r = .09$ ) at the .05 level, and a power of .47 to detect a medium effect size ( $r = .30$ ). Thus, the present results may be attributed to low statistical power, meaning that it would be useful for any future replication studies to use a larger sample size.

A potential mechanism which could account for heightened valence congruency bias, is a more narrowed attentional scope. According to the attentional scope model of rumination (Whitmer & Gotlib, 2013), heightened levels of ruminative disposition are associated with a more narrowed attentional scope, which results in more exacerbated attentional bias for emotional information. Thus, to the extent that rumination causally influences attentional bias, this narrowed attentional scope would result in greater valence congruency bias in individuals with higher relative to lower levels of ruminative disposition.

However, it is unclear why individuals with low levels of ruminative disposition demonstrated an attentional bias for valence-incongruent information. Although the attentional scope model predicts greater valence-congruency bias in individuals with higher levels of ruminative disposition, it was expected that this would reflect an exaggeration of valence-congruency bias relative to individuals with lower levels of ruminative disposition. Instead, the present findings demonstrated a shift in the direction of bias from valence-incongruent to valence-congruent stimuli as ruminative disposition increased. Thus findings from Study Five were not consistent with the attentional scope model of rumination.

Furthermore, the attentional scope model predicts that rumination-linked attentional bias favouring negative information would only be apparent in the context of negative affect, yet rumination-linked attentional bias for negative stimuli has also been observed in non-clinical samples in the absence of any negative mood inductions (Studies One, Two & Four). Thus, although a narrowed attentional scope may account for some of the findings of the present study, previous findings suggest that an attentional preference for negative information independent of negative emotional context is also present in individuals with high levels of ruminative disposition.

It is also notable that there was no main effect of the rumination inductions on attentional bias. The interaction between rumination condition and ruminative disposition

suggests that rumination has at least some effect on attentional bias, although this may be restricted to individuals with a certain level of ruminative disposition. It is possible that the lack of a main effect of induced rumination is again simply a result of low power, particularly considering that induced ruminative states are unlikely to be as strong as naturally occurring ones (Donaldson et al., 2007). Indeed, power analyses conducted in G-Power demonstrated that for between-group effects ( $N = 74$ ), the present study achieved a power of only .14 to detect small effect sizes ( $\eta_p^2 = .01$ ) at the .05 level, and a power of .58 to detect medium effect sizes ( $\eta_p^2 = .06$ ), both of which are below the recommended level of .80, indicating that larger sample sizes may be required to detect genuine effects using the present design. Furthermore, since the present study involved a one-off manipulation, the effects of rumination on attentional bias may have been limited. It is possible that more prolonged and repeated episodes of rumination may be necessary to reliably influence selective attention. The present study also only measured post-induction attentional bias, whereas assessing change in attentional bias from pre- to post-induction may have been more sensitive to detecting smaller effects of rumination on attentional bias.

Another limitation of the present study is that our rumination manipulation is confounded by the effects of the rumination inductions on mood, such that negative affect was higher in the negative rumination than the positive basking condition. There is evidence that mood has a causal influence on attentional biases for emotional information (Bradley, Mogg, & Lee, 1997), so it is unclear whether the between-group differences in the relationship between ruminative disposition and attentional bias in the present study can be attributed directly to induced rumination or to the associated mood effects. Separating the effects of ruminative thought and mood on cognition is inevitably challenging, since it is well established that ruminating on negative feelings results in increased negative affect (e.g., Morrow & Nolen-Hoeksema, 1990; Nolen-Hoeksema & Morrow, 1993), but there are a

range of methodologies that could be used to help delineate them. The present rumination inductions could be compared to mood inductions without a rumination component, but with comparable effects on mood.

Furthermore, the present study did not include a pre-rumination measure of attentional bias. Thus, although comparison between rumination conditions following each induction was possible, we could not specifically measure change in attentional bias as a result of rumination. Research comparing the relationship between ruminative disposition and attentional bias before and after rumination would be particularly useful for investigating default biases in selective attention in individuals with varying levels of rumination disposition, and how this relationship changes following rumination on different emotional material.

It would also be valuable for future research to investigate the causal relationship between rumination and attentional bias from the opposite direction, given the hypothesis that impaired disengagement of attention is an underlying process contributing to heightened levels of rumination (Koster et al., 2011). Attentional bias modification procedures (ABM; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002), which train attentional preference either towards or away from negative stimuli, can be utilised to test whether manipulating selective attention has a causal influence on levels of rumination during negative mood states. There is promising initial support for the causal effect of attentional bias on ruminative disposition, as a recent study found that repeated sessions of ABM training attention away from negative information resulted in reduced levels of rumination relative to placebo-training (Yang, Ding, Dai, Peng, & Zhang, 2015). Further research might extend this by investigating whether ABM specifically targeting bias in either attentional engagement or disengagement differentially influence the tendency to ruminate, although this

will depend on the successful development of ABM paradigms which exclusively manipulate either attentional engagement or disengagement bias.

In summary, the aim of the present study was to investigate the causal influence of rumination on selective attention for emotional information, and whether this influence was moderated by ruminative disposition. Although there was no direct effect of induced rumination on attentional bias, there was evidence that the effect of induced rumination was moderated by ruminative disposition. However, in contrast to predictions, individuals with low levels of ruminative disposition demonstrated a bias for valence-incongruent stimuli, which shifted toward a bias for valence-congruent stimuli as ruminative disposition increased. Thus, the causal effect of rumination on attentional bias, and the moderating effect of ruminative disposition on this relationship are unclear from the present study. Further research investigating the impact of attentional bias modification on the tendency to ruminate in response to negative mood will be necessary to examine the causal relationship between rumination and selective attention from the opposite direction.

## CHAPTER SEVEN: General Discussion

### 7.1 Summary of Aims and Findings

Prior research has demonstrated that heightened levels of ruminative disposition are associated with an attentional bias for negative relative to non-negative information (Donaldson, Lam, & Mathews, 2007; Joormann, Dkane, & Gotlib, 2006; Pe, Vandekerckhove, & Kuppens, 2013), leading some investigators to suggest that impaired disengagement of attention from negative information may be an underlying process contributing to rumination (Joormann, 2010; Koster, De Lissnyder, Derakshan, & De Raedt, 2011). The aim of this thesis was to further examine the relationship between rumination and attentional bias for negative information, in particular to investigate whether the tendency to ruminate is associated with impaired attentional disengagement from, or enhanced attentional engagement with negative information. Five studies investigated the relationship between rumination and biased attentional processing of negative information using attentional assessment paradigms that were capable of distinguishing between bias in attentional engagement and disengagement. The design, hypotheses, and findings of each of these studies are summarised in Table 7.1.

Study One (Southworth, Grafton, MacLeod & Watkins, under revision) investigated the relationship between individual differences in ruminative disposition and selective attention for negative information, using a modified dot-probe task designed by Grafton, Watkins, and MacLeod (2012) to enable the discrete assessment of biases in attentional engagement and disengagement. This study was also interested in whether biased attentional processing of negative information was specifically associated with ruminative brooding, but not reflection. Ruminative disposition was assessed using both the Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991) and an in-vivo assessment of ruminative

Table 7.1. Summary of studies and findings.

Study	Design	Measures	Hypotheses	Findings
1	Correlational	Ruminative disposition: - RRS - In-vivo assessment Modified dot probe.	Higher levels of ruminative brooding would be associated with greater attentional bias for negative relative to positive information, involving either impaired attentional disengagement from or enhanced attentional engagement with negative information.	Higher levels of ruminative brooding associated with more impaired attentional disengagement from negative relative to positive stimuli. In-vivo ruminative disposition associated with attentional engagement bias, but only for depression relevant stimuli presented for 1000ms.
2	Correlational	RRS Modified dot-probe	The relationship between ruminative disposition and attentional bias would be moderated by stimulus domain and exposure duration, such that higher levels of ruminative disposition would specifically be associated with bias for depression relevant negative stimuli, presented for 1000ms.	Higher levels of ruminative disposition associated with more impaired attentional disengagement from negative relative to positive stimuli, specifically for depression relevant stimuli presented for 1000ms
3	Correlational	Ruminative disposition: - RRS - In-vivo assessment Eye-tracking	Higher levels of ruminative disposition, would be associated with more impaired attentional disengagement from negative relative to positive stimuli	No relationship between ruminative disposition and attentional bias.

Study	Design	Measures	Hypotheses	Findings
4	Selected samples: - High rumination group - Low rumination group	Modified dot-probe. Attentional control (antisaccade).	Participants in the high compared to low rumination group would demonstrate more impaired attentional disengagement from negative relative to positive stimuli, specifically for depression relevant stimuli presented for 1000ms. Participants in the high rumination group would demonstrate more impaired attentional control than participants in the low rumination group.	Higher levels of ruminative disposition associated with greater attentional bias for negative relative to positive stimuli, specifically for depression relevant stimuli presented for 1000ms. Measure of attentional control not valid, so unable to examine relationships with attentional control.
5	Rumination manipulation: - Negative rumination - Positive basking	RRS Modified dot-probe.	Participants in the negative rumination condition would demonstrate greater attentional bias for negative relative to positive stimuli compared to those in the positive basking condition. The effects of the rumination manipulation would be moderated by ruminative disposition, such that individuals with higher levels of ruminative disposition would demonstrate a more pronounced bias towards negative stimuli in the negative rumination compared to positive basking condition.	No main effect of rumination manipulation on attentional bias. Effect of rumination manipulation on attentional bias moderated by ruminative disposition, such that individuals with low levels of ruminative disposition demonstrated a bias towards valence-incongruent stimuli, whereas individuals with high levels of ruminative disposition demonstrated a bias towards valence-congruent stimuli.

brooding. It was hypothesised that higher levels of ruminative brooding, but not reflection, would be associated with greater attentional bias for negative relative to positive information, and that this could involve either impaired attentional disengagement from or enhanced attentional engagement with negative information. Consistent with the impaired disengagement account of rumination (Koster et al., 2011), higher levels of dispositional ruminative brooding, as measured by both the brooding subscale of the RRS and the in-vivo assessment of ruminative brooding, was significantly associated with greater relative impairment disengaging attention from negative compared to positive stimuli. Ruminative disposition was not significantly associated with attentional engagement bias, although the relationship between dispositional ruminative brooding and attentional disengagement bias was not significantly stronger than the relationship with attentional engagement bias. Also, there was some evidence that in-vivo ruminative brooding indices were associated with attentional engagement bias, but only for depression relevant negative stimuli presented for 1000ms.

Study Two (Grafton, Southworth, Watkins, & MacLeod, in press) also utilised Grafton et al.'s (2012) modified dot-probe paradigm to examine the relationship between ruminative disposition and attentional bias for negative information. By employing a larger sample size, this study was better equipped to investigate whether the relationship between ruminative disposition and attentional bias is moderated by stimulus presentation duration and the emotional domain relevance of stimuli. Prior research has suggested that rumination is specifically associated with attentional bias for depression relevant information (Joormann et al., 2006), and that rumination-linked attentional bias is only observed under longer stimulus presentation durations (1000ms, but not 500ms; Donaldson et al., 2007). Consistent with previous findings, higher levels of ruminative disposition were found to be significantly associated with more impaired attentional disengagement from negative relative to positive

stimuli, but only when stimuli were relevant to depression rather than anxiety, and only when stimuli were presented for 1000ms rather than 500ms. There was no significant relationship between ruminative disposition and attentional engagement bias, but there was also no evidence that ruminative disposition was more strongly associated with attentional disengagement bias than attentional engagement bias.

Study Three went on to further investigate the nature of this rumination-linked attentional disengagement bias using an eye-tracking assessment of selective attention. Eye-tracking assessments of attentional bias have the advantage of enabling continuous assessment of the allocation of attention throughout stimulus presentation, resulting in greater temporal sensitivity (Armstrong & Olatunji, 2012). Also, since attentional assessment is not reliant on the presence of a response probe, or other task constraints, it is possible to measure the spontaneous allocation of attention between stimuli. Thus, we developed an eye-tracking assessment of attentional engagement and disengagement biases involving free-viewing of emotional stimuli. It was hypothesised that higher levels of ruminative disposition, as measured by both the RRS and the in-vivo ruminative brooding assessment used in Study One, would be associated with more impaired attentional disengagement from negative relative to positive stimuli. However, ruminative disposition was not significantly associated with any index of attentional bias during the eye-tracking assessment, neither with biased attentional disengagement, nor with biased attentional engagement or maintenance of attention.

Study Four sought to replicate and extend the findings of Study Two, using a selected sample of high and low ruminators. Our previous studies used healthy, unselected samples with levels of ruminative disposition within a relatively normal range. We therefore sought to investigate whether the observed relationships were maintained when examining individuals with more elevated levels of rumination, thus increasing generalizability to clinical

populations. Participants completed a modified dot-probe task identical to the assessment used in Study Two. It was hypothesised that participants in the high compared to low rumination group would demonstrate more impaired attentional disengagement from negative relative to positive stimuli, specifically for depression relevant stimuli presented for 1000ms. Participants in the high rumination group demonstrated greater attentional bias for depression relevant negative stimuli presented for 1000ms in comparison to those in the low rumination group. However, this between group difference reflected a general attentional preference for negative relative to positive stimuli (i.e., composite of attentional engagement and disengagement bias), but no specific difference in attentional disengagement bias or attentional engagement bias was observed. Participants in the high rumination group also demonstrated reduced bias for anxiety relevant negative stimuli presented for 1000ms in comparison to those in the low rumination group.

Study Four also sought to investigate the role of attentional control in rumination-linked attentional biases. Koster et al.'s (2011) disengagement hypothesis suggests that deficits in attentional control contribute to rumination-linked impairments in attentional disengagement. Prior research has established that heightened levels of ruminative disposition are associated with attentional control deficits (Davis & Nolen-Hoeksema, 2000; De Lissnyder, Derakshan, De Raedt, & Koster, 2011; De Lissnyder, Koster, Derakshan, & De Raedt, 2010; Whitmer & Banich, 2007), but since attentional control, attentional biases and rumination have not been assessed within the same study, it is unclear whether rumination-linked attentional control deficits and impaired disengagement from negative stimuli are functionally related, or represent separate facets of the heightened tendency to ruminate. Study Four attempted to address this question by including a response-probe version of the antisaccade task in order to assess attentional control. However, contrary to well established patterns of attentional distribution during antisaccade tasks (Hutton & Ettinger, 2006; Munoz

& Everling, 2004), participants were slower to identify probes on prosaccade than on antisaccade trials, calling into question the validity of this particular antisaccade task as a measure of attentional control. Thus, this study was unable to examine the relationship between attentional control and rumination-linked biases in selective attention.

Finally, Study Five took a first step towards examining the causal relationship between rumination and selective attention, by investigating the hypothesis that rumination has a causal effect on attentional bias. Consistent with theories that characterise rumination as being triggered by and involving thoughts focused on unresolved personal goal discrepancies (Martin & Tesser, 1996; Watkins 2008), rumination was induced using a goal-cuing manipulation, where participants were instructed to focus on either a problem or difficult (unresolved goal; negative rumination condition), or a success or achievement (resolved goal; positive basking condition) (Roberts, Watkins, & Wills, 2013). Selective attention for emotional stimuli was then assessed using a version of Grafton et al.'s (2012) modified dot-probe task to assess biases in attentional engagement and disengagement. It was hypothesised that participants in the negative rumination condition would demonstrate greater attentional bias for negative relative to positive stimuli compared to those in the positive basking condition. Furthermore, Study Five also investigated the hypothesis that the effects of induced rumination would be moderated by ruminative disposition, such that individuals with higher levels of ruminative disposition would demonstrate a more pronounced bias towards negative stimuli in the negative rumination compared to positive basking condition.

Although there was no overall significant difference between the rumination conditions in either attentional engagement or disengagement, the difference in attentional bias between rumination conditions was found to be moderated by ruminative disposition. However, in contrast to predictions, individuals with low levels of ruminative disposition demonstrated a bias for valence-incongruent stimuli, whereas individuals with high levels of

ruminative disposition demonstrated a bias for valence-congruent stimuli. The moderating effect of ruminative disposition was not found to be specific to either attentional engagement or disengagement bias. Analyses of the relationship between ruminative disposition and attentional bias in each rumination condition separately revealed that higher levels of ruminative disposition were associated with greater attentional bias for positive relative to negative stimuli in the positive basking condition. There was no significant relationship between ruminative disposition and attentional bias in the negative rumination condition.

Overall, there was support across the studies for the primary hypothesis that heightened ruminative disposition is associated with impaired attentional disengagement from negative information. However, the findings did not suggest that ruminative disposition is exclusively associated with attentional disengagement bias, but instead indicated that facilitated attentional engagement may also be involved under some circumstances. Furthermore, there was also strong evidence across the studies to suggest that ruminative disposition is specifically associated with attentional bias for depression relevant stimuli presented for longer exposure durations.

## **7.2 Theoretical Implications**

Following the observation that heightened levels of ruminative disposition are associated with an attentional bias favouring negative information, various theoretical models have proposed how individual differences in the attentional processing of negative information may be an underlying mechanism contributing to increased tendency to ruminate in response to negative mood. In particular, it is commonly suggested that heightened levels of ruminative disposition may be associated with difficulties disengaging attention from negative information, as a result of impairments in the control and inhibition of attention for negative information (Joormann, 2010; Koster et al., 2011). An alternative account suggests that heightened ruminative disposition is associated with a more narrowed attentional scope,

which results in greater attentional bias for negative information during negative mood states (Whitmer & Gotlib, 2013). The following section will discuss the theoretical implications of the findings from this thesis, with regard to various aspects of these attentional processing models of rumination.

### **7.2.1 Attentional Engagement and Attentional Disengagement Bias**

A number of theorists have suggested that high levels of rumination may be associated with difficulties disengaging attention away from negative information. The impaired disengagement hypothesis (Koster et al., 2011) maintains that experiencing negative thoughts in response to negative life events, mood states, or stressors is a normal, non-pathological process, but that this typically triggers attempts to disengage attention in order to terminate negative thoughts. If the disengagement of attention from negative information is disrupted, then negative thoughts will be maintained resulting in persistent rumination. This impaired disengagement model of rumination is illustrated in Figure 1.1 (see Chapter One). Similarly, Joorman's (2010) cognitive inhibition model proposes that inhibition deficits in the form of difficulty disengaging from and inhibiting the elaborative processing of negative material lead to difficulty terminating negative thoughts, resulting in more persistent rumination.

Whilst both Koster et al. (2011) and Joorman's (2010) emphasise the role of impaired attentional disengagement in contributing to heightened levels of rumination, neither model explicitly discusses the potential role of attentional engagement in rumination. A strong interpretation of this model would therefore suggest that, as far as selective attention is concerned, only attentional disengagement bias contributes to ruminative disposition, and that attentional engagement bias is not associated with ruminative disposition. Alternatively, a more open interpretation would suggest that attentional engagement bias could be an additional, unspecified factor contributing to heightened ruminative disposition.

The findings from this thesis generally supported the prediction that heightened ruminative disposition would be associated with impaired attentional disengagement from negative information. In this regard, our findings provide strong support for the central tenet of the impaired disengagement account of rumination, namely that the tendency to experience persistent ruminative thought is associated with difficulty in the disengagement attention from negative information.

However, evidence of specificity to attentional disengagement bias was limited, as ruminative disposition was not found to be more strongly associated with attentional disengagement bias than attentional engagement bias in any of the thesis studies. Furthermore, there was some evidence that heightened levels of ruminative disposition were also associated with facilitated engagement with negative information (Studies One & Four). Thus, our findings indicate a potential refinement of the impaired disengagement model to incorporate the role of attentional engagement bias in heightened ruminative disposition.

Impaired disengagement models of rumination have generally focused on explaining individual differences in the persistence of negative ruminative thoughts through differences in attentional disengagement and control (Joormann, 2010; Koster et al., 2011). However, there may be a useful distinction between the onset of rumination and the persistence of rumination. As noted by Koster et al., encountering negative events or mood states will typically trigger negative self-critical thoughts (i.e., ruminative onset). However, although experiencing negative thoughts in response to major stressors or severe emotional distress is relatively normal, the tendency for negative thoughts to arise in response to milder stressors may be more characteristic of pathological rumination. Facilitated attentional engagement with negative information could increase the readiness for negative thoughts to enter the focus of attention, thus broadening the range of situations in which negative ruminative thinking occurs. Therefore, whereas biased attentional disengagement from negative

information may be particularly associated with individual differences in ruminative persistence, biased attention engagement with negative information may be particularly associated with individual differences in ruminative onset. This modified impaired attentional disengagement model of rumination is illustrated in Figure 7.1.

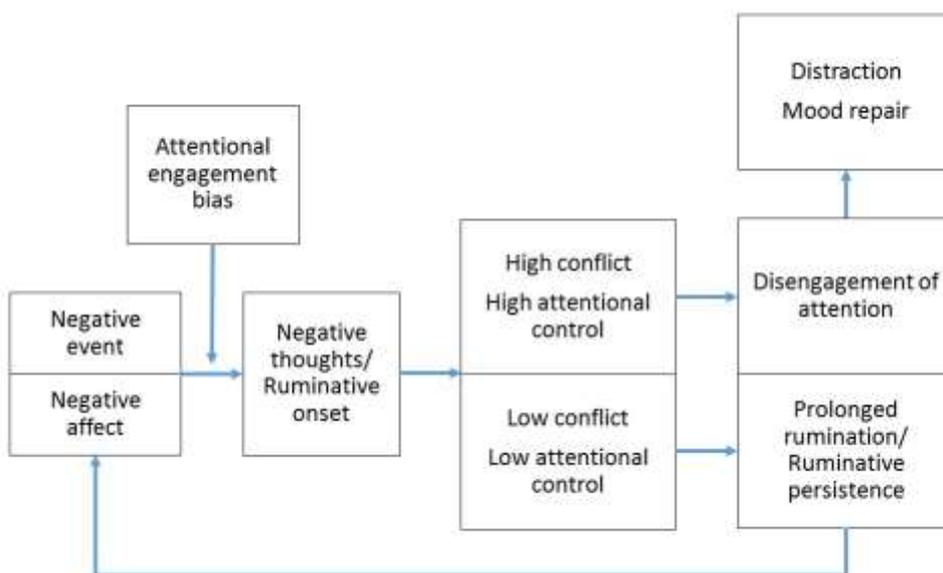


Figure 7.1. Outline of the modified impaired disengagement model of rumination, incorporating the role of attentional engagement bias.

It is also worth noting that the strongest evidence for a rumination-linked attentional engagement bias occurred when comparing selected samples of individuals with high and low levels of ruminative disposition (Study Four). This tentatively suggests that increased attentional engagement with negative information may be specifically characteristic of individuals with particularly high levels of ruminative disposition, and that there may be differential thresholds of ruminative disposition at which bias in attentional engagement and disengagement are observed. Our model suggests that facilitated attentional engagement with negative information will lead to negative thoughts being more readily triggered by negative events or moods. However, if these negative thoughts are typically not persistent, then

individuals will simply experience more frequent transient negative thoughts, rather than more frequent onset of ruminative episodes. Thus, a bias in attentional engagement alone may not be sufficient to impact ruminative disposition. Instead, facilitated attentional engagement with negative information may need to be accompanied by impaired attentional disengagement from negative information in order to influence the degree to which individuals experience episodes of persistent ruminative thought. As such, whereas individual differences in attentional disengagement bias may distinguish between individuals with low, moderate, and high levels of ruminative disposition, individual differences in attentional engagement bias may only differentiate between individuals with moderate and high levels of ruminative disposition. Further research investigating the patterns of selective attentional distribution associated with low, high, and mid-range levels of ruminative disposition will be required to test this prediction.

### **7.2.2 Stimulus Exposure Duration: Strategic vs. Automatic Processing Bias**

This thesis also investigated the hypothesis that the relationship between ruminative-disposition and attentional bias for negative information would be moderated by stimulus presentation duration, such that rumination-linked attentional bias would be observed specifically at longer stimulus presentation durations. Studies Two and Four both found that the rumination-linked bias for negative stimuli was specific for stimuli presented for 1000ms, and not 500ms. These findings are consistent with previous research which found evidence of a rumination-linked attentional bias only for stimuli presented for 1000ms, and not 500ms (Donaldson et al., 2007).

Some researchers have suggested that evidence of attentional bias specifically at longer stimulus exposure durations may indicate more strategic rather than automatic processing, as strategic processes are more likely to be evident when processing time is extended (McNally, 1995; Mogg & Bradley, 2005). Strategic processing is considered

controlled and effortful, as opposed to automatic processing which is effortless, unconscious, and involuntary. Thus, evidence that rumination-linked attentional bias is only observed at longer stimulus exposure durations may suggest that ruminative disposition is specifically associated with individual differences in the operation of controlled attentional processing bias. This does not necessarily imply that heightened rumination involves a voluntary attentional bias in favour of negative material, but could instead involve a deficit in the strategic and controlled inhibition of negative information. Such an interpretation would be consistent with models which suggest that heightened rumination is associated with a deficit in the attentional control and inhibition of negative information (Joormann, 2010; Koster et al., 2011).

However, it is important to note that 500ms exposure duration is sufficient to enable the operation of strategic processes, although to a lesser extent than would be possible at longer durations (Holender, 1986; Mogg, Bradley, & Williams, 1995). It is possible that the restriction of rumination-linked attentional bias to 1000ms stimulus exposure duration could simply be attributed to the time taken for attentional engagement or disengagement to take place, rather than to the strategic nature of this bias. Thus, further research will be required to determine whether rumination-linked attentional bias involves strategic or automatic processes (see Section 7.4 below).

### **7.2.3 Stimulus Domain Specificity**

Attentional processing models of rumination have typically suggested that heightened ruminative disposition may be particularly associated with attentional bias for concern-relevant negative information (Joorman, 2010; Koster et al., 2011; Whitmer & Gotlib, 2013). Previous research has highlighted the importance of emotional domain specificity in psychopathology, demonstrating that individuals typically demonstrate attentional biases

specifically towards information that is relevant to current emotional concerns (Pergamin-Hight, Naim, Bakermans-Kranenburg, van Ijzendoorn, & Bar-Haim, 2015).

Consistent with previous research (Joormann et al., 2006), findings from this thesis suggested that ruminative disposition was specifically associated with an attentional bias for depression-relevant negative information, and not anxiety relevant information (Studies Two & Four). Although rumination has been identified as a transdiagnostic process (Ehring & Watkins, 2008; Nolen-Hoeksema & Watkins, 2011), the phenomenological experience of depressive rumination (as assessed by the RRS) primarily involves focusing on sadness and depression (Nolen-Hoeksema, 1991; Nolen-Hoeksema & Morrow, 1991). Thus, although rumination may contribute to greater vulnerability to emotional disorders other than depression, it follows that heightened tendency to focus on depressive mood states might be specifically associated with increased attentional processing of depressive information.

However, it is notable that the present studies used non-clinical samples, not currently experiencing high levels of negative affect. To the extent that ruminative disposition may be associated with attentional biases for concern relevant information (Joormann, 2010; Koster et al., 2011; Whitmer & Gotlib, 2013), it is possible that individuals with high levels of ruminative disposition may demonstrate increased bias towards anxiety relevant information during periods of high state anxiety.

It is also notable that Study Four found that higher levels of ruminative disposition were associated with reduced attentional bias towards anxiety relevant negative stimuli (i.e., threat stimuli). Although this is the first study to suggest that heightened ruminative disposition is associated with reduced attentional bias for threatening information, similar findings have also been observed in the anxiety literature. Although anxious individuals exhibit an attentional bias towards threat at shorter stimulus presentation durations, they also demonstrate a reduced attentional bias for threat stimuli at longer presentation durations (e.g.,

Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006; Koster, Verschuere, Crombez, & Van Damme, 2005; Mogg, Bradley, Miles, & Dixon, 2004), suggesting that heightened anxiety is associated with initial vigilance for threatening stimuli, followed by subsequent avoidance. It has been suggested that emotion regulation strategies may underlie avoidance of threatening information in anxiety (Cisler & Koster, 2010). Similarly, one interpretation of the findings from Study Four is that individuals with high levels of ruminative disposition exhibit similar patterns of strategic attentional avoidance of threatening information. However, since this is presently the only study to suggest that heightened ruminative disposition is associated with avoidance of threatening stimuli, further replication of this finding will be required.

#### **7.2.4 Ability vs. Tendency Explanations of Attentional Bias**

Although studies using the modified dot-probe task found evidence of a rumination-linked attentional bias for negative stimuli (Studies One, Two, & Four), no evidence was found of a relationship between ruminative disposition and attentional bias using an eye-tracking assessment involving free-viewing of emotional stimuli (Study Three). A possible explanation for these discrepant findings is that rumination is particularly associated with a *reduced ability* to inhibit attentional processing of negative information, rather than a bias in *spontaneous tendency* to maintain or direct attention towards negative information. If rumination-linked attentional bias results from a reduced ability to control attentional processing of negative information, then this bias would only be apparent under conditions that impose explicit demands upon the allocation of attention. In contrast, if rumination-linked attentional bias results from a spontaneous tendency to preferentially allocate attention to negative information, then this would be apparent in the absence of explicit demands upon attention.

A key methodological difference between the modified dot-probe task used in Studies One, Two and Four and the eye-tracking assessment employed in Study Three is that whereas the dot-probe task requires participants to direct their attention towards the target probe presented immediately after the emotional stimuli, this response probe was absent in the eye-tracking assessment. The task demands imposed by the response probe may have influenced the allocation of attention during stimulus presentation to facilitate rapid responding to the target probe, such that participants pre-emptively disengaged attention from its initial location prior to probe onset, and strategically directed their attention towards the central location. As such, whereas an attentional bias as assessed by the dot-probe task could reflect either reduced ability to inhibit attentional processing of negative information, or increased tendency to direct attention towards negative information, the role of ability is diminished if no constraints are placed on attention. As such, any rumination-linked difficulties in inhibiting the attentional processing of negative information may result in an attentional bias towards negative stimuli on the modified dot-probe task, but may not manifest as a spontaneous bias in selective attention during free-viewing of stimuli. One hypothesis generated by the present findings is therefore that attentional bias associated with rumination is based on a reduced ability to control attention for negative information.

However, the absence of a rumination-linked attentional bias using the eye-tracking assessment could also be attributed to the fact that eye-movements can only index overt shifts in attention (i.e., attentional selection performed via eye-movements). If rumination-linked attentional bias does not translate into shifts in overt attention, but instead only involves shifts in covert attention (i.e., shifts in attentional selection occurring in between eye-movement without redirecting gaze), then eye-tracking assessments of attentional bias would be incapable of detecting this. This explanation seems unlikely, as in naturalistic viewing, eye-movements are the primary method of attentional selection, with covert attention generally

guiding eye-movements (Findlay & Gilchrist, 2003; Hayhoe & Ballard, 2005), but cannot be completely ruled out by the present methodology. Further research will be required to determine whether methodological differences in terms of sensitivity to shifts in covert attention, or capability to distinguish between biases in the ability and tendency to disengage attention from negative information can account for the present findings (see Section 7.4 below).

### **7.2.5 Attentional Bias vs. Attentional Scope Accounts**

The attentional scope model of rumination (Whitmer & Gotlib, 2013) proposes that individuals with high levels of ruminative disposition exhibit a more narrowed attentional scope, such that attentional processing is generally more constricted and less flexible. The model notes that negative mood states generally result in biased attentional processing towards negative information and activation of negative thoughts. Individuals with a narrow attentional scope will find it more difficult to direct attention away from negative information during negative mood states, resulting in an enhanced attentional bias for negative information and more persistent negative thoughts in the form of rumination. In contrast, individuals with a broader attentional scope will more easily direct attention towards a wider array of mood-incongruent information, thus attenuating attentional bias for negative stimuli, and facilitating the termination of negative thoughts in favour of distracting thoughts and activities.

A central tenet of the attentional scope model is that narrowed attentional scope results in an exaggeration of mood-congruent attentional bias effects, and thus individuals with high levels of ruminative disposition demonstrate enhanced mood-congruent attentional bias in response to negative mood states. Similarly, a logical inference would be that to the extent that state rumination might influence attentional biases for emotional information, these effects should be greatest in individuals with higher levels of ruminative disposition.

However, contrary to predictions, Study Five found that individuals with low levels of ruminative disposition demonstrated a bias for valence-incongruent stimuli, such that individuals in the positive basking condition demonstrated greater bias for negative relative to positive stimuli compared to individuals in the negative rumination condition. This bias for valence-incongruent stimuli then shifted to a bias for valence-congruent stimuli as ruminative disposition increased. Thus, findings from Study Five were not consistent with the attentional scope model, which predicts that higher levels of ruminative disposition will be associated with exaggeration of valence-congruent biases. The assumptions of the attentional scope model also have implications for the circumstances under which heightened ruminative disposition will be associated with biased attentional processing of negative information. One key assumption is that high levels of ruminative disposition are only associated with more biased attentional processing of negative information during negative mood states (Whitmer & Gotlib, 2013). However, the present thesis has demonstrated a relationship between ruminative disposition and attentional bias for negative stimuli in non-clinical samples not currently experiencing negative affect (Studies One, Two & Four). Thus, although a narrowed attentional scope may well be a factor associated with heightened ruminative disposition, this alone cannot account for the present findings. Instead, it seems that heightened ruminative disposition is also associated with an attentional bias favouring negative information independent of the presence of negative affect. These findings are therefore inconsistent with the original version of the attentional scope model.

#### **7.2.6 Causal Effect of State Rumination on Attentional Bias**

There are two directions of causality which might account for the observed relationship between ruminative disposition and attentional bias. As suggested by impaired disengagement models of rumination (Joorman, 2010; Koster et al., 2011), biased attentional processing of negative information may be an underlying process contributing to heightened

ruminative disposition. Alternatively, more frequent engagement in ruminative thought may causally contribute to increased attentional bias for negative information. Either one, or both, of these causal relationships could account for the association between ruminative disposition and attentional bias. There are some practical difficulties associated with attentional bias modification, particularly with regard to reliability, as changes in attentional bias produced by this task are often short lived and unreliable (Clarke, Notebaert, & MacLeod, 2014). Furthermore, there are currently no well-established ABM paradigms that independently manipulate attentional engagement and disengagement bias. Thus, for pragmatic reasons, we chose to first investigate the causal effect of rumination on attentional bias.

According to Nolen-Hoeksema's (1991) response style theory, rumination exacerbates the effects of negative mood on information processing biases, as focusing on negative feelings heightens the accessibility of negative information (Nolen-Hoeksema, 1991; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). If individuals habitually ruminate during negative mood states, as would be the case for those with high levels of ruminative disposition, such information processing biases could become increasingly ingrained and pervasive. Previous research has supported the causal influence of rumination on negative biases in a number of aspects of cognition, including negative interpretations (Lyubomirsky & Nolen-Hoeksema, 1995), increased negative future thinking and pessimism about future events (Lavender & Watkins 2004; Lyubomirsky & Nolen-Hoeksema, 1995), and greater negative autobiographical memory recall (Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998). Thus, there is good reason to suspect that rumination might also causally influence information processing in the form of attentional bias for negative information.

Study Five took a first step towards investigating the causal relationship between rumination and selective attention, by investigating the effect of induced rumination on attentional bias. There was no evidence of an overall significant main effect of the induced

rumination on attentional bias, although the interaction between the rumination manipulation and ruminative disposition suggests that rumination has at least some causal effect on attentional bias. It is possible that the effects of rumination on attentional bias may be restricted to individuals with high levels of ruminative disposition. Caution interpreting null findings from a single study is warranted though, particularly considering that induced ruminative states are unlikely to be as strong as naturally occurring ones (Donaldson et al., 2007). Thus, it is not yet clear whether the causal effects of rumination on attentional bias are restricted to individuals with high levels of ruminative disposition, or whether the lack of a clear main-effect can be attributed to low statistical power, measurement sensitivity, or the effectiveness of the rumination induction.

### **7.3 Strengths and Limitations**

A key strength of all the studies presented in this thesis is that they utilised attentional assessment tasks capable of distinguishing between bias in attentional engagement and disengagement. It has been previously established that neither the conventional dot-probe task, nor the modified Posner cuing task used in prior research investigating the link between rumination and selective attention are able to adequately separate biased attentional engagement from biased attentional disengagement (Clarke, MacLeod & Guastella, 2013; see section 1.2.1 in Chapter One). By introducing an anchor stimulus, which fixed attention in a predetermined location prior to the presentation of emotional stimuli, the attentional assessment paradigms used in the present thesis allowed for the independent assessment of the tendency for attention to be disproportionately captured by initially distal negative information (engagement bias), and to be disproportionately held by initially proximal negative information (disengagement bias). As far as we are aware, the studies presented in the present thesis are the first to investigate the relationship between ruminative disposition

and selective attention using paradigms capable of independently assessing biased attentional engagement and disengagement.

Whereas previous research demonstrating the link between heightened ruminative disposition and biased attentional processing of negative information has exclusively relied on the RRS questionnaire measure, Study One provided converging evidence for this relationship using a novel in-vivo assessment of ruminative disposition. There are two important problems with exclusive reliance on the RRS questionnaire approach to the assessment of ruminative disposition. Firstly, the RRS does not control for inter-individual variability in levels of exposure to negative events, meaning that a high score on the RRS could reflect more frequent, extended, or intense exposure to negative events capable of evoking rumination. Moreover, the RRS requires respondents to draw upon their long-term memory of potentially quite distant past episodes of rumination, and so permits contamination by biases in the operation of long-term memory, such as mood-congruency and recency effects (Kihlstrom et al., 2009; Trull & Ebner-Priemer, 2009). These limitations may be particularly problematic for attempts to demonstrate a link between ruminative-disposition and selective attention, as both exposure to negative events and biases in the operation of long-term memory are likely to also be associated with attentional bias for negative information (e.g., Beevers & Carver, 2003; Everaet, Tierens, Uzieblo, & Koster, 2013), thus introducing confounds which could account for the observed relationship between ruminative disposition and attentional bias. The in-vivo assessment reduces these limitations as participants are all equally exposed to the same standardized negative event, to reveal individual differences in the degree to which this serves to elevate ruminative thinking. Participants also report only the ruminative thinking they experienced in recent minutes, reducing distortion by biases in the operation of long-term memory. Therefore, Study One

strengthened evidence for the claim that attentional bias for negative information is directly associated with heightened ruminative disposition.

A limitation of the attentional bias assessment tasks used in this thesis is that they exclusively measured attention to external visual-spatial stimuli, whereas rumination is a process that involves focusing on internal thoughts and feelings. It is therefore relevant to consider whether individual differences in ruminative disposition are associated with similar attentional bias for internal representations in working memory. Other research has examined the relationship between ruminative disposition and attentional bias for internal stimuli using the internal shift task (IST), which assesses ability to shift internal attentional focus between emotional and neutral representations of stimuli (De Lissnyder, Koster, & De Raedt, 2012a; Koster, De Lissnyder, & De Raedt, 2013). Consistent with attentional disengagement bias accounts of rumination, higher levels of ruminative disposition have been found to be associated with greater switching impairments on the IST, particularly when switching attentional processing from negative to neutral information (Koster et al., 2013). Thus, although the present thesis is limited by the reliance on assessments of attentional bias for external stimuli, there is converging evidence to suggest that similar attentional processing biases for internal information are associated with heightened ruminative disposition.

The attentional bias assessment tasks used in this thesis are also potentially limited by the low reliability of attention probe tasks reported in previous studies (Schmukle, 2005; Staugaard, 2009; Waechter, Nelson, Wright, Hyatt, & Oakman, 2014; Waechter & Stolz, 2015). Reliability refers to the extent to which a measure's variance reflects true score variance, as opposed to measurement error. Low reliability is thus associated with increased error variance and reduced statistical power (Kopriva & Shaw, 1991; Waechter & Stolz, 2015), and has been demonstrated to result in lower levels of replicability (LeBel & Paunonen, 2011). Although the particular attentional bias assessment tasks used in the present

thesis have not been tested for reliability, given that all versions of the dot-probe task tested to date have consistently demonstrated low reliability, it is reasonable to assume that the present tasks may also have low reliability. As a result, reliability issues could potentially account for some of the inconsistent findings within this thesis, assuming that the current attention probe tasks also showed relatively low reliability.

In addition, it is important to note that with the exception of Study Two, the studies in this thesis were underpowered to detect small-to-medium effect sizes, which may account for some of the findings not being replicated across studies. In particular, the relationship between ruminative disposition and attentional disengagement bias found in Studies One and Two may not have been replicated in Study Four due to low statistical power. Similarly, the moderating effect of stimulus domain and exposure duration on the relationship between ruminative disposition and attentional bias (Studies Two and Four) may not have been statistically significant in Study One due to low power. Larger sample sizes may be required to consistently replicate findings across studies. Alternatively, using a more reliable attentional assessment task may help to improve power by reducing error variance and thus increasing effect sizes.

Finally, another important limitation of this thesis is that all studies involved non-clinical samples. It is possible that the relationship between rumination and attentional bias for negative information will differ in clinically depressed samples, or individuals experiencing high levels of negative affect. The relationship between rumination and negative attentional bias may simply be stronger during episodes of depression or anxiety, but there may also be various qualitative differences in rumination-linked attentional biases observed in clinical samples. Firstly, although our present findings tentatively suggest that impaired attentional disengagement from negative information might be a more prominent feature of heightened ruminative disposition than facilitated attentional engagement with negative

information, biases in attentional engagement might become more apparent during periods of heightened negative affect. Similarly, although we did not find evidence of rumination-linked biases in the allocation of attention via eye-movements during free-viewing of emotional stimuli, it is possible that such biases might emerge in clinical samples. Finally, although the present findings suggest that rumination is specifically associated with attentional bias for depression-relevant and not anxiety-relevant stimuli, to the extent that rumination might be associated with heightened attentional processing of concern relevant information, it is possible that a bias for anxiety-relevant stimuli could emerge in clinically anxious individuals.

#### **7.4 Future Research**

The main novel hypothesis generated from this thesis, which will require further investigation, is the proposal that whereas impaired attentional disengagement from negative information may be specifically associated with greater persistence of ruminative thoughts, facilitated attentional engagement with negative information may be associated with increased onset of negative ruminative thoughts. A crucial challenge of such research will involve developing a ruminative disposition assessment that can adequately distinguish between individual difference in the degree of ruminative onset and persistence. Experience sampling has previously been used to assess momentary levels of ruminative self-focus (Kircanski, Thompson, Sorenson, Sherdell, & Gotlib, 2015; Moberly & Watkins, 2008). This approach could conceivably be adapted to assess both the frequency of ruminative episodes (i.e., ruminative onset) and average duration of each ruminative episode (i.e., ruminative persistence). According to the model proposed in this thesis, facilitated attentional engagement with negative information would be associated with increased frequency of ruminative episodes, whereas impaired attentional disengagement from negative information would be associated with longer duration of ruminative episodes.

Further research will also be required in order to better understand why no relationship was observed between ruminative disposition and attentional bias assessed via eye-tracking in Study Three, but was observed when using a modified response-probe assessment of attentional bias (Studies One, Two & Four). At present, it is unclear whether these discrepant findings can be attributed to the absence of the response probe in Study Three or the inability of eye-tracking assessments to detect covert shifts in attention allocation. Future research could address this issue by applying eye-tracking to Grafton et al.'s (2012) modified attention probe task. If this combined approach were to produce evidence of a relationship between ruminative disposition and attentional bias on the response probe measure, but without a simultaneous bias in the allocation of attention via eye-movements, then this would indicate that the discrepant results can be accounted for by differences in the ability to detect covert shifts in attention. However, if simultaneous biases in selective attention were found using both measures, then the role of the response probe in eliciting this bias could be further investigated. A mixture of assessment trials both with and without the response probe would enable the determination of whether the task constraints imposed by the response probe are necessary for rumination-linked attentional biases to become apparent. Such research would have theoretical implications for the nature of the rumination-linked attentional bias, particularly the distinction between biases based on the ability to control the distribution of attention, or spontaneous tendencies in attentional preference. Specifically, if an attentional bias for negative information performed via eye-movements was observed in the presence of the response probe, but not during free-viewing of stimuli in the absence of a response probe, this would indicate that this rumination-linked attentional bias principally involved impaired ability to inhibit attentional processing of negative information, rather than a spontaneous tendency to preferentially direct attention towards negative information.

Although previous research has established that heightened ruminative disposition is associated with deficits in attentional control (Davis & Nolen-Hoeksema, 2000; De Lissnyder et al., 2011; De Lissnyder et al., 2010; Whitmer & Banich, 2007), it is not yet clear whether attentional control and attentional bias are functionally related, as suggested by attentional models of rumination (Joormann, 2010; Koster et al., 2011), or represent separate facets of ruminative disposition. The present thesis attempted to address this issue by assessing ruminative disposition, attentional bias, and attentional control within the same study (Study Four). However, due to reservations over the validity of the antisaccade task used in this study, we were unable to adequately assess attentional control. As such, further research using a more clearly valid measure of attentional control will be necessary to adequately investigate the relationship between rumination-linked deficits in attentional control and biased attentional processing of negative information. Alternative, well-established measures of attentional control that would be appropriate for addressing this question include task-switching paradigms (e.g., De Lissnyder et al., 2010; Whitmer & Banich, 2007), and eye-tracking assessments of attentional distribution during antisaccade tasks (e.g., Chen, Clarke, Watson, MacLeod, & Guastella, 2015; De Lissnyder et al., 2011). Another approach could involve training attentional control to investigate the hypotheses that improving attentional control would attenuate ruminative disposition, and that reductions in attentional bias for negative information would mediate the effects of attentional control training on rumination.

Another aspect of the impaired disengagement hypothesis not investigated in this thesis is the role of impaired conflict signalling in rumination-linked attentional bias. Koster et al.'s (2011) attentional disengagement model proposes that when individuals experience negative ruminative thoughts, this will typically result in conflict signalling triggering attempts to disengage attention from negative thoughts. Thus, impaired attentional disengagement from negative information may also occur due to impaired conflict signalling.

Previous research has indicated that conflict signalling in the presence of negative material is reduced during negative mood states, as indicated by reduced neural sensitivity to non-rewards versus rewards (Foti & Hajcak, 2010), and that increasing numbers of depressive episodes are associated with reduced conflict monitoring (Vanderhasselt & De Raedt, 2009). Further research might seek to investigate whether such impairments in conflict signalling are specifically associated with both heightened ruminative disposition and impaired attentional disengagement from negative stimuli.

Further research will also be necessary to investigate whether rumination-linked attentional bias involves strategic or automatic processing. One approach to determining the relative contribution of strategic and automatic processes would involve investigating the impact of secondary cognitive load disrupts on selective attention (Sternberg, 1966; van Dillen, Papiés, & Hofmann, 2012). Whereas automatic attentional processing biases are considered effortless and involuntary, strategic attention is effortful and requires sufficient availability of cognitive resources. Therefore, if the presently observed rumination-linked attentional biases involve strategic processing, then these biases should be attenuated under cognitive load.

Finally, the studies presented in this thesis primarily involved correlational designs, meaning that conclusions regarding the causal relationship between rumination and selective attention are limited. Study Five took a first step towards examining the causal relationship, by investigating the effect of induced rumination on attentional biases for negative information. Theoretical models of rumination have, however, also highlighted biased attentional processing of negative information as a potential underlying process contributing to heightened ruminative tendencies (Joormann, 2010; Koster et al., 2011). To directly investigate the causal effect of biased attentional processing of negative information on rumination, it will be necessary to investigate whether attention bias modification procedures

(ABM; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002) that train individuals to direct attention away from negative information can serve to attenuate the tendency to engage in depressive rumination. A recent study involving repeated sessions of ABM found that training attention away from negative information resulted in reduced levels of rumination relative to placebo-training, and that decreases in rumination mediate the effects of ABM on depressive symptoms (Yang, Ding, Dai, Peng, & Zhang, 2015). Thus, there is some initial support for the hypothesis that attentional biases favouring negative information causally contribute to heightened levels of rumination.

An interesting extension of this research could involve investigating whether attentional training specifically targeting bias in either attentional engagement or disengagement influences the efficacy of ABM aimed at reducing rumination. Whereas ABM targeting attentional engagement bias might specifically prevent any engagement with negative stimuli, ABM targeting attentional disengagement bias might strategically engage attention with negative stimuli, whilst encouraging swift disengagement from such stimuli. Building on new hypotheses concerning the roles of attentional engagement and disengagement bias in ruminative onset and persistence, such research could investigate whether training attentional engagement bias specifically influenced ruminative onset, whereas training attentional disengagement bias specifically influenced ruminative persistence. However, exclusive training of one mechanism of attentional bias, without transfer effects to the other (e.g., targeting attentional engagement bias without influencing attentional disengagement bias) may prove difficult in practice. In this case, an alternative approach could involve investigating the effects of standard ABM on attentional engagement and disengagement bias as assessed by the tasks used in Study One and Two, and the extent to which changes in attentional engagement and disengagement bias mediated effects of ABM on various aspects of ruminative disposition. According to new hypothesis generated

from this thesis, changes in attentional engagement bias would be expected to mediate the effects of ABM on ruminative onset, whereas changes in attentional disengagement bias would be expected to mediate the effects of ABM on ruminative persistence.

### **7.5 Clinical Implications**

It is well established that heightened ruminative tendencies are associated with greater vulnerability to depression and other emotional disorders (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). As such, interventions aimed at reducing rumination are likely to have value in the treatment of emotional disorders. There is growing evidence to suggest that biased attentional processing of negative information is an underlying process associated with heightened tendency to ruminate during negative mood states. Attempting to attenuate biased attentional processing of negative information using ABM may therefore be effective as a means of reducing ruminative disposition. Various studies have already demonstrated that ABM may be an effective intervention in the treatment of depression and anxiety (Hakamata et al., 2010; Yang et al., 2015), and that reductions in rumination mediate the effects of ABM on depressive symptoms (Yang et al., 2015). There is therefore good initial evidence to suggest that ABM has potential as a clinical intervention particularly targeted at individuals with high levels of ruminative disposition.

Furthermore, ABM may also have potential as a preventative intervention aimed at reducing emotional vulnerability in individuals with high levels of ruminative disposition. The negative effects of rumination are not necessarily restricted to clinical patients, as levels of ruminative disposition have also been found to predict vulnerability to the future development of emotional disorders in non-clinical samples (e.g., Just & Alloy, 1997; Nolen-Hoeksema, 2000). The present thesis found that biased attentional processing of negative information was associated with levels of ruminative disposition in non-clinical samples. Thus, training individuals with high levels of ruminative disposition to direct attention away

from negative information may help prevent the development of future episodes of emotional distress.

## **7.6 Summary and Conclusion**

The aim of this thesis was to further investigate the nature of rumination-linked bias in selective attention for negative information. Three studies found evidence that heightened ruminative disposition was associated with greater attentional bias for negative information (Studies One, Two & Four). Consistent with the impaired disengagement account of ruminative disposition, this rumination-linked attentional bias was found to involve impaired attentional disengagement from negative information (Studies One & Two), although facilitated attentional engagement with negative information also appears to be involved, possibly with more pathological levels of rumination. As such, the findings from this thesis suggest a refinement to the impaired disengagement hypothesis to incorporate the role of attentional engagement bias in heightened ruminative disposition. We propose that whereas impaired attentional disengagement from negative information may contribute to heightened persistence of rumination, facilitated attentional engagement with negative information may contribute to more frequent onset of negative thoughts that increase the likelihood of rumination.

There was also reliable evidence to suggest that heightened ruminative disposition is specifically associated with attentional bias for depression-relevant stimuli presented for longer exposure durations. The finding that rumination-linked attentional bias operates at longer exposure durations may indicate a deficit in the strategic processing of negative information, consistent with theories suggesting such attentional bias may result from deficits in the inhibition and control of attention for negative information. Research further illuminating the role of impaired attentional control in contributing to rumination-linked attentional bias will be an interesting area for future research to consider.

Finally, the present thesis took a first step towards investigating the causal relationship between ruminative disposition and selective attention, by investigating the effect of induced rumination on attentional bias. There was some evidence to suggest that rumination might causally influence attentional bias, although possibly only for individuals with higher levels of ruminative disposition. Further research investigating the causal effect of attentional bias on ruminative disposition will also be necessary, particularly since such research may have valuable implications for the potential use of ABM as a clinical and preventative intervention aimed at reducing the tendency to ruminate in response to negative mood.

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**Appendix One: Questions and response options for rumination ratings, with scores  
given for each response.**

<i>Score</i>	0	1	2	3	4
<i>Frequency</i>					
How often did this thought or a very similar thought come to mind during the 5 minutes of the breathing exercise?	Only once	Twice	Three times	Four times	More than four times
<i>Duration</i>					
How long were you thinking about the subject of the thought during the 5 minutes?	Only for an instant	Under 10 seconds	About 30 seconds	About half the time	Nearly all of the time
<i>Repetitiveness</i>					
When thinking about this subject, how much did your thoughts keep coming back to the same or similar ideas again and again?	Not at all	A bit	Somewhat	Moderately	Extremely
<i>Severity</i>					
How upsetting or distressing was the thought?	Not at all	A bit	Somewhat	Moderately	Extremely
<i>Control</i>					
How difficult did you find it to stop this thought coming or to move on to other thoughts?	Not at all	A bit	Somewhat	Moderately	Extremely

### Appendix Two: List of Emotional Word Stimuli

Sad/Happy		Anxious/Relaxed	
Negative Word	Positive Word	Negative Word	Positive Word
sluggish	happier	intimidated	brave
disappointed	enjoy	fretting	ease
aimless	pleased	fearful	relaxed
unhappy	brightness	tense	composed
emptiness	energetic	dangerous	heroic
lonely	lively	worried	confident
dreary	satisfaction	neurotic	serene
forlorn	buoyant	agitation	calm
dismal	merry	frightened	restful
defeat	passionate	nervous	tranquil
brooding	euphoric	suffocating	assertive
hopeless	zeal	attack	courageous
gloomy	excited	panicky	peaceful
failure	eager	uneasy	secure
upset	fulfilled	restless	safe
discouraged	fun	alarmed	fearless