Rumination-content and Attention in Depression

by

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Abstract

Cognitive theories of emotional disorders predict that individuals suffering from an emotional disorder exhibit increased interference for stimuli that are idiosyncratic to their disorder (Williams, Mathews, & MacLeod, 1996). However, due to inconsistent results, there is debate as to whether attention disrupting effects for negative information occur in depression. Suitability of experimental stimuli employed to elicit attentional biases is a commonly cited limitation that may have contributed to these inconsistencies. The present investigation was designed to examine the influence of rumination on the operation of attentional biases in depression using a digit-parity task. Depressed and never-depressed participants were required to make a speeded judgement about the parity of two digits flanking a to-be-ignored centrally presented word. Depressed individuals displayed longer digit-parity response times for depression-relevant words relative to never-depressed individuals. Furthermore, depressed individuals displayed the longest digit-parity response times for word stimuli relevant to the idiosyncratic content of their ruminative thoughts. These findings highlight the importance of studying the idiosyncratic content of each depressed individuals ruminative themes when investigating attentional biases within this population.

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Dedication

This Master's Thesis is dedicated to all the people who helped bring me to where I am today. To my parents who didn't laugh when at the age of 26, I told them I was going to abandon my career and embark on a 6 year journey to realize a dream. To my sister who not only inspires me but continues to represent what I one day aspire to be. I am eternally grateful for your steadfast commitment to my well-being, and unrelenting belief in my ability to succeed in whatever endeavour I pursue.

To anyone who has ever felt the darkness of depression - it is only when we attempt to see the world through your eyes, do we begin to understand your plight. This project is my attempt at understanding your world.

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Introduction

Of all mental illnesses, clinical depression is one of the single most common, affecting 16.2% of American adults over the age of 18 across the lifespan (Kessler et al., 2003). Depression is not only common but recurrent, with over 85% of depressed patients experiencing a repeat episode within 15 years after their first episode (Mueller et al., 1999). Given this high rate of recurrence, it has been reasoned that a stable vulnerability, or vulnerabilities exist which confer greater risk for experiencing a relapse.

For over two decades, a substantial effort has been made to identify such vulnerability factors. Much of this research has been guided by cognitive theories, which implicate biased information processing as a risk factor for experiencing depressive episodes. In studies of attention and memory, the "emotion-congruent hypothesis" predicts that individuals suffering from an emotional disorder are better able to learn and remember material that is consistent with their disorder (for a review see Williams, Mathews, & MacLeod, 1996). To this end, depressed individuals are said to pay greater attention to, and show greater recall for negative, depression-relevant information than either positive or neutral information. To-date research attempting to demonstrate the presence of depression-relevant attentional biases has yielded inconsistent findings. Indeed, while several authors have documented depression-relevant attentional biases in clinical populations (e.g., Gotlib & McCann, 1984; Gotlib & Cane, 1987; Gotlib, Krasnoperova, Yue, & Joormann, 2004), many others have not (e.g., Mogg, Bradley, Williams, & Mathews, 1993; McCabe, Gotlib & Martin, 2000; Yovel & Mineka, 2005).

Such inconsistencies led Mathews and MacLeod (1994) to conclude that anxiety disorders – but not depression- are characterized by selective attention favouring threatening information and that depression – and not anxiety disorders – is characterized by biases in

explicit memory favouring negative self-relevant information. However, in a more recent review of research on cognitive processing and emotional disorders, Mathews and Macleod (2005) concluded that research now suggests exceptions to their earlier general claim. Indeed, closer examination of this literature confirms the presence of attentional biases in depression, but results are dependent on the nature of the task employed to assess them and the nature of the depression-relevant stimuli used (i.e., whether the stimuli are negative in general or specifically related to patients' idiosyncratic depressive symptoms).

One of the most common methods used to examine attentional bias is the emotional Stroop colour-naming task. The emotional Stroop task is an interference task in which participants attend to one aspect of a compound stimulus and attempt to ignore another aspect of the stimulus. Specifically, participants are asked to name the colour in which a word is presented while attempting to ignore the emotional content of the word itself. In this task an inability to ignore the emotional content of the words will interfere with the participants' ability to name the colour of the words. It is reasoned that the emotional content of the word momentarily captures attention, resulting in slower colour naming times for emotional words as compared to neutral, or non-emotional, words (Wentura, Rothemund, & Bak, 2000). Response-time differences between emotional and neutral words have typically been found. However, the actual mechanism by which the emotional content affects performance is a matter of debate. For example, it has been suggested that the emotional Stroop effect is merely an artifact of improper matching of the linguistic characteristics of emotional and neutral words, and that the effects observed have little to do with the emotion status of the items.

Larsen, Mercer, and Balota (2006) demonstrated the importance of matching emotional and neutral words on linguistic variables. They evaluated the lexical features (e.g., frequency,

length, orthographic neighbourhood size) of 1,033 words used in 32 published emotional Stroop studies, finding that overall, the emotional words occurred less frequently in written text, contained more letters, and came from smaller orthographic neighbourhoods than words used as controls. This combination of linguistic characteristics could account for the slowing of colour naming times for emotional words compared to control words. Indeed, when authors controlled for lexical differences among the word categories, speed differences between the emotion words and control word categories disappeared. Furthermore, researchers have argued that attentional capture by emotional stimuli (relative to neutral stimuli) may not be the result of the emotionality of the stimuli per se but rather because the emotional words form a salient category, unlike their random-themed counterparts. Consequently, in the context of completing a cognitive task, participants notice that a particular percentage of the words they encounter belong to a specific category (resulting in longer response times on trials containing those stimuli) whereas other words are seemingly drawn from random categories (McKenna & Sharma, 1995).

An alternative tool for studying attentional bias is the dot-probe task. This task is purported to yield a more direct measure of the influence of emotional words on attention. In this task, two words are briefly presented on a computer screen (one just above the center of the screen and one just below). Participants are instructed to read the top word aloud. On some trials, when the words disappear a dot appears in the same location as one of the words. Participants are instructed to make a button-press response as quickly as they can as soon as they see the dot. Participants' responses to the probes are timed and used to infer where the person's attention was focused. The dot-probe task is predicated on assumptions concerning spatial attention; when we shift our attention to specific locations in space, objects within that location will be more efficiently processed than objects in different locations. As such, if one of the words captures

attention, then probes presented in that location will be responded to more efficiently than probes presented in the other location. To study the influence of emotion on attention using a dot-probe paradigm, one of the presented words is neutral, and the other is an emotional word. It is assumed that if attentional biases exist for certain words in people with mood and anxiety problems, they will respond faster when the dot appears in the same spatial location as the emotional word. Indeed, anxious individuals respond faster to dots that are in the same location as a threatening stimulus, than in the other location. These response time effects have been interpreted as a form of hyper-vigilance for threat (for a review, see Mogg & Bradley, 1998).

Like the emotional Stroop task, the dot-probe task is not immune from controversy. Derryberry and Reed (2002) point out that faster response times for probes appearing at the threat word location may also arise as a result of a difficulty disengaging from threatening material rather than a hyper-vigilance for threat. Furthermore, although at first glance, the dot-probe task seems like a simple detection task, a breakdown of this task's components reveals layers of complexity. First participants are asked to read the top word of each word pair aloud as soon as it appears. Thus attention is allocated preferentially to the topmost display location, and indeed all participants, regardless of clinical diagnosis, show faster dot-detection for top locations. Participants are then asked to shift attention from word reading in one location to dot detection in either the same location or a different location. Thus in terms of attention, the task contains a salient location (the top word), a switch of attention (from word reading to dot detection), as well as the attention disrupting features of the emotional words. It is unknown which aspects of this complex task are underlying the response time effects in depressed and anxious participants compared to healthy controls.

An alternative to the dot probe task is Wolford and Morrison's (1980) digit-parity task. In this task, a fixation cross is presented in the center of a computer display. The fixation cross is then replaced by a centrally presented word flanked by two digits. Participants are instructed to ignore the center word and make a speeded judgement about whether the parity of the two digits match (i.e., both odd, or both even) or mismatch (i.e., one odd and the other even). Recently this task has proven to be a sensitive measure of the attention-disrupting effects of sexually-explicit word stimuli in an unselected population (Aquino & Arnell, 2007). Although to date this task has only been used on unselected individuals it is a good candidate for detecting attentional biases in those suffering from depression.

When considering any type of cognitive task designed to study attentional biases in clinical populations care must be taken to effect a close match between the concerns of the population being examined and the stimuli used within the cognitive task. For example, using a dot probe task, MacLeod, Mathews, & Tata (1986) found that clinically anxious but not clinically depressed participants were faster to detect probes in threatening word locations compared to affectively neutral word locations. This study is commonly cited as evidence for the existence of anxiety-relevant attentional biases and the absence of an equivalent depression-relevant attentional bias. However, it could be argued that the null effects of the depressed group are not surprising given that the words used (i.e., threat-related) did not properly reflect their concerns.

Using a similar study design, Mathews, Ridgeway, and Williamson (1996) found that response times of depressed, but not anxious participants, were influenced by socially-threatening words (e.g., lonely, stupid). They concluded that these results provided evidence for the preferential attention to socially threatening stimuli in depression. Interestingly, the authors

acknowledged that their findings could be interpreted as evidence for the existence of rumination-relevant attentional biases in depression; "if depressed subjects ruminate a great deal about their own personal inadequacy, then they may attend to related words because they match these ruminations, rather than because they are perceived as threatening in the sense of representing a dangerous event" (p.704). It seems then when assessing the match between the words used in cognitive paradigms and depressed participants' concerns, an important concept to consider is rumination. Although these authors and others have speculated about a possible link between attention and rumination, there is a paucity of research applying the experimental paradigms used to study attention to the topic of rumination. Indeed, given the importance of matching the words used in cognitive paradigms to the direct concerns of the clinical populations being studied, the content of participants' rumination and the extent to which this is reflected in the stimuli used to study attention, may be a key factor in finding evidence for attentional biases in depression.

In the past 15 years, persistent, recyclic, negative thinking, in the form of rumination, has attracted increasing theoretical and empirical interest. From a clinical perspective, many depressed patients report experiencing rumination, describing a repetitive reconsideration and intrusive recollection of negative thoughts. Although the experience of depressed mood is understandably unpleasant, depressed individuals who report experiencing repetitive intrusive recollections of negative thoughts may find it difficult to concentrate on everyday tasks. For example, a dysphoric student may report having his concentration derailed during a lecture by thoughts about what is wrong with him and why he is feeling so down. From an empirical perspective, the recognition of rumination as a key cognitive feature of depression has led to an emergence of research highlighting the possible mechanistic role of rumination in the

development, maintenance, and recurrence of depression (Teasdale, 1988; Nolen-Hoeksema, 1991).

Several theorists have argued that depression is maintained through a vicious cycle between depressed mood and negativistic ruminative thinking. According to Teasdale's (1988) differential activation theory, once an individual is initially depressed, an important factor that determines whether their depression remains mild or becomes more severe and persistent is the nature of the negative cognitive processes and constructs that become active and accessible in the depressed state. Depression is maintained when depressed mood leads to negative attributions and self-evaluations, which in turn contribute to more depressed mood, and so on.

Within the response styles theory of depression, Nolen-Hoeksema and colleagues have been influential in advancing our knowledge of ruminative thinking in depression. Here, rumination is defined as "behaviours and thoughts that focus one's attention on one's depressive symptoms and on the implications of these symptoms" (Nolen-Hoeksema, 1991, p. 569). Accordingly, ruminative responses to depression are symptom focused and contemplative.

This repetitive style of negative thinking in response to depressed mood has been associated with a number of deleterious outcomes. Empirically supported research and field studies have shown that ruminative responses to depression prolong and intensify depressed mood (e.g., for review, see Nolen-Hoeksema, 1991). For example, using a prospective longitudinal study design, Just and Alloy (1997) found that initially nondepressed individuals who reported ruminating in response to depressed mood were more likely to experience a major depressive episode over eighteen months than were individuals who reported distracting themselves from their symptoms. Additionally, using a large scale longitudinal community-based study design, Nolen-Hoeksema (2000) found that individuals who were clinically depressed and

had a ruminative style at the initial assessment had relatively more severe and longer lasting depressive symptoms one year later after accounting for initial levels of depressive symptoms. Furthermore, when individuals ruminate in the context of dysphoric mood, they recall more negative memories from the past, interpret their current situation more negatively, and are more pessimistic about their future (Lyubomisky & Nolen-Hoeksema, 1993, 1995).

In a study designed to explore the phenomenology of dysphoric rumination, Lyubomirsky, Tucker, Caldwell, and Berg (1999), found that compared to dysphoric non-ruminators and non-dysphoric ruminators, the ruminative thoughts of dysphoric ruminators tended to be more negative, self-critical, and self-blaming (e.g., thinking "I'm lazy" or "I'm unpopular"). In addition, depressed individuals paid significantly more attention to their ruminative thoughts and they rated them as being more intrusive in comparison to non-clinical samples (Papegeorgiou & Wells, 1999). This finding supports previous assertions that rumination may function to draw one's attention to one's depressive symptoms, activating a network of negative biased thoughts (Fennel & Teasdale, 1984).

Only in the last decade have empirical attempts been made to link information processing disruptions to rumination. Confirmatory evidence has emerged highlighting the association between rumination and excessive elaboration on negative information, as indexed by pupil dilation (Siegle, Steinhauer, Carter & Thase, 2003). Our pupils will constrict and retract to a variety of external stimuli even in an environment with constant lighting. In general, negatively valenced stimuli will lead to a sustained state of dilation (as opposed to an alteration of constriction and dilation). Notably, sustained pupil dilation in depressed individuals was particularly apparent for negative and personally relevant information involving words and sentences.

More recently, Donaldson, Lam, and Mathews (2007) investigated the role of rumination on attention using a cognitive paradigm. Depressed and control participants were randomly assigned to either a rumination or distraction condition. The individuals assigned to the rumination condition were instructed to focus their attention inward using a series of statements aimed at promoting thoughts related to emotion, behaviours and the self. Those assigned to the distraction condition were instructed to focus their attention externally, away from thoughts related to emotion, behaviours and the self. Participants then participated in a dot-probe task. Results revealed that the depressed, but not the control, participants were faster to detect probes in the location of negative words compared to dots in positive, or affectively neutral word locations. Furthermore, trait rumination predicted attentional bias scores (the difference between response times for probes in negative word locations versus neutral word locations). That is, depressed individuals who showed high levels of habitual rumination had higher attentional bias scores, leading study investigators to conclude that depression is associated with an attentional bias for negative information and that this bias is stronger in individuals who ruminate.

Thus, the maladaptive impact of rumination as a *style* of thinking on the course and maintenance of depression is well established in the literature. Furthermore, recent attempts have been made to link ruminative style to the existence of attentional biases in depression. However, much remains unclear regarding the possible influence of rumination *content* on attentional biases within depression. More specifically, given that depressed persons may ruminate about certain concepts but not others, it is important to use stimuli that reflect the idiosyncratic content of each participant's ruminative themes when investigating attentional biases within this population.

Present Investigation

The goal of the present study was to use a cognitive paradigm to demonstrate that depressed individuals who ruminate display attentional biases for stimuli relevant to content of the themes on which they ruminate. The logic behind the current investigation is based on three premises. First, rumination is an important cognitive feature of depression. Second, when ruminating, depressed individuals are focusing on their emotional state (i.e., depressive symptoms and the implication of these symptoms). Third, the stimuli employed for the purposes of detecting attentional biases in depression should reflect the ruminative-content of the particular individual.

Based on these considerations, the present investigation examines the role of rumination-content on the presence of attentional biases in persons diagnosed with Major Depressive Disorder (MDD) using Wolford and Morrison's (1980) digit-parity task.

At a global level, we first examined whether depression-relevant words would disrupt attention and limit participant's ability to perform a simple digit-parity task. We predicted that depression-relevant words will influence parity judgments only in individuals who are clinically depressed. In order to conclude that the depression relevance of the words was responsible for disrupting performance a number of control sets of words matched in word length and frequency to the depression-relevant word category were employed (as per Larsen et al., 2006). The first set of control words consisted of random neutral words. A second set of control words were drawn from a highly salient, but non-emotional, category – musical instruments, in order to control for category saliency (as per McKenna & Sharma, 1995). Since musical instruments form a salient category (as salient, if not more so – than depression-relevant words), if it is category membership, (as opposed to depression relevance) that influences parity judgement times, then

these effects should emerge for both depression-relevant and musical instrument names. If only depression-relevant words have an influence on parity judgement response times, we can rule out that this effect is due to the fact that these words come from a salient category. Since our interest was in depression relevance as opposed to the emotional content of words per se, we chose as a final control set, adjectives that conveyed emotion, but were not relevant to depression (e.g., calm, agreeable, gentle). Thus if attention was disrupted by words that convey emotion (and not just by depression-relevant words as we predicted) then these words should also influence parity judgements. Therefore, all four word categories (depression-relevant words, neutral control words, musical instrument control words and emotional adjective control words) were presented randomly within a block of trials.

Although at a global level we were interested in attentional biases for depression-relevant words, we were primarily interested in the influence of stimuli relevant to participant's specific ruminative content on attention. We speculated that although depression-relevant words might disrupt performance in a digit-parity task to some degree, words relevant to a specific depressed individuals' ruminative-content would disrupt performance considerably more. In order to test this hypothesis a rumination-relevant word category was created for each depressed participant using data from the Rumination-Relevant Rating Scale (RRRS) (this procedure is described in detail later). Thus, for depressed participants depression relevant words were parsed into rumination relevant, and depression relevant words (the latter category involving depression relevent words that were NOT the focus of their ruminative thoughts).

Thus, there were two main hypotheses:

First, depressed individuals would show an attentional bias for depression-relevant words; specifically, we expected an increase in digit-parity response times (RTs) on trials in

which the depression-relevant words are presented between the digits, relative to trials in which words from any of the control word categories are presented. By contrast, digit-parity RTs for the never-depressed individuals would be similar across all word categories (i.e., digit-parity RTs for the depression-relevant words will parallel RTs for all three control word categories).

The second, central prediction was that depressed individuals would show the longest response times for words that specifically matched the content of their rumination (i.e., rumination-relevant words would be associated with even longer parity judgement times than depression relevant words that were outside the focus of that individual's particular ruminations).

Methods

Participants

Participants were recruited from a sample of approximately 1500 University of Waterloo undergraduate psychology students who received course credit for their completion of a mass testing screening session at the beginning of the academic term. Those whose Beck Depression Inventory, second edition (BDI-II) scores were less than 6 at the time of the screening were identified as "likely never depressed controls," and those whose BDI-II scores were greater than 18 were identified as "likely depressed."

Of that sample forty-five participants, identified as belonging to one of the aforementioned potential categories, were recruited to participate in the study for additional course credit. Upon completion of study procedures, all participants completed the Mood Disorders module of the Structured Diagnostic Interview for DSM-IV Axis I Disorders (SCID; First, Spitzer, Gibbon, & Williams, 1997) to confirm diagnostic status. In addition to the SCID interview, participants were screened for additional diagnoses including schizophrenia, panic disorder, specific phobia, generalized anxiety disorder, anorexia nervosa, and bulimia nervosa using procedures developed by Othmer & Othmer (1989).

The depressed group consisted of a total of 6 (5 male, 1 female) University of Waterloo undergraduate students ranging in age from 18 to 24 (M = 20.2 years) who met criteria for current Major Depressive Disorder on the SCID. Participants in the depressed group were required to have a primary diagnosis of major depression and currently be in a depressive episode. Participants were also required to be without current or past organic, psychotic, or manic features, and free from a co-morbid anxiety disorder. The never depressed control group consisted of 30 (8 male, 22 female) University of Waterloo undergraduate students ranging in

age from 16 to 24 (M = 19.2 years). Participants were required to have no current or past history of emotional disorder (including anxiety disorders). Lastly, all study participants had normal or corrected-to-normal vision, were right –handed, and had learned English by the age of eight.

Stimuli and Apparatus

There were four categories of stimulus words: 25 depression-relevant words, 25 neutral control words, 25 musical instrument control words, and 25 emotional adjective control words. The depression-relevant words were selected from multiple studies in which valence norms from both clinical and non-clinical samples were reported (Bradley & Mathews, 1983; Mogg, Bradley, Williams, & Matthews, 1993). Each depression-relevant word was paired with a neutral word, a musical instrument word, and an emotional adjective word matched for length and frequency using the MRC Psycholinguist Database. Thus, each word in the depression-relevant category had a length-and-frequency-matched counterpart in each of the other three control categories. Word sets are shown in Appendix A.

Word stimuli were presented on a computer screen in black against a light grey background. Digits and words were presented in 16-point bold Courier New font and all words were capitalized. The words were 4 to 9 letters long and subtended approximately 1º in height and 2º to 5º in width. The digits were spaced 10.5 cm apart (11.5º) on all trials. Only the digits 2, 3, 5, and 8 were used as parity stimuli. The digits were randomly paired with the constraint that on half of the trials the pair of digits had the same parity.

All participants were presented with two blocks of 100 digit-parity trials each, with 20 practice trials prior to block 1. The practice block used neutral words that were different from the neutral words presented in blocks 1 and 2. The words were chosen randomly by the computer

with the constraint that each word category be presented 5 times every 20 trials. In block 2 the same 100 words were again shown in random order with the same constraints.

Digit-Parity Task

Each parity trial began with the presentation of a black fixation cross in the center of the computer screen for 500ms, followed by a 500ms blank interval. The word and the digits that flanked the word were presented simultaneously. The word and digits remained on the screen until a parity judgement response was made. Participants were told to use their dominant hand to press the 'M' key if the parity of the digits matched (were both odd, or were both even), and to press the 'N' key if the parity of the digits mismatched (one odd and the other even). Participants were asked to respond as quickly as possible while being accurate and to ignore the centrally presented word. The experiment was controlled using E-Prime software (Schneider, Eschman, & Zuccolotto, 2002) running on an IBM-compatible desktop computer with a 17" colour monitor. Displays consisted of two digits flanking a word and were viewed from an unfixed distance of approximately 55 cm.

Questionnaires

Beck Depression Inventory – Second Edition (BDI-II). The BDI-II (Beck, Steer, & Brown, 1996) is a 21-item self-report questionnaire used to measure the severity of current depressive symptomatology, with documented adequate validity and reliability for both clinical and research purposes (Beck, Steer, & Garbin, 1988). In order to complete the questionnaire, participants were asked to rate on a scale of 0 to 3 the degree to which they have experienced various symptoms of depression during the past two weeks (e.g., loss of pleasure, change in sleep patterns). Scores from all of the items were summed for a total score ranging from 0 to 63, with higher scores indicating greater levels of distress.

Response Styles Questionnaire (RSQ). The RSQ was used to measure individual differences in response to sadness or depressed mood by asking participants what they generally do when they feel depressed. Participants were asked to indicate the extent to which they engaged in each activity (e.g., "think about how alone you feel") when depressed on a four-point Likert-type scale ranging from 1 (almost never) to 4 (almost always). According to the scoring method outlined by Nolen-Hoeksema and Morrow (1991), the RSQ has two scales: 21 items on the RSQ comprise the rumination scale (RRS) and 11 items comprise the distraction scale (RDS). Both subscales demonstrate adequate test-retest reliability (Just & Alloy, 1997), convergent validity (Nolen-Hoeksema, Morrow, & Fredrickson, 1993), and construct validity (Keuhner & Weber, 1999).

Beck Anxiety Index (BAI). The BAI (Beck, Epstein, Brown, & Steer, 1988) is a 21-item self-report questionnaire used to measure the severity of a range of physiological and cognitive symptoms of anxiety over the preceding week. Respondents indicate on a four-point Likert-like scale the degree to which each of the 21 symptoms have bothered them in the past week. The scale ranged from 1 (not at all) to 4 (Severely, e.g., "I could barely stand it"). Items include "heart pounding or racing" and "nervous." Furthermore, in terms of item overlap between depression and anxiety, the BAI and BDI appear to have the best discriminant validity (Clark & Watson, 1991).

Penn State Worry Questionnaire (PSWQ). The PSWQ (Meyer, Miller, Metzger, & Borkovec, 1990) is a 16-item self-report questionnaire used to assess worry. Respondents indicated on a five-point Likert-like scale ranging from 1 (not at all typical) to 5 (very typical) the degree to which each of the 16 statements applied to them. Items include "My worries overwhelm me" and "I am always worrying about something." The PSWQ has been shown to

have good internal consistency and test-retest reliability in undergraduates (Meyer, Miller, Metzger & Borkovec, 1990).

Rumination-Relevant Rating Scale (RRRS). The RRRS is a 25-item self-report questionnaire designed by the study author as a gross measure of the amount of time participants spent ruminating about each of the depression-relevant word items found within the digit-parity task (see Appendix B). Participants were asked to rate how often they thought about a list of statements when feeling down, sad, or depressed on a four-point Likert-type scale ranging from 1 (never) to 4 (always). Statements contained each of the 25 depression-relevant words previously shown in the digit-parity task. Items include "How much of a **failure** I am," "How **unhappy** I am," and "How **stupid** I am."

Experimental Procedure

All participants were tested individually. Testing sessions ranged from 90 minutes to 120 minutes depending on the length of the diagnostic interview. Although the experimenter was not blind to the hypotheses of the experiment, the experimenter was blind to the depression status of the participants as each participant completed a SCID-interview only after completing all of the experimental procedures.

At the beginning of the testing session, participants were asked to complete an information consent form. After consent was obtained, participants completed the digit-parity task. Following the digit-parity task, participants completed the BDI-II, BAI, PSWQ, RSQ, and rumination rating scale. Upon completion of the rumination rating scale, each participant completed a SCID-interview to determine their depression status. Finally, participants were verbally debriefed and given an information sheet that described the study and thanked them for their participation.

Design

A rumination-relevant word category was created for each depressed participant using data from the Rumination-Relevant Rating Scale (RRRS), completed at the end of the testing procedure. Any depression-relevant item endorsed as a 4 (indicating "always" thinking about this item when feeling down, sad, depressed) on the RRRS was selected to comprise the rumination-relevant word category for the individual. Thus, for each depressed participant the depression-relevant word category was subdivided into rumination-relevant and non-rumination relevant word categories. Since depression relevant words were parsed into rumination and non-rumination categories, so too were the control words. Recall that each depression-relevant word had a frequency-matched and length-matched counterpart in each of the three control word categories. Thus, if a depressed participant reported ruminating about 10 words (as indicated by a 4 on the RRRS) they would have 10 rumination-relevant and 15 non-rumination depression-relevant words. The control categories would similarly be parsed into 3 sets of 10 words (matched to the rumination words) and 3 sets of 15 words (matched to the non-rumination depression relevant words). In this way, the rumination-relevant and non-rumination depression-relevant words would have three sets of frequency and length matched control words (neutral controls, musical instrument controls, emotional adjective controls. Accordingly, each participant had eight word sets 1) rumination-relevant words (R) 2) control neutral words matched to R words (C1-R) 3) control musical instrument words matched to R words (C2-R) 4) control emotional adjective words matched to R words (C3-R) 5) non-rumination depression-relevant words (NR) 6) control neutral words matched to NR words (C1-NR) 7) control musical instrument words matched to NR words (C2-NR) 8) control emotional adjective words matched to non-rumination relevant words (C3-NR). Note, in the nomenclature above R stands for

Rumination, NR non-rumination, and C stands for control. Six never depressed control participants served as yoked controls for each depressed participant.

Results

Participant Characteristics

Demographic and clinical characteristics for the depressed and never-depressed control participant groups are presented in Table 1.

Table 1. Demographic and clinical characteristics of the two participant groups. Means and (standard deviations) of variables by diagnostic group.

	Diagnostic Group	
Variable	Depressed	Never Depressed
N	6	28
Age	20.2 (1.8)	19.2 (1.9)
BDI-II	25.7 (9.9)	12.6 (7.1)
BAI	35.8 (11.3)	31.5 (5.9)
PSWQ	47.7 (8.5)	41.4 (9.5)
RRS	59.7 (16.7)	48.1 (8.9)
RDS	24.0 (5.2)	22.5 (5.4)

An independent samples t-test revealed no significant difference between the two groups in terms of age, $t(32) = 1.13$, $p = 0.27$.

Participants' scores on the BDI-II, BAI, PSWQ, and RRS, completed after the digit-parity task, are also presented in Table 1. Independent sample t-tests yielded significant differences among the two groups on the BDI-II, $t(34) = 3.96$, $p < .01$. As expected, the depressed participants showed higher scores on the BDI-II than did the control participants, indicating a greater level of depressive symptomatology. No other self-report measures yielded significant results all p's >0.14.

Frequency and word length

One-way ANOVA's were performed to examine whether word length or word frequency differed significantly across word categories (depression-relevant, neutral, musical instruments, and emotional adjectives). Both ANOVAs showed nonsignificant results, p's > 0.18, providing evidence for the equivalence of the word types in terms of word frequency and length.

Digit-Parity Task

Hypotheses 1 and 2

Only digit-parity response times (RTs) for **correct** responses were analyzed. Error rates were low (depressed: 0.06%, and control: 0.05%). An independent samples t-test comparing mean error rates for the depressed participants and the control participants, revealed no significant differences among the two groups, $t(32)=.017$, $p = .99$. Furthermore, a 2x2x4 mixed model analysis of variance (ANOVA) was performed on mean error rates with rumination category (rumination-relevant, non-rumination-relevant) and word (depression-relevant, neutral, music, emotional adjectives) as within-participant variables and group (depressed, non-depressed) as a between-participant variable. The analysis did not reveal any significant results, all p's > .13. Thus any differences in the response times (reported below) were not attributable to speed-accuracy tradeoffs.

In attention disrupting tasks such as the digit-parity task used here, the predicted effects are likely to be carried in the tail of the RT distribution. Hence liberal outlier trimming procedures would likely eliminate any effects. The response times were analyzed in two ways. First for each participant the RTs for each of the eight cells were averaged, and these raw means served as the input data for the analyses of variance and planned comparisons. Second a conservative data trimming procedure was used. Any RT greater than 2500 ms was excluded,

and the averages were recalculated. (To foreshadow the results, both analytical strategies yielded similar effects).

Response Times Untrimmed

Mean digit-parity response times (ms) for each word category as a function of diagnosis are shown in Table 2.

Table 2. Untrimmed digit-parity mean response times (ms) for each word category as a function of diagnosis.

	R	C1-R	C2-R	C3-R	NR	C1-NR	C2-NR	C3-NR
Depressed	865.76 (246.63)	723.67 (221.27)	699.87 (195.31)	754.62 (203.32)	804.76 (265.87)	787.59 (239.13)	731.51 (204.68)	780.69 (205.03)
Never-Depressed	641.79 (139.03)	642.00 (114.08)	644.68 (121.00)	659.34 (112.38)	634.03 (106.30)	640.14 (120.48)	642.28 (104.44)	631.77 (109.97)

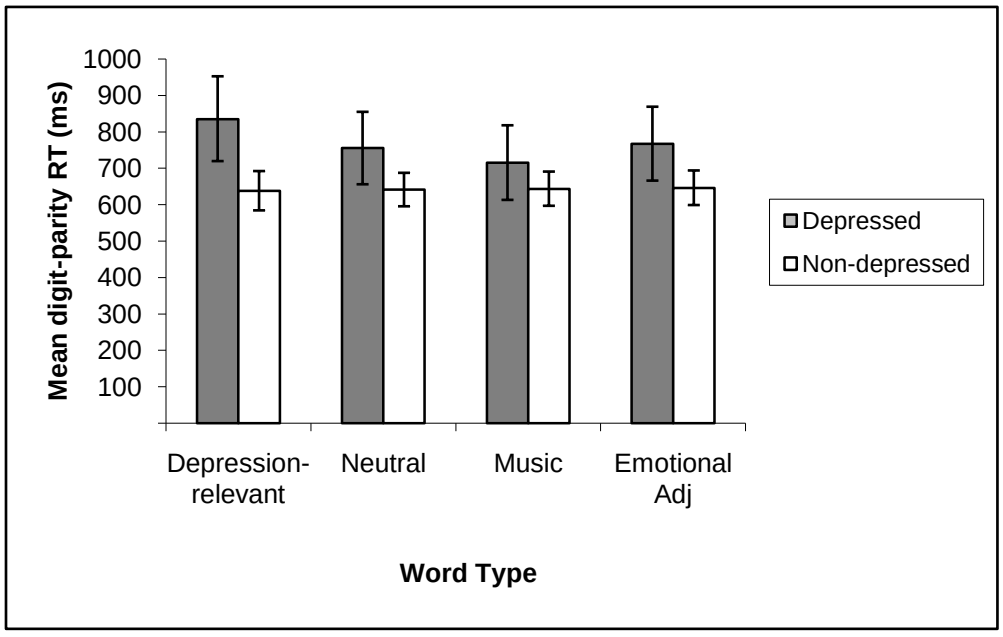
Note. R stands for Rumination, NR for non-rumination, and C stands for control. Standard deviations are shown in brackets.

A 2x2x4 mixed model analysis of variance (ANOVA) was performed on mean response times with rumination category (R, NR) and word category (depression-relevant, neutral, musical instrument, emotional adjective) as within-subjects variables and diagnosis (depressed, non-depressed) as a between-subjects variable. The analysis revealed a main effect of word category, $F(3,96) = 6.28$, $p < .05$, with significantly longer digit-parity RTs for depression-relevant words relative to all other word categories (all p's $<.05$). Pairwise comparisons also revealed significantly longer digit-parity RTs for emotional adjective words than musical instrument words, $p > .05$, but no other significant differences between word categories (all p's $>.05$). Such main effects, however, must be interpreted within the context of higher-order interactions

involving diagnosis. Consistent with our first prediction there was a word category x diagnosis interaction, $F(3,96) = 7.55$, $p < .05$.

As can be seen in Figure 1A, for the non-depressed individuals word category had minimal influences on RTs. By contrast, for the depressed individuals the depression relevant words delayed parity judgements relative to the other control conditions. As can be seen by the confidence intervals around the means, when comparing the depressed and non-depressed individuals, the confidence intervals are overlapping in all the control conditions, but are non-overlapping for the depression relevant words.

Figure 1A. Untrimmed mean digit-parity reaction times for each word type as a function of diagnostic group.



Note. Error bars represent confidence intervals for each mean.

There was an unexpected rumination category x word category interaction, $F(3,96) = 2.86$, $p < .05$. One notes however that the effect size of this interaction was much smaller than the predicted interaction between diagnosis and word category, and that this interaction did not emerge for the trimmed data analysis (described later).

Consistent with our second hypothesis, the planned comparison between the rumination and non-rumination words within the depression relevant category was significant for the depressed individuals $t(5)= 2.81$, $p<.05$, with longer digit-parity RTs for rumination-relevant words relative to non-rumination relevant words. The same contrast was not significant for the non-depressed individuals $t(27)= .485$, $p= 0.63$.

Response Times after Trimming

To ensure that the predicted effects noted above were not merely due to a few extreme RTs we reanalyzed the data using a conventional trimming strategy, excluding response times greater than 2500 ms. We once again conducted a rumination category (rumination-relevant, non-rumination-relevant) by word category (depression-relevant, neutral, emotion-relevant, music) by diagnosis (depressed, non-depressed) analysis of variance. Mean digit-parity response times (ms) for each word category as a function of diagnosis are shown in Table 3. The analysis

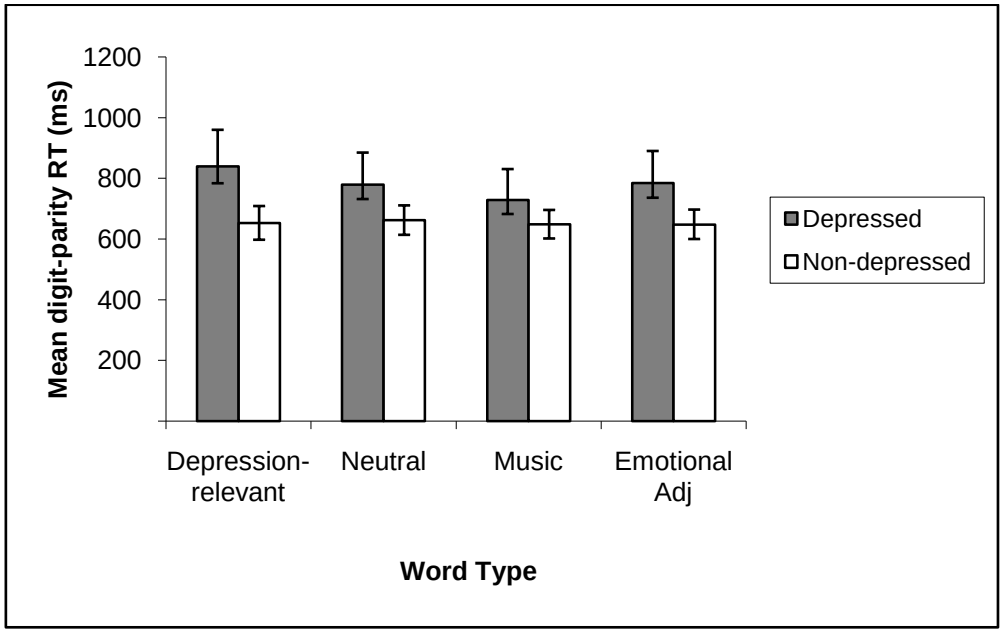
Table 3. T*rimmed digit-parity mean response times (ms) for each word category as a function of diagnosis.*

	R	C1-R	C2-R	C3-R	NR	C1-NR	C2-NR	C3-NR
Depressed	865.76 (246.63)	753.25 (175.06)	726.73 (175.44)	754.62 (203.32)	813.03 (255.33)	805.51 (218.36)	814.74 (204.68)	731.51 (191.19)
Never-Depressed	641.79 (119.10)	642.00 (107.61)	644.68 (112.91)	659.34 (112.38)	634.03 (113.56)	640.14 (109.60)	642.28 (112.17)	631.77 (106.28)

Note. R stands for Rumination, NR for non-rumination, and C stands for control. Standard deviations are shown in brackets.

revealed a main effect of word category $F(3, 93) = 3.536$, $p < .05$, with significantly longer digit-parity RTs for the depression-relevant words relative to the musical instrument words, $p < .05$. All other pairwise comparisons were non-significant, p's $< .06$. The analysis also revealed the predicted word category by diagnosis interaction $F(3, 93) = 3.499$, $p < 05$. No other interactions or main effects were significant. As can be seen by the graph in panel B of Figure 1, which shows the diagnosis by word category interaction, for the non-depressed individuals, word category had minimal influences on RTs, whereas for the depressed individuals the depression relevant words delayed parity judgements relative to the other control conditions. As can be seen by the confidence intervals around the means, when comparing the depressed and non-depressed individuals, the confidence intervals are overlapping in all the control conditions, but are non-overlapping for the depression relevant words.

Figure 1B. Trimmed mean digit-parity reaction times for each word as a function of diagnostic group.



Note. Error bars represent confidence intervals for each mean.

As predicted, the planned comparison between the rumination and non-rumination words within the depression relevant category was significant for the depressed individuals $t(5)= 2.04$, $p<.05$ one tailed. The same contrast was not significant for the non-depressed individuals $t(27) = .783$, $p= .22$ one-tailed.

In summary, the analyses of the untrimmed and trimmed RTs both supported our a priori predictions: only the depressed participants were preferentially influenced by depression relevant words, and among these depressed participants words that matched the specifics of what depressed participants ruminated about were more disruptive than words that were only generally related to depression.

Discussion

The present study examined the attention disrupting effects of depression-relevant words on digit-parity response times in clinically depressed and never-depressed individuals. Using a digit-parity task, participants were asked to make a speeded judgement about the parity of two digits flanking a to-be-ignored, centrally presented word. Word categories included depression-relevant, neutral, musical instrument, and emotional adjective words. The results indicated that, as predicted, depressed individuals demonstrated significantly longer digit-parity response times on trials in which a depression-relevant word was presented between the digits relative to all other word categories. Furthermore, when the depression-relevant word group was parsed into rumination and non-rumination relevant word groups results indicated that, as predicted, depressed individuals demonstrated longer digit-parity response times on trials in which a rumination-relevant word was presented between the digits relative to non-rumination relevant words.

The present results support the findings of previous studies that have documented the operation of attentional biases in clinically depressed individuals (e.g., Gotlib & McCann, 1984; Gotlib & Cane, 1987; Gotlib et al., 2004; Siegle et al., 2003; Donaldson et al., 2007). However, as previously noted, the depression and attention literature has been plagued by inconsistent results. Many researchers have previously argued that attentional effects often depend on the match between presented stimuli and the emotional concerns of the population being examined (Mathews & McLeod, 1994; Mathew, Ridgeway, and Williamson, 1996). Indeed, inconsistent findings within the depression and attention literature can be attributed to a poor matching between the stimuli employed and the concerns of the depressed individuals being examined. The question remains then how to best reflect the concerns of depressed populations. Extending

the depression and attentional bias literature, results from the present investigation suggest that the answer resides, at least in part, within the ruminative content of the depressed individual. More specifically, results emphasize the need to consider individual differences in ruminative content and stress the importance of tailoring experimental designs to best reflect the idiosyncratic nature of depressive-rumination.

Previous attempts have been made to capture the idiosyncratic nature of depressive-rumination. Siegle and colleagues (2003) asked depressed and never depressed participants to generate personally-relevant stimuli that best represented what they thought about when feeling depressed, to be used in the experimental task. Results indicated that depressed individuals displayed elevated and sustained pupil dilation responses to such stimuli on an emotional processing task. Not only were these pupil dilation responses larger for depressed versus non-depressed individuals doing the same task , but pupil dilation among the depressed individuals was particularly apparent in response to personally relevant information versus other negative, but not personally relevant information. Although these researchers took care to match the stimuli to the particular concerns of the individual, no attempts were made to control for lexical features of participant-generated word stimuli. Specifically, it is unknown whether sustained pupil dilation to personally relevant information is an artifact of greater attention allocation or a result of differing linguistic characteristics between word groups. After all, pupil dilation is induced by a myriad of cognitive operations (e.g., problem solving, task difficulty etc [see Andreassi, 2000]) To correct for this limitation, the present investigation employed an experimental design which not only was able to match on an individual level, the words used to disrupt attention on a parity judgement task with the content of a given person's rumination, but

also to ensure that the obtained effects were due to the semantic content of the words and not due to the linguistic features of these words such as word length, or frequency.

Why does rumination content disrupt attention in cognitive tasks? One possibility is that content that has been recently processed preferentially disrupts attention in cognitive tasks relative to information that has not been recently processed. For example, Seigle, Germar, Truchon, Guirguis, and Horowitz (1995) found that the level of colour-naming interference shown by depressed patients increased when the colour carriers were negative words that had been processed immediately prior to carrying out the test trials. More specifically, depressed participants showed slower colour-naming latencies for self-descriptive negative words primed by self-descriptive negative phrases than when these same words were preceded by the processing of positive adjectives. It is possible that our findings as well as the confirmatory results of other dot-probe and Stroop experiments may arise because the negative material used as experimental stimuli has been primed due to prior processing of similar material during depressive rumination. Given the frequency of rumination among depressed participants it is likely that certain words (i.e., the content of a given participants rumination) had been actively processed shortly before participating in the digit parity task. This would explain why in the present study, depressed participants exhibited the longest digit-parity RTs when rumination-relevant words appeared between the digits. This pattern of findings suggest that negative rumination-relevant information may be more salient within the cognitive systems of depressed individuals than information that is negative but not rumination-relevant.

Before considering the broader clinical implications of the current findings, a number of factors should be considered. The depressed participants in the present study were diagnosed on the basis of a clinical interview with current unipolar major depressive disorder according to

DSM-IV diagnostic criteria. Experimental rigour prompted us to seek a relatively "pure" sample of depressed participants free from any comorbid diagnoses. In addition, they were recruited from a sample of University undergraduates. Take together, it remains possible that our finding of a rumination-relevant attentional bias may not generalize to more severely depressed 'real-world' clinical samples which typically consist of high levels of comorbidity between symptoms of depression and most commonly symptoms of anxiety (Mineka, Watson, & Clark, 1998). Previously, it has been suggested that biases sometimes detected in depression are a function of elevated anxiety levels frequently seen in depressed individuals (Mineka, Rafaeli, & Yovel, 2003). The choice of restricting our depressed participant population to only those individuals free of comorbid diagnoses while perhaps curtails the generalizability of our findings, nevertheless allows us to rule out an anxiety comorbidity explanation for our results.

It is possible that the addition of a psychopathological control group would have allowed for a stronger case to be made that interference for rumination-relevant words is specific to depression and not just a function of psychopathology in general. This drawback is somewhat off-set by our prediction for a differential pattern of interference within the depression group rather than between depressed versus non-depressed groups. That is, our most important finding was that **within the depressed group** ruminative content was more disruptive than depressive, but non-ruminative content.

This study was designed to rectify shortcomings in extant studies researching attentional biases and depression. In providing this link between rumination and attentional biases, the results suggest that rumination may be a vulnerability factor in depression. Rumination may render persons susceptible to depression in part because environmental stimuli relevant to the content of a given depressed individuals negative ruminative thoughts will receive priority in

attentional processing. This prioritization of environmental triggers related to the content of their ruminative thoughts would serve to reinforce these ruminative thoughts and lead their depressed mood to become more severe over time. Eventually, that depressed mood may evolve into a major depressive episode. Furthermore, results suggest that the ruminative thoughts of depressed individuals may be a good place to start when attempting to intervene and prevent relapse.

This study has a number of potentially important clinical implications. The observation that depressed individuals show attentional biases for stimuli that are congruent with the content of their self-reported depressive rumination suggests that treatment interventions should specifically focus on helping depressed individuals to disengage from ruminative processes. For that reason, the results from the present investigation have clear relevance for the use of mindfulness-based cognitive behavioural therapy (MBCT).

Grounded in Teasdale's (1983) differential activation hypothesis and the interacting cognitive subsystems (ICS) framework, the theoretical background of MBCT argues that individuals who have experienced a depressive episode acquire strong associations between depressed mood and patterns of negative, self-devaluative, hopeless thinking (Teasdale, Segal, & Williams, 1995). The resulting pattern of thinking leaves depressed individuals vulnerable to future depressive episodes because even a mild increase in sad mood can reactivate patterns of thinking reminiscent of past depressive episodes. Thus, these reactivated patterns of thinking can act to maintain and intensify the sad mood state through escalating and self-perpetuating cycles of ruminative cognitive-affective processing (Teasdale, 1988).

The above account suggests that risk of relapse and depression recurrence will be reduced if depressed individuals can respond to future incidents of sad mood in ways that allow them to disengage from ruminative depressive processing. Accordingly, the purpose of MBCT is to

interrupt this ruminative cycle and teach depressed individuals to become more aware of their thoughts and feelings and respond to them in a "wider, decentered perspective as mental events rather than as aspects of the self or as necessarily accurate reflections of reality" (Teasdale, Segal, Williams, Ridgeway, Soulsby, Lau, 2000). It is assumed that by cultivating a more detached view of thoughts MBCT will provide depressed individuals the skills necessary to prevent the escalation of negative thinking patterns at times of potential relapse. Preliminary evidence of the effectiveness of MBCT in the prevention of relapse in major depression show potential therapeutic promise. For example, Teasdale and colleagues (2000) found that for depressed patients with recurrent depression who had experienced three or more previous episodes, MBCT reduced relapse by almost 50% over the follow up period.

In conclusion, these preliminary data indicate that contrary to what has long been assumed, attentional biases do operate in depression. Furthermore, these biases were shown to be related to rumination-relevant information. Future research that employs a similar methodology to the present study and uses formerly depressed participants will help to elucidate the nature of attentional biases in depression and advance our understanding of the possible role of rumination in maintaining these cognitive biases.

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Appendices

Appendix A – Word Lists

Depression-relevant	Neutral	Musical Instrument	Emotional Adjective
ALONE	TABLE	PIANO	SOUND
ASHAMED	ANGULAR	TRUMPET	EARNEST
AWFUL	FLEET	BUGLE	LOYAL
BORING	BEACON	VIOLIN	POLITE
DEPRESSED	DISCOURSE	ACCORDION	AGREEABLE
EMPTY	CHAIR	FLUTE	QUICK
FAILURE	DEVELOP	TIMPANI	OBVIOUS
GUILTY	ALLIED	CORNET	ABSENT
HELPLESS	HERITAGE	TRIANGLE	RATIONAL
HOPELESS	ELIGIBLE	MANDOLIN	ANALYTIC
HURT	CORE	OBOE	CALM
ISOLATED	SEQUENCE	TROMBONE	ABSTRACT
LONELY	WEEKLY	BONGOS	GENTLE
LOST	READ	TUBA	LIVE
PATHETIC	PHONEMIC	CLARINET	TOLERANT
REPULSIVE	REDUNDANT	XYLOPHONE	ATTENTIVE
STUPID	SUBTLE	GUITAR	CASUAL
UGLY	URGE	HARP	NEAT
UNHAPPY	UTTERLY	PICCOLO	ETHICAL
UNPOPULAR	DUPLICATE	HARMONICA	COURTEOUS
USELESS	CABINET	COWBELL	ORDERLY
WEAK	FOLK	DRUM	CURT
WORTHLESS	WATERSHED	SAXOPHONE	EXPECTANT
RESENTFUL	REPAYMENT	CASTANETS	RIGHTEOUS
CONFUSED	CREATION	RECORDER	VALUABLE

Appendix B

Rumination-Relevant Rating Scale

People think about many different things when they feel depressed. Please read each item below and indicate whether you ***never, sometimes, often, or always*** find yourself thinking about each one when you feel down, sad, or depressed.

	1 never	2 sometimes	3 often	4 always
When feeling sad I think about….				
How much of a **failure** I am	1	2	3	4
How **hopeless** I am	1	2	3	4
How **unhappy** I am	1	2	3	4
How **pathetic** I am	1	2	3	4
How **worthless** I am	1	2	3	4
How **repulsive** I am	1	2	3	4
How **stupid** I am	1	2	3	4
How **awful** I am	1	2	3	4
How **alone** I am	1	2	3	4
How **empty** I am	1	2	3	4
How **useless** I am	1	2	3	4
How **lost** I am	1	2	3	4
How **ashamed** I am	1	2	3	4
How **lonely** I am	1	2	3	4
How **ugly** I am	1	2	3	4

How **weak** I am	1	2	3	4
How **guilty** I am	1	2	3	4
How **unpopular** I am	1	2	3	4
How **boring** I am	1	2	3	4
How **depressed** I am	1	2	3	4
How **resentful** I am	1	2	3	4
How **helpless** I am	1	2	3	4
How **hurt** I am	1	2	3	4
How **confused** I am	1	2	3	4
How **isolated** I am	1	2	3	4