FOXWORTH, TAMARA E., Ph.D. Rumination and Inhibitory Difficulties: Exploring the Role of State Rumination with Emotionally Self-Relevant Words. (2014) Directed by Dr. Kari M. Eddington. 119 pp.

The aim of this project was to examine the roles of working memory capacity, depressive symptoms, and rumination (state and trait) in inhibitory difficulties with self-relevant emotional words following a rumination/distraction manipulation using the negative affective priming cognitive task. It was hypothesized that brooding would predict inhibitory difficulties with negative rather than positive self-relevant words in a non-clinical undergraduate sample (N = 148). Additionally, it was proposed that state rumination would play a mediating role in the relationship between brooding and inhibitory difficulties with emotional words, a relationship that would be further moderated by working memory capacity. Though brooding marginally predicted negative bias scores using multiple regression, this valence-specific finding was not confirmed with multi-level statistical analysis. Results failed to support the proposed moderated meditational model, a finding that may be impacted by restricted range of dysphoric affect in the sample. However, results from linear regression indicated that brooding predicted state rumination regardless of condition.

Keywords: rumination, brooding, inhibition, working memory, negative affective priming

RUMINATION AND INHIBITORY DIFFICULTIES: EXPLORING THE ROLE OF STATE RUMINATION WITH EMOTIONALLY SELF-RELEVANT WORDS

by

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A Dissertation Submitted to
the Faculty of The Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Greensboro
2014

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ACKNOWLEDGMENTS

Acknowledgements to Beatrice Kuhlmann, Ph.D. for programmatic assistance; Robert Henson, Ph.D. for statistical consultation; committee chair and advisor Kari Eddington, Ph.D., and dissertation committee members Michael Kane, Ph.D., Rosemery Nelson-Gray, Ph.D., and Stuart Marcovitch, Ph.D. for their theoretical guidance and consultation on this project's design, implementation, and interpretation of results.

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

CHAPTER I

INTRODUCTION

The past decade has seen an explosion of research examining cognitive and neurobiological factors associated with rumination and its relationship with depression. Rumination, which is one of several forms of repetitive thought, is an intriguing phenomenon, as everyone reflects on their mood, reasons why they feel a certain way, and possible consequences for their actions. However, depressed individuals tend to hold extremely negative views about themselves, and have a tendency to become stuck in a self-defeating cycle of self-blame, guilt and hopeless thoughts (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Responding to depressed mood with self-focused ruminative thinking is thought to exacerbate a recursive cycle of dysphoric affect and negative cognitions and results in amplified negative affect and deficient problem-solving abilities (e.g., Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008).

Researchers have made considerable strides within the past few years in identifying potential cognitive processes that might underlie this maladaptive style of responding to negative affect. It has been proposed that individuals with trait-like *depressive* rumination tendencies exhibit deficits in working memory processes, namely with the processing, manipulation, and removal of irrelevant negative information in memory (e.g., Koster, De Lissynder, Goeleven, Franck, & Crombez, 2005; Joormann, 2010; Joormann & Gotlib, 2010; Joormann & Siemer, 2011) . However, there is a

paucity of research examining the role that depressive rumination *in the moment* plays on working memory processes. In fact, state-based depressive rumination may further impede one's ability to inhibit the processing of irrelevant or distracting negative information, as working memory is limited in capacity. Within this paper, I will briefly review the operationalization of depressive rumination and factors that contribute to its development, provide a brief overview of relevant processes within working memory, discuss the theoretical models exploring the relationship between rumination with inhibitory difficulties, and review the relevant research examining inhibitory difficulties associated with trait and state depressive rumination. I will then present the results from my current project that further examines the role of state depressive rumination in inhibitory difficulties with self-relevant emotional information.

Rumination Definition

Although rumination has been studied extensively and there is strong support for its relationship to depression, as a construct it has been loosely defined and measured (for a review see Smith & Alloy, 2009). For the purposes of this paper, rumination is defined in accordance with Nolen-Hoeksema's depressive rumination construct: a trait-like response style including repetitively thinking about the symptoms, causes and consequences of one's depressed mood (Nolen-Hoeksema, 1991, 2000, 2004). Nolen-Hoeksema's (1991) depressive rumination construct is derived from Responses Styles Theory (RST) and has been commonly used in the literature examining the relationship between rumination and depression. This conceptualization of rumination builds upon

mood congruent processing, where depressed mood can lead to greater recall of mood congruent information in memory (Bower, 1981; Teasdale, 1983).

Though the Response Styles Questionnaire (RSQ; Nolen-Hoeksema & Morrow, 1991) has been routinely used to measure depressive rumination, the RSQ has received criticism for its overlap with depression symptom scales (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Therefore, it is difficult to ascertain whether past research findings using this scale may be attributable to the depressive rumination construct or to depressive symptoms. Recent research has provided further insight into the construct of depressive rumination, clarifying subtypes of responding that are associated with both maladaptive and adaptive outcomes. The shortened Ruminative Responses Scale (RRS; Treynor et al., 2003) consists of two distinct subscales of *brooding* and *reflective pondering*. While brooding involves focusing on dysphoric mood and associated symptoms, reflective pondering (sometimes referred to as reflection) is "an attempt to understand oneself from an open and accepting perspective" (Jones, Papadakis, Hogan, & Strauman, 2009, p. 258).

Brooding subscale items include content such as: "What am I doing to deserve this, why do I have problems other people don't have, and why can't I handle things better?" (Treynor et al., 2003, p. 248). These items reflect attention towards negative self-evaluation, which is in contrast with reflective pondering where the focus is on analytical processing of situations, emotions, and thoughts to understand reasons for one's mood. While brooding tends to be strongly associated with negative consequences and increased risk for depression, reflective pondering does not (Burwell & Shirk, 2007;

Jones et al., 2009; Treynor et al., 2003; Watkins, 2004a, 2008). This indicates that components of depressive rumination may indeed be adaptive, and that focusing on negative mood and negative self-evaluation may be contributing factors that trigger and maintain a depressive ruminative cycle that is maladaptive.

Contributing Factors to Rumination: Mood, Thought Content, and Self-relevance

Researchers have proposed that mood state (Joormann, Levens, & Gotlib, 2011; Lyubomirsky & Nolen-Hoeksema, 1993, 1995; Nolen-Hoeksema, Morrow, & Frederickson, 1993), valence (Watkins, 2008) and self-relevance (Joormann & Gotlib, 2010; Thomsen, 2006; Watkins, 2008) of thought content are factors that may play contributing roles in ruminative thought. In fact, many studies have induced state rumination in clinically depressed or dysphoric participants (through mood manipulation and/or self-reported depressive symptoms), and include valenced stimuli in their research designs (e.g., Watkins & Brown, 2002; Whitmer & Gotlib, 2012). Within these paradigms, inhibition is assessed following a rumination/distraction manipulation whereby participants engage in either ruminative self-focused processing or focus attention on "neutral" information (e.g., shape of objects, geographical location). Though most studies incorporated mood and valenced information in their designs, few studies have assessed all three of the aforementioned factors (mood, valence, self-relevance) in their research paradigms (Joormann, 2006).

Mood State

Deleterious effects of state rumination on cognitive abilities are reliably demonstrated when individuals are in a sad/dysphoric mood prior to a rumination

induction in comparison to a distraction condition (Lavender & Watkins, 2004; Lyubomirsky & Nolen-Hoeksema, 1995; Morrow & Nolen-Hoeksema, 1990; Watkins, Teasdale, & Williams, 2003). Negative mood has been associated with a narrowed attention for negative information and enhanced accessibility of negative material in memory (Blaney, 1986; Mathews & MacLeod, 2005; Rusting, 1998). However, at least in non-depressed individuals, negative affect is typically transient and individuals can make efforts to regulate and improve their mood (Erber & Erber, 1994; Parrott & Sabini, 1990; Rusting & DeHart, 2000). Depressive ruminators tend to experience difficulties in these emotion regulation abilities; in response to negative mood, depressive rumination not only brings attention to one's negative feelings, but has been shown to sustain and exacerbate negative affect despite unconstructive consequences with cognitive and social functioning (see Nolen-Hoeksema et al., 2008 for a review).

Thought Valence

In addition to dysphoric mood, the valence (emotionality) of one's thought content also affects depressive ruminative processing. Mor and Winquist (2002) suggested that processing information that was negative and self-focused was associated with enhanced negative affect, while processing information that was positive and self-focused was associated with amelioration of negative mood. In addition, researchers have also proposed that there has been a distinction between repetitive thoughts that are positive and those that are negative (Gohm, Isbell, & Wyer, 1996; Trapnell & Campbell, 1999). In a review of repetitive thought, Watkins (2008) identified the importance of valence in the content of cognition. If thought valence was negative, repetitive thought

was associated with psychopathology, physical problems (e.g., insomnia), and poorer health (Watkins, 2008).

Depressive rumination is a negativistic cycle that maintains and exacerbates negative mood. Though depressive rumination consists of negative content, designs that examined cognitive control deficits using valenced material found deficits associated with both positive and negative information (Joormann, 2006; Joormann & Gotlib, 2008, 2010; Joormann et al., 2011). However, most researchers used emotional stimuli based on normative ratings and not identified as emotional to the participants. Using data with normative ratings is a common strategy, as it provides easy access to stimuli data (e.g., emotionality means) that is representative of a general population distribution (including clinical and non-clinical). However, if stimuli are not perceived as negative, positive, or neutral to the participants, this would serve as a confounding factor that could contribute to null results or results that are misleading (i.e., attributable to a factor other than valence).

Self-relevance

Additionally, since depressive ruminative responding is self-focused, stimuli identified as self-relevant would best capture the content of ruminative processing and better address ecological validity. In fact, some studies of rumination have incorporated self-referential encoding into their research designs whereby participants process the stimuli on a personal level by either asking whether stimuli are self-descriptive (e.g., Joormann, 2006) or encoding stimuli in a self-relevant manner (e.g., Daches, Mor, Winquist, & Gilboa-Schechtman, 2010). For example, Joormann (2006) had participants

indicate whether emotional word stimuli were self-descriptive (yes/no). Additionally, Daches et al. (2010) examined the association between attentional control for self-relevant information (neutral words that were self-referentially encoded through generation of autobiographical memories) and brooding and reflection in depressed undergraduates. Researchers assessed inhibitory difficulties using a modified Garner task with words that were self-referentially encoded and those that were not. Participants were required to ignore the self-referential nature of words and process only the task relevant (categorize time or family). Findings showed that while brooding was significantly associated with inhibitory difficulties, reflective pondering was significantly negatively associated with inhibition (Daches et al., 2010). Memory valence had no effect on the results. Thus, brooders were unable to inhibit self-relevant information in the absence of emotionality. This indicates that self-referential processing may contribute to inhibitory difficulties above and beyond thought valence.

Researchers have also suggested that there are different types of self-processing: concrete processing that focuses on the experiential nature of one's mood/symptoms and analytical processing that focuses on the reasons why and the consequences of feeling a certain way (Watkins, 2004a, 2004b, 2008; Watkins & Teasdale, 2001, 2004). This distinction in processing appears conceptually similar to the aforementioned differences with brooding and reflection. However, brooding not only includes analytical processing, but also involves specifically focusing on negative self-evaluations. Williams and Moulds (2010) found that analytical processing of intrusive memories in a dysphoric sample was associated with greater ratings of distress and negativity in comparison to

distractive processing. In addition, analytical processing of self-referential memories in ruminators was associated with enhanced dysphoric mood, which could make the inhibition of this information much more difficult.

The self-referential encoding effect is a robust phenomenon whereby self-relevant information is learned and recalled from memory more easily (Symons & Johnson, 1997). Thus, self-focus may enhance the damaging effects of negative affect on cognition (Ingram, 1990; Ingram & Smith, 1984; Pyszczynski & Greenberg, 1987) and vice versa (Mor & Winquist, 2002). In addition, research has shown that the emotional processing of negative information (words) is intensified and prolonged in ruminators (Siegle, Carter, & Thase, 2006; Siegle, Steinhauer, Thase, Stenger, & Carter, 2002). Thus, repeated retrieval and focus on mood and negative cognitions that are self-relevant in ruminators may enhance the accessibility and salience of these types of thoughts and may have deleterious effects on one's ability to inhibit processing of negative information.

Mood state may narrow attention onto emotional information, an effect that may be most pronounced under conditions of self-relevance. Depressive rumination is often triggered by negative affect and involves repetitive self-focused processing of negative information. In fact, the combination of all three of the aforementioned factors (valence, mood, and self-relevance) and a depressive ruminative processing style may negatively affect one's cognitive functioning and result in increased inhibitory difficulties with emotional information. As stated earlier, only one study incorporated all three factors into the research design and cognitive task (Joormann, 2006). In addition, although

researchers have readily documented inhibitory difficulties with depressive rumination (e.g., Joormann & Gotlib, 2010; Watkins & Brown, 2002), they used a variety of cognitive tasks that examine different cognitive processes within executive control.

Working Memory and Rumination

As mentioned earlier, depressive rumination has been associated with deficits in cognitive control (e.g., Joormann & Gotlib, 2010; Koster et al., 2005). For example, Linville (1996) proposed that rumination may be a consequence of inhibitory failures in attention. Throughout the literature, cognitive control is often used as an "umbrella" term that is broadly defined and includes multiple processes involved in working memory. Working memory is a system of processes involved in the "temporary maintenance and manipulation of memory" that is an important component of cognitive control (Baddeley, Eysenck, & Anderson, 2009, p. 9). Working memory is often conceptualized as a workstation whereby cognitive processes are coordinated by the central executive to facilitate efficient processing of relevant information (Baddeley et al., 2009). Working memory as a system encompasses the coordination of many processes including the inhibition of irrelevant information to maintain attention on a task, the ability to switch attention to a different task and coordinate performance during multiple tasks, and the ability to manipulate information (Hester & Garavan, 2005). Rumination is often conceptualized as difficulty inhibiting the intrusion of negative self-focused thoughts, removing these thoughts once they have entered working memory, and experiencing cognitive inflexibility in switching attention to a different task (Joormann, 2010; Smith & Alloy, 2009).

Rumination and Cognitive Control: Theoretical Models

Researchers have proposed theoretical models to further clarify the relationship between depressive rumination and the aforementioned inhibitory difficulties. Specifically, three models have evoked the notion of cognitive control in their explanations of maladaptive rumination. Koster, De Lissynder, Derakshan, and De Raedt (2011) proposed an impaired disengagement model that conceptualized rumination as a "self-referential thinking" (p. 139) style that includes negative content. According to Koster et al. (2011), rumination is often adaptive, as people try to understand themselves and the world. However, this process becomes maladaptive when individuals are unable to exert attentional control and disengage their attention away from these thoughts. In this model, attentional control generally relates to the ability to inhibit irrelevant information. Thus, rumination represents a continuum of functioning, becoming maladaptive when individuals are unable to inhibit attention to negative thoughts. Many researchers documented inhibitory difficulties with brooding rather than reflective pondering (Daches et al., 2010; Koster, De Lissnyder, & Raedt, 2013; Vanderhasselt, Kühn, & Raedt, 2011). This implies a unique association between attentional control and brooding that may result in maladaptive outcomes.

Watkins provided an extensive review of repetitive thought processes and proposed a "level of construal dysregulation hypothesis" to explain depressive rumination (Watkins, 2008, p. 194). Watkins (2008) proposed that depressive rumination is a maladaptive form of self-focused attention that occurs as a result of an inability to adapt the level of construal in the face of difficulties (e.g., novel tasks, stress). Additionally,

Watkins proposed that factors such as content, cognitive control (inhibitory difficulties), motivation and situational context contribute to depressive ruminative processing as well. At the simplest level, depressive ruminators may be prone to focusing on abstract (reasons for feeling sad, the meaning of negative event) rather than concrete (e.g., how event happened) levels of construal in response to negative mood. In fact, Markman and Miller (2006) found that in the face of a negative event, severe depressive symptoms were associated with abstract construals (e.g., making self-characteristics) while mild depressive symptoms were associated with specific informational processing. Additionally, motivational factors may further promote analytical processing; depressed and depressive ruminators tend to believe that ruminative processing will be helpful (e.g., Lyubomirsky & Nolen-Hoeksema, 1993; Papageorgiou & Wells, 2001; Watkins & Baracaia, 2001), though it is associated with negative consequences.

Lastly, Joormann (2010) implicated the role of inhibitory difficulties in her model of rumination, emotion regulation and depression. Joormann proposed that depressed individuals show inhibitory deficits characterized by enhanced accessibility of task irrelevant negative information in working memory and the deficient removal of this information. Both of these inhibitory difficulties are proposed to result in increased rumination and decreased ability to use reappraisal (a coping skill where mood-incongruent information is accessed to repair mood). As a result, individuals continue to process negative information within working memory, strengthening the likelihood this information will be recalled at a later time and maintaining negative affect. Research has

documented these difficulties within working memory updating paradigms that will be discussed later.

In summary, researchers suggest that difficulties inhibiting the processing of negative and/or irrelevant information in working memory contribute to maladaptive ruminative processing. Watkins (2009) suggests that maladaptive self-focused attention may be due to an interaction of a multitude of factors including cognitive (difficulty inhibiting information), motivational, and environmental that result in abstract rather than concrete processing of information. Joormann (2010) and Koster et al. (2011) both implicate the deleterious effects of inhibitory difficulties in emotion regulation, namely the inability to use an adaptive coping strategy in the face of dysphoric mood. These theories integrate a variety of factors that may contribute to depressive rumination; however, the impact of rumination in the moment has not been readily explored as most research has examined the relationship between a trait based style of responding and inhibitory processes.

Research Findings: Rumination and Inhibition

Within the past decade, research identifying underlying cognitive processes associated with depressive rumination has been growing. However, researchers have used variable paradigms to assess cognitive processes within working memory (namely inhibition). In addition, sample characteristics have differed (depressed, healthy ruminators), making results difficult to generalize. Depressive rumination is proposed to involve inhibitory difficulties in working memory (deficits associated with the entry, removal and manipulation of valenced information) that contribute to impaired

disengagement from negative information once that information has entered memory (e.g., Joormann, 2010; Joormann & Gotlib, 2010; Joormann & Siemer, 2011). However, researchers have measured "inhibitory difficulties" quite broadly, and only recently have begun to use tasks that can differentiate difficulties with the entry, removal and manipulation of information in working memory.

Rumination and Working Memory Updating

As stated earlier, working memory is a complex system of processes that underlies one's ability to temporarily maintain and manipulate information in memory (Baddeley et al., 2009). Although working memory includes the coordination of multiple processes to engage in activities ranging from carrying on a conversation to performing task-oriented duties at work, it is limited in capacity (Baddeley et al., 2009). Therefore, for each individual, there is a limit to the scope of information that can be held and manipulated within working memory at one time. In addition, research indicates that as working memory loads increase, inhibitory and/or task switching abilities decrease (e.g., Baddeley, Chincotta, & Adlam, 2001; Mitchell, Macrae, & Gilchrist, 2002). Stout and Rokke (2010) found that an interaction of lower filtering (inability to inhibit irrelevant information) and low capacity was associated with greater ruminative tendencies (as measured by Ruminative Response Scale). Their study represents an important first step in demonstrating the importance that working memory capacity and filtering may have on ruminative response styles.

Since working memory is limited in capacity, information has to be efficiently updated within working memory. It has been proposed that inhibitory processes play

contributing roles in working memory updating (e.g., Friedman & Miyake, 2004; Hasher & Zacks, 1988). In fact, research is beginning to explore the relationship between working memory updating and depressive rumination. For example, Joormann and Gotlib (2008) showed difficulties expelling irrelevant negative information within working memory for depressive ruminators who were clinically depressed. Additionally, Zetsche, D'Avanzato, and Joormann (2012) examined the impacts of depression and rumination on working memory updating (removal of irrelevant information using the emotional flanker task with words) and the ability to control the interference of irrelevant information in working memory in a sample including clinically depressed and healthy individuals. Results showed that depression was associated with difficulties with interference control of negative information, whereas rumination was associated with working memory updating difficulties with negative information.

Rumination and Task Switching

In addition to removing irrelevant information from memory, it is also important to manipulate information within working memory in a flexible manner in response to the task at hand (especially when processing different sets of information/rules for tasks). In fact, it has been proposed that mental inflexibility may be a factor in depressive rumination and depression (Joormann et al., 2011). Researchers have primarily used task switching paradigms including a variety of stimuli (faces, words) to assess one's ability to flexibly manipulate information within memory. For example, De Lissnyder, Koster, Derakshan, and De Raedt (2010) examined whether depressive symptoms and/or ruminative response style were associated with inhibitory difficulties processing

emotional (happy and angry faces) and neutral information (gender) in a non-clinical undergraduate sample. De Lissnyder et al. (2010) used an Affective Shift Task where participants had to identify the discrepant face out of a presentation of four faces in a square-like grid based on a cue. Within this task, participants were required to inhibit irrelevant cues (e.g., emotion). De Lissnyder et al. (2010) found an association between impaired inhibition and higher trait rumination (RRS), especially in reference to brooding (e.g., faster response to angry faces).

Additionally, De Lissnyder, Koster, and De Raedt (2012) examined valence based shifting impairments using the Internal Shift Task (IST) in dysphoric and non-dysphoric college students. The IST required participants to perform a count depending on condition (emotional or gender). For example, the emotion condition required participants to count faces based on emotional features (e.g., number of angry or neutral) and the gender condition required participants to count faces based on gender (the number of male and female). Participants pressed a button to indicate completion of the count for each trial. Switch costs represent the response time difference between switch (e.g., angry to neutral, neutral to angry) and no switch trials (e.g., angry to angry, neutral to neutral). Though depressive symptoms were not associated with shifting difficulties, ruminative response style was associated with greater shifting impairments with negative rather than positive facial stimuli (e.g., greater shift costs). This study used the RRS-NL (Nolen-Hoeksema & Morrow, 1991), a 26-item scale that also includes brooding and reflective subscales. No effects were found for subscale, a finding that is incongruent with De Lissnyder et al.'s earlier study in 2010.

Koster et al. (2013) found cognitive control difficulties using the IST task as well, and reported findings similar to De Lissynder et al. (2010) where switching impairments were strongly associated with negative information (angry faces) and brooding tendencies. Thus, research examining working memory updating (WMU) and task switching show difficulties expelling and manipulating irrelevant negative information within working memory for depressive ruminators (e.g., Joormann & Gotlib, 2008; Zetsche et al., 2012) with some studies demonstrating subscale specific effects with brooding (De Lissnyder et al., 2010; Koster et al., 2013).

Cognitive control includes a complex system of processes within working memory, and research is only beginning to understand the intricacies associated with depression, trait-based ruminative styles, and brooding tendencies. Though research has only recently begun to explore the relationship between WMU and trait-based depressive ruminative styles, research examining broader inhibitory difficulties is growing.

Inhibition, Emotionality, and Ruminative Response Style

Since the content of rumination is proposed to include negatively valenced and self-referential information, many studies have included emotional stimuli (faces, words) in experimental paradigms in order to examine how this information is processed and may contribute to maladaptive responding in the face of dysphoric affect. Several studies have used negative stimuli in a task called a negative affective priming paradigm (NAP; Joormann, 2006; Joormann & Gotlib, 2010; Zetsche & Joormann, 2011). This task requires participants to respond with an evaluative judgment (non-word/word or self-referential description) to a target word or picture presented with a distractor word or

picture. If participants are actively inhibiting the distractors as instructed, they will typically exhibit a *negative priming effect* where they take longer to respond to a target stimulus that was presented as a distractor on a preceding trial than to a stimulus that was not presented on a preceding trial. (Note that the word "negative" here does not refer to the valence of the stimuli but to the delayed response that occurs when the target was a distractor.) However, shorter latencies indicate difficulties inhibiting the distractor word, a pattern of responding found in the literature with depressed and dysphoric individuals with ruminative tendencies (e.g., Joormann, 2006; Joormann & Gotlib, 2010). Within these paradigms, researchers compute bias scores (composite averages of response latencies) as indicators of inhibitory difficulties.

Joormann (2006) examined the association between the inhibition of emotional information (standardized positive and negative adjectives that were potentially self-referential) and the tendency to ruminate using a NAP task that included self-referential encoding of the target adjectives. Participants were instructed to respond with a self-referential judgment (yes = describes me, no = does not describe me) to adjectives presented in dark letters as quickly as they could. Participants included undergraduates split into high and low ruminators based upon a median split of scores on the RSQ-R measure. The RSQ-R is a 21-item Ruminative Response Scale that assesses responses to dysphoric affect that does not include reflective pondering items. Results indicated that less inhibition of emotional information (no negative priming for positive and negative words) was associated with the tendency to ruminate (as measured by the RSQ-R scale after controlling for depression). Thus, individuals who indicated high levels of a

ruminative response style did not show the expected delayed response (greater inhibition) specific to emotional words, but tended to respond to these words quickly.

Joormann and Gotlib (2010) also used a NAP task in a sample of depressed, previously depressed, and control individuals; however, they included positive, negative and neutral adjectives (ANEW database: Bradley & Lang, 1999) as the stimuli. Neutral words were used as distractors in prime trials only in the control condition of the NAP. Participants were instructed to ignore the distractor (red) word and indicate whether the target (blue) word was positive or negative as quickly as possible. Results indicated that in comparison to controls, participants diagnosed with major depressive disorder (MDD) were slower to respond to positive and faster to respond to negative targets when the targets shared the same valence as distractors in the preceding trial, indicating difficulties with inhibition. This finding is consistent with Joormann's (2006) study as well. Moreover, rumination was associated with difficulty inhibiting negative information only in the MDD group.

Zetsche and Joormann (2011) used NAP tasks with words and emotional faces, and an emotional variation of the Eriksen Flanker task (Eriksen & Eriksen, 1974) that required the undergraduate participants to ignore emotional or neutral distractor words. This prospective study used the 22-item RRS scale including both the brooding and reflective pondering 5-item subscales as a measure of depressive rumination. They found that inability to ignore negative words predicted rumination scores in the flanker task at baseline assessment, but did not find an association between NAP deficits and rumination (RRS total score) in either verbal and pictorial variants of the task at the first time point.

However, analyses conducted using the two subscales of the RRS (brooding and reflective pondering) instead of the composite score showed an association between reduced negative priming of negative words and the brooding but not the reflection subscale at the second time point (six months later). This finding is unexpected, as reflection is associated with adaptive rather than maladaptive outcomes. Results also showed that inhibitory difficulties associated with sad faces in the NAP pictorial design predicted RRS total rumination scores at the second time point.

Goeleven, De Raedt, Baert, and Koster (2006) also used a pictorial NAP design, but included happy, sad and neutral faces. Goeleven et al. examined inhibitory deficits associated with ruminative tendencies (measured by RRS-Dutch version) and the processing of emotional information in depressed outpatients, remitted depressed individuals, and non-depressed individuals. Though findings showed reduced inhibition for sad faces for the MDD group in comparison to the controls and reduced inhibition for sad and happy faces in the remitted group, there was no significant correlation with ruminative response style and negative priming effects.

Summary: Depressive rumination and NAP design. Thus, a majority of the research using emotional stimuli in the NAP design has shown inhibitory difficulties in reference to emotional stimuli (positive and negative words, angry and sad faces). However, some studies examining inhibitory difficulties associated with ruminative responding failed to find these results, which may be due to small effect sizes, using different measures of rumination and different types of stimuli, and sample characteristics (Goeleven et al., 2006; Zetsche & Joormann, 2011). For example, Goeleven et al. (2006)

failed to find inhibitory difficulties with rumination using a pictorial NAP design with sad faces in a clinically depressed sample, but Zetsche and Joormann (2011) did using sad faces in a non-clinical sample. Goeleven et al. (2006) failed to find significant correlations between rumination and bias scores, and reported results including the RRS as a "control" variable in the regression model. It is unclear whether subscales were examined, which may have yielded different findings.

Additionally, Zetsche and Joormann (2011) found that inhibitory difficulties predicted reflective pondering rather than brooding using the verbal NAP task six months later though failed to find inhibitory difficulties with rumination subscales at baseline. Depressive rumination is proposed to be a trait-like response style, so it is interesting that responses on the RRS differed within a six-month time period. All the aforementioned research using the NAP task included bias scores as indicators of inhibitory difficulties. It is unclear if the discrepancies in research findings may be attributable to including composite averages of response latencies (bias scores) in regression models instead of using multilevel statistical analyses that are more appropriate for nested data (response times within individuals). Using statistical programs such as Hierarchical Linear Modeling may provide greater sensitivity to detecting variability on a trial by trial basis and more accurately represent the data.

Lastly, findings have differed with respect to valence-specificity. For example, Joormann (2006) showed inhibitory difficulties with both positive and negative words in a clinically depressed sample and Joormann and Gotlib (2010) found inhibitory difficulties with negative words only in the depressed group. Joormann (2006) used the

RSQ-R measure that does not include reflective pondering and Joormann and Gotlib (2010) used the RRS measure that does. As documented previously, some studies used different variants of the shortened ruminative response scale (RSQ-R, RRS, RRS-NL) and it is unclear what factors (brooding, depression related) may be driving the findings.

As previously discussed, valence, self-relevance and mood state are critical factors in depressive rumination. Yet, Joormann (2006) is the only researcher that incorporated all three components into her design using the NAP task. Additionally, rumination in the moment may have affected the aforementioned findings. Research has only begun to explore the effect that state based rumination plays on inhibitory processes within working memory with a paucity of studies examining the impact of rumination in the moment.

Inhibition and State Rumination

Watkins and Brown (2002) were the first to examine the effects of induced state rumination on inhibitory processing using a random number generation task that required depressed and non-depressed participants to recall the numbers 1 through 9 in a random order one hundred times at a pace of one second per number guided by a metronome. This paradigm measures the inhibition of "prepotent responses," the tendency to count in series of numbers instead of randomly (1-2-3, 9-8-7-6). This study also included a negative mood induction that required participants to think about a recent time they experienced difficulty prior to a distraction or rumination manipulation. Participants in the rumination condition were asked to think about items that were emotional and self-focused (e.g., "Think about what your feelings might mean"), while participants in the

distraction condition were asked to think about items (e.g., black umbrella) that were not related to emotions or depressive symptoms (Watkins & Brown, 2002, p. 401).

Results indicated that rumination was associated with increased inhibitory difficulties of prepotent responses (higher count scores) only in depressed participants. In addition, these participants reported greater frequency of ruminative thoughts during the task (assessed by retrospective report). This study is important because it not only used a rumination induction, but also assessed for thoughts during the task (retrospectively) and examined dysphoric mood. However, it is unclear whether the inhibitory deficits measured by this paradigm translate to other processes of inhibition assessed with other cognitive tasks using valenced and/or self-referential stimuli (e.g., removing irrelevant information from WM, manipulating information within working memory, negative priming).

Curci, Lanciano, Soleti, and Rimé (2013) also examined the effect of state-based rumination on working memory, but used a prospective study design and a rumination induction that differed from the aforementioned Watkins and Brown (2002) study. Participants included undergraduate students who were split into high versus low working memory capacity (as measured by the OSPAN WM task). Curci et al. included a measure of state mood, the RRS scale as a measure of trait rumination, and Likert scales assessing state based rumination (e.g., duration of time thinking about manipulation, frequency of thoughts, interference with functioning). For the manipulation, participants either read a positive (distraction induction) or negative (rumination induction) two-page excerpt from a novel. Findings indicated that state

rumination played a mediating role in the relationship between negative affect and performance on a working memory task. These researchers concluded that rumination may have detrimental effects on working memory and interfere with performance on the task at hand (Curci et al., 2013).

One of the strengths of Curci et al.'s (2013) study includes the examination of the intrusive nature of thoughts (frequency, avoidance) and the related impairment in daily functioning after a 24 hour delay. However, it is unclear whether these thoughts were present during the cognitive task. Additionally, past rumination inductions have used Nolen-Hoeksema's design, focusing attention inward on one's mood and related contributing factors. Curci et al.'s rumination induction involved reading the experiences of a prisoner of war, and it is unclear how self-relevant the state ruminative thoughts were and the extent to which these thoughts corresponded to ruminative type processing. It will be important to expand upon these findings and use designs that both evoke and measure self-focused processing.

Though studies have found that trait rumination is associated with task switching deficits as previously reviewed, research has started to examine the impact that state rumination plays in these difficulties as well. Whitmer and Gotlib (2012) not only examined the effects of trait and state rumination on task switching deficits in depressed individuals, they also aimed to differentiate which underlying mechanisms were playing contributing roles. Whitmer and Gotlib used a backward switching task to clarify whether inhibitory processes (deactivation of previous set demands or "no longer relevant" task rules) and/or "non-inhibitory switching processes" (processing new set

demands or task rules) contributed to task switching deficits in depressed individuals (p. 571). Participants included depressed and non-depressed individuals who were administered a distraction or rumination manipulation similar to Watkins and Brown (2002) as an attempt to trigger state based rumination. Results indicated that state rumination was associated with switching difficulties, but trait rumination was related to difficulty deactivating previous task sets. Researchers proposed that trait based rumination was associated with difficulties deactivating previous task set information and rules, whereas state rumination was associated with non-inhibitory switching processes Whitmer & Gotlib, 2012). Similar to the Curci et al. (2013) study, state rumination was not assessed during the cognitive task so it is unclear whether participants were engaging in ruminative processing throughout the task.

Summary of Findings

Most studies indicate that individuals with depressive ruminative tendencies show deficient inhibitory processing with self-referential and emotional stimuli in both clinical and non-clinical samples across a number of experimental paradigms broadly assessing inhibitory processes within working memory. In fact, brooding has emerged as an indicator of valence-specific inhibitory difficulties with negative information (e.g., De Lissnyder et al., 2010; Koster et al., 2013; Vanderhasselt et al., 2011), though some studies have failed to find results (De Lissnyder, Koster, & De Raedt, 2012; Zetsche & Joormann, 2011). In addition, although sparse, research has indicated that depressive rumination is associated with difficulties expelling and manipulating emotional information (especially negative information) in working memory. Most of the

aforementioned studies examined trait-based ruminative tendencies, with only three studies inducing rumination and examining the effects of state rumination and dysphoric mood on inhibition (Curci et al., 2013; Watkins & Brown, 2002; Whitmer & Gotlib, 2012). Additionally, only two studies have incorporated self-referential encoding into their designs (Daches et al., 2010; Joormann, 2006). It will be important to continue to examine the relationships among depressive symptoms, ruminative and brooding tendencies, state rumination, and inhibitory processes to further clarify discrepancies in the literature and to continue to build upon existing conceptualizations of depressive rumination.

State Rumination: Informative Next Steps

Though research addressing the impact of state rumination on inhibitory difficulties is growing, it is unclear whether mechanisms and factors previously documented with trait ruminative styles play similar roles in the relationship between cognitive control and state rumination. The aforementioned studies are an important first step, as findings suggest that state rumination has deleterious effects on inhibitory processes. In order to further clarify underlying mechanisms and elucidate the relationship between trait and state rumination, within-task rumination needs to be assessed. Cognitive psychology offers informative research designs like those on mind wandering that may better enable researchers to assess the extent to which ruminative thoughts occurring during a task are associated with inhibitory difficulties.

Mind Wandering

Mind wandering has been defined as repetitive off-task thoughts that occur during an ongoing task or activity (McVay & Kane, 2009) and thus has conceptual similarities to depressive rumination. Mind wandering has been assessed using "in-the-moment" techniques (thought probes during a task) or by retrospective questionnaires administered following task completion. In-the-moment questions typically assess the content of thought prior to the presentation of the thought probe (thinking about one's performance on the task, life events or everyday concerns), and can be randomly presented within an executive control task (see McVay & Kane, 2009). As an alternative approach, Smallwood, O'Connor, Sudbery, and Obonsawin (2007) required participants to say their thoughts aloud (thoughts when they saw the word STOP). These thoughts were then coded into categories by the experimenter. Questionnaires assessing retrospective report have also been administered following the computer task (e.g., Thinking Content Component of the Dundee Stress State Questionnaire; Matthews et al., 1999). These types of experimental paradigms and measures would assess rumination in the moment and could be used to further explore the relationships among state-based rumination, trait based ruminative responses and inhibitory difficulties. Further, these thought probes may increase self-focused attention and provide information regarding thought content (mood, performance) that would clarify conceptual models of depressive rumination.

Review of Important Factors and Study Proposal

As mentioned earlier, dysphoric mood may narrow attention onto negative stimuli and cause problems inhibiting the processing of that information. However, these effects

may be evident primarily when the content of information is self-referential. The aforementioned 'cognitive control' findings indicate associations with rumination and inhibitory difficulties when stimuli are emotional or self-referential. Although most research has used valenced stimuli that have been standardized with other populations (e.g., De Lissnyder et al., 2010; Joormann & Gotlib, 2010; Zetsche & Joormann, 2011), it should not be assumed that the stimuli are emotional and/or self-referential to the individual participant. Differences between ruminators and non-ruminators may exist in the salience and activation of negative self-referential thoughts. Once these negative self-referential thoughts are triggered, it may be difficult to stop the cycle, as memory tends to better encode and recall information that is emotional. In addition, the self-referential nature of these thoughts may act to increase the ease with which this information is accessed and the difficulty in inhibiting processing of this information as well.

Study Proposal

I propose that depressive rumination may be conceptualized as a process associated with deficient WM inhibition that is driven by the current mood state, and the valence (emotionality) and self-referential nature of the information processed in memory. Importantly, most research designs used emotional stimuli selected based on means and normative data, and it is unclear how emotional and self-referential the stimuli were to the individual. Additionally, examining thought content during the cognitive task can provide insight into additional factors other than the task demands that may exert additional demands on working memory. Thus, I aimed to improve upon previous studies by incorporating stimuli that individuals rated as emotional and self-referential

and assessing for the individual's thoughts throughout the task. It is unclear whether trait ruminative styles lead to state rumination, which in turn affects inhibitory processes during a task. To the author's knowledge, this was the first study to actually assess the association between state rumination and inhibitory difficulties using thought probes during a cognitive task.

For the current study, I examined the relationship between inhibitory difficulties and depressive rumination using self-relevant emotional words in a NAP paradigm including thought probes to assess thought content during the task. Thus, I included a rumination induction and incorporated stimuli identified as positive, negative, neutral and self-referential by each individual participant into the NAP design. Though past studies have used self-referential processing (Daches et al., 2010; Joormann, 2006), this was the first study to include stimuli that were chosen specifically for each individual participant based on responses to the stimuli. This was an attempt to assess inhibitory difficulties with content that may be reflective of depressive ruminative processing. Since working memory capacity may affect inhibitory control as well, WMC was controlled for in the primary analyses. My aims for this study were to examine the effects of brooding, mood state, and state rumination (thoughts during a task) on inhibitory difficulties with emotionally self-relevant stimuli.

I examined two hypotheses with the current study. First, I aimed to replicate previous findings that individuals with higher brooding response styles exhibited greater inhibitory difficulties with emotional words than those with lower ruminative styles following a rumination manipulation. Specifically, I hypothesized that depressive

ruminative response styles (brooding) would predict inhibitory difficulties with negative rather than positive self-referential adjectives following a rumination induction. To examine the aforementioned hypothesis, I used comparative statistical approaches. Thus, I not only aimed to replicate past findings using bias scores, but examined whether findings would differ using hierarchical linear modeling (HLM). HLM can better account for the dependency and variability within nested data (responses within individuals). Bias scores are not included in HLM, as these averages may not be indicative of differences at the individual trial level.

Secondly, I hypothesized that state based rumination in response to a rumination induction would partially mediate the relationship between a tendency to ruminate (brooding scores) and inhibitory difficulties with negative information (see Figure 1). As mentioned previously, though few studies have examined state rumination, findings indicate deleterious relationships among brooding, state rumination and inhibition (Curci et al., 2013; Watkins & Brown, 2002). I sought to further clarify these relationships assessing rumination in the moment following a rumination manipulation. Specifically, I proposed that brooders' difficulties with inhibition would be attributable to the presence of state rumination and attempted to replicate Curci et al.'s (2013) findings demonstrating this mediational relationship.

Past research findings indicate that state rumination is increased in brooders asked to self-reflect (Watkins & Brown, 2002). Since there is a limit to the amount of information that can be processed within working memory, I also hypothesized that WMC would play a moderating role in the aforementioned mediating relationship.

Specifically, I proposed that the impact of brooding tendencies on state rumination would vary as a function of WMC (i.e., at lower levels of WMC, the relationship between brooding and state rumination would be most pronounced in participants asked to self-reflect). Findings from Stout and Rokke (2010) implicate a combination of factors (decreased inhibition and decreased WMC) associated with depressive rumination. Additionally, findings from the cognitive literature indicate that lower WMC may negatively affect inhibition under increased cognitive loads (e.g., Baddeley et al., 2001; Mitchell et al., 2002). Therefore, WMC may not only moderate the relationship between brooding and state rumination, but may presumably moderate the direct relationship between brooding and inhibition as well (see Figure 1). I sought to examine whether the presence of state ruminative thoughts and lower WMC would negatively affect inhibition with emotional words in brooders.

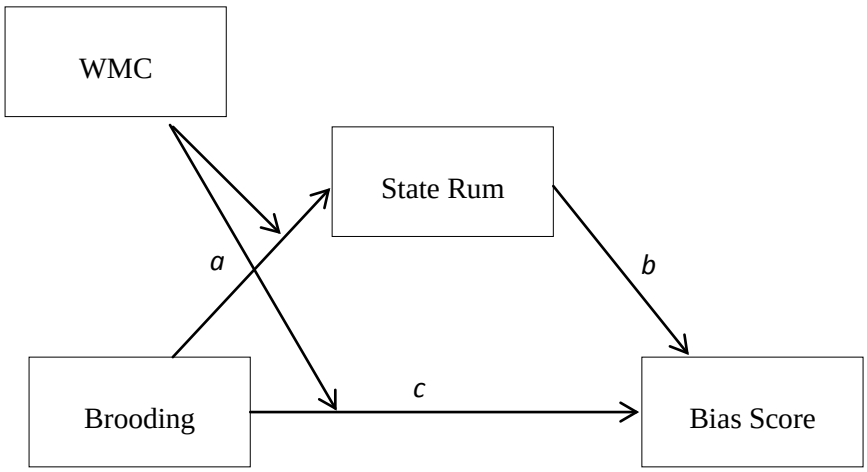

Figure 1. Moderated mediation model with brooding as the IV, state rumination as the mediator, WMC as the moderator, and the bias score as the dependent variable. Note that state rum = total state ruminative thoughts and WMC = working memory capacity.

Lastly, I aimed to explore gender effects in relation to study hypotheses for exploratory reasons. Depressive rumination is derived from Nolen-Hoeksema's RST theory, which was an attempt to explain the emergence of sex differences in depressive symptomatology in adolescents (Nolen-Hoeksema, 1991, 2000, 2004). Thus, I sought to clarify whether gender may contribute to inhibitory difficulties in depressive ruminators as well.

CHAPTER II

METHOD

Participants

Screening for Inclusion

The majority of participants were recruited through Experimetrix, a psychology experiment sign-up system. To increase predictive power and oversample for brooding tendencies, a small subset of participants (n = 5) were recruited from the community through flyer advertisement. All participants were screened by age (must have been 18 or older), English language comprehension (must have been able to speak and read English), and visual impairment (no visual impairments other than corrective vision or color blindness).

Sample Characteristics

Participants primarily consisted of undergraduate students enrolled in psychology courses at the University of North Carolina at Greensboro; however, a small subset of participants (5 recruited, 4 enrolled) responded to a recruitment flyer advertisement and were compensated for their participation. Students signed up for the experiment through a computerized registration system. The study was divided into two parts, an initial word rating task completed remotely and a laboratory session. Not all participants who completed the word rating task qualified for the lab session (see procedures below). Five hundred seventy students were consented and completed the initial word rating task for

the study (263 or 46% excluded due to not meeting word rating criteria, 147 or 26% failed to respond to invitation). One hundred sixty participants completed the lab tasks for the study and 148 were included in statistical analyses (12 excluded for technical problems/incomplete data). See Figure 2 for enrollment flow chart. This sample consisted of Caucasian (56.1%), African American (26.4%), Asian (6.8%), Hispanic (4.7%) and racially identified other (6.1%) students with a mean age of 19.66 (*SD* = 2.55, range = 18 - 38). For participants who responded to the flyer advertisement, inclusionary criteria included obtaining a minimum brooding subscale score of 12 or higher.

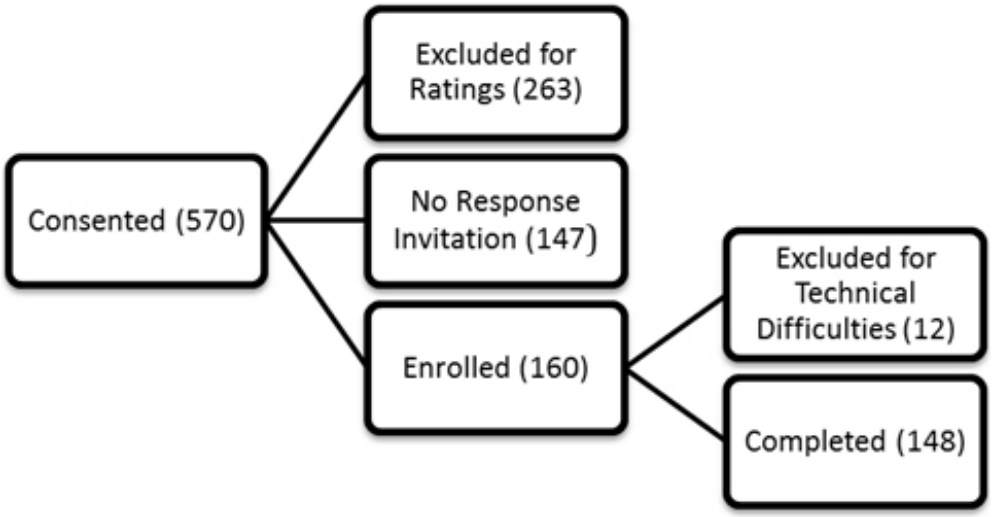

Figure 2. Enrollment flow chart for study recruitment.

Materials

Measures and Questionnaires

Demographics. A questionnaire was administered to gather demographic information such as age, gender, race, and ethnicity (see Appendix A).

Beck Depression Inventory (BDI-I; Beck, 1976). This questionnaire was used to assess the severity of depressive symptomatology. The BDI has demonstrated reliability and validity (α = .81; Beck 1976; Beck, Steer, & Garbin, 1988) and has been recognized to tap features that map onto clinical depression as defined by the DSM-IV-TR criteria. The BDI assesses somatic, emotional and cognitive domains of depression. Participants were asked to answer 21 questions in reference to how they have been feeling in the past week including that day. Each question is on a scale of 0–3, with the highest possible score being 63. For this study, the internal consistency for the BDI was good (Cronbach's α = .88).

State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The STAI includes two scales that assess trait and state anxiety characteristics. The STAI has documented reliability and validity (α = .86 - .95; Spielberger & Vagg, 1984). The internal consistency for this study was excellent for both the STAI-State (Cronbach's α = .94) and STAI-Trait (Cronbach's α = .93).

Ruminative Responses Scale (RRS; Treynor et al., 2003). The RRS is a 22-item rumination measure that includes two subscales: reflective pondering and brooding (see Appendix A). The RRS assesses one's tendency to repetitively think about one's dysphoric mood and current state, the causes (precipitating events, one's shortcomings, failures, faults) and consequences of one's dysphoria. The brooding subscale includes the following five items: Thinking "What am I doing to deserve this; why do I always react this way; thinking about a recent situation, wishing it had gone better; why do I have problems other people don't have; why can't I handle things better?" (Treynor et al.,

2003, p. 248). The reflective pondering subscale includes five items as well, but focuses on analyzing situations, emotions, and thoughts to understand reasons for one's mood. The remaining twelve items on the RRS are depression-related (Refer to Appendix A for measure).

Participants rated items on a 4-point scale (0 = never, 4 = almost always). The RRS and its subscales have documented reliability (α = .90; Treynor et al., 2003). For this study, the internal consistency was good for the Brooding subscale (Cronbach's α = .80) and Reflective Pondering subscale (Cronbach's α = .85).

Letter Number Sequencing Task (Wechsler Adult Intelligence Scales; Wechsler, Coalson, & Raiford, 2008). Working memory capacity was assessed using the Letter Number sequencing task. This task required participants to recall digits and letters in the correct numeric and alphabetic order they were read in. It is suggested that this task represents a valid test of working memory and is tapping the same construct as other WM tasks consistently used in the cognitive literature (Shelton, Elliott, Hill, Calamia, & Gouvier, 2009).

Visual analogue scales. These scales assessed sad, happy and anxious mood states on a scale of 0–100%, asking the participant how he/she felt right at that moment (Bradley, Mogg, & Lee, 1997). Refer to Appendix A for the measure.

Post study questionnaire. Participants were asked to rate the extent of effort, focus and concentration, and self-focused attention on a scale of 0 - 100% during the manipulation and the NAP task. Participants were also asked to list up to four thoughts

they could recall during the manipulation and the NAP task (Refer to Appendix A for measure).

Word Rating Task

The word rating task included neutral, positive and negative words that were selected from the Affective Norms for English Words list (ANEW: Bradley & Lang, 1999). This database included arousal and valence ratings on a scale of 0 - 9 (with 0 = unhappy/calm and 9 = happy/excited); selected words were matched on mean word length and did not differ in arousal. One hundred negative adjectives with a valence rating of less than 4, sixty neutral adjectives with a rating of 4 - 6 and one hundred positive adjectives with ratings above 7 were included.

Positive and negative adjectives were displayed in ten blocks consisting of 10 adjectives, and neutral adjectives were displayed in six blocks consisting of 10 adjectives. Participants rank ordered the positive, negative, and neutral adjectives presented within each block of ten adjectives in reference to valence and self-relevance (i.e., highest ranked indicated these words were negative/positive/neutral and self-relevant). Participants then answered questions regarding how the top five ranked words within each block made them feel (unpleasant, neutral, pleasant) and how much they associated with or related to the word (not at all, a little, a lot). These ratings were adapted from Phan et al. (2004). Participants provided individual ratings for 50 negative and positive words, and answered the aforementioned questions for all 60 neutral words that were presented.

Though participants may have ranked negative, positive or neutral words within the top five of their lists, they did not always individually rate those ranked words as negative (unpleasant), positive (pleasant) or neutral in the questions following the ranking. Therefore, only the highest ranked words that were also individually rated as emotional or neutral and self-relevant were considered for selection into the NAP design to minimize time constraints and maximize the likelihood of inclusion (see Appendix A). Participants were invited to the lab if they rated at least 42 words as negative, 42 words as positive, and 24 words as neutral (amount of words required for NAP design).

Since this task has not been used in previous research, pilot data was collected with a separate sample (N =10). Participants consisted of undergraduate students enrolled in summer psychology courses at the University of North Carolina at Greensboro. The exclusion rate for this sample was 20% due to failure to meet word rating criteria, which was deemed acceptable for recruitment purposes.

Rumination and Distraction Induction (Lyubomirsky & Nolen-Hoeksema, 1995)

The rumination condition required participants to focus their attention on various self-referential and mood-specific items for five minutes (e.g., *Think about what your feelings might mean*). The distraction condition required participants to focus their attention on items that were non-emotional and non-self-referential (e.g., *shape of an umbrella*). Refer to Appendix A for sample items in both conditions. Participants were provided with the items in paper format and were instructed to spend time visualizing each statement. Participants were told they would be tested on the items at a later time as an attempt to ensure effort and focus throughout the five-minute duration (items were not

actually tested). This manipulation has been used in previous studies with clinically depressed and healthy ruminators (Joormann, 2006; Watkins & Brown, 2002), and proved efficacious in enhancing negative mood as well (Watkins & Brown, 2002).

Negative Affective Priming Task (NAP; Joormann, 2006; Joormann & Gotlib, 2010)

The NAP was adapted from previous studies and assesses the ability to inhibit the processing of previously presented irrelevant emotional information. During this task, prime and test trials were presented consecutively. These trials included the simultaneous side by side presentation of word pairs (target and distractor). Participants responded with a button press to indicate the valence (positive or negative) of the target word (targets were shown in blue font and distractors in red) as quickly as possible. This task included two types of conditions: negative priming (NAP) and control. In the NAP condition, the distractor from the prime trial and the target in the test trial share the same valence (see Figure 3). The control condition included a neutral word as a distractor in the prime trial and a valenced word as the target in the test trial. Thus, in the control condition, the distractors in the prime and the targets in the test trial were unrelated. However, in both conditions the target in the test trial is either a positive or negative valenced word. It is expected that faster responding when the valence of the targets in test trials match the valence of the distractors in the priming trials represent enhanced inhibitory difficulties.

This task included a total of 192 trials that took approximately seven minutes to complete (48 negative and 48 positive trials for NAP condition and 48 negative and 48 positive in control condition). These trials were randomly presented and counterbalanced

for target position (right/left). All trials were preceded with a fixation cross that was presented for 500 ms. Word pairs were presented on the screen until the participant responded with a button press on a serial response box to indicate the valence of the target word (negative or positive). Inhibitory difficulties were measured through a comparison of response time during NAP priming versus control test trials of the same valence.

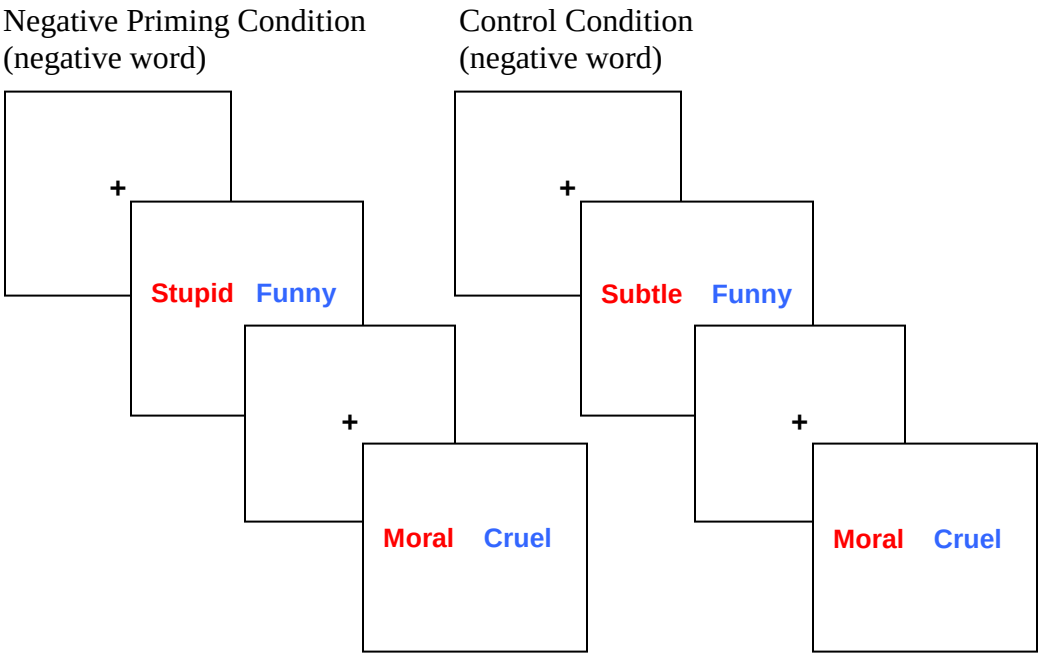

Figure 3. Prime and test trials of the negative priming and control conditions in the NAP task. Participants were instructed to press the button that corresponds to the valence of the blue word (negative or positive).

Stimuli. Stimuli for the affective priming task (NAP) included 42 negative and positive adjectives and 24 neutral adjectives that participants ranked and individually rated as emotional (negative, positive, neutral) and self-relevant. See Figure 4 for relevance statistics. In terms of ANEW ratings (1 = unpleasant to 9 = pleasant), included

positive words corresponded to pleasant ratings, *M* = 7.38, *SD* = 0.66, negative words corresponded to unpleasant ratings, *M* = 7.38, *SD* = 0.66, and neutral words corresponded to neutral ratings, *M* = 5.07, *SD* = 0.79. In terms of arousal (1 = calm to 9 = excited), neutral words were less arousal provoking, *M* = 4.4, *SD* = 1.00, than positive, *M* = 5.28, SD = 1.03, and negative words, *M* = 5.36, *SD* = 1.05. Examination of frequency ratings indicated that negative words were less commonly used than neutral and positive words (negative: *M* = 20.87, *SD* = 35.35; neutral: *M* = 42.86, *SD* = 63.88; positive: *M* = 55.35, *SD* = 101.15).

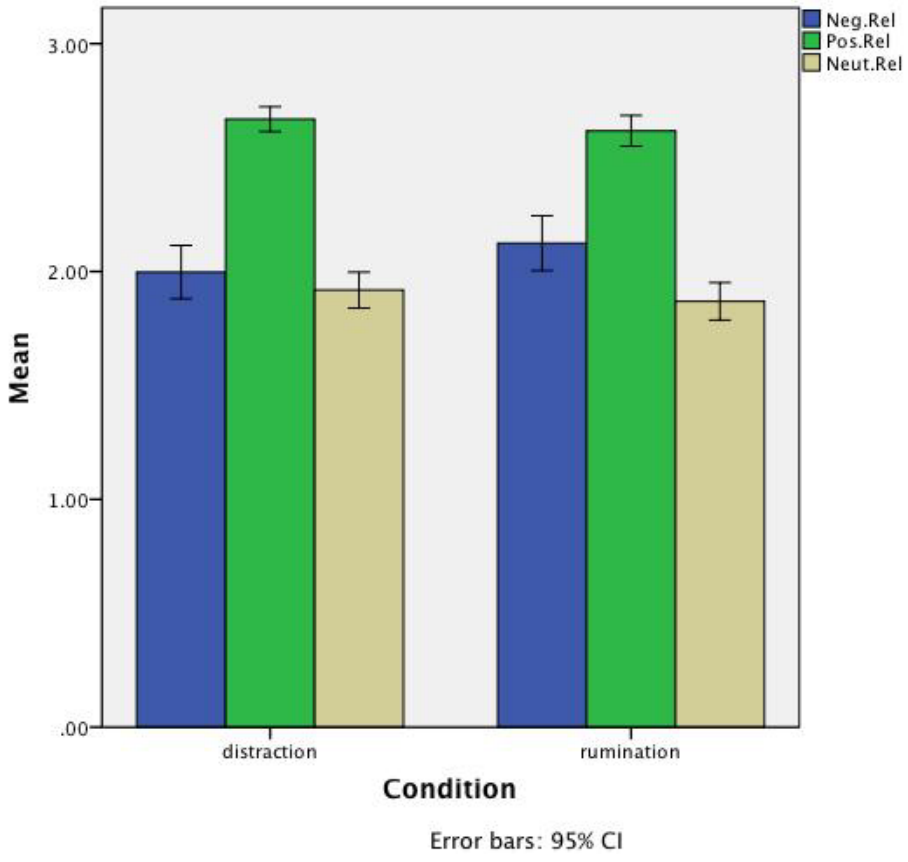

Figure 4. Relevance ratings of word stimuli. For relevance ratings, 0 = associate or relate to word not at all, 1 = associate or relate to word a little, 2 = associate or relate to word a lot.

Thought probes. Sixteen thought probes were randomly presented throughout the NAP design with the restriction that the probes were presented at least four trials apart. These thought probes assessed the content of thought on the trial preceding the presentation of thought probe (e.g., McVay & Kane, 2009). Participants were provided with instructions adapted from mind wandering research (McVay & Kane, 2009). Participants were asked to identify the category using the numerical keypad that corresponds to their thoughts at various points throughout the NAP task (the task, task experience/performance, everyday things, current mood state/reasons why you feel this way, personal worries, daydreams, external environment, other). Sum scores were calculated for each category (lowest score = 0, highest = 16). See Appendix A for measure.

Happy Mood Induction

Following completion of the NAP task, all participants underwent a happy mood induction. Participants were instructed to choose one video clip out of five that would increase their positive mood. Watching video clips or films has been shown to be effective as a positive mood manipulation (Westermann, Spies, Stahl, & Hesse, 1996). The videos included three-minute clips of movies/television shows identified as popular and inducing happy affect through an online search (trailers of *The Princess Bride, Pretty Woman, Willy Wonka and the Chocolate Factory, Ferris Bueller's Day Off, Finding Nemo, Lion King*, clips from *Big Bang Theory, Family Guy*). Employing techniques to ensure mood repair is a standard procedure to reduce participant harm required for compliance with Institutional Review Board (IRB) regulations.

Procedures

Study Experimental Protocol

Participants completed the study consent, demographics measure and the word rating task remotely. Participants were invited to the lab if they met minimal word rating criteria (identified at least 42 words as negative, 42 words as positive and 24 words as neutral) and were randomly assigned to a rumination or distraction condition through use of a random number generator (263 participants failed to meet criteria). Efforts were taken to ensure both conditions have an equal number of participants.

First, participants completed questionnaires (BDI, STAI, RRS) using the computer program Medialab. They were then administered the Letter Number sequencing WMC task. Following the WMC task, participants were administered the Visual Analog Scale as a baseline assessment of mood prior to completing the NAP task.

Participants were then seated 70 inches from the computer screen and positioned appropriately with the response box (right index finger positioned on the right-most button and left index finger positioned on the left-most button). They were instructed to read NAP task instructions presented on the computer through ePrime software. Instructions were verbally reviewed again with an emphasis on responding as quickly and accurately as possible for the entire duration of the task.

Following the instructions for the task, participants completed 30 seconds of practice trials including positive, negative, and neutral words used in previous designs (Joormann, 2006). Two mind wandering probes were presented during practice trials as well. Participants were then administered the rumination or distraction manipulation.

The rumination/distraction induction was immediately followed by administration of the VAS scales as a manipulation check for assessing mood.

Participants were provided with the opportunity to repeat practice trials or to begin the NAP task after reviewing the instructions. All stimuli including thought probes remained on the screen until the participant responded, and were preceded by a fixation cross for 500 ms. Immediately following the presentation of thought probes, participants were instructed to place their hands back on the response box and to indicate when they were ready to resume NAP trials. Upon completion of the NAP task, participants were provided with the VAS scales to assess mood and completed a post study questionnaire. Both conditions then completed a positive mood induction procedure and were administered the VAS scales one final time to ensure their mood has stabilized (happy rating returned to within 20 points of baseline). This was a manipulation to ensure participants were able to repair any consequential negative affect from the NAP task. Following the positive mood induction, participants were debriefed.

Data Analytic Strategy

Preliminary Analyses

Bias scores were calculated for both negative and positive words in the NAP task by subtracting the mean latency of responses to targets in the control condition from the latency of responses to targets in the negative priming condition. Thus, there was both a negative and positive bias score. Higher scores indicate increased inhibitory control (greater inhibition), while lower scores indicate decreased inhibitory control (greater inhibitory difficulties). In order to eliminate the influence of outliers and to address the

large range of variability with responses latency, response times less than 300 ms and greater than 2000 ms were removed from analyses. In addition, consistent with previous studies using the NAP, incorrect responses were not included in analyses.

Correlations between variables (BDI, STAI, RRS subscales, WMC, bias scores) were run using Pearson's correlations. Chi square analyses were conducted on demographic data (race, socioeconomic status) and *t*-tests on age and study questionnaires to assess for significant group differences. To assess the effects of the rumination/distraction manipulations, two separate repeated measures *t*-tests were conducted with both conditions on the sadness and happiness ratings at baseline and following the rumination or distraction manipulation.

Hypothesis 1

To examine whether brooding predicted inhibitory difficulties (lower negative bias score or decreased inhibition) for negative self-referential information in participants following the rumination induction, two statistical approaches were employed. To most accurately replicate the past NAP research findings that use bias scores as the dependent variable, two separate hierarchical multiple linear regression analyses were conducted on the bias scores. In the first step, the WMC score was entered as the control variable, as WMC may play confounding roles impacting inhibition. The brooding score and depressive symptom score were entered in step 2 followed by the entry of condition (rumination or distraction) in step 3. Lastly, the interaction term of brooding and condition, was entered in step 4 (interaction created

with mean centered factors). Dummy coding was used for the condition (1 = rumination induction, 0 = distraction induction).

Since traditional regression analyses include multiple assumptions which may be compromised by the nested data in this study (responses at multiple time points within individuals), hierarchical linear modeling (HLM) was used as a comparative measure to examine the aforementioned hypothesis. HLM offers enhanced hypothesis testing by taking into account that variables such as response time latencies may be similar within and across individuals; furthermore, HLM can assess cross-level effects of nested data with greater accuracy than other statistical methods for nested designs (Raudenbush & Bryk, 2002). HLM accounts for the inherent dependency among response time data from multiple time points within individuals and can better account for variability on a trial by trial basis. Therefore, bias scores were not used, as some meaningful data may be lost in examining average scores. This project included nested data (responses within individuals) and some instances of missing data; therefore an ANCOVA analysis was conducted in HLM.

Level 1 Model

$$RT_{ij} = \beta_{0\,j\,+}\ \beta_{1j}\,(\mathrm{ValTRIAL}_{ij}) + \beta_{2j}\,(\mathrm{TRIALType}_{ij}) + r_{ij}$$

Level 2 Model

$$\beta_{0j} = \gamma_{10} + \gamma_{11}\,(\mathrm{COND}) + \gamma_{12}\,(\boldsymbol{BROOD}) + \gamma_{13}\,(\boldsymbol{WMC}) + \gamma_{14}\,(\boldsymbol{CONDXBROOD}) + u_{1j}$$

$$\beta_{1j} = \gamma_{20} + \gamma_{21}\,(\mathrm{COND}) + \gamma_{22}\,(\boldsymbol{BROOD}) + \gamma_{23}\,(\boldsymbol{WMC}) + \gamma_{24}\,(\boldsymbol{CONDXBROOD}) + u_{1j}$$

$$\beta_{2j} = \gamma_{30} + \gamma_{31}\,(\mathrm{COND}) + \gamma_{32}\,(\boldsymbol{BROOD}) + \gamma_{33}\,(\boldsymbol{WMC}) + \gamma_{34}\,(\boldsymbol{CONDXBROOD}) + u_{1j}$$

Level 1 predictors in this model constituted the nested data (information that corresponds to each response of the individual during the computer task). The variables included in this level 1 model were the emotionality of trials presented (ValTRIAL: negative or positive), and the condition of the trials (TRIALType: NAP or control). While level 1 variables indicated responses within each individual, level 2 predictors corresponded to variables that identified the individuals in this study. The variables of interest for this model were the manipulation condition of the participant (rumination or distraction), the participant's brooding score, the WMC capacity score, and the interaction term of brooding and condition.

Hypothesis 2

Prior to running the mediational analysis, bivariate correlations were assessed among WMC, instances of ruminative thoughts identified through the thought probes (total count collapsed across blocks), the brooding score, and bias scores. To assess the mediational role of rumination in the moment, two separate regression analyses were run on the conditions (rumination and distraction) with the positive and negative bias scores as the dependent variables using PROCESS in SPSS 21. PROCESS is a statistical method that can examine mediation, moderation, and moderated mediation models using logistic regression or ordinary least squares to estimate both direct and indirect effects (Hayes, 2013). PROCESS can reliably estimate paths in models with ranging complexity including interactions and multiple moderators and mediators. Additionally, PROCESS implements boot-strapping techniques (tests 10,000 samples and provides confidence intervals) that are crucial for inferential statistics and can also provide

statistical results on varying levels of variables. As a result, this technique is becoming more commonly used relative to the well-known Baron and Kenny (1986) causal step approach (Hayes, 2009). The current study used PROCESS to enhance statistical power (due to limited sample size) and provide a greater framework for inferential reasoning. The moderated mediation model was estimated in SPSS 21 using the PROCESS model 14 macro (Hayes, 2013). The model included the entry of brooding as the independent variable, state rumination as the mediator variable, WMC as the moderator variable and negative and positive bias scores as the dependent variables (see conceptual Figure 1). This model was run separately on both conditions, as it was unclear whether the factors played differential roles in the groups. As mentioned previously, PROCESS was used to increase statistical power due to the reduced sample size (n = 74).

CHAPTER III

RESULTS

Data Screening

Participant screening due to failure to meet word rating criteria included the exclusion of 263 (46%) of participants who completed the word rating task. This exclusionary rate is greatly increased but not statistically different, $\chi^2(1, N = 580) = 2.71$, $p = .100$, from the previous pilot data (20% exclusion rate) collected with a separate sample. Partial data was collected (brooding) on a subset of the sample ($n = 265$) indicating no group differences between those who failed to meet criteria and those who did not in brooding scores, $t(263) = -1.00$, $p = 0.314$. Missing data from questionnaires accounted for 0.37% (54 items) of the sample data. To reliably account for these missing data points, multiple imputation at the item level was conducted on the questionnaire data (Gottschall, West, & Enders, 2012). Consistent with past research NAP designs examining ruminative tendencies, participant response times on the NAP computer task that were less than 300 ms or greater than 2000 ms were excluded from data analyses (trials that accounted for 3.4% of data [483 trials]) to minimize the effect of outliers (Joormann, 2006; Joormann & Gotlib, 2010). Incorrect responses were removed from data analyses as well (Joormann, 2006; Joormann & Gotlib, 2010). These erroneous responses accounted for 5.9% of data (838 trials). After removal of erroneous responses

and trials exceeding response time limits, data analyses were then completed on 91.2% of the data.

Demographic and Participant Characteristics

This study included 148 participants: 74 participants (18 males, 56 females) in the distraction condition and 74 (15 males, 59 females) in the rumination condition. All demographic and participant characteristics for completed participants are included in Table 1.

Table 1

Frequency of Demographic Variables and Measure Descriptives by Condition

	Distraction Condition[a]			Rumination Condition[b]		
	n%	*M*	*SD*	*n*%	*M*	*SD*
Gender						
Male	24.3			20.3		
Female	75.7			79.7		
Age		19.99	2.93		19.34	2.08
Race						
AA		29.7			23.0	
American Indian or Alaskan Native		0.0			0.0	
Asian/Pacific Islander		8.1			5.4	
Hispanic or Latin American		51.4			60.8	
Caucasian		4.1			5.4	
Other		6.8			5.4	
Measure						
STAI-State		40.54	11.50		41.47	11.73
STAI-Trait		45.15	11.44		44.24	11.63
BDI		8.79	6.84		5.58	7.11
WMC		20.24	2.63		19.89	2.45
Brood		10.41	3.37		10.04	3.07
Reflective Pondering		9.62	3.84		8.74	2.92

Note. AA = African American or Black, STAI = State-Trait Anxiety Inventory, BDI = Beck Depression Inventory, WMC = working memory capacity, Brood = Brooding Subscale.
[a]*n* and [b]*n* = 74.

The participants in the two conditions did not differ significantly with respect to age, $t(146) = 1.55$, $p = .122$, race, $\chi^2(4, N = 148) = 1.89$, $p = .757$, or gender, $\chi^2(1, N = 148) = 0.35$, $p = .693$. Additionally, they did not differ significantly on any of the questionnaires: STAI-State scores, $t(146) = -0.49$, $p = .625$, STAI-Trait scores, $t(146) = 0.48$, $p = .630$, brooding subscale scores, $t(146) = 0.68$, $p = .496$, reflective pondering subscale scores, $t(146) = 1.57$, $p = .119$, BDI scores $t(146) = 0.19$, $p = .851$, and WMC scores $t(146) = 0.84$, $p = .401$. See Table 1 for descriptive statistics.

Effect of Manipulation on Affect and State Rumination

Group Differences in Affect

To examine the effects of the manipulation (rumination should narrow attention on negative affect and increase dysphoric mood), two 2 X 2 repeated measures MANOVAs were conducted on the sadness and happiness ratings (baseline and following rumination/distraction at time point 2). For sadness, results were marginally significant for time, $F(1, 144) = 3.11$, $p = .08$, $d = 0.02$, with lower sadness ratings (1.70) following the manipulation. Results were non-significant for condition, $F(1, 144) = .86$, $p = .356$, $d = 0.01$, and the interaction of time and condition, $F(1, 144) = 2.15$, $p = .144$, $d = 0.02$.

For happiness ratings, results were marginally significant for condition, $F(1, 144) = 3.49$, $p = .064$, $d = 0.00$, with participants in the distraction condition rating themselves happier (7 point mean difference) than the rumination condition. Results were non-significant for time, $F(1, 144) = 0.29$, $p = .589$, $d = 0.01$, and the interaction of time and condition, $F(1, 144) = 2.41$, $p = .123$, $d = 0.03$. Refer to Table 2 for descriptive statistics.

Table 2

Visual Analogue Scale Mood Ratings Prior to and Following Manipulation

	Happy Time 1		Happy Time 2		Sad Time 1		Sad Time 2		Anxious Time 1		Anxious Time 2	
Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Distraction	68.53	22.69	69.51	21.08	21.71	24.27	18.60	21.97	45.16	26.19	40.35	28.55
Rumination	63.04	24.52	61.00	25.01	23.74	23.61	23.46	23.02	42.22	28.50	38.81	25.99

Note. Time 1 = Baseline mood, Time 2 = mood following distraction/rumination manipulation.

Gender differences in affect. To examine gender effects for exploratory reasons, two 2 X 2 X 2 repeated measures ANOVAs were conducted on the sadness and happiness ratings (baseline and following rumination/distraction at time point 2) including gender and condition as the fixed effects. Results for multivariate within subject tests were non-significant for the happiness ratings. However, there was a significant main effect for condition, $F(1, 142) = 3.93$, $p = .049$, $d = 0.03$, indicating that the distraction condition rated themselves as 8.97 points happier than the rumination condition. Results were non-significant for gender, $F(1, 142) = 2.53$, $p = .114$, and the interaction of gender and condition, $F(1, 142) = 0.46$, $p = .497$ for happiness ratings.

Though the multivariate within subject tests were non-significant for sadness ratings, results indicated significant main effects for condition, $F(1, 142) = 5.13$, $p = .025$, $d = 0.04$, gender, $F(1, 142) = 4.13$, $p = .044$, $d = 0.03$, and the interaction of condition and gender, $F(1, 142) = 6.33$, $p = .013$, $d = 0.04$. Males reported increased sadness ratings in comparison to the females, an effect that was most pronounced in the rumination condition (see Figure 5). Please note that due to the limited sample size of males ($n = 32$), there was a large range of variability in mood ratings and violation of assumptions necessary for regression (normality). Thus, the aforementioned results should be interpreted with caution.

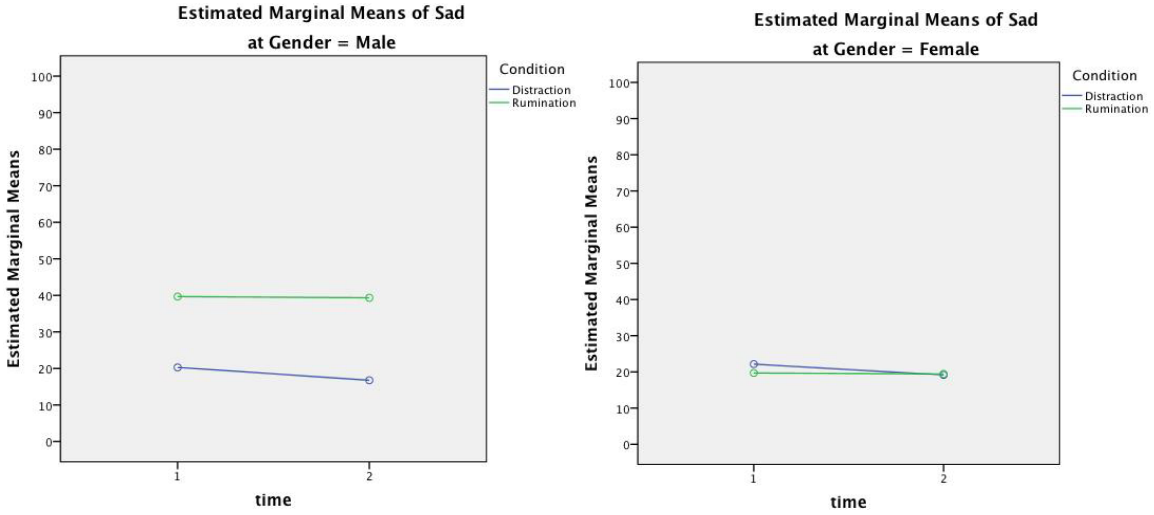

Figure 5. Male and female ratings of dysphoric affect prior to and following manipulation.

Group Differences in State-based Thoughts throughout NAP

In terms of state-based thought content measured by thought probes during the NAP computer task, conditions did not differ significantly with respect to task relevant thoughts, $t(146) = 0.63$, $p = .531$, $d = 0.10$, performance-based/evaluative thoughts, $t(146) = -1.53$, $p = .13$, $d = -0.25$, thoughts regarding daily routine activities, $t(146) = 1.38$, $p = .171$, $d = 0.22$, mood and ruminative focused thoughts, $t(146) = -0.42$, $p = .675$, $d = -0.07$, worrying thoughts, $t(146) = 1.12$, $p = .264$, $d = 0.18$, daydreaming thoughts, $t(145) = 0.13$, $p = .898$, $d = 0.02$, and thoughts focused on the external environment, $t(145) = -0.19$ $p = .847$, $d = -0.02$. Refer to Table 3 for descriptive statistics and Figure 6 for state rumination descriptives.

Table 3

State-Based Thought Content Measured during NAP Computer Task

	Distraction		Rumination	
Thought Content	*M*	*SD*	*M*	*SD*
Task	6.50	4.56	6.04	4.32
Performance	3.47	3.67	4.42	3.86
Daily Routine	1.31	2.15	.86	1.77
State Rum	.95	1.79	1.08	2.11
Worry	1.54	3.08	1.07	1.93
Daydream	.81	1.67	.77	2.16
Environment	.26	.70	.28	.97

Note. State rum = state ruminative thoughts.

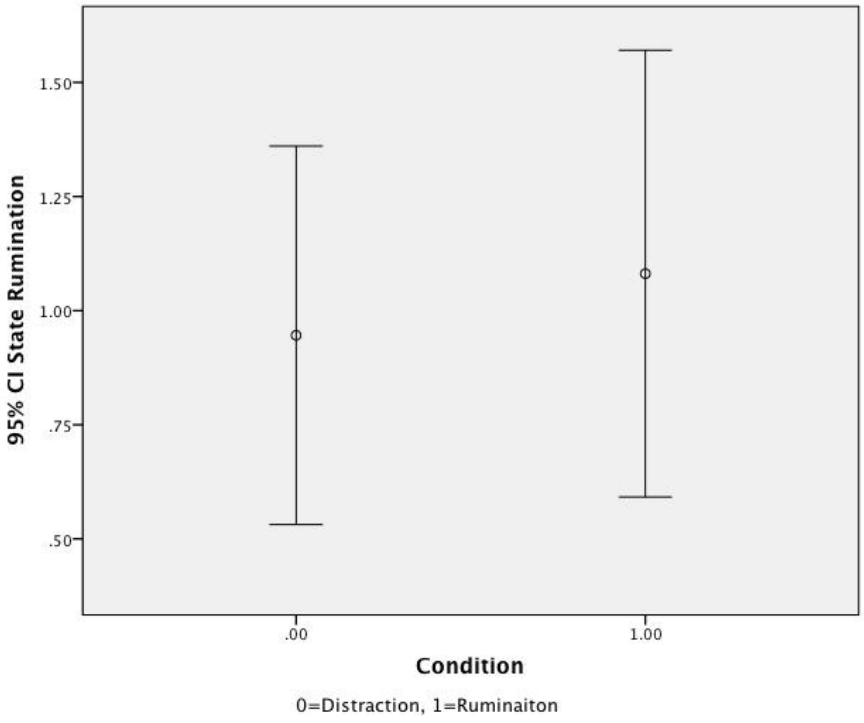

Figure 6. Error plot of state ruminative thoughts. The range of state rumination was 0 – 14.

Association between Brooding and State Rumination

To examine whether trait rumination predicted state rumination following the manipulation, linear regression was conducted using the brooding score and condition as the predictors and the state rumination total count score as the outcome measure. Including condition in the regression did not account for significant variance, $\Delta R^2 = .00$, $p = .561$; therefore it was dropped from the model. Results indicated that brooding significantly predicted state rumination, $b = 0.12$, $t = 2.55$, $p = .012$, with the model accounting for 4% of the variance, $R = .21$, $F(1, 146) = 6.49$, $p = .012$. Higher brooding tendencies were associated with increased state ruminative thoughts during the NAP task.

Group Differences in Effort and Self-focused Attention

To examine group differences in effort and self-focus, *t* tests were conducted on the overall ratings between conditions. It is important to note that this information was collected for a subset of the sample (Effort: $n = 91$; Self-Focus: $n = 85$). Results indicated group differences in reference to effort, $t(89) = 4.04$, $p < .001$, $d = 0.84$, with the rumination condition expending less effort during the manipulation than the distraction condition. Additionally, groups differed in respect to how self-focused they were during the manipulation, $t(89) = -2.14$, $p = .035$, $d = -0.45$, with the rumination condition rating themselves as more self-focused during the manipulation than the distraction condition. Conditions did not differ in respect to how focused they were on the items during the manipulation ($p = .737$, $d = -0.07$). Refer to Figure 7 for estimated parameters.

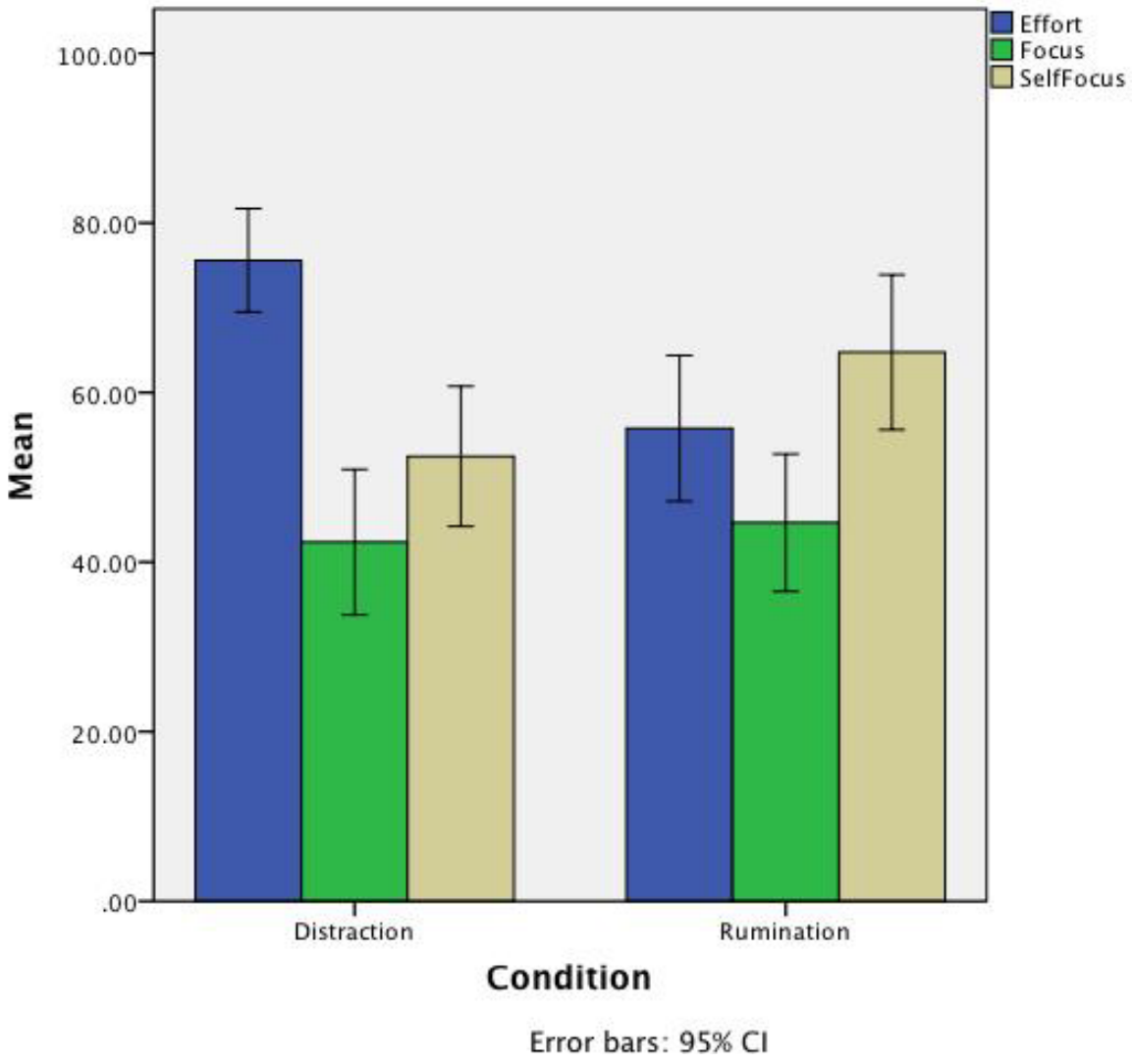

Figure 7. Group differences in self-ratings of effort, focus and self-focus during manipulation. $p < .05$.

Though the aforementioned data was collected on a partial subset of the sample due to the delayed addition of questions to the study protocol, data in reference to effort, focus/concentration and self-focused attention during the NAP task were collected on the entire sample. To examine group differences, *t*-tests were conducted on the overall ratings between conditions. Conditions did not differ in respect to effort, $t(146) = 1.59$, p

= .113, d = 0.25, focus/concentration, $t(146) = -1.23$, $p = .221$, $d = -0.22$, and self-focused attention, $t(145) = 0.83$, $p = .406$, $d = 0.14$ during the NAP task.

Correlations among Measures

Bivariate correlations were examined among the measures and bias scores prior to conducting analyses relevant to study hypotheses. Brooding was significantly correlated with reflective pondering ($r = .69$, $p < .001$), state rumination assessed via thought probes ($r = .21$, $p = .021$), STAI-State ($r = .56$, $p < .001$), STAI-Trait ($r = .70$, $p < .001$), the BDI ($r = .65$, $p < .001$), WMC ($r = -.27$, $p = .001$), and negative bias scores ($r = -.18$, $p = .031$). Brooding was positively correlated with all aforementioned measures with the exception of WMC and negative bias scores, indicating that higher brooding scores was associated with decreased WMC and increased inhibitory difficulties with negative words during the NAP task. See Table 4 for correlations among all measures.

Hypothesis 1: Effects of Brooding and Rumination Manipulation on Bias Scores

Prior to running two separate hierarchical multiple linear regression analyses on positive and negative bias scores, correlations were examined among the predictors (see Table 4). Due to concerns about collinearity with brooding, depression was not entered into the regression models. The overall models including WMC and brooding, $R = .19$, adjusted $R^2 = .02$, $p = .068$, and WMC, brooding, and condition, $R = .21$, adjusted $R^2 = .03$, $p = .085$, were marginally significant and accounted for a minimal amount of variance in negative bias scores (see Table 5).

Table 4

Bivariate Correlations among Measures and Bias Scores

	Brood	Reflect	State Rum	STAI-S	STAI-T	BDI	WMC	Neg Bias	Pos Bias	Mean	*SD*
Brood	1	.69**	.21*	.56**	.70**	.65**	-.27**	-.18*	.02	10.26	3.30
Reflect	-	1	.19*	.48**	.60**	.62**	-.09	-.19*	.09	9.18	3.43
StateRum	-	-	1	.25**	.23**	.23**	-.09	-.12	-.08	1.01	1.95
STAI-S	-	-	-	1	.83**	.73**	-.10	-.11	-.05	41.05	11.71
STAI-T	-	-	-	-	1	.82**	-.15	-.14	-.04	44.70	11.51
BDI	-	-	-	-	-	1	-.10	-.12	.04	8.87	7.49
WMC	-	-	-	-	-	-	1	-.02	.01	20.07	2.54
Neg Bias	-	-	-	-	-	-	-	1	.03	9.55	79.11
Pos Bias	-	-	-	-	-	-	-	-	1	1.73	75.13

Note. $N = 148$. Reflect = reflective pondering subscale of RRS, StateRum = ruminative thought probe total, WMC = working memory capacity.
$^{*}p < .05$. $^{**}p < .01$.

Table 5

Summary of Hierarchical Regression Analysis for Variables Predicting Negative Bias Scores

Variable	R^2	ΔR^2	F	p	B	SE	β
Step 1	.00	.000	0.07	.794			
WMC					-0.68	2.58	-0.02
Step 2	.04	.04*	2.74	.068			
WMC					-2.31	2.64	-0.07
Brooding					-4.72	2.03	-0.20*
Step 3	.05	.01	2.25	.085			
WMC					-2.57	2.65	-0.08
Brooding					-4.91	2.03	-0.21*
Condition					-14.44	12.92	-0.09
Step 4	.05	.00	1.75	.142			
WMC					-2.64	2.66	-0.09
Brooding					-4.79	2.05	-0.20*
Condition					-14.41	12.95	-0.09
Brood x Condition					2.15	3.95	0.05

Note. WMC = working memory capacity.
[a]$n = .065$.
*$p < .05$.

Brooding scores significantly predicted negative bias scores above and beyond WMC, $b = -4.72$, $t = -2.33$, $p = .027$, condition, $b = -4.91$, $t = -2.41$, $p = .017$, and the interaction of brooding and condition, $b = -4.79$, $t = -2.34$, $p = .021$. These findings indicated that higher brooding scores were related to lower negative bias scores (faster responses to NAP trials; increased inhibitory difficulties).

For positive bias scores, the interaction of brooding and condition marginally predicted positive bias scores, $b = 7.37$, $t = 1.94$, $p = .054$. However, the overall model was non-significant, $R = .17$, adjusted $R^2 = .00$, $p = .411$. Brooding, $b = 1.09$, $t = 0.56$, $p = .579$, WMC, $b = 0.45$, $t = 0.18$, $p = .861$, and condition, $b = 3.58$, $t = 0.29$, $p = .774$ did not account for a significant amount of variance in positive bias scores. Refer to Table 6 for estimated parameters.

Table 6

Summary of Hierarchical Regression Analysis for Variables Predicting Positive Bias Scores

Variable	R^2	ΔR^2	F	p	B	SE	β
Step 1	.00	.00	0.03	.875			
WMC					0.39	2.45	0.01
Step 2	.00	.00	0.07	.934			
WMC					0.61	2.55	0.02
Brooding					0.66	1.96	0.03
Step 3	.00	.00	0.07	.975			
WMC					0.68	2.57	0.02
Brooding					0.70	1.97	0.03
Condition					3.49	12.54	0.02
Step 4	.03	.03[a]	1.00	.411			
WMC					0.45	2.55	0.02
Brooding					1.09	1.96	0.05
Condition					3.58	12.42	0.02
Brood x Condition					7.37	3.79	0.16[a]

Note. WMC = working memory capacity.
[a] $n = .054$.

Due to concerns regarding the restricted range of dysphoric affect following the rumination manipulation, post hoc analyses were conducted using dysphoric mood percent change as a predictor to further determine whether dysphoric affect played any roles in inhibitory difficulties following the rumination manipulation. I proposed that brooding would predict inhibitory difficulties with negative words in individuals who experienced increased dysphoric affect following the rumination manipulation. Two multiple hierarchical regression analyses were conducted on the negative and positive bias scores using two steps: Step 1 included the entry of WMC, and step 2 included the entry of brooding and the dysphoric percent change mood score. The dysphoric percent change mood score was calculated with the following formula: {[(time 1 sadness - time 2 sadness ratings)/time 1 sadness] X 100}. Positive values corresponded to decreased sadness ratings following the manipulation while negative values corresponded to increased reported sadness. Brooding emerged as a non-significant trend for positive bias scores, $b = 5.97$, $t = 1.91$, $p = .061$. However, the overall model was non-significant, $R = .26$, adjusted $R^2 = .03$, $p = .175$. Working memory capacity, $b = 6.47$, $t = 1.54$, $p = .128$, and dysphoric percent mood change, $b = 0.22$, $t = 1.08$, $p = .283$, were non-significant predictors.

The overall model examining negative bias scores did not account for a significant amount of variance, $R = .18$, adjusted $R^2 = - .01$, $p = .521$, with WMC, $b = 4.02$, $t = 0.92$, $p = .361$, brooding, $b = -2.45$, $t = -0.75$, $p = .454$, and dysphoric percent mood change, $b = 0.19$, $t = 0.88$, $p = .381$ making insignificant contributions.

Note that multiple hierarchical linear regression analyses were conducted on the positive and negative bias scores including gender instead of condition in the models for exploratory reasons. Results did not yield significant results.

Hypothesis 1: Comparison Using Hierarchical Linear Modeling

To test the hypothesis that rumination would predict inhibitory difficulties (faster responses for NAP trials) for negative self-relevant information in participants following the rumination induction, a random effects ANCOVA was conducted in HLM. Results did not indicate significant differences in reference to trial valence (emotionality of words), $\gamma_{10} = 28.85$, $t(143) = 1.39$, $p = .168$, $d = 0.23$. However, results indicated a significant difference in response time to trial type, $\gamma_{20} = 33.35$, $t(143) = 2.11$, $p = .026$, $d = 0.35$, for control trials. For coding of trial type, control trials corresponded to a value of zero and NAP trials were assigned a value of 1. Examination of the intercept coefficient indicated that on average participants took longer to respond (33.35 ms mean difference) on NAP trials.

Brooding was found to be a significant predictor for the change in slope between control and NAP trials, $\gamma_{22} = -9.29$, $t(143) = -2.45$, $p = .015$, $d = -0.41$. These results indicated that increased brooding tendencies were associated with decreased reaction time (9.29 ms) between control and NAP trials (refer to Table 7 for estimated parameters and Figure 8).

Table 7

Summary of Hierarchical Linear Modeling Analysis for Variables Predicting Response Time

Fixed Effect	*B*	*SE*	*t*	*df*	*p*
Intercept Slope, β_0					
Intercept, γ_{00}	883.98	47.37	18.66	143	<0.001
WMC, γ_{01}	-7.59	4.52	-1.68	143	0.095
Brooding, γ_{02}	-16.78	12.59	-1.33	143	0.185
CondXBrood, γ_{03}	10.89	7.67	1.42	143	0.158
Condition, γ_{04}	-110.78	85.60	-1.29	143	0.198
Trial Valence Slope, β_1					
Intercept, γ_{10}	28.84	20.83	1.39	143	0.168
WMC, γ_{11}	1.19	2.12	0.56	143	0.574
Brooding, γ_{12}	3.89	6.18	0.63	143	0.531
CondXBrood, γ_{13}	-2.28	3.67	-0.62	143	0.535
Condition, γ_{14}	17.97	39.44	0.46	143	0.649
Trial Type Slope, β_2					
Intercept, γ_{20}	33.35	14.82	2.25	143	0.026*
WMC, γ_{21}	-1.17	1.83	-0.64	143	0.523
Brooding, γ_{22}	-9.29	3.79	-2.45	143	0.015*
CondXBrood, γ_{23}	4.93	2.58	1.91	143	0.058
Condition, γ_{24}	-55.03	29.12	-1.89	143	0.061

Note. WMC = working memory capacity, Condition = distraction or rumination, CondXBrood = interaction of condition and brooding, Trial Valence = negative or positive, Trial Type = control or NAP.
*$p < .05$.

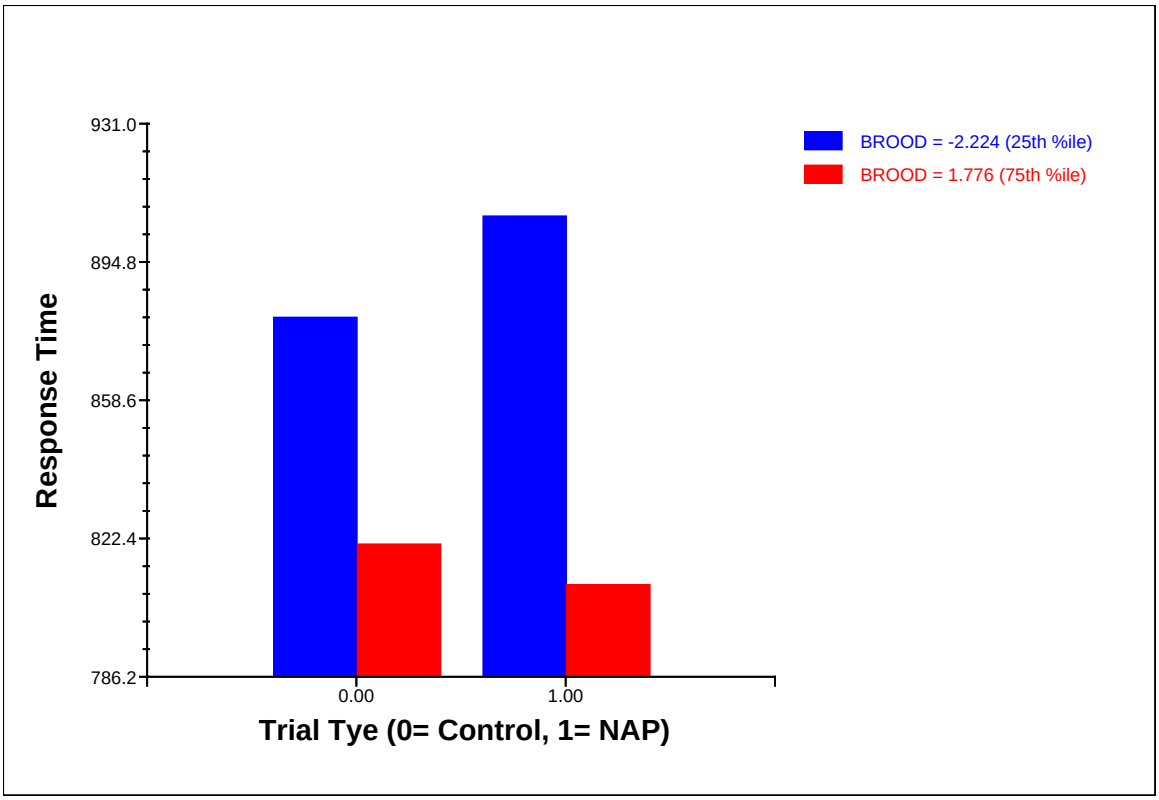

Figure 8. HLM Results: Relationship between brooding and trial type.

Though results indicate inhibitory difficulties with both negative and positive words, they are consistent with the near significant pattern documented with brooding and negative bias scores using multiple regression. Results also indicated that the difference in response time to trial type was not moderated by condition, $\gamma_{24} = -55.03$, $t(143) = -1.89$, $p = .06$, $d = -0.32$ or an interaction of condition and brooding, $\gamma_{23} = 4.93$, $t(143) = 1.91$, $p = .058$, $d = 0.32$. These findings were marginally significant indicating that brooders tended to respond faster to NAP rather than control trials, an effect that was most pronounced in the rumination condition (see Figure 9).

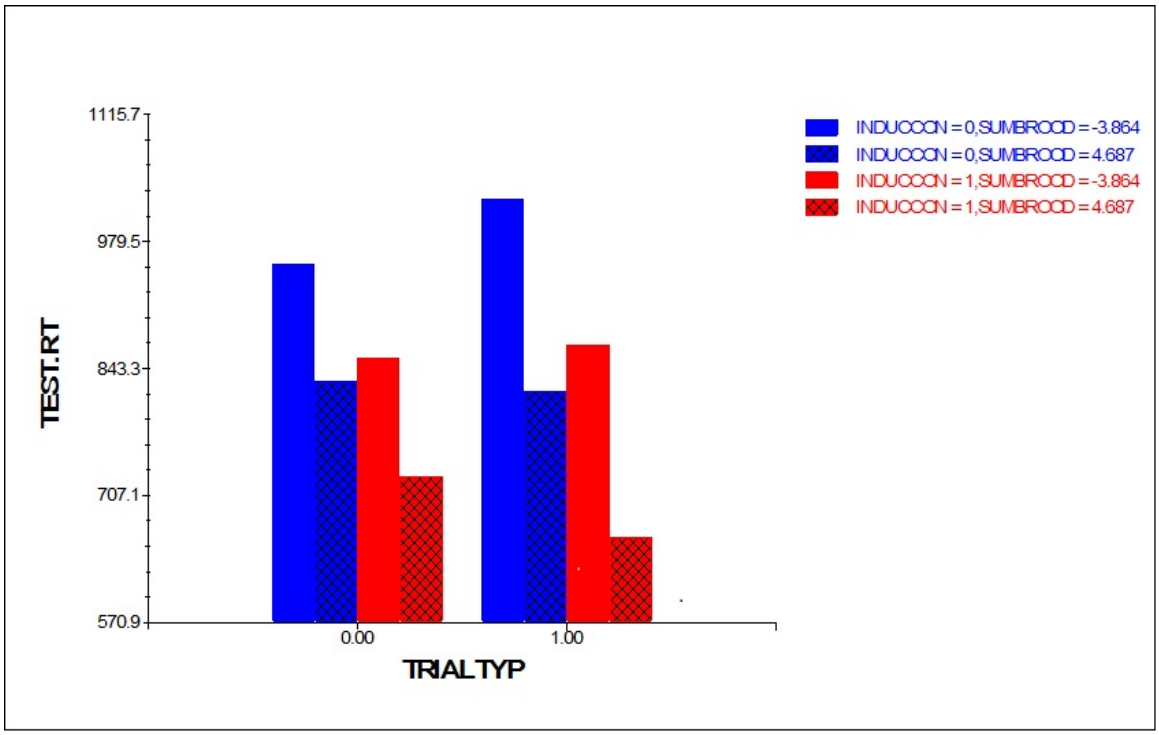

Figure 9. HLM Results: Relationship between interaction of brooding and condition and trial type. Note that for trial type, 0 = control and 1 = NAP and for INDUCCON, 0= distraction and 1 = rumination. Intervals for sumbrood (brooding score) correspond to the 25th and 75th percentiles.

Exploratory analyses were run including gender instead of condition in HLM due to significant gender effects in mood ratings. Again, results were non-significant.

Hypothesis 2: Mediational Role of State-based Rumination on Bias Scores

Prior to running the mediational analysis, bivariate correlations were assessed among WMC, state rumination assessed via thought probes, the RRS subscale of brooding, and bias scores (see Table 8). Significant correlations relevant to model predictions were found between brooding and working memory capacity (r = -.27, p = .001), brooding and state rumination (r = .21, p = .021), and brooding and negative bias scores (r = -.18, p = .031).

Table 8

Bivariate Correlations among WMC, State Rumination, Brooding, and Bias Scores

		WMC	State Rum	Brood	Neg Bias	Pos Bias
WMC	Pearson Correlation	1	-.09	-.27**	-.02	.01
State Rum	Pearson Correlation	-	1	.21*	-.12	-.08
Brood	Pearson Correlation	-	-	1	-.18*	.02
Neg Bias	Pearson Correlation	-	-	-	1	.03
Pos Bias	Pearson Correlation	-	-	-	-	1

Note: WMC = working memory capacity, State Rum = total of state rumination thought probes.
*$p < .05$. **$p < .01$.

To examine the roles that brooding, state-based rumination and WMC play on inhibitory difficulties with valenced information, a moderated mediation model was conducted in SPSS. Due to recent evidence recommending the utilization of bootstrapping techniques for moderation and mediation and the decreased sample size for the intended model ($n = 74$), analyses were conducted with PROCESS macros provided by Andrew Hayes (Hayes, 2009, 2013). Specifically, it was proposed that state rumination would play a mediating role in the relationship between brooding and inhibitory difficulties based on past research documenting deleterious effects of state rumination on inhibition in brooders (Curci et al., 2013; Watkins & Brown, 2002). Since WMC may impact the relationships between brooding and state rumination and brooding and inhibition, it was proposed that the mediational relationship would be further moderated by WMC (see Figure 1). Separate models were run by group condition (distraction and rumination) with the negative and positive bias scores as the dependent

variables. Models included the entry of brooding as the independent variable, state rumination (thought probe total) as the mediating variable, and WMC as the moderating variable.

For the distraction condition, brooding, b = -0.06, t = -0.12, p = .906, WMC, b = 0.02, t = 0.08, p = .936, and the interaction of brooding and WMC, b = 0.01, t = 0.33, p = .740, did not predict state rumination (path a) with the overall model only accounting for 4.64% of the variability in state rumination, R = .22, p = .341. Though the overall model accounted for 13.5% of the overall variance in negative bias scores, R = .37, p = .038, no individual predictors were significant. This indicates that the combined variance of the predictors rather than the individual predictors may be driving the results. In terms of positive bias scores for the distraction condition, there were no significant predictors with the overall model accounting for 6.25% of the variance, R = .25, p = .341. Thus, mediation is not supported for negative or positive bias scores for the distraction condition. See Tables 9 and 10 for estimated parameters.

For the rumination condition, brooding, b = 0.43, t = 0.66, p = .512, WMC, b = -0.03, t = -0.08, p = .936, and the interaction of WMC and brooding, b = -0.02, t = -0.44, p = .666 did not significantly predict state rumination (path a). However, the overall model predicting state rumination was significant, accounting for 10.6% of the variance, R = .33, p = .048. Brooding, b = -49.99, t = -1.21, p = .064, and the interaction of brooding and WMC, b = 2.48, t = 1.83, p = .072, were marginally significant predictors of negative bias scores.

Table 9

Moderated Mediation Model Estimations with Positive Bias Scores as the Outcome Measure

Variables	*R*	R^2	*F*	*B*	*SE*	*t*	LLCI	UPCI
				Distraction condition				
Outcome: State rumination	.22	.05	1.13					
Brooding				-0.06	0.50	-0.12	-1.05	0.93
WMC				0.02	0.26	0.08	-0.49	0.54
Brood X WMC				0.01	0.02	0.33	-0.04	0.06
Outcome: Pos Bias Score	.25	.06	1.15					
State rumination				-4.35	4.58	-0.95	-13.48	4.78
Brooding				15.21	19.00	0.80	-22.69	53.11
WMC				5.90	9.88	0.60	-13.82	25.62
Brood x WMC				-0.91	0.93	-0.97	-2.76	0.95
				Rumination condition				
Outcome: State rumination	.33	.11	2.78*					
Brooding				0.43	0.66	0.66	-0.88	1.75
WMC				-0.03	0.34	-0.08	-0.70	0.64
Brood X WMC				-0.01	0.03	-0.43	-0.08	0.05
Outcome: Pos Bias Score	.24	.06	1.06					
State rumination				-2.02	4.78	-0.42	-11.55	7.50
Brooding				18.40	26.44	0.70	-34.36	71.15
WMC				10.67	13.39	0.80	-16.03	37.38
State rum x WMC				-0.65	1.35	-0.48	-3.34	2.05

Note. LLCI = lower limit confidence interval, UPCI= upper limit confidence interval, WMC = working memory capacity, Brood x WMC = interaction term including brooding and WMC, state rum = state ruminative thought probe total, State rum x WMC = interaction term including state rumination and WMC.

*$p < .05$.

Table 10

Moderated Mediation Model Estimations with Negative Bias Scores as the Outcome Measure

Variables	*R*	R^2	*F*	*B*	*SE*	*t*	LLCI	UPCI
				Distraction condition				
Outcome: State Rumination	.22	.05	1.13					
Brooding				-0.06	0.50	-0.12	-1.05	0.93
WMC				0.02	0.26	0.08	-0.49	0.54
Brooding x WMC				0.01	0.02	0.33	-0.04	0.06
Outcome: Neg Bias Score	.37	.14	2.69*					
State Rumination				1.57	4.81	0.33	-8.02	11.15
Brooding				-26.02	19.95	-1.30	-65.81	13.78
WMC				-17.02	10.38	-1.64	-37.72	3.68
State Rum x WMC				-0.93	0.98	0.95	-1.02	2.88
				Rumination condition				
Outcome: State Rumination	.33	.11	2.78*					
Brooding				0.43	0.66	0.66	-0.88	1.75
WMC				-0.03	0.34	-0.08	-0.70	0.64
Brooding x WMC				-0.01	0.03	-0.43	-0.08	0.05
Outcome: Neg Bias Score	.30	.09	1.65					
State Rumination				-5.78	4.79	-1.21	-15.33	3.78
Brooding				-49.99	26.52	-1.89[a]	-102.91	2.93
WMC				-21.75	13.43	-1.62	-48.53	5.04
State Rum x WMC				2.48	1.36	1.83[b]	-0.23	5.18

Note: LLCI = lower limit confidence interval, UPCI= upper limit confidence interval, WMC = working memory capacity, Brood x WMC = interaction term including brooding and WMC, state rum = state ruminative thought probe total, State rum x WMC = interaction term including state rumination and WMC.

[a] $n = .064$. [b] $n = .072$

* $p < .05$.

Results indicated that higher brooding tendencies were associated with decreased bias scores (faster responses, greater inhibitory difficulties) with negative words. PROCESS provides conditional effects at values of the moderator as well. Results indicated that the direct effect of brooding on negative bias scores was most pronounced for individuals with average scores (WMC = 17.44). The overall model only accounted for 8.74% of the variance in negative bias scores, R =.30, p =.171, so findings should be interpreted cautiously.

For positive bias scores, state rumination, b = -2.02, t = -0.43, p = .673, brooding, b = 18.40, t = 0.70, p = .489, WMC, b =10.67, t = 0.80, p = .428, and the interaction of brooding and WMC, b = -0.65, t = 0.48, p = .633, were non-significant predictors. The overall model was non-significant, accounting for 5.77% of the variance in positive bias scores. Again, mediation was not supported.

Due to the restricted range of state rumination (see Figure 6) and aforementioned findings indicating that WMC may impact inhibition, post hoc analyses using a reduced moderation model were conducted. For exploratory reasons, two moderation models were conducted using PROCESS examining the moderating role of WMC on the relationship between brooding and inhibitory difficulties (see Figure 10). For negative bias scores, the overall model was significant, accounting for 5.33% of the variance, R = .23, p =.048. Brooding, b = -30.24, t = -1.88, p = .075, and WMC, b = -14.82, t = -1.80, p = .075, emerged as marginally significant predictors. However, the interaction of brooding and WMC was non-significant, b = 1.29, t = 1.60, p = .112. Though moderation is not supported, results indicate a trend towards higher brooding and

increased WMC predicting faster responses (decreased negative bias scores and increased inhibitory difficulties).

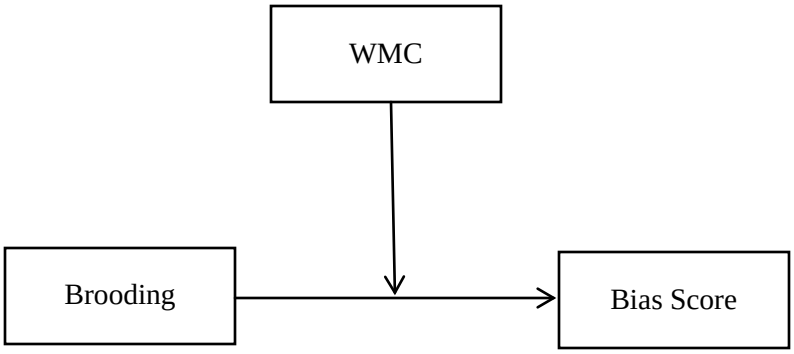

Figure 10. Moderation model including brooding as the IV, WMC as the moderator, and bias score as the dependent variable. Note that WMC = working memory capacity.

For positive bias scores, WMC, $b = 11.36$, $t = 1.42$, $p = .156$, brooding, $b = 22.58$, $t = 1.45$, $p = .150$, and the interaction of WMC and brooding, $b = -1.11$, $t = -1.42$, $p = .156$ were non-significant predictors. The overall model was non-significant as well, explaining only 1.47% of the variability in bias scores, $R = .12$, $p = .544$. Thus, moderation is not supported for positive bias scores as well (see Table 11 for model estimations).

Table 11

Moderation Model Estimations with Bias Scores as Outcome Measures

Outcome	Predictors	*R*	R^2	*F*	*B*	*SE*	*t*	LLCI	UPCI
Neg Bias Scores	Overall Model	.23	.05	2.70*					
	Brooding				-14.82	8.25	-1.80[a]	-31.14	1.49
	WMC				-30.24	16.09	-1.88[b]	-62.05	1.56
	Brood x WMC				1.29	0.81	1.60	-0.30	2.88
Pos Bias Scores	Overall Model	.12	.02	0.72					
	Brooding				22.58	15.59	1.45	-8.23	53.39
	WMC				11.36	8.00	1.42	-4.45	27.17
	Brood x WMC				-1.11	0.78	-1.42	-2.65	0.44

Note: LLCI = lower limit confidence interval, UPCI= upper limit confidence interval, WMC = working memory capacity, Brood x WMC = interaction term including brooding and WMC.

[a] $p = .075$. [b] $p = .062$.

*$p < .05$.

CHAPTER IV

DISCUSSION

My aims for this project were to broadly examine the roles that brooding, state based rumination assessed during a task, and WMC play on inhibitory control using stimuli that participants identified as self-referential and emotional (negative, positive, neutral). For the purposes of this study, cognitive control deficits were conceptualized as inhibitory difficulties exhibited during a negative affective priming (NAP) task (operationally defined as faster response times to emotional stimuli). I not only used stimuli with normative ratings on valence and arousal from the ANEW database (Bradley & Lang, 1999), but incorporated an additional rating task to ensure the words included in the NAP task were both emotional and self-referential to each individual participant. Since self-relevance further facilitates the ease of processing mood congruent information, this was an attempt to magnify difficulties with inhibition throughout the task. To assess state based rumination and examine its relationship with cognitive control, I incorporated a technique used in the mind wandering literature (McVay & Kane, 2009) where participants were prompted via thought probes presented to categorize their thoughts while completing the NAP task.

The first hypothesis was an attempt to replicate previous findings in which trait based brooding was associated with inhibitory difficulties using a NAP task (Joormann, 2006; Joormann & Gotlib, 2010). Though findings did not indicate group differences due

to induction type (rumination or distraction), brooding was found to marginally predict negative but not positive bias scores. Specifically, higher brooding scores were associated with greater inhibitory difficulties with negative information (lower bias scores so faster response times to negative words). This finding adds to a growing literature base documenting valence specific inhibitory difficulties in non-clinical samples (e.g., De Lissynder, Koster, Goubert, et al., 2012; Koster et al., 2013).

I did not replicate past research findings regarding significant group differences in dysphoria following a rumination/distraction manipulation (Watkins & Brown, 2002). Though the rumination condition rated themselves as experiencing lower positive affect than the distraction condition following the manipulation, they did not report a resulting increase in negative affect. This could be due to a number of reasons. First, the manipulation may not be a reliable tool for inducing negative affect in sub-clinical populations. Whitmer and Gotlib (2012) found that Nolen-Hoeksema's rumination manipulation (the same one used for current study) resulted in increased dysphoric affect only in the depressed group and not in healthy individuals. However, in a different study, Watkins and Brown (2002) found that the rumination manipulation resulted in increased dysphoric affect in both depressed and non-depressed individuals. Priming negative affect prior to the rumination induction may have impacted participants' responses to the rumination induction through attentional narrowing on the items and experiencing increased dysphoric affect as a result (Watkins & Brown, 2002; Wisco & Nolen-Hoeksema, 2009). In addition, some studies included a sample of depressed individuals who reported higher baseline ratings of dysphoria, and who may respond differently to

the manipulation as well (Lavender & Watkins, 2004; Watkins & Brown, 2002; Whitmer & Gotlib, 2012).

Another possible explanation is that participants in the current study did not expend sufficient effort and attention on the items during the induction to produce negative affect. This may be a more plausible explanation, as post hoc exploration of the data revealed that participants in the rumination condition expended less effort than those in the distraction condition during the induction. Though this information was gathered for a partial subset of the sample, it indicates that lack of effort may have negatively impacted the results in reference to consequential dysphoric affect. Although the rumination condition reported increased self-focused attention in comparison to the distraction condition, this suggests that factors other than self-focused attention (e.g., narrowed attention on negative content, baseline dysphoria, situational stressors) may be required to influence mood. Negative affect plays a critical effect in triggering and maintaining the ruminative cycle (Joormann, 2010); thus it was an elemental component that may have negatively affected the findings for all study hypotheses.

Results examining the first hypothesis including a dysphoric change score instead of manipulation condition (rumination or distraction) conducted for exploratory purposes due to the aforementioned concerns indicated a trend towards inhibitory difficulties in dysphoric brooders who were asked to self-reflect with positive rather than negative words. Past research has documented both emotion-specific (negative) and general difficulties inhibiting both positive and negative words. Though this finding was marginally significant and should be interpreted cautiously due to the restricted range of

dysphoric affect, it suggests that self-relevance may contribute above and beyond valence to inhibitory difficulties (positive rated as more self-relevant than negative words) in individuals asked to self-reflect. Examining the self-relevance of stimuli included in experimental tasks is indicated to further explore this relationship.

Interestingly, I also documented significant gender effects and an interaction between gender and condition for negative affect. Specifically, males rated themselves as more dysphoric than females, an effect that was most pronounced in the rumination condition. This sample included a low number of males overall (n = 33, 22%), so it is unclear if this gender effect would reliably be seen with comparable sample sizes of males and females. In addition, the rumination induction did not result in increased dysphoric affect in males and subsequent analyses including gender yielded no significant gender effects. This implies that ruminative processing resulting in increased dysphoric affect may play a greater role in inhibitory difficulties during a NAP task rather than baseline differences in mood between males and females.

As a comparative statistical approach, I also examined the first hypothesis using HLM. Again, no significant group differences based on manipulation were found. Though results indicated no significant overall differences in response time to the emotionality of the words (negative or positive trials), on average participants took longer to respond on NAP trials rather than control trials. So, regardless of the emotionality of the word trial (negative or positive), participants responded slower to trials where the valence of the distractor in the prime trial matched the valence of the target in the test trial rather than trials where the distractor in the prime trial (neutral word) was unrelated

to the valenced target. This finding that participants respond slower to NAP trials rather than control trials is conceptually similar to participants exhibiting higher bias scores (decreased inhibitory difficulties).

However, brooding was found to significantly predict reaction times for the change in slope for trial type (control or NAP). Results indicated that on average for individuals with higher brooding tendencies, there was less of a difference in response time between control and NAP trials with these participants responding faster on NAP trials. Additionally, the interaction of condition and brooding was marginally significant in predicting response time. Brooders responded faster to NAP trials; a pattern most pronounced in the rumination condition. These marginally significant results may be attributable to the inefficacy of the rumination manipulation. However, this overall pattern of responding to emotional information illuminates the inconsistencies documented in previous research where some studies find valence-specific effects and others do not (e.g., De Lissnyder, Koster, Everaert, et al., 2012; Joormann & Gotlib, 2012).

Though past research typically conceptualizes inhibitory difficulties through a computational average of responses with bias scores, utilizing multi-level statistical analysis on individual data points may offer enhanced sensitivity to detect effects that represent changes within each participant and across groups (Raudenbush & Byrk, 2002). My findings using HLM indicate that bias score averages may not adequately represent changes in response time from trial to trial within individuals and may clarify reasons for

mixed findings in reference to valence-specificity, as using bias scores may overestimate variability in analyses.

Lastly, I hypothesized that state based rumination following a rumination induction would mediate the relationship between brooding and inhibitory difficulties with negative information. In addition, working memory capacity was predicted to play moderating roles in the relationships between brooding and state rumination and brooding and bias scores. This moderated mediation model was run separately on the rumination and distraction conditions including brooding as the predictor, state rumination as the mediator, WMC as the moderator, and bias scores as the outcome (negative and positive). State rumination did not emerge as a mediator in the relationship between brooding and negative and positive bias scores for the distraction or rumination condition.

However, findings indicated that brooding predicted negative (marginally significant) but not positive bias scores only for the rumination condition. Specifically, higher brooding scores were associated with less inhibitory control (lower negative bias scores) with negative words. This finding is consistent with results from the first hypothesis using multiple hierarchical regression. Results also indicated a trend towards increased WMC and higher brooding tendencies predicting inhibitory difficulties with negative words. This trend was replicated in post hoc analyses conducted with a reduced moderation model to further examine the relationships among WMC, brooding and inhibition. It was expected that lower working memory capacity would be associated with inhibitory difficulties, as working memory is limited. However, results indicated a

trend in the opposite direction with increased WMC predicting inhibitory difficulties with negative words. It has been proposed that difficulties with inhibition increase as working memory loads increase (e.g., Baddeley et al., 2001). The NAP task required relatively low demands on cognitive control (fairly simple, quick), therefore there may be other variables (e.g., self-relevance of stimuli, environmental factors, limited number of high brooders) impacting these results. Though marginally significant, this finding is unexpected and warrants future study to clarify the relationships between brooding, WMC and inhibition.

It is interesting that brooding did not predict state rumination in the mediated moderation model. The simple regression analysis conducted on the entire sample including only brooding as a predictor was significant, indicating that higher brooding tendencies predicted increased state rumination during the NAP task. Brooding no longer significantly predicted state rumination in the moderated mediation model, a finding that may be 'washed out' by the inclusion of unnecessary predictors in the model (brooding alone significantly predicted state rumination). It is important to note that the range and frequency of state ruminative thoughts was quite limited in the sample. This in combination with the absence of negative affect in response to the rumination induction may have contributed to the lack of findings. However, these findings indicate that even in the absence of negative affect, brooders who are asked to self-reflect may experience more ruminative thoughts during a task.

Interestingly, researchers have documented differences in neural activation due to inhibiting valenced information in healthy brooders, but have failed to find behavioral

manifestations of inhibitory difficulties associated with reaction time during an executive functioning task (e.g., Lo, Lau, Cheung, & Allen, 2012; Vanderhasselt et al., 2011). So, for ruminators who are asked to self-reflect, there may be differential neural activation that may not manifest in behavioral indices (inhibitory difficulties) on tasks in the absence of significant negative affect. Kühn, Vanderhasselt, De Raedt, and Gallinat (2012) showed that neural correlates of rumination were consistent with inhibitory and suppressive processes in healthy individuals. Thus, the deleterious effects of rumination may be most pronounced when there is a combination of brooding, depressive symptoms, salient triggering events and negative affect. Additionally, these effects may be dependent upon task demands, state rumination, and an individual's ability to flexibly maintain relevant information in mind.

In addition, the findings with the proposed moderated mediation model may be impacted due to the exclusion of determining factor(s) in the model[1] and predictors accounting for minimal variance individually. These findings may also be affected by limitations discussed previously (e.g., utilizing bias scores, limited range and low frequency of state rumination). Again, the deleterious effects of state rumination on WMC may only be evident in the presence of significant negative affect.

Limitations

Though this study was novel in its approach to incorporate self-referential information and assess state-based rumination using the NAP design, there were many

[1] Please note that models were run including sad mood and WMC as moderators in the mediational relationship between brooding and bias scores. The overall models did not account for a significant amount of variance in bias scores.

issues that should be discussed. First, the proportion of participants who did not meet study word rating criteria was exceptionally high (45%). The words from the ANEW database were chosen based on normative ratings so that only highly emotional and neutral words were included in the rating task. This could indicate that the normative ratings are not representative of the population (specifically college students at UNCG) and would represent a considerable methodical issue for investigators. Additionally, the large proportion of students who did not find the words to be emotional and self-relevant in the current study calls into question the assumptions regarding contributing factors associated with depressive rumination and inhibitory processes made in past research. If stimuli are not considered to be emotional or neutral to individual participants, it may be other factors such as arousal that may be driving past findings.

Other factors that may contribute to the large proportion of excluded participants are participant and situational variables. The word rating task was completed remotely at participants own will, so a variety of confounding factors could play roles (e.g., inattention, fatigue, confusion with word meanings). Anecdotally speaking, some participants required clarification as to word meanings during the lab visit for words they previously rated and identified as emotionally self-relevant. Examination of word frequency ratings provided by Bradley and Lang (1999) indicated that negative words were not as commonly used as positive and neutral. Thus, reading level of participants may confound results using these stimuli. As such, it may be informative for investigators to assess the emotionality and personal relevance of data used with their participants to address the aforementioned concerns.

As discussed earlier, the rumination induction was ineffective in priming negative affect. My sample included non-depressed individuals with lower baseline levels of dysphoria. For these individuals asked to self-reflect, the rumination items may not prime negative self-evaluative thoughts. Additionally, individuals who are not experiencing dysphoric affect may not relate to the rumination items at that time and/or may experience less difficulty using effective emotion regulation skills (e.g., distraction) to manage their distress. Dysphoric affect may be a critical factor in triggering and maintaining the ruminative cycle; therefore, all study hypotheses were most likely impacted by the absence of dysphoric mood. Importantly, it will be critical to ensure that individuals are in a negative mood state prior to beginning the task to facilitate mood congruent processing of ruminative content and to assess how state-based thoughts may impact cognitive control and interfere with a task. Using mood priming techniques (e.g., music, written excerpts) prior to the rumination induction may ensure increased dysphoric affect and also enhance the likelihood of engaging in depressive ruminative thought in the moment.

Additionally, the range of state-based ruminative thoughts was limited and quite low in the sample, which may affect statistical sensitivity in detecting indirect effects in the proposed models. The overall low frequency of state rumination may be attributable to problems with validity and a failure to capture thoughts that are ruminative-focused within the design. State rumination was defined specifically as focusing on current mood and reasons why the participant feels the way he/she does. However, depressive rumination, or more specifically brooding, encompasses a broader range of functioning

that may not have been captured by one statement. I required participants to identify their preceding thought and categorize it based upon how accurately it reflected one of the eight statements. This skill requires insight and effort, as some thoughts may not fit neatly into the presented categories. Though an alternative method requiring participants to orally state their thoughts may decrease difficulties with categorization, this method may also be influenced by experimenter bias and social desirability. Overall, my findings suggest that continuing efforts to conceptualize and measure state rumination are warranted. Building upon my study by using thought probes including various statements to assess the different components of brooding (e.g., negative self-evaluation) throughout tasks may be an important first step.

In addition, the conclusions from my current findings cannot be generalized to a clinically depressed sample, as this study did not include clinically depressed individuals and a high frequency of trait brooders. Depressed individuals may respond differently to the NAP task, especially when self-referential information is included in the design. Past research has documented differences with inhibitory difficulties between trait ruminators and clinically depressed participants, so it will be important to include participants who meet criteria for major depressive disorder and an increased number of *healthy* trait brooders to fully address study hypotheses.

Lastly, the NAP task provides only a snapshot of the multiple processes involved in inhibition and no conclusions can be made from these findings related to underlying differential processes (e.g., working memory updating). In addition, some researchers have questioned the validity of the NAP task in assessing inhibitory difficulties (Mayr &

Buchner, 2007; Rothermund, Wentura, & De Houwer, 2005). Therefore, a growing number of researchers are utilizing paradigms such as task switching and emotional flanker tasks that can more adequately answer questions regarding specific mechanisms underlying inhibition (difficulty dispelling no longer relevant information or processing new information).

Summary

In summary, this was the first study to examine state based rumination during a NAP task using techniques modified from the cognitive literature. Though hypotheses were not fully supported, I documented both general and emotion specific inhibitory difficulties. In terms of valence specificity, brooding marginally predicted inhibitory difficulties with negative words regardless of whether participants completed a rumination or distraction condition when bias scores were used in statistical analyses. However, results from multilevel statistical analyses indicated that brooders experienced inhibitory difficulties with both positive and negative words during NAP trials. Though marginally significant, this pattern was most pronounced in the rumination condition.

Importantly, I showed a relationship between rumination in the moment and trait brooding even in the absence of significant negative affect triggered by a rumination induction in a non-clinical undergraduate sample. I also incorporated stimuli (words) into the cognitive task that were verified by each participant to be both self-relevant and emotional to maximize the likelihood that self-focus would be maintained throughout the task. The results of this study add to a growing literature base clarifying the relationship between a trait based ruminative style and state rumination and the impact that both play

on “cognitive control,” indicating that state rumination may not play deleterious effects on inhibitory difficulties in the absence of dysphoric mood. Models conceptualizing rumination (Joormann, 2010; Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008) include negative mood state as a trigger for the ruminative cycle. Rumination may then consume available resources by maintaining ‘irrelevant emotional information’ in memory that interferes with the processing of new information. Research including paradigms that assess underlying inhibitory processes and state based rumination is indicated to further clarify the effects of depression, brooding, and state rumination on inhibitory processes within working memory.

Future Directions

As research is rapidly growing, the variety of methodologies assessing the relationship between rumination and cognitive control is increasing. Demeyer, De Lissnyder, Koster, and De Raedt (2012) used a prospective study design assessing the role of cognitive control difficulties (using the internal shift task) on rumination and depressive symptoms in a sample of depressed individuals in remission. Results indicated that rumination mediated the relationship between baseline cognitive control deficits and depressive symptoms reported at the one year follow up (Demeyer et al., 2012). De Lyssnyder et al. (2012) also used a prospective design to examine the impact that cognitive control deficits (measured by an internal switching cognitive task) play in the relationship between ruminative responses and stressors in an undergraduate student population. Results indicated that cognitive control impairments predicted ruminative response styles and a reciprocal relationship was proposed to exist between cognitive

control and rumination, as research has not only provided evidence that cognitive control impairments predict ruminative response styles (De Lissynder, Koster, Goubert, et al., 2012; Zetsche & Joorman, 2011), but that rumination predicts cognitive control impairments as well (De Raedt & Koster, 2010; Koster et al., 2011; Whitmer & Banich, 2007).

It will be important to build upon past research and use a variety of designs (e.g., prospective, experimental), cognitive tasks (e.g., task switching, WMU), statistical methods, and indices (e.g., neuro-imaging, behavioral) that can clarify underlying processes associated with depression, rumination, brooding and state-based rumination. Additionally, the information gained from this variety in methodology may better inform the conceptualization of trait and state-based rumination and further elucidate the conditions under which depressive rumination may result in maladaptive outcomes. It has been suggested that state and trait rumination differentially affect cognitive control. Whereas trait depressive rumination may be associated with difficulties dispelling no longer relevant information from memory, state rumination may be related to difficulties encoding new information in memory (Whitmer & Gotlib, 2012).

Building upon the design of the current study and incorporating techniques similar to those used in the mind wandering literature will be essential in teasing apart the relationship between a trait based style of responding and thoughts that represent in the moment processing of information. In regards to word stimuli used in designs, results from the current study indicate that it may be informative to assess the emotionality of the included stimuli to ensure designs are incorporating information that is deemed

emotional to each individual participant. Some word stimuli may be associated with increased arousal, and may be not be representative of the emotional and self-focused content associated with depressive ruminative thoughts that has been conceptualized by Nolen-Hoeksema (1991, 2000, 2004). Therefore, it may be important in the future to include examples of rumination focused thoughts in the task design to further facilitate ruminative processing. In addition, clarifying and expanding the definition of state rumination is indicated.

The results of the current study add to the growing literature base documenting inhibitory difficulties with emotional information in healthy brooders and provide insight into the role that state rumination may play on processes within working memory. It may also be informative to use multiple measures of cognitive control and rumination (as previous research have used different versions of RRS scales) in study designs to ascertain what components of ruminative processing (e.g., abstract and analytical) may differentially impact behavioral indices of inhibitory processing. Further delineating these differences will clarify whether depressive rumination lies on a continuum of functioning or represents different processes in clinically depressed and healthy brooders.

Understanding the underlying mechanisms contributing to depressive ruminative processing often anecdotally seen in clinical settings can also guide treatment. If an individual can become "unstuck" from the ruminative cycle by focusing attention away from negative information while experiencing dysphoric affect, this may provide clinicians with an invaluable tool to supplement current empirically based treatments for treating depression. Attentional training utilizing paradigms that target attentional

orienting and disengagement has been shown to be effective in decreasing depressive symptoms (e.g., Amir, Beard, Burns, & Bomyea, 2009; Wells & Beevers, 2010), and research examining the impact of cognitive training on inhibitory processes associated with rumination is growing. Daches and Mor (2014) showed that inhibitory difficulties could be decreased in brooders through cognitive training using a modified NAP design. Though the results did not generalize to decreased depressive symptomatology, it highlights the utility that executive functioning tasks could have on risk factors associated with depression. Bormyea and Amir (2014) also showed that tasks enhancing working memory capacity decreased the likelihood of experiencing intrusive thoughts. Rumination is associated with difficulties utilizing effective coping strategies in the face of dysphoric mood with problems inhibiting the processing of negative and/or irrelevant information in working memory playing contributing roles (Joormann, 2010; Koster et al., 2011). Thus, improving one's ability to process competing information (relevant in the face of irrelevant) in combination with enhancing working memory capacity may result in minimizing costs in the face of ruminative processing. Since working memory encompasses a variety of cognitive processes, future research should continue to clarify contributing mechanisms in both a clinically depressed population and a sub-clinical population of ruminators, as these individuals may be vulnerable to impaired psychological functioning in the face of stressors.

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APPENDIX A

STUDY DOCUMENTS

Computer Rating Task

For this task, you will be asked to answer questions regarding your reactions to words. Please press the button to continue.

Please rank the following adjectives in the order in which you relate to the most and make you feel pleasant (excitement, pride, happiness, joy).

Please answer the following questions regarding the adjectives you have selected.

What does the meaning of this word make you feel?

1—unpleasant, 2—neutral, 3—pleasant)

How much do you associate or relate to the meaning of this word?

1—not at all, 2—a little, 3—a lot)

Please rank the following adjectives in the order in which you relate to the most and make you feel unpleasant (anger, frustration, sadness, anxiety, fear).

Please answer the following questions regarding the adjectives you have selected.

What does the meaning of this word make you feel?

1—unpleasant, 2—neutral, 3—pleasant)

How much do you associate or relate to the meaning of this word?

1—not at all, 2—a little, 3—a lot)

Please select the adjectives that do not that evoke any emotion within yourself.

Please answer the following questions regarding the adjectives you have selected.

What does the meaning of this word make you feel?

1—unpleasant, 2—neutral, 3—pleasant

How much do you associate or relate to the meaning of this word?

1—not at all, 2—a little, 3—a lot

*Adapted from Phan et al., 2004

ID: ___ Date: _____

Form: _____

Please draw a line below indicating how you feel AT THIS MOMENT.

Happy

_____

0 10 20 30 40 50 60 70 80 90 100

not at all very much so

Sad

_____

0 10 20 30 40 50 60 70 80 90 100

not at all very much so

Anxious

_____

0 10 20 30 40 50 60 70 80 90 100

not at all very much so

Thought Probes

During the task, you may find yourself thinking about something other than the task. We are interested in what types of things people think about during a task like this. In order to examine this, the computer will periodically ask you what you were *just* thinking about. It is perfectly normal to think about things that are not related to the task. We will give you several categories of things that people might think about during a task like this. Please try your best to honestly assess your thoughts and choose a category that best describes your thoughts at the time when we ask.

Press the space bar to continue…

As you are performing the task, you will periodically see a screen like this:

What were you just thinking about?

Please press the designated number on the keyboard:

1. The task (Select this number if your thoughts were about the words you saw, their meaning, or if you were thinking about pressing the button).

2. Task experience/performance (Select this number if your thoughts were about how well you are doing on the task).

3. Everyday things (Select this number if your thoughts were about normal, routine, everyday things you did recently or that you'll be doing sometime later).

4. Current state of being (Current mood state, reasons why you feel this way)

5. Personal worries (Select this number if your thoughts were about life concerns or worries, for example regarding your health and well-being, a relationship with a friend or family, or a goal you have yet to achieve).

6. Daydreams (Select this number for fantasies or thoughts disconnected from reality. For example, thoughts about being at the beach instead of doing this task might be considered daydreaming).

7. External environment (Select this number if you were thinking about something in your environment, other than this task. For example, you would select this choice if you were thinking about the hum of the computer or the quality of light in the room.

8. Other (Select "other" ONLY if your thoughts do not fit into any of the other category options).

As soon as you finish responding to the question about your thoughts the task will resume, so promptly place your fingers back on the SR box.

*Adapted from McVay & Kane, 2009

RRS

Instructions: People think and do many different things when they feel sad, blue, or depressed. Please read each of the items below and indicate whether you never, sometimes, often, or always think or do each one when you feel sad, down, or depressed. Please indicate what you generally do, not what you think you should do.

		never	sometimes	often	always
1.	I think about how alone I feel	1	2	3	4
2.	I think “I won’t be able to do my job if I don’t snap out of this.”	1	2	3	4
3.	I think about my feelings of fatigue and achiness	1	2	3	4
4.	I think about how hard it is to concentrate	1	2	3	4
5.	I think “What am I doing to deserve this?”	1	2	3	4
6.	I think about how passive and unmotivated I feel	1	2	3	4
7.	I analyze recent events to try to understand why I am depressed	1	2	3	4
8.	I think about how I don’t seem to feel anything anymore	1	2	3	4
9.	I think “Why can’t I get going?”	1	2	3	4
10.	I Think “Why do I always react this way?”	1	2	3	4
11.	I go away by myself and think about why I feel this way	1	2	3	4
12.	I write down what I am thinking and analyze it	1	2	3	4

	never	sometimes	often	always
13. I think about a recent situation, wishing it had gone better	1	2	3	4
14. I think “I won’t be able to concentrate if I keep feeling this way.”	1	2	3	4
15. I think “Why do I have problems other people don’t have?”	1	2	3	4
16. I think “Why can’t I handle things better?”	1	2	3	4
17. I think about how sad I feel	1	2	3	4
18. I think about all my shortcomings, failings, faults, and mistakes	1	2	3	4
19. I think about how I don’t feel up to doing anything	1	2	3	4
20. I analyze my personality to try to understand why I am depressed	1	2	3	4
21. I go someplace alone to think about my feelings	1	2	3	4
22. I think about how angry I am with myself	1	2	3	4

Ruminative Thoughts Questionnaire

Please read each of the items below and indicate how many times you had each thought or a similar thought whilst you were doing the random number task. Please indicate what you were thinking not what you think you should think.

	Never	Once	Twice	More than Twice
1. Why is this happening to me?	1	2	3	4
2. Why can't I feel better?	1	2	3	4
3. Why do I feel like this?	1	2	3	4
4. What am I doing wrong?	1	2	3	4
5. Why can't I get things right?	1	2	3	4
6. Why do I have these problems?	1	2	3	4
7. What causes these things to happen?	1	2	3	4
8. What caused this problem/feeling?	1	2	3	4
9. How can I make sense of this?	1	2	3	4
10. How can I understand this?	1	2	3	4
11. Why do I react the way I do?	1	2	3	4
12. What did I do wrong?	1	2	3	4
13. What do these feelings mean?	1	2	3	4
14. Why do I get this way sometimes?	1	2	3	4
15. What causes things to go wrong?	1	2	3	4
16. What is the reason/cause behind all this?	1	2	3	4
17. Why am I moody?	1	2	3	4
18. Why do I feel like a failure?	1	2	3	4
19. What's wrong with me?	1	2	3	4
20. How come I feel depressed?	1	2	3	4

*Watkins & Brown, 2002

Manipulation Instructions

Rumination Condition Instructions

This is a task in which you must focus your attention on series of ideas and thoughts. Use your ability to visualize and concentrate. Please continue with the task for the entire 5 minutes.

Think about "what your feelings might mean," "the physical sensations you feel in your body," "the possible consequences of the way you feel," "how quick/slow your thinking is right now."

Distraction Condition Instructions

This is a task in which you must focus your attention on series of ideas and thoughts. Use your ability to visualize and concentrate. Please continue with the task for the entire 5 minutes.

Think about "the layout of the local shopping centre," "the size of the Golden Gate Bridge," "two birds sitting on a tree branch," "the shape of the continent of Africa."

Spend 8 minutes focusing on the specific thoughts.

*Adapted from Lyubomirsky & Nolen-Hoeksema, 1995

Post-Study Questionnaire

Questions to examine the participants' reactions to the study (to be administered at the end of the experimental session, just before debriefing):

How much effort did you put into the task prompting you to visualize different items and concepts?

Responses can range from 0 → did not try at all to 100 → tried very hard throughout

Overall, how difficult was it to focus on the items in the task prompting you to visualize different items and concepts?

Responses can range from 0 → very easy, not difficult at all to 100 → not easy at all, extremely difficult

Rate the extent to which you thought about yourself during the task prompting you to visualize different items and concepts. This includes thinking about how you were feeling, about what was going on in your mind.

Responses can range from 0 → did not think about myself at all to 100 → was thinking about myself constantly

Please list some examples of thoughts you had during the task prompting you to visualize different items and concepts. You can list up to 5.

How much effort did you put into the computer task?

0) No effort at all (I did not try to do well at all)

1) Minimal or little effort (I tried at times, but mainly did not not)

2) Moderate amount of effort (I tried most of the time)

3) A lot of effort (I tried very hard throughout)

Overall, how difficult was the computer task?

1) Not difficult at all (extremely easy)
2) Somewhat difficult (easy at most times)
3) Moderately difficult (easy at very few times)
4) Extremely difficult (not easy at all)

Rate the extent to which you thought about yourself during the computer task. This includes thinking about how you were feeling, about what was going on in your mind, or about your appearance.

Responses can range from 0 → did not think about myself at all to 100 → was thinking about myself constantly

Please list some examples of thoughts you had during the computer task. You can list up to 5.

What do you think was the purpose of the study?

Happy Mood Induction

Below is series of five two-minute clips from movies and television shows. Please indicate which of the following you would like to watch that would increase your positive affect.

The Princess Bride

Pretty Woman

Finding Nemo

Willy Wonka and the Chocolate Factory

Ferris Bueller's Day Off

Lion King

Big Bang Theory

Family Guy

APPENDIX B

PERMISSION TO REPRODUCE INSTRUMENTS

From: Tamara Foxworth [mailto:tefoxwor@uncg.edu]
Sent: 07 December 2011 19:26
To: Watkins, Edward
Subject: Rumination Scale (RTF)

Dr. Watkins,

I am currently a 4th year graduate student at UNC-Greensboro, and was interested in obtaining the RTF measure you used in your study inducing rumination published in 2002 (Rumination and executive function in depression: an experimental study). Your RTF scale is the only state-based rumination measure I could find. I am more interested in examining the frequency of intrusive ruminative thoughts throughout my experimental paradigm, not just trait-based measures of ruminative response style.

I appreciate your time and look forward to hearing back from you!

Tamara Foxworth, M.A.
Graduate Student
UNC-G Clinical Psychology
ph: 336-256-0058
fax: 336-334-5754

---------- Forwarded message ----------
From: **Watkins, Edward** <E.R.Watkins@exeter.ac.uk>
Date: Sun, Jan 15, 2012 at 3:56 PM
Subject: RE: Rumination Scale (RTF)
To: Tamara Foxworth <tefoxwor@uncg.edu>

Dear Tamara

Thank you for your enquiry. Please see attached a copy of the requested questionnaire.

Professor Edward Watkins

Professor of Experimental and Applied Clinical Psychology & Chartered Clinical Psychologist

Co-founder and Director of Mood Disorders Centre and Sir Henry Wellcome Building for Mood Disorders Research

Mood Disorders Centre

Sir Henry Wellcome Building for Mood Disorders Research

College of Life and Environmental Sciences

University of Exeter

EX4 4QG

01392 724692

---------- Forwarded message ----------
From: **Michael Kane** <mjkane@uncg.edu>
Date: Thu, Jan 19, 2012 at 8:13 AM
Subject: Re: Mind Wandering
To: Tamara Foxworth <tefoxwor@uncg.edu>
Cc: Matthew Meier <memeier@uncg.edu>

Hi Tammy,

I'm copying this message to Matt.

Matt, when you get a chance, could you please cut and paste the text of our thought current probes for Tammy? And perhaps some of the text from the instructions that include/lead up to these probes? Thanks!

Please let me know if you want to discuss any of this further, Tammy.

Best,

Mike