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ORIGINAL ARTICLE

Trait Rumination is Associated with Enhanced Recollection of Negative Words

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Abstract Rumination is associated with Major Depressive Disorder (MDD). To better understand this association, researchers have begun to investigate the relationship between rumination and cognitive biases that are linked to MDD. To date, several studies have found that rumination is related to negatively biased memory, but it is not clear whether this relationship is independent of depressive symptoms. To address this question, the present study examined 97 healthy Caucasian women between the ages of 18 and 25. Participants performed an encoding task of self-referent adjectives, followed by a recognition task. The recognition task utilized a remember/know paradigm to separately examine recollection-based memory and familiarity-based memory. Trait rumination was assessed using the ruminative response scale (RRS). Results indicate that high trait rumination is associated with selective enhancement of recollection for negative words compared to neutral words and a trend toward selective enhancement for recollection for negative words compared to positive words. Trait rumination does not affect biases in overall recognition sensitivity or familiarity.

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Introduction

Rumination is a form of self-reflection that involves repetitive, intrusive thoughts, often centering on emotionally negative content. A sizeable literature now suggests that rumination is associated with a multitude of negative outcomes (Mor and Winquist, 2002; Watkins 2008) including anxiety disorders, eating disorders, binge drinking, and self-harm. Perhaps most notably, rumination is strongly associated with Major Depressive Disorder (MDD). Rumination can increase the severity of depressive symptoms (Nolen-Hoeksema et al. 2008) and the tendency to ruminate (hereafter referred to as trait rumination) is an important predictor of onset of depression (Just and Alloy 1997; Nolen-Hoeksema 2000).

One pressing question is *why* individual differences in trait rumination are associated with other negative outcomes, most notably depression. To address this question, researchers have begun to examine cognitive vulnerability factors associated with rumination and depression. Theoretical models presented by Nolen-Hoeksema and colleagues describe rumination as a self-focused processing style that leads individuals to direct their attention on their depressed mood, thereby increasing or maintaining their dysphoric state (Nolen-Hoeksema 1991). The self-focused nature of rumination suggests that biased self-referential processing may be a key factor linking rumination and depression. Self-referential processing refers to the process of associating internal and external stimuli to one's self (Northoff et al. 2006). Evidence suggests that stimuli that are processed with reference to the self increases

subsequent memory performance compared with stimuli that are processed non self-referentially (Denny and Hunt 1992; Watkins et al. 1992; Turk et al. 2008).

A handful of studies employing self-referential processing paradigms indicate a link between rumination and preferential memory for negative compared to neutral or positive information. Depressed individuals who ruminate may demonstrate negative biases in the retrieval of autobiographical memories (Lyubomirsky et al. 1998). Further, dysphoric (but not euthymic) individuals show biased recall for self-referent negative words learned following a rumination induction (Moulds et al. 2007). And lastly, trait rumination in depressed adults is associated with enhanced recall for negative compared to positive words learned earlier in the session, but this effect does not withstand control for depressive symptoms (Joormann et al. 2006). In sum, extant data indicate an association between rumination and memory biases among depressed or dysphyric individuals. However, what remains unclear is whether this link relies solely on the presence of depressive symptoms and/or is the outcome of a mood-congruency effect, which refers to the tendency to retrieve information that is consistent with one's mood (Mayer et al. 1995; Ruiz Caballero and Moreno 1993). It may be, for instance, that the depressed individuals included in studies to date were experiencing a negative mood during the experimental procedure and therefore, reported greater recall for negative stimuli. Given that a majority of studies examining the link between rumination and memory biases has been among depressed individuals, what remains unknown is whether there is a direct relationship between rumination and memory biases or, if this relationship is merely a common effect of depression or negative mood. In order to address this question, studies examining the relationship between rumination and memory biases among non-depressed individuals are warranted.

Moreover, there is a growing consensus that memory is not a unitary process, and hence, it may be that rumination is linked to negative biases in some memory processes but not others. Two memory processes that have gained substantial empirical attention are recollection and familiarity (Yonelinas 2002). These two memory processes are behaviorally and neurally dissociable (Yonelinas et al. 2005), and are believed to work at least partially independently during encoding, where recollection-based memory may be associated with deeper, more elaborative processing (Yonelinas 2002). At test, recollection of a stimulus involves recalling contextual details associated with its presentation, while familiarity involves a judgment of having seen the stimulus before, but without any memory of associated details. Though they represent very different processes, recollection and familiarity both contribute to overall memory accuracy, meaning that deficits in one of these processes may be masked by the other process (Yonelinas 2002).

A recent study by Jermann et al. (2009) examined the potentially unique roles of these two memory processes in a clinically depressed sample. Using a Remember/Know/Guess paradigm with negative, positive, and neutral words, the authors examined whether clinically depressed individuals exhibited differential biases in recollection (i.e., "Remember") versus familiarity (i.e., "Know") for each word valence compared with their non-clinical counterparts. Participants were presented with 22 verbs of each valence for a total of 66 verbs. Following this encoding phase, participants engaged in the recognition phase in which words from the encoding phase were presented along with distractor words. Participants were instructed to respond to each word with "Remember" (i.e., if the word, when recognized, elicited an association, thought, or feeling), "Know" (i.e., if the word felt familiar but did not bring to mind other details) or "Guess" (i.e., if they were unsure if they previously viewed the word). Results indicated that there were no between-group differences in recollection, familiarity, or guessing for any word valence. Depressed individuals, however, reported fewer "Know" responses in general compared with the control group. Moreover, individuals within the depressed group exhibited greater recollection for negative than positive and neutral words, although there were no within group differences for familiarity or guessing. These findings suggest that there may be an independence of recollection and familiarity memory biases among depressed individuals. Although reasons for the reported bias in recollection and not familiarity are unclear, this finding might potentially be explained by the presence of rumination among the depressed group. Indeed, given that rumination is a process associated with repetitive, elaborative processing, it is, by definition, highly reflective of recognition-based, rather than familiarity-based memory. The authors' findings of an overall reduction of Know (i.e., familiarity-based) responses in the depressed group compared with the control group also indicates a general tendency toward more detailed and elaborative processing which might also be accounted for by rumination, rather than depression. Unfortunately, this study did not include a measure of rumination and therefore, future studies should examine whether rumination, when controlling for depression, is associated with a similar bias in memory.

In order to address the limitations in the existing literature, we examined the relationship between rumination and memory biases in a large non-depressed sample. Selecting a non-depressed sample allowed us to more directly evaluate whether the relationship between rumination and memory biases exists independent of depressive symptoms. Selecting this sample also allows us to avoid sources of ambiguity that remain even after statistically

controlling for symptoms, particularly when symptoms are highly correlated with the construct of interest but not necessarily causally antecedent to it (Briere and Elliott 1993). We first examined the association between rumination and overall memory performance. We then aimed to more precisely expound the relationship between rumination and memory biases by examining two components of memory: recognition and familiarity. Consistent with previous reports by Jermann et al. (2009), we hypothesized that trait rumination is correlated with biased recollection but not familiarity of negative words. Finally, as secondary analyses, we examined the relationship between two subtypes of rumination and overall memory performance, recognition, and familiarity: (1) reflective pondering, which refers to the purposeful engagement of problem-solving, and (2) brooding which refers to a non-effective, constant comparison of one's current situation with an unachievable standard (Treynor et al. 2003). Finally, although our non-depressed sample allows us to control for the effects of depressive symptoms, given reports of the mood-congruency effect among non-clinical samples (Mayer et al. 1995; Ruiz Caballero and Moreno 1993), we also elected to rerun our analyses controlling for state negative affect.

Method

Participants

Participants were 97 healthy, 18–25 year old Caucasian women (median age: 22) recruited via advertisements and web-based listings on the Stanford University campus and in the San Francisco Bay Area. Women were targeted because they are twice as likely as men to develop affective disorders and because they are more likely than men to display ruminative tendencies (Nolen-Hoeksema et al. 1999).

All potential participants were screened using a phone interview based on the Structured Clinical Interview for DSM-IV (SCID; First 1997). Eligible participants: (1) were native English speakers, (2) performed within the normal range on vocabulary and abstract reasoning sections of the Shipley Institute of Living Scale (Shipley 1940), (3) had no indication of any current psychiatric disorder within the past year or substance abuse within the past 6 months, and 4) had scores no higher than 13 (minimal symptoms) on the Beck Depression Inventory (BDI-II; Beck et al. 1996). Of 477 potential participants who completed the phone screen, 177 were eligible, and 99 completed the study reported here. Two were excluded because they did not perform above chance on the memory task at the $P = 0.01$ level, leaving a total sample size of 97.

Procedure

This study was conducted in three parts. The first of these was the eligibility screen, which was administered over the phone and generally took between 10 and 20 min. Eligible participants came into the laboratory for two experiment sessions on two different days, approximately 1 week apart. Each session lasted roughly 2 h. During session one, participants provided informed consent, completed a series of questionnaires (including assessment of rumination and depressive symptoms) and completed several cognitive tasks not relevant to the present study. During session two, participants filled out additional questionnaires (including assessment of negative state affect) and completed four computer-based information-processing tasks. The second of the computer tasks was the encoding task (the learning phase), which was followed 20 min later by the recognition task (the memory test). All computer tasks were programmed with E-Prime, and participants were compensated at a rate of $15/h.

Trait Rumination

Rumination was assessed using the 22-item Ruminative Responses Scale (RRS) (Treynor et al. 2003). This measure asks participants how often they engage in ruminative thought patterns when they are feeling sad or down. Factor analyses reveal that the RRS can be broken down into two subscales: brooding (sample $\alpha = 0.75$) and reflective pondering (sample $\alpha = 0.80$) (Treynor et al. 2003). As a whole, the RRS shows high internal consistency (sample $\alpha = 0.90$) and good test–retest reliability ($r = 0.67$ over 1 year, Treynor et al. 2003).

Negative Affect

Negative affect was assessed using the negative affect (NA) subscale of the Positive and Negative Affect Schedule—State (PANAS—S; Watson and Clark, 1999). The PANAS—S consists of 20 mood adjectives that participants rate on a five-point scale based on how they are feeling at the moment. The PANAS has acceptable internal consistency (sample α for NA scale $= 0.69$) and excellent convergent and discriminant validity (Humrichouse et al. 2007).

Self-referential Encoding Task

The self-referential encoding task consisted of 150 trials. During each trial, a word stimulus appeared in the middle of a computer screen preceded by the phrase "You are." Prior to the task, the participant was instructed to apply each word to herself. Stimuli consisted of 25 words from

each of three valence categories: negative, neutral, and positive for a total of 75 word stimuli that were each presented twice. Negative, neutral and positive words came from the Affective Norms for English Words (ANEW; Bradley et al. 1998) word set (40%) and from a word set piloted for the present study (60%). Words did not differ significantly by category on frequency or word length, and positive and negative words did not differ significantly on arousal ($P > 0.10$). All words were non-physical, trait-related, and abstract adjectives (e.g. friendly, skeptical, talented, etc.).

The encoding task was programmed to have a set word category order but to randomly select words from each category during each session. Category order was balanced such that there was roughly an equal (33%) probability that a word in any given category would be followed by a word in the same or either of the other two categories. However, the ordering was modified slightly so that no more than three words of any stimulus type (negative, neutral, positive, old, or new) appeared consecutively. This semi-random ordering was intended to address potential confounds of stimulus association and order effects. A neutral word was used at the beginning and at the end of the task to limit the influence of recency and primacy effects on indices of valenced memory.

Each word appeared on the screen for 2 s (followed by a 1 s rest), during which time the participant pressed a button on the keyboard to indicate the location of a probe appearing in the vicinity of the word (data related to the probe not presented here). The task was self-advancing and lasted a total of 10 min.

Recognition Task

A recognition task was completed approximately 20 min after the encoding task. An unrelated cognitive task was administered in the intervening time. The recognition task used a two-step remember/know paradigm (Tulving 1985), which has been used successfully by other researchers to distinguish between recollection (e.g., "remember") and familiarity (e.g., "know") (Yonelinas and Jacoby 1995).

In the recognition task, the participant was again presented with word stimuli preceded by the phrase "You are". On each trial, the participant was first asked whether the word stimulus was old (she had seen it in the encoding task) or new (she had not seen it in the encoding task). If the participant identified the word as old, she was then asked whether she remembered the word (R), or knew the word (K). Participants were told that while "remembering" entails recollection of the specific circumstances surrounding the presentation of a word (e.g., remembering that the word brought to mind a prior experience, that it made them think about themselves), "knowing" represents an equal measure of certainty that the word was in the encoding list, but without any of the associated details of the word's presentation. To motivate participants to do their best, they were told that their performance on this task would be compared to others' performance.

The recognition task used a total of 150 words, with 50 in each category (negative, neutral and positive), and 25 of each 50 being old words and the other 25 being new words (foils). Foils were selected from the same word sets as encoding words—ANEW (52%) and study-piloted (48%)—and by the same criteria. As in the encoding task, words for the recognition task were presented in a fixed, semi-random order. This task was not timed and advanced only when participants made a response.

Data Reduction and Analysis

Three memory indices were calculated for each subject within each of the three word valences, for a total of nine indices per subject. First, we calculated *d'* as an index of overall memory performance/sensitivity (MacMillan and Creelman 2005). Specifically, *d'* is calculated based on the difference between a participant's hit rate (i.e., correct identifications) and false alarm rate (i.e., incorrect identifications) such that the larger the positive difference between one's hit rate and false alarm rate, the higher the subject's sensitivity. To separately examine the contributions of recollection and familiarity, we followed Yonelinas and colleagues' guidelines for using remember and know responses for words categorized as old to calculate a recollection index and a separate familiarity index (Yonelinas et al. 1998). The calculations for each index within each valence category was as follows:

$$\text{RECOLLECTION} = (\text{R\_old} - \text{R\_new})/(1 - \text{R\_new}).$$

$$\text{FAMILIARITYold} = \text{K\_old}/(1 - \text{R\_old}).$$

$$\text{FAMILIARITYnew} = \text{K\_new}/(1 - \text{R\_new}).$$

"R_old," and "R_new," refer to the proportion of old and new words that participants responded to with "Remember." "K_old" is the proportion of old words that participants responded to with "Know." "K_new" refers to the proportion of new words that participants responded to with "Know" and therefore, is a false alarm measure that is akin to the false alarm measure of Remember (see last column in Table 1). The Familiarity variable was the d' calculated from "FAMILIARITYold" and "FAMILIARITYnew."

To assess the relationship between trait rumination and memory performance for negative, neutral, and positive words, we used repeated-measures general linear models (GLMs) with word valence as a repeated factor and RRS as

Table 1 Mean hit rates and false alarm rates for negative, neutral, and positive words

	Hit rate	Remember and hit rate	False alarm rate	Remember and false alarm rate
Negative	0.77	0.45	0.29	0.09
Neutral	0.72	0.46	0.17	0.05
Positive	0.73	0.44	0.30	0.10
Overall	0.74	0.45	0.25	0.08

Note: Hit rate is the proportion of correct identifications (i.e., old words that were identified as "old," and correct rejections (i.e., new words that were identified as "new"). Remember and Hit rate is the proportion of old words that were both identified as "old" and marked as "remember." False alarm rate is the proportion of new words that were identified as "old." Remember and False alarm rate is the proportion of new words that were identified as "old" and marked as "remember."

a continuous predictor. Significant overall GLMs were followed by post hoc, pair-wise contrasts.

Results

Descriptive Data

Mean score on the RRS was 42.67, with a standard deviation of 11.15, which is similar to what has been reported in previous non-clinical samples (Moulds et al. 2008; Raes and Hermans 2008) and approximately 1 standard deviation lower than what has been reported in clinically depressed samples (Raes et al. 2006; Goring and Papageorgiou 2008). Mean score and standard deviation were 4.30 and 3.38, respectively on the BDI, and 12.72 and 2.83, respectively on the NA component of the PANAS—S. Figure 1 illustrates participants' performance on measures of sensitivity, recollection, and familiarity for each word valence. Interestingly, participants exhibited greater overall memory performance/sensitivity, recollection, and familiarity for neutral words versus negative and positive words. Although statistically significant, difference scores were small and potentially reflect a saliency effect. While 25 words were of neutral valence and 50 words were affectively-valenced, it could be that the smaller proportion of non-valenced words were more salient because they were fewer and, thus, more easily recalled. Table 1 illustrates participants' overall hit rate and false alarm rates for each word valence.

We also examined associations among total trait rumination and the RRS subscale scores (i.e., brooding and reflection) using Pearson's correlations. Results indicated a modest correlation between brooding and reflection ($r = 0.37$, $P < 0.001$). Both brooding and reflection were highly correlated with rumination total scores (brooding, $r = 0.74$, $P < 0.001$; reflection, $r = 0.71$, $P < 0.001$).

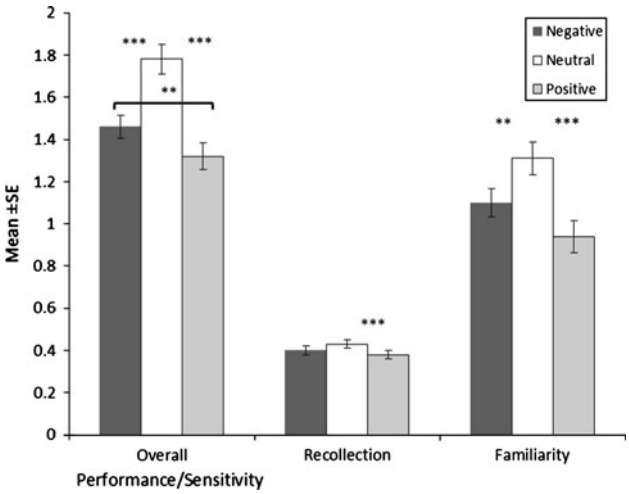

Fig. 1 Overall performance/sensitivity, recollection, and familiarity for *negative*, *neutral*, and *positive* words: descriptives and pair-wise t-tests

Trait Rumination and Memory Biases: Overall Memory Performance/Sensitivity, Recollection, and Familiarity

Examination of overall memory performance/sensitivity (*d'*) scores by repeated measures GLM revealed no main effect of RRS, $F(1, 95) = 0.04$, $P = 0.84$, and no interaction between RRS and valence, $F(2, 190) = 0.18$, $P = 0.84$.

Examination of recollection scores by repeated measures GLM revealed no main effect of RRS, $F(1, 95) = 1.19$, $P = 0.28$, but the interaction of valence and RRS was significant, $F(1, 190) = 4.32$, $P = 0.02$. To interpret this interaction, we performed all pair-wise post hoc tests (negative vs. neutral, negative vs. positive, neutral vs. positive). Bonferroni adjustments were applied for multiple comparisons, such that the statistically significant cut-off was a P-value of $P < 0.02$. When comparing negative versus neutral, the valence by RRS interaction was significant, $F(1, 95) = 7.40$, $P = 0.008$. There was a trend toward a significant valence by RRS interaction when comparing negative and positive words, $F(1, 95) = 4.41$, $P = 0.04$ and there was no significant valence by RRS interaction when comparing neutral and positive words, $F(1, 95) = 0.04$, $P = 0.84$. Figure 2 shows the relationship between RRS score and recollection for each word valence.

Familiarity also did not vary by RRS, $F(1, 94) < 0.001$, $P = 0.99$ or by the interaction between RRS and valence, $F(2, 94) = 0.13$, $P = 0.88$.

Secondary Analyses: RRS Subscales (Brooding, Reflection) and Negative Affect

In secondary analyses, we first examined the relationships between memory and RRS subscales. The brooding by

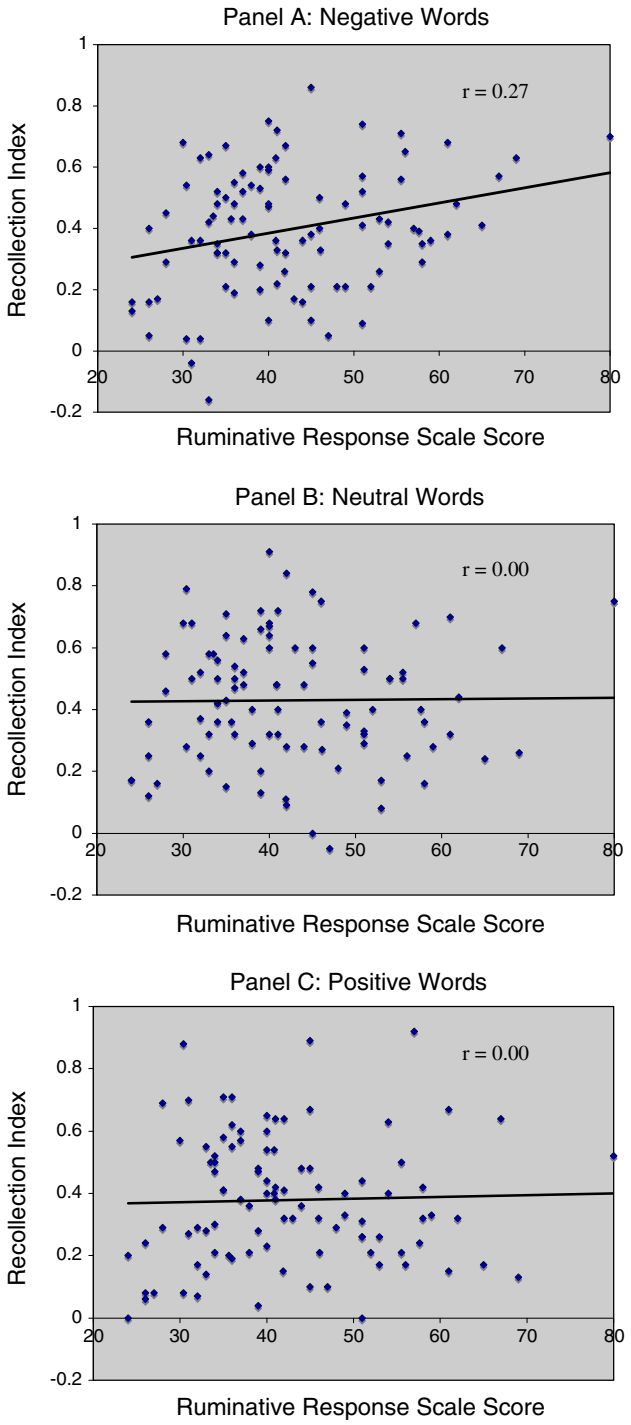

Fig. 2 Trait rumination predicts recollection memory for *negative*, but not *neutral* or *positive* words

valence interaction was not significant for overall memory performance/sensitivity, recollection (all $Ps > 0.32$), or familiarity. Similarly, there was no reflection by valence interaction for overall memory performance/sensitivity or familiarity ($Ps > 0.4$). However, there was a significant reflection by valence interaction for recollection, $F(1.75, 165.86) = 3.86$ (Greenhouse-Geisser corrected for violation of sphericity), $P = 0.03$. Post hoc contrasts with Bonferroni adjustments indicated a trend toward significance when comparing negative versus neutral words, $F(1, 95) = 4.05$, $P = 0.05$. There was a significant difference when comparing negative versus positive, $F(1, 95) = 5.34$, $P = 0.02$, indicating increased recollection of negative words compared with positive words. There was no significant difference between neutral and positive words, $F(1, 95) = 0.73$, $P = 0.40$.

Finally, we performed an additional analysis to test the effects of controlling for negative state affect as assessed by the NA component of the PANAS—S on the observed association between rumination and recollection. The interaction between rumination and valence remained significant when negative affect was included in the analysis, $F(1.76, 165.86) = 5.04$ (Greenhouse-Geisser corrected for violation of sphericity), $P = 0.01$. Post hoc tests using Bonferroni adjustments indicated the effect was attributable to a difference between the negative and neutral condition, $F(1, 94) = 7.24$, $P = 0.008$, as well as negative and positive condition, $F(1, 94) = 6.02$, $P = 0.02$, rather than a difference between positive and neutral, $F(1, 94) = 0.03$, $P = 0.86$. Negative affect did not interact with valence to predict familiarity, $F(2, 186) = 0.14$, $P = 0.87$, or overall memory performance/sensitivity, $F(2, 188) = 0.32$, $P = 0.73$.

Discussion

The results of this study suggest that while rumination is not associated with negative biases in overall memory performance (*d'*) or familiarity-based memory performance, high trait rumination is associated with enhanced recollection memory for negative words in young, healthy females. Further, the relationship between RRS and recollection remains significant after controlling for state negative affect.

Implications for Rumination

Since rumination often centers on negative content, the present finding that trait rumination is associated with selective enhancements in one type of memory for negative words provides support for the intuitive suggestion that rumination should be linked to negative memory biases. What is more, the finding that such biases appear only in the type of memory believed to be associated with deep, elaborative encoding suggests a possible mechanism for this link: rumination centered on negative information may alter post-attentional processing in a way that privileges that information. This mechanism has been suggested previously in studies of social anxiety (Mellings and Alden 2000; Edwards

et al. 2003). Though our study design prevents us from drawing causal conclusions, it is possible that habitual rumination precedes and causally contributes to the formation of stable negative information processing biases by this privileged processing mechanism. Moreover, this information processing biases may transactionally maintain rumination, thereby creating a reciprocal cycle that renders one vulnerable to depression and other forms psychopathology.

An unexpected, secondary finding was that the observed association between rumination and recollection was driven primarily by individual differences in reflective pondering. This finding was unexpected given evidence that brooding is more consistently associated with negative outcomes (Treynor et al. 2003; Joormann et al. 2006). However, one potential theoretical explanation is that the thought patterns involved in reflective pondering are more conducive to elaborative encoding than the patterns associated with brooding. Brooding items on the RRS center on self-blame (e.g. "[I] Think 'Why can't I handle things better?"). This type of generalized negative reaction may divert resources from the stimulus that elicited the problem and/or reaction. In contrast, reflection items center on problem solving (e.g. "[You] Go away by yourself and think about why you feel this way") which facilitates an identification and analysis of the stimulus eliciting the reaction. Such drawn out consideration prolongs the processing of the original stimulus and may encourage deep encoding.

Implications for Clinical Science

Linking rumination to cognitive biases in the absence of depressive symptoms is a step toward understanding the relationships between these constructs, and provides some evidence that risk factors for depression that are frequently studied in isolation may be inter-related. It is possible that some risk factors are downstream results of other factors, and it is also possible that downstream risk factors mediate the effects of more fundamental risk factors. For example, if rumination is a cause of negative memory biases, therapeutic efforts to reduce rumination may diminish memory biases. At the same time, if the effects of rumination are partially mediated by negative memory biases, then high ruminators may be good targets for treatments that aim to diminish memory biases (e.g., MacLeod et al. 2004). Either way, further disentangling and understanding the connections between risk factors should aid efforts to choose useful targets in the treatment of depression.

Limitations and Future Directions

One key limitation of this study is the restricted nature of the sample, as the participants' psychological profile, age range, gender and race may restrict generalizability. Indeed, a sample of non-depressed ruminators is not representative of the general population of ruminators. However, the psychological health of our participants was necessary to create an internally valid design and allowed us to accomplish the key objective of investigating the relationship between rumination and cognitive biases independent of depressed mood. In addition, a past history of depression was not assessed in this study. Therefore, the results are only representative of individuals who are not *currently* depressed. Future studies selecting individuals without past or current depression would more effectively examine whether the biases reported in this study independently characterize rumination.

There is some debate as to the accuracy of the remember/know paradigm in assessing recollection. Though this paradigm has been reliably used in many studies to separately examine recollection and familiarity, it has been suggested that slight alterations in the instructions for remember/know tasks can lead participants to misinterpret the difference between remember and know responses, which can produce results that diverge from other measures of recollection (Rotello et al. 2005). In the present study, participants confirmed they understood the distinction between remember and know before beginning the task, but future studies should replicate these findings utilizing a remember/know paradigm or alternative paradigms such as process-dissociation and receiver operating characteristic procedures, response-speed methods, and item/associative recognition comparisons (Yonelinas 2002).

Perhaps the most significant limitation of the present study is that it uses a correlational rather than an experimental design, restricting our ability to make causal inferences. If rumination were found to be associated with negative biases in recollection in a study where rumination was experimentally induced, this would establish the plausibility of the hypothesized mechanism for the effects observed in this study.

It should be noted that one study has indeed attempted such an experimental approach, and obtained null results in their euthymic group (Moulds et al.2007). However, their criterion for euthymia (BDI-II < 5) was quite strict, while their criterion for dysphoria (BDI-II > 13) was quite liberal, and they obtained significant results in their dysphoric group. As such, it is possible that an examination of a broader range of euthymic individuals (e.g., BDI-IIs between 0–13 and 0–19) might have yielded evidence for a connection between experimentally induced rumination and memory bias. Still, even under ideal conditions, experimental approaches may be unable to detect causal relationships between rumination and biased memory that do not take immediate effect; it may be that the repeated

practice of rumination eventually leads to memory biases, but short-term rumination inductions are inadequate to produce them.

If only long-term trait rumination is associated with memory biases, longitudinal studies that track multiple sources of depression risk over time could prove useful. Such studies should begin with completely healthy, never-depressed participants, measure rumination and memory, and follow participants longitudinally, noting which develop major depression and which do not. If such a study were to support a mediation role for cognitive biases, this would provide insight into avenues for preventative clinical interventions in individuals who habitually ruminate.

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