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Abstract

Background and Objectives: Rumination, a maladaptive cognitive style of responding to negative mood, is thought to be maintained by a variety of cognitive biases. However, it is unknown whether rumination is characterized by interpretation biases.

Methods: Two experiments examined the link between rumination and interpretation biases, revealed in lexical-decision tasks (LDT). A homograph with both benign and ruminative or otherwise negative meaning was presented on each trial and followed by a letter string, to which participants responded by judging whether it was a word or a non-word. Letter strings were non-words or words related or unrelated to one meaning of the homograph.

Results: In both experiments, faster latencies to respond to targets related to the ruminative meaning of the homographs were produced by students with higher scores on self-report measures of rumination. Moreover, these biases were associated with both brooding, the maladaptive form of rumination, and reflection, the more adaptive component. No measure of rumination was significantly correlated with general biases toward negative meaning (Experiment 1) or with threatening interpretations of homographs (Experiment 2).

Limitations: The paucity of available rumination-related homographs dictated the use of non-fully randomized stimuli presentation (Experiment 1) or the use of only one set of the meanings associated with the homographs (Experiment 2).

Conclusions: Rumination is associated with a tendency to interpret ambiguous information in a rumination-consistent manner. This tendency may exacerbate ruminative thinking and can possibly be a target for future intervention.

Keywords: rumination, brooding, interpretation bias, information processing

Interpretation Bias Characterizes Trait Rumination

Rumination, a cognitive habit of repetitively analyzing one's problems, concerns, and negative feelings (Nolen-Hoeksema, 1991), is a particularly maladaptive form of self-focus (Mor & Winquist, 2002). Rumination predicts depression both prospectively and concurrently (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008), and is considered a transdiagnostic factor in psychopathology (e.g., Nolen-Hoeksema & Watkins, 2011) because measures of rumination predict symptoms of anxiety, eating disorders, substance abuse and alcohol abuse. (See Aldao, Nolen-Hoeksema, & Schweizer, 2010, for a recent meta-analysis.)

Although originally construed as a unitary construct, later research identified two subtypes of ruminative thinking: brooding and reflection (Burwell & Shirk, 2007; Schoofs, Hermans, & Raes, 2010; Treynor, Gonzalez, & Nolen-Hoeksema, 2003; Whitmer & Gotlib, 2011). Whereas brooding is a perseverative, passive, and judgmental focus on one's mood, reflection is a contemplative, intentional pondering of one's mood in order to engage in problem solving. Brooding is considered the maladaptive aspect of rumination and is the form of rumination that is most associated with psychopathology (e.g., Nolen-Hoeksema, Stice, Wade, & Bohon, 2007; Watkins, 2009).

It has been argued that rumination exerts its negative effects by making negative content more accessible (Nolen-Hoeksema et al., 2008). Indeed, ruminators, and particularly brooders, exhibit a variety of cognitive biases that maintain negative emotional states. Specifically, recent research has shown that brooding is associated with preferential attention to negative and self-related information and to difficulty ignoring, inhibiting, or forgetting such information (Bernblum & Mor, 2010; Daches, Mor, Winquist, & Gilboa-Shechtman, 2010; Joormann,

Dkane, & Gotlib, 2006), as well as with memory deficits such as decreased specificity of autobiographical memory (Debeer, Hermans & Raes, 2009).

Although interpretation biases play a central role in theories of depression and anxiety (Beck, 1967), they have so far not been examined in relation to rumination. Interpretations are thought to maintain negative emotional states by strengthening negative self-beliefs and reinforcing negative memory biases (e.g., Hertel et al., 2008). Interestingly, several recent studies have failed to find evidence for interpretive biases in depression (e.g., Bisson & Sears, 2007; Lawson & MacLeod, 1999; Mogg, Bradbury, & Bradley, 2006). Indeed, self-referential processing may be necessary for these biases to emerge (e.g., Hindash & Amir, 2012; Wisco & Nolen-Hoeksema, 2010), and ruminative thinking may thereby provide the link between depression and the tendency to infuse ambiguous stimuli with negative meaning.

Negative interpretations of an ambiguous event can exacerbate the tendency to ruminate by fueling future thoughts of its now disambiguated meaning; in this way interpretation biases can contribute to the spiraling relation between rumination and negative mood states (Nolen-Hoeksema et al., 2008). Interpretation biases have also been related to worry (Hayes, Hirsch, Krebs, & Mathews, 2010; Hirsch, Hayes, & Mathews, 2009), a repetitive and negative cognitive style similar to rumination but focused on the future instead of the past. (For a review see Nolen-Hoeksema et al., 2008.) Moreover, dysphoric individuals who were induced to ruminate showed an interpretation bias, favoring negative interpretations of emotionally ambiguous content (Hertel & El-Messidi, 2006). However, despite the importance of interpretation biases in understanding psychopathology and the indirect evidence concerning their relation to ruminative thinking, there is to date no research showing that trait ruminators hold negative interpretation biases.

In two experiments, we investigated the link between rumination and interpretation biases. Several questions guided our research. We explored whether rumination is specifically associated with interpretation biases instead of merely with a tendency to respond quickly to stimuli with negative meaning, as depressed individuals have been shown to do (see Mathews & MacLeod, 2005). We further examined whether interpretation biases are specific to brooding or are also linked to overall rumination and reflection. Finally, we evaluated the content specificity of the biases. To answer these questions, we used a paradigm developed by Richards and French (1992) to document interpretation biases in anxiety. In the original paradigm, participants performed a lexical decision task in which they were presented with a priming word followed by a target to be judged as a word or non-word. On critical trials, the primes were homographs with both threatening and benign meanings. Targets were words related to either the benign or the threatening meaning of the prime, unrelated benign and threatening words, and non-word letter strings. Richards and French found that anxious participants made faster decisions in response to targets that were related to the threatening meaning of the prime. In the current experiments, we were interested in whether the use of homographs with benign and ruminative meanings (e.g., *bitter, finished*) would invite a similar bias on the part of individuals with the habit of ruminating.

Experiment 1 used a design identical to that of Richards and French (1992). In this study, benign and negative homograph-related and unrelated targets were used to contrast an interpretive-bias account with a general-negativity account. We predicted that rumination, and brooding in particular, would be characterized by faster latencies to respond to the target denoting the ruminative meaning of the homograph, compared to the target denoting its benign meaning. This facilitation was expected for the negative targets that were related to the preceding

homographs (denoting an interpretation bias) but not for negative but unrelated targets (denoting a negativity bias). In Experiment 2, to examine the specificity of the interpretation bias to rumination-related material, homographs with negative meanings that were either ruminative or threatening were used. We predicted that rumination would be associated with speeded responding to related as compared to unrelated targets denoting ruminative meanings but not when the targets denoted threatening meanings.

Experiment 1

Method

Participants and Design

Participants were 27 female and 22 male students at the Hebrew University of Jerusalem, who took part in the study in return for course credit or payment. Participants' mean age was 25 (SD = 2.70). All participants were native Hebrew speakers.

Materials

Lexical decision task. The task consisted of 80 trials, with each trial presenting a prime and a target. Primes were Hebrew homographs that each had a benign meaning as well as a negative, rumination-related meaning. Targets were non-words on half of the trials and words on the other half. Word targets belonged to one of four categories: words related to the negative meaning of the homograph (related-negative, e.g., bitter-*resentful)*, words related to the benign meaning of the homograph (related-benign, e.g., bitter-*chocolate)*, benign words that were unrelated to either of the homograph meanings (unrelated-benign, e.g., bitter-*branch)*, and negative words that were similarly unrelated (e.g., bitter-*dirt)*.

Because no homograph norms are available in Hebrew, we followed the procedure outlined by Richards and French (1992) in pretesting homographs and targets. Thus, student

volunteers listed associations for an initial pool of 140 negative/benign homographs. Homographs were selected if the benign and negative associations were similarly frequent. Subsequently, the valence of the two possible meanings of the selected homographs was rated in a new sample of volunteers. Rating was provided using a visual analog scale, on a 100-mm horizontal line whose ends were labeled "extremely negative" and “not negative at all”. The final set of 80 homographs, included homographs for which negative and benign associates were listed with similar frequency, and the selected associates for the homographs differed significantly in their valence. Non-word targets were created by changing one letter in benign unrelated words, so that each benign word produced a pronounceable non-word.

Each homograph was presented once during the task and the order of trials was randomly determined for each participant. Because few rumination-related homographs are available in Hebrew, we did not use a fully randomized design in matching homograph primes with the four types of word targets and with non-word targets. We were most interested in differential priming of the related negative and benign meanings of the homographs (for a similar approach see Taghavi, Moradi, Neshat-Doost, Yule & Dalgleish, 2000). Therefore, each of the 20 homographs that we considered “best” (for which negative and benign associates were generated with approximately equal frequency) was randomly matched across participants to a target that was related to either the negative or the benign meaning of the prime. Each of the 20 homographs for which the frequency of negative and benign associates was less comparable, was matched with either a benign or a negative unrelated target word. Pairing was done with caution to ensure that homographs were indeed semantically unrelated to the target words. Following this matching scheme, each participant received a unique set of homograph-target pairs, with 10 pairs of each pairing type (related-negative, related-benign, unrelated-negative, unrelated-benign). The

remaining 40 homographs that did not fully meet the selection criteria for rumination and benign homograph pairings were randomly paired with a non-word target. Given the small number of rumination-related homographs, this pairing scheme allowed us to make sure the best stimuli were used for the critical targets rather than with non-words.

Questionnaires. The Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991), a 22-item questionnaire was used to assess the tendency to engage in ruminative thinking in response to negative mood. Brooding and reflection scores were calculated by using the five items identified by Treynor et al. (2003) for each subscale. Internal reliability of the RRS and its brooding and reflection subscales in the current sample was good (α = .92, .86, .71 for the overall RRS scale and for brooding and reflection respectively). Participants also completed the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996), a 21-item inventory that assesses the severity of depressive symptoms. The internal reliability of the BDI as measured in the current study was high (α = .89). Descriptive statistics for these self-report measures are reported in Table 1. Both measures have been widely used in Hebrew and have been reported to have good predictive validity (e.g., Bernblum & Mor, 2010; Zalsman, Weizman, Carel, & Aizenberg, 2001).

Procedure

Following consent, participants completed the lexical decision task. We first described the two-part structure of the trials and asked them to determine as quickly as possible whether each letter string in the second part of each trial formed a word. Participants completed five practice trials, during which the experimenter was present in the room to ensure the task was performed correctly. The experimental trials were randomly presented in a single block. Each trial was preceded by a centrally located + sign, presented for 2000 ms. The homograph was

presented for 750 ms and followed by the target, which remained on the screen until the participant responded by pressing the F or K keys to indicate whether or not the target formed a word. The key press initiated the next trial with an ISI of 2000 ms. Following the lexical decision task, participants filled out the BDI and the RRS, presented on the computer in a random order and followed by a brief demographic questionnaire. At the end of the session, participants were asked to describe their experiences throughout the experiment and to indicate their thoughts regarding the goal of the study. None of the participants was aware of the true nature of the experiment.

Results and Discussion

Only reaction times (RTs) for correct decisions were analyzed. The overall error rate was low ($M = 0.03$, $SD = 0.04$) and error rates did not differ by trial type, $F < 1.0$. Data were trimmed by removing reaction times faster than 200 ms and slower than 2000 ms (1% of responses). In addition, we removed from the analyses data from three participants whose mean RT was more than two standard deviations above the mean RT of the sample.

We computed an interpretation bias score by subtracting the latency to respond to targets related to the negative meaning of the homograph from the latency to respond to targets related to the benign meaning of the homograph. Similarly, we computed a negativity bias score by subtracting the latency to respond to negative targets unrelated to the homograph from the latency to respond to benign targets that were unrelated to the homograph.

Correlations between bias measures, rumination, reflection, and brooding are presented in Table 2. As can been seen in the table, overall rumination scores as well as brooding and reflection were significantly and positively correlated with interpretation bias scores but not with

negativity bias scores. Depression scores on the BDI were unrelated to both interpretation and negativity bias scores.

We conducted three hierarchical regression analyses, to further examine the link between rumination, brooding and reflection on the one hand and interpretation bias on the other. In these regression analyses, rumination, brooding or reflection scores served as the outcome measure; we entered negativity bias scores in the first model and added interpretation bias scores in a subsequent model. Thus, these analyses allowed us to test whether the relationship between the outcome measures and interpretation bias, holds up after accounting for negativity bias.

These analyses (presented in Table 3) indicated that whereas interpretation bias scores significantly predicted rumination, brooding, and reflection, negativity bias scores did not. The first model accounted for 2% of the variance in rumination and in brooding ($p > .3$), and none in reflection ($p = .93$). The second model added significantly to the prediction, accounting for 13%, 10%, and 11% of the variance in rumination, brooding, and reflection respectively; F_{change} (1, 43) = 6.86, $p = .01$ for rumination; $F_{\text{change}}(1, 43) = 4.58$, $p = .038$, for brooding; and F_{change} (1, 43) = 5.48, $p = .02$ for reflection.

Thus, our prediction that brooding would be related to interpretation biases was confirmed. Brooding was not associated with a general tendency to respond more rapidly to negative than to benign targets. Brooding was associated with a faster response to targets that were related to the negative meanings as compared to those that related to the benign meanings of the homographs. Contrary to our expectation, interpretation biases were not uniquely linked with brooding, but were also related to reflection and to overall rumination scores.

Experiment 2

In Experiment 1, we did not examine the specificity of the interpretation bias to rumination-relevant content. At the start, however, we also hypothesized that rumination is associated with an interpretation bias when processing ambiguous stimuli that can be interpreted in a rumination-relevant manner, but not in processing other ambiguous stimuli. To examine this prediction in Experiment 2, we used homographs with negative meanings that were either ruminative (e.g., stern, strain, blue) or threatening (e.g., mug, alarm, club). By including homographs in the threatening category, we hoped to demonstrate that rumination would be characterized by a bias that seems specific to negative pondering while one is feeling sad and not just a bias to think negative thoughts. We also included a set of homographs with personal but non-negative meanings and paired them with targets that denoted their impersonal meaning (e.g., *reflect-mirror, relish-mustard, well-water*). This benign category of homographs was used to disguise the purpose of the study, so that participants would not believe that all primes were negative nor adopt a strategy of anticipating that negative targets would follow homographic primes. Again, due to the limited number of rumination-related homographs available—this time in the English language—we could not tests all of our predictions in the same experiment. An important feature of Experiment 2, in contrast to Experiment 1, was our presentation of the *same* target words following both related and unrelated homographs. This strategy allowed us to conclude that any effects we observe are not just due to the nature of the specific targets that were used.

Method

Participants

Participants were 13 female and 15 male undergraduate students who enrolled in introductory psychology courses or participated in summer research at Trinity University. (Age

was not recorded because rarely are Trinity-University students older than 22.) Participants received either course credit or monetary compensation upon the completion of the session.

Materials

Lexical decision task. This task consisted of 92 trials of prime-target presentations. Each trial belonged to one of four different categories: related word trials, unrelated word trials, related non-word trials, and unrelated non-word trials. The non-word trials were created by pairing 46 non-homographs with either their related targets (e.g., *speaker-talk*) or their unrelated targets (e.g., *hatch-paper*) and then changing one letter in each target word to produce a pronounceable non-word (e.g., *speaker-malk, hatch-baper*). In total, 23 related non-word trials and 23 unrelated non-word trials were created, and they served as fillers to disguise the nature of the study.

The word trials involved pairings of 46 homographic primes and their targets in ways that created 23 related and 23 unrelated trials. These homographs belonged to one of three different categories: ruminative, benignly personal, or threatening. The ruminative category was comprised of 16 homographs with personal meanings that were negative and, in our opinion, brooding-related (e.g., *bitter*); they were each paired with targets denoting their negative meaning (e.g., *bitter-resentful*). The threatening category contained 16 homographs, each of which was paired with a target denoting its negative meaning (e.g., *beat-hit*). Finally, the benign category consisted of 14 homographs with benignly personal meanings (e.g., *reflect*); these homographs were paired with targets denoting their impersonal meanings (e.g., *reflect-mirror*). Because very few brooding-related homographs are available, we did not compare latencies to respond to both meanings of the homograph (e.g., brooding and benign meanings). Instead, in this experiment, we compared latencies to respond when the targets were preceded by related or

unrelated homographs. For this purpose, each category of pairs was divided into two subsets, and all subsets were balanced according to the frequency with which normed responses to the homographs belong to the same category of homograph meaning as the chosen targets (mainly in norms collected by Twilley, Dixon, Taylor, & Clark, 1994, and supplemented by the norms from Nelson, McEvoy & Schreiber, 1998).

Re-pairing for the unrelated trials was done with caution to ensure that the new pairs were not semantically related. Subsequently, two versions of the task were made in order to counterbalance subsets with relatedness of the pair. For example, if *bitter-resentful* was a related pair in the first version, then in the second version *bitter* was paired with *stress*, an associate of *strain*, to form an unrelated pair. Each version consisted of 92 prime-target pairs, half of which were related and the other half unrelated. The related and unrelated trials each consisted of 8 negative, 7 benign, 8 threat, and 23 non-homographic pairs.

Procedure

After informed consent, participants completed the lexical decision task. The task included 12 initial practice trials and 92 experimental trials divided into 8 blocks. Except the last, each block consisted of 6 non-homographic and 6 homographic pairs (two from each of the three categories: negative, benign, and threat); half of the pairs in each block were related and half unrelated. The last block was similar, except it contained no benign pairs and only four filler pairs. All trials in a block were randomized anew for each participant.

On each trial, a prime appeared in the center of the screen for 750 ms before being replaced by its target. Participants were instructed to read the first word that appeared and, after the letter-string replaced the word, to quickly and accurately judge whether the letter-string

formed a word or a non-word by pressing keys labeled W or N. The key press initiated an inter-stimulus interval of 1000 ms.

After task completion, participants filled out the BDI-II, the RRS, and the trait version of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) and sealed all the paper forms in an envelope, under the understanding that it would not be opened by the experimenter. (Descriptive statistics for the self-report measures are reported in Table 1.) At the end of the session, prior to debriefing, participants were asked to disclose any speculation regarding the nature of the study and to elaborate on their experiences throughout the experiment in an attempt to ensure that participants were not aware of the manipulation; no participant showed such awareness.

Results and Discussion

Only reaction times (RTs) for correct responses were analyzed. The overall error rate was low (M = 0.02, SD = 0.02). When proportion of errors on word trials was submitted to an analysis of variance with within-subjects factors for relatedness to prime and homograph type, we found that they differed significantly according to homograph type, $F(2, 54) = 3.97$, MSE = .002, p = .025. Errors were more frequent following ruminative homographs (M = .03, compared to .01 for the other categories).

We computed interpretation bias scores for each trial type by subtracting the latency to respond on related trials from the latency to respond on unrelated trials. Table 3 presents zero-order correlations between measures of interpretation bias, anxiety, depression, rumination, reflection, and brooding. As can been seen in the table, rumination, reflection, and brooding were all significantly correlated with ruminative bias scores and not with threatening bias scores. A tendency to avoid benign personal interpretations was associated with reflection scores but not

with brooding or the overall RRS score. BDI and STAI scores were not significantly correlated with any of the biases. Thus, our prediction that brooding would be characterized by a bias to interpret ambiguous stimuli in a rumination consistent manner was confirmed. This ruminative bias was not unique to brooding and was also related to reflection and overall ruminative thinking. No aspect of rumination was associated with a tendency to make threatening interpretations. Unexpectedly, reflection scores were correlated with a tendency to interpret benign homographs in a non-personal manner.

Finally, we conducted three hierarchical regression analyses to further examine the link between rumination, brooding and reflection on the one hand and interpretation bias on the other. The outcome measure was the rumination, brooding, or reflection score. Threat bias scores and impersonal-benign bias scores were entered first, followed by interpretation bias scores. Thus, these analyses allowed us to test whether the rumination-related bias holds up after accounting for the other forms of bias. These analyses (presented in Table 5) indicated that whereas interpretation bias scores for rumination-related content significantly predicted brooding and reflection, the other forms of bias did not. The first model accounted for a nonsignificant15% of the variance in brooding scores (p = .13) and a significant 22% of the variance in reflection scores, $F(1, 25) = 3.46$, $p = 0.05$. The second model added significantly to the prediction, accounting for an additional 16% of the variance in brooding (F_{change} (1, 24) = 5.54, p = .03) and an additional 17% of the variance in reflection (F_{change} (1, 24) = 6.87, p = .015). Interestingly, reflection was predicted by interpretation biases concerning both brooding-related content and benign personal content. The full model accounted for 39% of the variance in reflection, $F(3, 24) = 5.14$, p = .007. The model predicting rumination was not significant, $F(3, 24) = 1.77$, p = .18.

Clearly, the bivariate correlation between the rumination bias and the total rumination score was not significant when allowing for partial correlations with the other bias scores.

General Discussion

The present research investigated the link between rumination and interpretation biases. In the two experiments presented here, we have demonstrated that rumination is associated with a tendency to interpret ambiguous information in a rumination-consistent manner. In Experiment 1, higher rumination levels were predicted by faster response times to targets related to the ruminative meaning of homographs compared to the non-ruminative meaning of these homographs. Rumination was not associated with a tendency to respond faster to other negative compared to neutral targets, thus substantiating the claim that an interpretive process is involved. Contrary to prediction, this interpretive bias was linked to reflection and overall rumination scores and was not specific to brooding, the particularly maladaptive form of rumination. In Experiment 2, brooding, reflection, and overall rumination scores were all characterized by faster response times to targets related to the ruminative meaning of homographs, compared to the same targets when they were not meaningfully related to the priming homographs. Rumination as well as brooding and reflection were not associated with a tendency to infuse ambiguous stimuli with threat-related meaning. Unexpectedly, reflection was associated with a tendency to avoid benign personal interpretations.

The evidence we provide that links rumination with a tendency to interpret ambiguous information in a rumination-consistent manner is particularly compelling given the convergent findings from both experiments. In the two experiments, we employed different ways of operationalizing interpretive biases and found similar effects using

stimuli in two different languages. Our findings extend those of Hertel and El Messidi (2006), who showed that induced rumination leads to interpretation biases among dysphoric individuals. We demonstrated that self-described habitual rumination, regardless of depression level, is associated with a negative interpretation style. We also addressed the specificity of ruminative biases by showing their distinction from a general negative bias or a bias toward threatening interpretations.

This particular form of a negative interpretation style may be part of what makes rumination a risk factor for psychopathology. Ruminators process information in ways that make negative information salient. They attend to it more readily (Joormann, Dkane, & Gotlib, 2006), show difficulty disengaging from it (Koster, De Lissnyder, Derakshan, & De Raedt, 2011), and have trouble forgetting it (Bernblum & Mor, 2010; Joormann & Tran, 2009). Our findings add to this list by showing that ruminators find negative meaning in ambiguous material—in particular in ambiguous material where the negative interpretation is specific to rumination and not more generally negative. These findings are important in demonstrating that cognitive biases in attention, memory and interpretation are not just concomitants of emotional disorders such as anxiety and depression, but are associated with know risk factors for these disorders. They add to a growing body of work that demonstrates cognitive biases in people at risk for emotional disorders (e.g., Dearing & Gotlib, 2009).

Our findings regarding the specificity of the bias to particular components of rumination are straightforward. Experiment 1 provided no evidence of such specificity, because the interpretation bias was associated with scores on both subscales—brooding and reflection—and with the overall score on the RRS. Experiment 2 produced similar results,

although the relation with the total rumination score was no longer significant when allowing for correlations with other biases. These findings may seem at odds with prior work that considers brooding a uniquely maladaptive form of rumination. However, recent research has shown that reflection is also associated with negative outcomes such as high levels of suicidal ideation, eating disorders and depression (Cowdrey & Park, 2012; Marroquín, Fontes, Scilletta & Miranda, 2010; Surrence, Miranda, Marroquín & Chan, 2009), and cognitive biases (e.g., Whitmer & Banich, 2012).

At first blush, the correlation between reflection and the tendency to interpret homographs with benign meanings in impersonal ways might suggest some sort of avoidance of personal interpretation when material is not ruminative. Instead, however, it is important to realize that the bias score is simply a measure of how much a prime speeds responding to related targets, compared to unrelated targets. Therefore, a more parsimonious conclusion is that reflection subscores were related to priming, regardless of the valence of the prime-target pair. However, this explanation is not consistent with the lack of correlation with threatening prime-target pairs. We are therefore left with the possibility that the correlation with benign pairs was a type I error, and may be associated with the relatively small size of the sample.

No study is without limitations. A main limitation of the current research involves the paucity of available rumination-related homographs in both Hebrew and English, which dictated the use of non-fully randomized stimuli presentation (Experiment 1) or the use of only one set of the meanings associated with the homographs (Experiment 2). It was partly for this reason that we conducted the two experiments by using different lexical-priming methods. Clearly, future research would benefit from the use of ambiguous materials other

than homographs, such as ambiguous scenarios with varying possibilities for resolutions (e.g., Mathews & Mackintosh, 2000) or an auditory interpretation task (Rinck, Klein, Bakens, van Niekerk, & Becker, 2012), that afford more flexibility in stimulus selection. A second limitation of the study is the relatively small sample size of both studies. Although both studies were not characterized by a restriction of range of rumination and psychopathology measures, it is still possible that some of the null effects observed in the study can be attributed to low statistical power.

Despite the importance in understanding cognitive biases that characterize or contribute to depression and other disorders with ruminative features, research on interpretation biases related to depression still lags behind similar research on anxiety disorders. Findings from our experiments may help in further understanding the mechanisms of rumination and, perhaps, in developing ways to modify these biases and their emotional consequences (see Hertel & Mathews, 2011).

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Table 1.

Means (and Standard Deviations) for the Self-Report Measures

	Exp 1	Exp 2
BDI	6.5 (6.5)	11.6 (9.5)
RRS	37.8 (11.2)	47.2 (12.0)
Brooding subscale	9.0 (3.3)	11.2 (3.5)
Reflection subscale	8.2 (2.80)	10.6 (3.5)
STAI-trait form	--	42.5 (13.2)

Note. BDI = Beck Depression Inventory-II; RRS = Ruminative Response Scale; STAI = State Trait Anxiety Inventory.

Table 2.

Experiment 1: Correlations Between Bias Scores and Measures of Dysphoria and Rumination (N = 46)

	1	2	3	4	5
1 BDI					
2 RRS	.43**				
3 Brooding subscale	.52**	.82**			
4 Reflection subscale	.12	.64**	.28		
5 Interpretation bias	.11	.39**	.33*	.33*	
6 Negativity bias	-.05	.16	.14	.01	.20

Note. BDI = Beck Depression Inventory-II; RRS = Ruminative Response Scale.

*p < .05, ** p < .01

Table 3.

Brooding, reflection and rumination scores predicted by interpretation bias and negativity bias (N = 46)

Dependent Variable	Independent Variable	B	SE	β	t
Rumination	Negativity bias score	0.01	0.022	0.08	.57
	Interpretation bias score	0.05	0.018	0.37	2.62*
Brooding	Negativity bias score	0.00	0.007	0.08	0.51
	Interpretation bias score	0.01	0.006	0.31	2.14*
Reflection	Negativity bias score	-0.00	0.006	-0.05	.71
	Interpretation bias score	0.01	0.005	0.34	2.34*

Note. $*p < .05$

Table 4.

Experiment 2: Correlations Between Bias Scores and Measures of Trait Anxiety, Dysphoria, and Rumination (N = 28)

	1	2	3	4	5	6	7
1 STAI-trait							
2 BDI	.82**						
3 RRS	.60*	.43**					
4 Brooding subscale	.41*	.25	.80**				
5 Reflection subscale	.35	.21	.74**	.68**			
6 Ruminative bias	.22	.21	.39*	.50**	.46*		
7 Benign bias	.06	-.05	.17	.14	.43*	.02	
8 Threatening bias	-.03	-.09	-.13	-.33	-.07	-.31	.22

Note. STAI = State Trait Anxiety Inventory; BDI = Beck Depression Inventory-II; RRS = Ruminative Response Scale. *p < .05, ** p < .01

Table 5.

Brooding, reflection and rumination scores predicted by benign, threat, and ruminative bias (N = 28)

Dependent Variable	Independent Variable	B	SE	β	t
Rumination	Benign bias score	2.51	2.39	0.21	1.05
	Threatening bias score	-2.07	2.39	-0.17	-0.87
	Ruminative bias score	4.46	2.34	0.37	1.91
Brooding	Benign bias score	0.77	0.66	0.22	1.16
	Threatening bias score	-1.32	0.66	-0.38	-1.97
	Ruminative bias score	1.47	0.63	0.42	2.35*
Reflection	Benign bias score	1.64	0.63	0.47	2.60*
	Threatening bias score	-0.62	0.63	-0.18	0.34
	Ruminative bias score	1.53	0.58	0.44	2.62*

Note. $*p < .05$