

All in the Mind's Eye? Anger Rumination and Reappraisal

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Research on rumination has demonstrated that compared with distraction, rumination intensifies and prolongs negative emotion. However, rumination and distraction differ both in *what* one thinks about and *how* one thinks about it. Do the negative outcomes of rumination result from how people think about negative events or simply that they think about them at all? To address this question, participants in 2 studies recalled a recent anger-provoking event and then thought about it in 1 of 2 ways: by ruminating or by reappraising. The authors examined the impact of these strategies on subsequent ratings of anger experience (Study 1) as well as on perseverative thinking and physiological responding over time (Study 2). Relative to reappraisal, rumination led to greater anger experience, more cognitive perseveration, and greater sympathetic nervous system activation. These findings provide compelling new evidence that how one thinks about an emotional event can shape the emotional response one has.

Keywords: rumination, reappraisal, anger, emotion regulation, autonomic nervous system

Emily and Bob stand on the corner waiting for their coworker Jeff, who is driving the van pool to work. Nervous about her unfinished presentation, Emily waits impatiently and mentally rehearses her main points. Bob glances anxiously at his watch, not wanting to miss an important phone call. The van finally arrives, though late enough to leave Emily no time to finish her presentation and to make Bob miss his call. Jeff, the driver, apologizes for being late again. Throughout the ride to work, Emily ruminates on Jeff's tardiness and gets angrier by the minute. By contrast, Bob thinks about how Jeff, though not punctual, is a fine coworker overall. So Bob decides to propose to the van pool that they take turns covering Jeff's driving duties.

An age-old conviction holds that how we think about an event determines how we feel about it. This proposition is the cornerstone of appraisal theories of emotion (Arnold, 1960; Lazarus, 1991; Schachter & Singer, 1962; Scherer, Schorr, & Johnstone, 2001). Appraisal theories postulate that the appraisals (or evaluations) an individual makes in a given situation determine both the type and intensity of emotion that a person will have in that

particular situation. One important corollary of this view is that modifying how an individual appraises an event should alter the emotional responses to that event. Despite the intuitive appeal of this proposition, it has been very difficult to disentangle the effects of thinking about an upsetting event per se from the effects of using one way versus another of thinking about that event.

One literature area concerned with the link between thinking and feeling is the literature on *rumination*, which may be broadly defined as repetitive thoughts around a common theme, absent immediate environmental demands for those thoughts (Martin & Tesser, 1996). Findings suggest that, compared with distraction, thinking repeatedly about an emotional event maintains and/or amplifies the emotional response (Morrow & Nolen-Hoeksema, 1990). Furthermore, individual differences in rumination predict both the diagnosis (Nolen-Hoeksema, 2000) and severity of depression (Just & Alloy, 1997). One important limitation of this literature is that it is not yet clear whether rumination produces negative emotional outcomes solely because the negative material is called to mind or because of the way that material is called to mind.

To address this issue, rumination must be compared not with distraction, which involves thinking about something unrelated, but with another cognitive strategy for processing the same emotional event. In the following sections, we first review the literature on rumination and its consequences and then distinguish rumination from *reappraisal*, the process of reinterpreting the meaning of an upsetting event. We then present two studies that examine how these two different ways of thinking about a personally relevant

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anger episode predict different emotional responses, as assessed by self-reported emotion experience and by physiological responding.

Rumination

Defining rumination as repetitive self-focused attention to sad or angry thoughts and feelings, Nolen-Hoeksema and her colleagues (Nolen-Hoeksema & Morrow, 1991) have shown rumination to be associated with several negative consequences. Individuals who ruminate report higher levels of negative emotion (Segerstrom, Tsao, Alden, & Craske, 2000) and less control over intrusive thoughts (Watkins, 2004). In addition, a tendency to ruminate is associated with longer lasting depressive symptoms (Nolen-Hoeksema, Morrow, & Fredrickson, 1993) and an increase in occurrence of depressive episodes (Nolen-Hoeksema, 2000). Rumination has been linked to physiological indicators of negative emotion, including increased and/or prolonged amygdalar activation in response to negative pictures and negative words (Ray et al., 2005; Siegle, Steinhauer, Thase, Stenger, & Carter, 2002) and increased cortisol levels after a stressor (Roger & Jamieson, 1988).

Alternatives to Rumination: Distraction and Cognitive Reappraisal

Experimental studies have focused on one alternative to rumination, namely, *distraction*—moving one's attention away from the upsetting event and onto unrelated neutral contents. Compared with distraction, rumination increases or maintains sad moods for depressed individuals (Morrow & Nolen-Hoeksema, 1990) as well as increasing or maintaining anger and aggressive behavior (Bushman, Bonacci, Pedersen, Vasquez, & Miller, 2005; Rusting & Nolen-Hoeksema, 1998). However, this comparison has several important limitations, the most important of which is the fact that distraction by definition involves not thinking about the emotion-generating event. Comparisons of rumination to distraction cannot resolve whether adverse consequences are guaranteed just by thinking about a negative event or whether the way one thinks about the negative event affects the outcome.

Investigators have started to explore alternatives to rumination that, unlike distraction, keep the focus on the upsetting situation. One alternative to rumination is *cognitive reappraisal*, which entails keeping the emotion-eliciting event in mind and actively seeking alternate interpretations of the meaning or self-relevance of the event (Gross, 2001). Reappraisal as an emotion regulation strategy was first specified in the stress and coping work of Lazarus and colleagues (Lazarus & Alfert, 1964) and in appraisal theories of emotion (Lazarus, 1991; Schachter & Singer, 1962). We conceptualize cognitive reappraisal as a rich class of cognitive strategies that alter a person's initial appraisals so that an emotional stimulus comes to have a different emotional impact. Among others, reappraisal can involve considering new information about the stimulus and/or taking a different perspective on the stimulus' relevance to one's goals.

Previous studies have documented the efficacy of reappraisal. The proclivity to reappraise is correlated with fewer depressive symptoms (Garnefski & Kraaij, 2006) and with both expressions of greater positive emotion and better interpersonal functioning (Gross & John, 2003). Reappraisal has also been linked to decreased startle response and to decreased amygdalar activation in

negative slide-viewing paradigms (Jackson, Malmstadt, Larson, & Davidson, 2000; Ochsner, Bunge, Gross, & Gabrieli, 2002; Ochsner et al., 2004) as well as to decreased cardiovascular response to disgusting stimuli and to lesser blood pressure increases in response to negative slides (Richards & Gross, 1999). Work on reappraisal is augmented by Kross, Ayduk, and Mischel (2005), who reported that creating distance—by visualizing increased physical distance—is insufficient to attenuate negative emotions. Reinterpreting or gaining new insight seems to be necessary for such visualizations to work.

Another relevant line of work focuses on changing the social perspective from a first-person to a third-person perspective. This strategy draws attention to the broader meaning or consequences of events (Libby & Eibach, 2002), expanding one's own aperture, to consider additional situational features to be important. This can create a more nuanced or altogether different appraisal of events, which, in turn, can change the character and the intensity of the person's emotional response to the event (Lazarus, 1991). Such changes in cognitions have been suggested as the mechanism by which cognitive therapy works to decrease the distress in psychopathology (Clark, Beck, & Alford, 1999). Although clinical trials have demonstrated that cognitive therapy can reduce distress, few studies to date have tested the acute effects of the mechanism by which it is thought to work.

The Present Studies

There is growing support for the notion that an upsetting event may be called to mind in more or less disruptive ways. However, there are two important gaps in the research literature. First, there has thus far been no direct experimental comparison of rumination to a different and less disruptive way of continuing to think about negative events (such as reappraisal). Second, the effectiveness of reappraisal has not yet been demonstrated in the context of potent self-generated negative autobiographical events.

To address these important gaps, we conducted two experimental studies within the context of recent anger-inducing autobiographical events and directly contrasted rumination and reappraisal as ways of thinking about negative life events. The first study contrasts the emotional and cognitive consequences of ruminating or reappraising while recalling a recent anger-eliciting event. The second study extends the first by examining how rumination and reappraisal differentially affect multiple channels of emotional responding, including physiology, over time. In both studies, our general expectation was that reappraisal (compared with rumination) would produce less anger experience and fewer thoughts about the anger-eliciting event. To control the reappraisal strategy participants deployed, these studies focus on a specific reappraisal strategy—viewing an upsetting autobiographical event from the perspective of an uninvolved observer or a mediator. This strategy maintains the negative event as the focus of attention, while allowing for the possibility of alternate interpretations of the meaning and/or relevance of the event. This form of reappraisal thus provides a strong contrast to rumination.

Study 1: Anger Rumination Versus Reappraisal

In Study 1, we asked participants to call to mind a recent, personally relevant, anger-eliciting event. We chose anger because

prior work on rumination has demonstrated the importance of anger rumination in maintaining angry moods, increasing the likelihood of aggressive acts, and adversely affecting physiological recovery (e.g., Bushman et al., 2005; Glynn, Christenfeld, & Gerin, 2002). To ensure a clear contrast between rumination and reappraisal, we then asked participants either to ruminate about this event (review it repeatedly from a first-person perspective focusing on their own feelings) or to reappraise this event (e.g., review it from an objective third-person perspective and how the third person might feel).

To examine the acute effects of rumination and reappraisal on emotional responding, we assessed self-reports of emotion experience at three time points: (a) at baseline, (b) after individuals called the event to mind without other instructions, and (c) again after individuals called the event to mind with specific between-groups experimental instructions to ruminate or reappraise. The uninstructed period, in which participants thought about the event without yet having specific instructions to ruminate or reappraise, allowed us to evaluate, within subjects, how calling and holding an event in mind differs from rumination or reappraisal.

On the basis of the prior literature, we expected rumination and reappraisal to differ both during the acute emotional response and during the recovery period. Specifically, we expected that reappraisal would produce low levels of anger experience during the recall period and would facilitate recovery during the recovery period, whereas rumination would perpetuate angry feelings and thoughts about the anger-eliciting event both during the recall and recovery periods.

Method

Participants

Eighty-two female participants aged 18–27 years ($M = 19.3$, $SD = 1.7$) were recruited from an introductory psychology course and given course credit. Only female participants were used to reduce variability in anger response (Linden et al., 2003). Participants identified their ethnicity as Caucasian (50%), African American (4.9%), Asian American (26.9%), Latina/Hispanic (10.9%), and Native American (1.2%). Five participants' data were excluded, 3 due to high ratings of dysphoria at baseline, and 2 for not following instructions, leaving usable data for 77 participants.

Procedure

A female experimenter conducted individual experimental sessions. Participants began by rating the amount of positive and negative emotions they currently felt (baseline rating). Each participant then identified an unresolved event from the preceding 2 weeks in which she became very angry with another person (angering event). The participant then rated how unresolved the event was and the amount of anger she felt during the event as well as other negative and positive emotions. This personal, unresolved anger event was then used as the focal content in each of four subsequent task periods.

In the first period, the participant freely recalled the event and kept it in mind for 2 min with no other specific instructions (free-recall phase). Immediately after this period, the participant rated her current anger and other emotions. The participant also

indicated what percentage of the period she had spent thinking about the event and the extent to which she viewed the event from her own perspective. This was followed by a period in which the participant was told to "Rest quietly" for 2 min. At the end of the period, the participant rated her current emotions and again indicated what percentage of the previous rest period was spent thinking about the event that had previously made her angry.

The participant was then randomly assigned to either a rumination condition ($n = 34$) or a reappraisal condition ($n = 43$). In each condition, the participant was instructed to think about the angry event for 2 min. In the rumination condition, participants also were instructed to "think about [the event] from your own perspective, and turn it over and over in your mind. Focus on those things that initially made you feel and respond the way that you did." In the reappraisal condition, participants were instructed to "think about [the event] from a different perspective from the one you used earlier. For example, you might try to see this event from the perspective of an impartial observer." At the end of the period, the participant again provided ratings of anger as well as other emotions, an estimate of the actual time spent thinking about the anger-inducing event during the recall period, and ratings of the extent to which the participant viewed the event from her own perspective. In the final period, the participant was again instructed to "Rest quietly," followed by a final rating of anger and other emotions as well as an estimate of time spent thinking about the event.

Measures

Instruction manipulation check. Participants rated the extent to which they thought about the event from their own perspective and, separately, from another person's perspective. Ratings were made using a 5-point Likert scale (0 = *not at all*, 4 = *a lot*).

Time thinking about anger episode. Participants estimated the percentage of time they spent thinking about the emotional event (0%–100%). This allowed us to test whether people were thinking about the event when asked to and also assess the extent to which participants continued to think about the event during the rest periods without being instructed to do so.

The experience of anger, positive emotion, and negative emotion. Participants rated the degree to which they felt anger as well as five positive emotions (happy, amused, proud, hopeful, affectionate; $\alpha = .82$) and six negative emotions (anxious, jealous, sad, rejected, guilty, confused; $\alpha = .81$). Ratings were made on a 5-point Likert scale (0 = *not at all*, 4 = *a lot*).

Writing task. Participants wrote about the perspective from which they thought about the event. Raters categorized narratives into one of five different perspectives. These perspectives varied in distance from the participant and the event. The perspective closest was one's own perspective; then the perspective of the other person with whom the participant was angry; the perspective of a good friend involved in the anger-eliciting event; the perspective of a good friend not involved in the anger-eliciting event; and the most distant perspective was that of a stranger not involved in the situation. Interrater reliabilities were high ($K = .96$).

Data Analysis

To examine anger experience, we subtracted the anger at baseline (i.e., before thinking about the anger-eliciting event) from

subsequent anger ratings. Nested repeated measures analyses of variance (ANOVAs) were conducted, with condition (ruminate vs. reappraise) as a between-subjects factor and time (recall before manipulation and recall after manipulation) as a within-subjects factor, with task (recall and rest) nested within time. Significant main effects and interactions were followed up with independent t tests and paired t tests. Greenhouse–Geisser corrections for heteroscedasticity were applied where necessary (Keselman, Algina, & Kowalchuk, 2001). Effect sizes are reported in terms of partial eta squared, with the notation η_p^2 .

Results

Preliminary Analyses

Instruction compliance. The two groups did not differ in any aspect of the event recalled,¹ nor did they differ in the amount of time spent thinking about the anger-eliciting event during both the free-recall phase and instructed recall phase, as evidenced by the lack of main effect of condition, $F(1, 75) = 0.62, p = .43$. As expected, those instructed to ruminate viewed the event from their own perspective ($M = 3.30 \pm 0.84$) more than those who were instructed to reappraise ($M = 1.14 \pm 0.86$), $t(75) = 11.28, p < .001$. Also, those assigned to reappraise viewed the event from another person's perspective ($M = 2.59 \pm 1.34$) more than those who were assigned to ruminate ($M = 0.76 \pm 0.92$), $t(75) = -6.80, p < .001$.

Anger intensity. When participants called the anger-eliciting event to mind prior to group assignment instructions, they reported significantly greater levels of anger as compared with baseline ($M_{\text{baseline}} = 0.12 \pm 0.56, M_{\text{free recall 1}} = 1.78 \pm 0.95$), $t(75) = 15.01, p < .001$. During the rest period immediately following, participants reported substantial decreases in their anger ($M_{\text{rest 1}} = 0.46 \pm 0.73$), $t(75) = 11.78, p < .001$. Success of random assignment was reflected by an absence of any differences between experimental groups during these periods (all $ps > .58$).

Main Analyses: Emotion Experience

To test whether reappraisal and rumination differed in their consequences for anger, a nested repeated measures ANOVA was performed on the two tasks before instructions (free recall, Rest 1) and on the two tasks after the instructions (instructed recall, Rest 2), with condition (ruminate, reappraise) as a between-subjects variable and time (prior to group assignment instructions, after group assignment instructions) and task (recall, rest) as within-subjects variables. This analysis revealed a three-way Time \times Task \times Condition interaction, $F(1, 75) = 7.71, p < .007, \eta_p^2 = .09$, as well as a two-way Task \times Condition interaction, $F(1, 75) = 5.60, p < .021, \eta_p^2 = .07$ (see Figure 1). Main effects were also evident for condition, task, and time. To follow-up on the three-way interaction, a repeated measures ANOVA was conducted separately for each condition, with task and time as within-subjects variables.

For those in the rumination condition, there was a main effect of task only, with the periods of both free and instructed recall producing more self-reported anger than the rest periods (free recall and instructed recall = 1.77 ± 1.06 , Rest 1 and Rest 2 = 0.41 ± 0.81), $F(1, 75) = 221.66, p < .001, \eta_p^2 = .75$. There were no anger differences between the periods before and after the

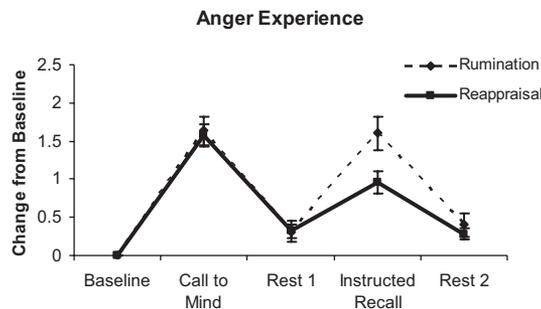


Figure 1. Anger experience (change from baseline) in recall and rest trials in Study 1.

manipulation for those assigned to ruminate, nor any interaction with task ($ps > .40$). With respect to level of anger invoked, simply calling to mind an unresolved angry event is not distinguishable from rumination.

By contrast, for those assigned to the reappraisal condition, the repeated measures ANOVA showed an interaction between Task and Time, $F(1, 75) = 12.65, p < .001, \eta_p^2 = .14$, as well as main effects of task and time. The periods of recall produced more anger than the periods of rest (free recall and instructed recall = 1.28 ± 0.96 , Rest 1 and Rest 2 = 0.30 ± 0.56), $F(1, 75) = 142.02, p < .001, \eta_p^2 = .65$, and participants reported less anger in the periods after the reappraisal manipulation instructions than before the reappraisal manipulation instructions (free recall and Rest 1 = 0.95 ± 0.79 , instructed recall and Rest 2 = 0.63 ± 0.72), $F(1, 75) = 16.32, p < .001, \eta_p^2 = .18$. Follow-up paired t tests on both recall and rest periods for those in the reappraisal condition showed that those assigned to reappraise reported much less anger after the manipulation in the instructed recall phase than in the free-recall phase, $t(75) = 2.14, p < .018$ (free recall = 1.57 ± 0.97 , instructed recall = 0.95 ± 0.94); however, there were no differences between the two rest periods, $t(75) = 0.14$. Additionally, independent t tests between the groups confirmed that participants in the rumination condition reported more anger in the instructed recall phase than those in the reappraisal condition, $t(75) = 2.90, p < .002$ (rumination = 1.79 ± 1.31 , reappraisal = 0.95 ± 0.94). There were no differences in self-reported anger between the conditions during the final rest period, $t(75) = 0.22, p > .4$, indicating that reappraisal did not facilitate anger recovery over and above the instruction to rest.

Secondary Analyses

Negative emotion. To test whether the effects of rumination and reappraisal were specific to anger, a nested repeated measures ANOVA was performed on the composite of negative emotions (apart from anger) reported after each period. Time and task were within-subjects variables, and condition was a between-subjects

¹ The events that participants reported were assessed along several dimensions to ensure that random assignment was successful in producing groups with events that were comparable. Participants in the two conditions did not differ either in the type of event called to mind or in the intensity of the initial emotional response.

variable. Like the anger analysis, this analysis revealed a significant three-way interaction of Time \times Task \times Condition, $F(1, 75) = 10.45, p < .002, \eta_p^2 = .13$, as well as a two-way interaction of Task \times Condition, $F(1, 75) = 4.30, p < .042, \eta_p^2 = .06$, and a two-way interaction of Time \times Condition, $F(1, 75) = 5.13, p < .026, \eta_p^2 = .07$. Main effects were also evident for condition, task, and time. To follow-up on the three-way interaction, a repeated measures ANOVA was conducted separately for each condition, with task and time as within-subjects variables. For those in the rumination condition, there was a main effect of task only, with the periods of both free and instructed recall producing more self-reported negative emotion than the rest periods (free recall and instructed recall = 1.29 ± 0.75 , Rest 1 and Rest 2 = 0.49 ± 0.42), $F(1, 75) = 55.05, p < .001, \eta_p^2 = .64$. There were no differences in negative emotion between the periods before and after the manipulation for those assigned to ruminate, nor any interaction with task ($ps > .63$). With respect to amount of negative emotion invoked, as with anger invoked, simply calling to mind an angry event is not distinguishable from rumination.

For those assigned to the reappraisal condition, the repeated measures ANOVA showed an interaction between task and time, $F(1, 75) = 32.03, p < .001, \eta_p^2 = .43$, as well as main effects of task and time. The periods of recall produced more negative emotion than the periods of rest (free recall and instructed recall = 0.88 ± 0.61 , Rest 1 and Rest 2 = 0.33 ± 0.39), $F(1, 75) = 70.61, p < .001, \eta_p^2 = .62$, and participants reported less negative emotion in the periods after the reappraisal manipulation instructions than before the reappraisal manipulation instructions (free recall and Rest 1 = 0.67 ± 0.51 , instructed recall and Rest 2 = 0.54 ± 0.25), $F(1, 75) = 43.00, p < .002, \eta_p^2 = .20$. Follow-up paired t tests on both recall and rest periods for those in the reappraisal condition showed that those assigned to reappraise reported much less negative emotion after the manipulation in the instructed recall phase than in the free-recall phase, $t(75) = 9.20, p < .001$ (free recall = 1.03 ± 0.61 , instructed recall = 0.73 ± 0.61); however, there were no differences between the two rest periods, $t(75) = -0.91$. Additionally, independent t tests between the groups confirmed that participants in the rumination condition reported more negative emotion in the instructed recall phase than those in the reappraisal condition, $t(75) = 17.97, p < .001$ (rumination = 1.32 ± 0.83 , reappraisal = 0.73 ± 0.61). There was a significant difference in self-reported negative emotion between the conditions during the final rest period, $t(75) = 2.36, p < .020$ (rumination = 0.48 ± 0.49 , reappraisal = 0.34 ± 0.39), suggesting that reappraisal did facilitate negative emotional recovery over and above the instruction to rest.

Positive emotion. One possible explanation for our results is that the reappraisal group increased their positive affect to decrease their anger. However, a repeated measures ANOVA performed on the free-recall and instructed recall periods, with condition as the group factor and time as the repeated measure, showed that there were no differences between the groups in positive emotion at any time point ($p > .21$). In addition, a repeated measures ANOVA performed on the free-recall and instructed recall periods, with positive emotion partialled out of the anger reports, demonstrates that controlling positive emotion does not change the pattern of anger reports (Time \times Condition interaction for anger partialling out positive emotion), $F(1, 75) = 10.85, p = .002, \eta_p^2 = .19$, compared with the previous

interaction of Time \times Condition for anger, $F(1, 75) = 10.55, p = .002, \eta_p^2 = .18$.

Amount of time thinking. To confirm that the difference in anger between the groups was not due to the amount of time spent thinking about the anger-eliciting event, an ANOVA was performed on the anger ratings for the instructed recall period, partialling out the percentage of time spent thinking about the anger-eliciting event. The anger ratings between the conditions remained significantly different, $F(1, 75) = 10.44, p = .002, \eta_p^2 = .12$, with those assigned to ruminate experiencing more anger than those assigned to reappraise (rumination residual = 0.44 ± 1.12 , reappraisal residual = -0.33 ± 0.95).

Distancing. If reappraisal success depends on the participant taking a more socially distanced perspective, then we would expect perspectives closer to the self to result in higher anger scores and perspectives farther away, such as the perspectives of a stranger to produce lower anger scores. To test this possibility, an ANOVA was performed on the anger ratings of those assigned to reappraise using the coded perspective as the independent variable. This analysis demonstrated no differences between the reappraisal perspectives in anger scores during the instructed recall, $F(4, 40) = 0.18, p = .950$. Anger ratings decreased similarly, whether one reappraised from one's own perspective or from the perspective of an uninvolved, distant stranger. This indicates that the mechanism responsible for the change in anger ratings was not the degree of social distance of the perspective taken.

Discussion

In Study 1, we compared two common ways of attending to and thinking about emotionally evocative autobiographical events. Reappraising the event from an impartial observer's perspective produced less self-reported anger. This was true both within subjects, compared with the prior free recall of the event, and also between groups, compared with ruminating about the event. By contrast, ruminating about the event yielded the same level of anger as during the prior free recall. From these findings, we conclude that calling an angry event to mind and maintaining focus on it behaves much like rumination, in invoking and maintaining anger. By contrast, reappraising an event actively alters the emotional trajectory, decreasing anger.

One possible explanation for reappraisal's effects on anger might be that reappraisal focuses on positive aspects of the event and increases positive emotion. However, this does not appear to be the case because the groups did not differ in reported positive emotion. Nor were reappraisal's effects on anger a result of social distance from the anger-eliciting event. Instead, these findings suggest that reappraisal produces different emotional consequences from rumination by reinterpreting the meaning of the anger-provoking event as less intensely negative. However, in order to understand the nature of any changes in interpretation, more information is needed about how reappraising participants thought about the anger-eliciting event.

Beyond the acute effects, there were also lingering effects of rumination and reappraisal. Those assigned to ruminate continued to think more about the anger-eliciting event after they were told they could stop, compared with those assigned to reappraise. Interestingly, those assigned to reappraise felt less overall negative emotion during the rest period, but not less anger, contrary to our

initial hypothesis. This may be due to the instruction to rest being taken as an imperative to clear the mind and impose calm, leaving just lingering negative affect not specific to anger. Thus, to test whether rumination and reappraisal differ in recovery profiles, the instruction to rest must be replaced with a truly uninstructed recovery period. In the same vein, one might expect stronger effects over time, if the effects of rumination and reappraisal are cumulative. The instructed rest period after the instructed thinking period may have not only prevented accumulation of effects but also increased attention on recovery as a goal. In order to test this hypothesis of cumulative effects, in a second study (described below), rumination and reappraisal were assessed across multiple rumination and reappraisal cycles.

Study 2: Physiological Consequences of Rumination Versus Reappraisal

Given the results of Study 1, we thought it important, in a second study, to test directly the hypothesis that rumination and reappraisal affect not only self-reported emotion but also additional channels of emotional responding (e.g., physiological channels) and that such differences may unfold over time. Measurement of the sympathetic branch of the autonomic nervous system provides a reliable measure of responding that is unaffected by demand characteristics (see Bradley, 2000, for a review).

On the basis of our analysis of rumination and reappraisal, we expected different patterns of physiological responding. Specifically, the sympathetic branch of the autonomic nervous system is sensitive to changes in anger (Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000; Stemmler, Heldmann, Pauls, & Scherer, 2001). We thus expected rumination to be associated with greater increases in sympathetic responding than reappraisal. In addition, parasympathetic reactivity has been associated with perseverative thinking (Brosschot, Gerin, & Thayer, 2006) and recovery trajectories for depression (Rottenberg, Salomon, Gross, & Gotlib, 2005). We thus expected that rumination would be associated with lesser parasympathetic reactivity than reappraisal. To test these predictions, we assessed both branches of the autonomic nervous system. To confirm that any physiological effects were not due to effort, questions about perceived effort were added.

Previous studies have not captured the unfolding of rumination's cumulative effects in the laboratory. In Study 2, we wanted to examine the effects of cyclical rumination over time to better understand how the short-term effects of rumination build. We expected such effects to persist in subsequent uninstructed trials. As in Study 1, we expected rumination to lead to greater amounts of thinking about the event during uninstructed periods.

A third important goal of Study 2 was to explore the possible mechanisms by which reappraisal changes affective responding. Because the social distance embedded in the reappraisal strategy had no effect in Study 1, the reappraisal perspective was made the same for all participants. Also, to assess changes in participants' interpretation of the recalled event, we asked how participants thought about the anger-eliciting event during the instructed periods. On the basis of work by Kross et al. (2005) and Pennebaker, Mehl, and Niederhoffer (2003), we expected that those assigned to reappraisal would use more change and insight words, reflecting the reinterpretation used to decrease their anger.

Method

Participants

One hundred seventeen female participants aged 18–28 years ($M = 20.0$, $SD = 1.9$) were recruited from an introductory psychology course. Participants were paid \$40 for their participation in a larger study, of which this was one element. Participants self-identified as Caucasian (47.9%), African American (17.1%), Asian American (24.8%), Latina/Hispanic (9.4%) and Native American (0.8%). One participant's data were removed due to her failure to complete the study.

Procedure

As in Study 1, participants called to mind recent personally relevant anger-eliciting events. One important change was that we then immediately asked them either to ruminate about these events or to reappraise these events, without an extended period of free recall. To increase the salience of the objective nature of the third-person's perspective and goal structure, we suggested the perspective of a mediator who is not the advocate for either party but who wants the best outcome for all. Also, because repeated focus on a reappraised event might attenuate its negative affective load, and with it, the personal importance of the event, we shortened the trial length to 1.5 min to ensure that reappraisal participants continued to focus on the event for the same amount of time as those assigned to ruminate. Finally, we continuously assessed physiological responding throughout the experiment, and after each trial, we assessed how angry the participants felt and the extent to which they were thinking about the anger-making event.

Participants were tested individually. A female experimenter attached physiological sensors for continuous monitoring of physiological responses. Participants viewed a 5-min neutral film,² providing a physiological baseline, and completed an emotion rating form. Participants identified an unresolved angry event and rated it as they did in Study 1.

Participants were randomly assigned to either a rumination ($n = 61$) or reappraisal ($n = 55$) condition. In either condition, they were asked to think about the event that made them angry for 90 s. In the rumination condition, participants were instructed to "Think about it (the event) from your own perspective, and turn it over and over in your mind. Focus on those things that initially made you feel and respond the way that you did." In the reappraisal condition, participants were instructed to "Think about it (the event) from the perspective of a third party—such as a counselor or mediator—(someone) who wants the best for all involved. Focus on how this person might frame the event and find the good that could come from it." Participants saw the instructions on the television screen as they heard them.

After the 90-s instructed recall phase, participants provided anger ratings and an estimate of the actual time spent thinking about the anger-eliciting event during the recall phase. Participants were instructed to wait until they received the next instructions (90-s delay),

² The neutral film was a 5-min segment from the documentary "Denali," depicting nature scenes previously rated by judges as not inducing negative emotion and inducing only marginal amounts of positive emotion (Rottenberg, Ray, & Gross, 2007).

followed by another anger rating and an estimate of time spent thinking about the event during the delay. The participants completed retrospective questions about the extent to which they thought about the event from their own perspective and the effortfulness of the task. The set of tasks (instructed anger recall, delay) were completed two more times with a short verbal working memory filler task, to mark iterations, for a total of three repetitions. After the last repetition, participants were instructed to write a description of the anger-eliciting event and describe what and how they thought about the event during the instructed recall and delay periods.

Measures

The experience of anger, positive emotion, and negative emotion. The same ratings as those in Study 1 were used. These positive and negative emotions, not including anger, were used to create positive ($\alpha = .81$) and negative ($\alpha = .77$) emotion composites.

Cognitive components contributing to reappraisal. Retrospective ratings of how effortful it was to think about the event in the instructed manner were collected for each instructed recall trial, using the same 5-point Likert scale ranging from 0 (*not effortful at all*) to 4 (*extremely effortful*).

Physiological measures. Physiological responding was assessed using an SA 12-channel bioamplifier and a Pentium PC. Measures used to assess the sympathetic nervous system response included a central measure, pre-ejection period (PEP), and a peripheral composite measure (Gross & Levenson, 1997). A measure of motor movement was included by measuring somatic activity. Respiratory sinus arrhythmia (RSA) evaluated parasympathetic activation and was derived using heart rate and respiration. All physiological measures, with the exception of the PEP, were based on signals sampled at 400 Hz. The PEP was sampled at 1000 Hz. Customized software was used to perform waveform transformation, feature detection, graphic display, and artifact removal for each physiological channel and derived parameter offline (Wilhelm, Grossman, & Roth, 1999). After artifact control, period averages were created for each measure.

We assessed the PEP using impedance cardiography (HIC-2000, Instrumentation for Medicine, Inc., Chapel Hill, NC), ensembled by electrocardiographic (ECG) R-waves (Sherwood et al., 1990). The PEP was calculated as the time (in milliseconds) between the Q-point in the ECG signal and the B-point in the derived impedance signal. Four spot electrodes were used in a configuration, suggested by Sramek (1982), thereby decreasing the effects of any movement artifacts and increasing the signal-to-noise ratio (Qu, Zhang, Webster, & Tompkins, 1986).

A second measure of sympathetic activation of the cardiovascular system used a composite score that included measures indicating increased peripheral vasoconstriction (finger temperature, finger pulse transit times and amplitudes, as well as ear pulse transit time; Gross & Levenson, 1997). A plethysmograph transducer (Model 1020 photo-plethysmograph; UFI, Morro Bay, CA) attached to the tip of the participant's second finger provided *finger pulse amplitude* and *finger pulse transit time*, whereas a second plethysmograph transducer attached to the ear lobe provided *ear pulse transit time*. A thermistor attached to the palmar surface of the distal phalange of the fourth finger recorded *finger temperature* in degrees Fahrenheit. The composite score was constructed by transforming change scores to z scores and reversing their polarity so that increased sympathetic

responses would be positive and decreased sympathetic responses would be negative. The alpha for those measures across tasks was between .78 and .85.

We measured RSA as an index of parasympathetic activation. RSA was estimated by converting the respiratory rate (RR) interval series from the ECG to a time series of instantaneous RR intervals with a resolution of 4 Hz. The transfer function was determined relating RR interval oscillations to lung volume oscillations (resampled to 4 Hz) at the peak respiratory frequency, adjusting RSA for tidal volume changes. The peak respiratory frequency was automatically detected as the greatest local maximum in the lung volume power spectral density. All of the epochs met inclusion criteria for spectral coherence being greater or equal to 0.5 and peak respiratory frequency being above 0.15 Hz. *Heart rate* (HR) was obtained using Beckman miniature electrodes (Beckman Coulter, Inc., Fullerton, CA) placed in a bipolar configuration on opposite sides of the participant's chest. The interval (in milliseconds) between successive R-waves in the ECG was converted to instantaneous HR after editing RR interval outliers due to movement artifacts or ectopic myocardial activity. RR was measured using bellow devices placed around the abdomen and chest. For each individual, signals were calibrated using a fixed volume bag. RR was calculated by counting the breath-to-breath cycle at breath onsets per minute.

Writing task. At the end of the session, each participant wrote a free-form description of the emotional event during the instructed anger-recall periods and how they thought about it in both the instructed and uninstructed periods. Independent coders rated the seriousness of the initial event recalled. Interrater reliabilities for these ratings were excellent ($\alpha = .94$). This information was used to test whether randomization was successful. Independent coders rated the extent to which people reported reinterpreting the event during the periods of instructed recall. The scale was from "−1," the participant expressed a change in interpretation of the event to be more negative, to "1," meaning a change in interpretation to be more positive. There was no change with a rating of "0". Interrater reliabilities for these ratings were good ($\alpha = .79$). In addition, a list of words was generated that was thought to reflect a change of thinking when used in a sentence about one's thoughts. This list included words such as *different, change, started, stopped, more, less, realized, discovered, begin, end, and move*. Raters then counted the number of insight or change words that the participants used in their descriptions of how they thought about the event. Interrater reliabilities for both of these ratings were good ($\alpha = .89$).

Data Analysis

For emotion experience and physiological responding, changes from baseline were calculated. For thoughts of the anger episodes, raw scores were used. Nested repeated measures ANOVAs were conducted, with condition (ruminate vs. reappraise) as a between-subjects factor and time (Block 1–3) as a within-subjects factor, with task (instructed anger recall and delay) nested within time.³

³ Analyses in which hierarchical linear modeling was used produced the same results. Because there were few missing data, a repeated measures ANOVA was preferred because it was both conservative and paralleled the analyses in Study 1.

Significant interactions were followed up with *t* tests. Greenhouse–Geisser adjustments for heteroscedasticity were applied, as indicated by degrees of freedom.

Results

Preliminary Analyses

The groups did not differ in any aspect of the initial event.⁴ They also did not differ in how much they thought about the anger-eliciting event, as evidenced by the repeated measures ANOVA, with condition (reappraise vs. ruminate) as the between-subjects factor and time (instructed recall for Time 1–3) as the repeated within-subjects factor performed on the percentage of time thinking about the event. This analysis produced neither a main effect of condition ($M_{\text{Ruminate}} = 83.78\% \pm 14.83\%$, $M_{\text{Reappraise}} = 80.43\% \pm 17.43\%$), $F(1, 113) = 1.97$, $p = .16$, nor a Condition \times Time interaction, $F(2, 226) = 1.99$, $p > .15$. The main effect of time was significant, $F(2, 226) = 17.74$, $p < .001$, $\eta_p^2 = .14$, and post hoc contrasts showed that thinking about the event made participants angry less in the last instructed recall trial than in the previous two (instructed recall Time 1 and 2 = $85.20\% \pm 13.19\%$, instructed recall Time 3 = $76.23\% \pm 22.52\%$), $F(1, 226) = 25.51$, $p < .001$, $\eta_p^2 = .20$.

As in Study 1, participants instructed to ruminate reported viewing the anger-eliciting event more from their own perspective than those instructed to reappraise. This was demonstrated by a repeated measures ANOVA, with condition as a between-groups measure and time (repetition Times 1–3) as the repeated within-groups measure, performed on the first perspective ratings of viewing the anger-eliciting event, which produced a main effect for condition and no interaction with time, $F(1, 113) = 62.78$, $p < .001$, $\eta_p^2 = .36$.

Main Analyses

Anger experience. To test the hypothesis that rumination would maintain anger, whereas reappraisal would decrease anger, a nested repeated measures ANOVA was performed. This analysis revealed a main effect of condition, such that those assigned to ruminate reported more anger than those assigned to reappraise at all time points (ruminate = 1.44 ± 0.96 , reappraise = 0.87 ± 0.80), $F(1, 113) = 16.80$, $p < .001$, $\eta_p^2 = .13$; see Figure 2), as well as a significant Time \times Task \times Condition interaction, $F(2, 226) = 3.13$, $p = .046$, $\eta_p^2 = .03$. Follow-up nested repeated

measures ANOVAs on anger ratings for each condition indicated that rumination participants did not show signs of waning anger over time, as evidenced by the lack of a significant main effect of time or Task \times Time interaction ($p > .1$). By contrast, those assigned to reappraise experienced a linear decrease in anger over time during the repeated instructed recall periods. This linear decline was exhibited by a main effect for time, $F(2, 226) = 18.65$, $p < .001$, $\eta_p^2 = .14$, and by the follow-up contrasts to the main effect of time for the instructed anger-recall task, $F_{\text{linear}}(2, 226) = 36.78$, $p < .001$, $\eta_p^2 = .14$, as well as suggested by further paired *t* tests (Time 1–Time 2 = 0.24 ± 1.01), $t(226) = 1.10$, $p = .10$, (Time 1–Time 3 = 0.36 ± 0.80), $t(226) = 1.88$, $p = .03$, and a Time \times Task interaction, $F(2, 226) = 6.36$, $p = .002$, $\eta_p^2 = .05$. Follow-up *t* tests demonstrated that reappraisal participants reported less anger in the instructed recall periods over time while actively focusing on and reappraising an anger-eliciting event. During the instructed recall tasks, participants' reported anger held steady from Time 1 to Time 2, $t(226) = 1.21$, $p = .113$, and then decreased between Time 2 and Time 3, $t(226) = 2.80$, $p = .003$.

Cognitive consequences. To test the hypothesis that rumination would perpetuate thinking about the anger-eliciting event more than reappraisal, a nested repeated measures ANOVA was performed. Condition was the between-groups factor, and time (repetition of reported percentage of time thinking about the anger-eliciting event during the delay period for Times 1–3) was the repeated factor, and it revealed a main effect of condition. Rumination participants continued to think about the event more than the reappraisal participants during the uninstructed delay periods, $F(1, 113) = 8.55$, $p < .005$, $\eta_p^2 = .07$. Also, a main effect of time indicated that over time, all participants reported thinking less exclusively about the event that made them angry during the delay period, $F(2, 226) = 19.85$, $p < .001$, $\eta_p^2 = .15$. The Time \times Condition interaction was not significant. Not only did ruminators continue to think about the event more when they were not instructed to, they also thought about it in the same way. Independent *t* tests on the amount the participant reported changing her interpretation of the event shows that those assigned to ruminate were less likely to change how they thought about the event, whereas those assigned to reappraise expressed change in their interpretation of the event (ruminate = 0.17 ± 0.35 , reappraise = 0.46 ± 0.48), $t(87.48) = 3.52$, $p < .001$.

Physiological consequences. To examine whether rumination differed from reappraisal in terms of physiological responding, nested repeated measures ANOVAs were performed. As predicted, rumination participants showed greater physiological activation in both measures of sympathetic responding than reappraisal participants. A nested repeated measures ANOVA performed on the peripheral sympathetic composite score (change from baseline) detected a main effect of condition: Those assigned to ruminate showed greater increases in peripheral sympathetic responding

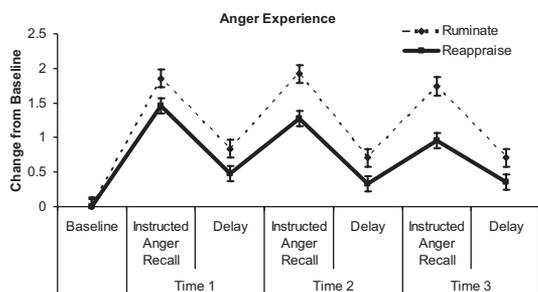


Figure 2. Anger experience (change from baseline) in instructed anger-recall and delay trials in Study 2.

⁴ The events that individuals reported in Study 2 were assessed along several dimensions to ensure that random assignment was successful in producing groups with equally anger-provoking events. Participants in the two conditions did not differ either in the type of event called to mind or in the intensity of the initial emotional response. These events originally elicited moderate levels of anger and were not yet resolved. The participants also did not differ in physiological activation during baseline.

than those assigned to reappraise (ruminate = 0.99 ± 1.28 , reappraise = 0.14 ± 1.38), $F(1, 105) = 12.53$, $p = .001$, $\eta_p^2 = .11$ (see Figure 3A). Condition did not interact with either time or task, nor was there a three-way interaction of Task \times Condition \times Time, $F(1.71, 179.23) = 1.06$, *ns*. The nested repeated measures ANOVA did, however, reveal a Task \times Time interaction, $F(1.71, 179.23) = 30.75$, $p < .001$, $\eta_p^2 = .23$. A main effect of task, $F(1, 105) = 49.48$, $p < .001$, $\eta_p^2 = .32$, showed that instructed recall increased peripheral sympathetic responding more than the delay, and a main effect of time, $F(1.48, 155.85) = 45.94$, $p < .001$, $\eta_p^2 = .30$, suggested that with each iteration, sympathetic responding increased over time. Follow-up repeated measures ANOVAs on peripheral sympathetic composite scores for each task separately and follow-up linear contrasts confirmed that peripheral sympathetic responding increased from baseline linearly over time, $F_{\text{instructed anger recall}}(1.86, 179.23) = 8.02$, $p < .001$, $\eta_p^2 = .06$, $F_{\text{delay}}(1.67, 179.23) = 110.08$, $p < .001$, $\eta_p^2 = .47$.

Similarly, a nested repeated measures ANOVA performed on the central sympathetic measure, PEP, revealed a main effect of condition: Those assigned to ruminate showed larger decreases in PEP from baseline than those assigned to reappraise (ruminate = -4.19 ± 5.59 , reappraise = -1.95 ± 3.34), $F(1, 104) = 5.74$, $p = .018$, $\eta_p^2 = .05$ (see Figure 3B). A decrease in PEP indicates

increased central sympathetic response, with those assigned to reappraise experiencing less central sympathetic response than those assigned to ruminate. Additionally, a main effect of task suggests that participants' PEP was shorter during the delay task than during the instructed anger-recall task (delay = -3.29 ± 5.42 , anger recall = -2.86 ± 5.76), $F(1, 104) = 5.35$, $p = .023$, $\eta_p^2 = .05$. As with the composite sympathetic measure, the PEP findings demonstrate that rumination produces greater sympathetic responding than does reappraisal.

Written response of cognitive change. To test the hypothesis that reappraisal instructions would encourage reinterpretation of the anger-eliciting event, participants' written descriptions of how they thought about the event were coded for change in interpretation of the event. A chi-square analysis tested the association between condition and the three ratings. Those assigned to the reappraisal group were significantly more likely to reinterpret the anger-eliciting event more positively, $\chi^2(2) = 19.23$, $p < .001$, ruminate = .24, reappraise = .41, whereas those assigned to ruminate were equally likely to interpret the anger-eliciting event more negatively (negative = .23) or more positively (positive = .24). Another test for change in interpretations was performed on the number of change or insight words that participants used when describing how they thought about the anger-eliciting event. An independent *t* test on the number of change or insight words confirmed that those assigned to reappraise reported more insight or change words than those assigned to ruminate, $t(111) = 2.43$, $p = .017$, $\eta_p^2 = .05$ ($M_{\text{ruminate}} = 0.28 \pm 0.90$, $M_{\text{reappraise}} = 0.72 \pm 1.00$). However, the number of change words does not fully account for the differences between the conditions in anger reports. An independent *t* test on anger reports controlling for the amount of change words finds that the conditions still differ significantly, $t(111) = 4.17$, $p < .001$, $\eta_p^2 = .13$.

Secondary Analyses

Effortful processing. Rumination and reappraisal both require cognitive effort, and this might translate into increased sympathetic responses. To confirm that the sympathetic differences were not due to differences in effort, a repeated measures ANOVA was performed on retrospective ratings of effort after each cycle of instructed recall and delay. The repeated measures ANOVA revealed a main effect of time, $F(2, 226) = 5.89$, $p = .005$, $\eta_p^2 = .05$, whereas the main effect of condition and interaction with condition were not significant, $F_{\text{Condition}}(1, 113) = 0.004$, $p = .985$; $F_{\text{Time} \times \text{Condition}}(2, 226) = 1.09$, $p = .244$. Moreover, repeated measures ANOVAs on both the central and peripheral sympathetic composite controlling for effort ratings did not substantially change the main effect for condition: central sympathetic responding, $F(1, 103) = 4.34$, $p = .032$, $\eta_p^2 = .04$, from $F(1, 103) = 5.22$, $p = .024$, $\eta_p^2 = .05$; peripheral sympathetic responding, $F(1, 104) = 12.45$, $p = .001$, $\eta_p^2 = .11$, from $F(1, 105) = 12.64$, $p = .001$, $\eta_p^2 = .11$.

Parasympathetic activation. The sympathetic branch of the autonomic nervous system can be influenced by the parasympathetic branch (Berntson, Cacioppo, & Quigley, 1991) and by somatic activity. Consequently, secondary analyses examined (a) the impact of rumination and reappraisal on the parasympathetic branch of the autonomic nervous system and (b) the role of somatic activity in determining physiological responding. A re-

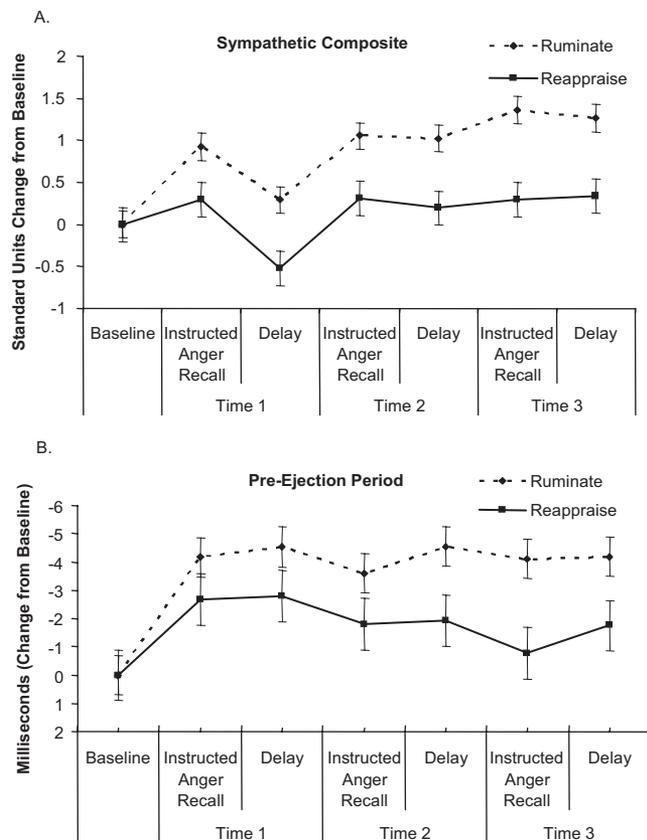


Figure 3. A: Peripheral sympathetic responding (change from baseline) in instructed anger-recall and delay periods in Study 2, scaled so that greater activation is up. B: Preejection period (change from baseline) in instructed anger-recall and delay periods in Study 2, scaled so that greater activation is up.

peated measures ANOVA using RSA scores failed to detect a significant difference between those assigned to ruminate and those assigned to reappraise, $F(1, 100) = 1.43, p = .232$; however, the means were in the direction of those assigned to ruminate experiencing smaller increases in RSA ($M = 0.001 \pm 0.54$) than those assigned to reappraise ($M = 0.094 \pm 0.59$). These null findings suggest that in this task, sympathetic and parasympathetic activity is not tightly coupled, and consequently, each is differently affected by rumination and reappraisal (Berntson et al., 1991).

Discussion

Study 2 is the first to demonstrate affective, cognitive, and physiological differences between rumination and reappraisal. These differences were found not only during the task but also during the recovery period. This study provides strong evidence that reappraisal can contribute to emotional, cognitive, and physiological recovery from anger-inducing events.

As in Study 1, Study 2 showed that those instructed to ruminate reported more anger than those instructed to reappraise despite spending the same amount of time thinking about the anger-inducing event. Reappraising allowed individuals to think about the event without experiencing the intensity of anger that is a consequence of rumination. One mechanism suggested by our results is the increased insight reported by those who reappraised.

Study 2 also demonstrated the differential effects of rumination and reappraisal over time. Those assigned to ruminate about their anger-eliciting event maintained their anger each time they brought the event to mind, whereas those assigned to reappraise showed decreases in anger with each repetition. This finding, together with the finding from Study 1 that free recall produces levels of anger indistinguishable from ruminating, provides strong evidence that reappraisal works to attenuate anger. In addition, by using delay instead of "rest" periods, Study 2 revealed that, compared with reappraisal, rumination perpetuates anger and perseverative thinking about the event, even after participants had been told they could stop.

Study 2 showed that rumination and reappraisal differed not only in self-reported emotion but also in physiological responding. Those assigned to ruminate had greater central and peripheral sympathetic responses than those assigned to reappraise, both during the instructed anger-recall periods and in the delay periods. This difference between the groups increased over time, with those assigned to ruminate maintaining or increasing their level of activation and those assigned to reappraise decreasing their activation.

These physiological findings may be interpreted as evidence that ruminators continue to refresh the arousing properties of events that make them angry, whereas reappraisers were able over time to cognitively transform the event so that their physiology could recover to baseline. Furthermore, increases in sympathetic responding for ruminators is consistent with other findings of decreased autonomic recovery following rumination (Glynn et al., 2002; Vickers & Vogeltanz-Holm, 2003). This is also consistent with the association between hostility and increases in measures of central PEP sympathetic activation (Neumann, Waldstein, Sollers, Thayer, & Sorkin, 2004). This pattern in the anger rumination components (anger experience, thoughts about the angry event, and increased central cardiovascular sympathetic activation) sup-

ports the notion that chronic anger rumination creates a vulnerability for cardiovascular disease (Brosschot et al., 2006).

General Discussion

According to appraisal theories of emotion, the key determinant of emotional responses is the way one thinks about (or appraises) an event (Lazarus, 1991; Scherer et al., 2001). Anger-eliciting situations provide an ideal context within which to investigate the relationship between thinking and feeling. In daily life, we encounter many opportunities to have our plans and hopes thwarted, by accident or by the incompetence or even malice of others. Some people, like Emily in the van pool, ruminate over these events, mentally replaying upsetting appraisals and focusing on how it makes them feel. They are emotionally the worse for it (Morrow & Nolen-Hoeksema, 1990). Others, like Bob, manage mentally to review and focus on upsetting events in ways that help them integrate these experiences, leaving them emotionally recovered from the event (Pennebaker et al., 2003).

Rumination and Reappraisal Have Different Consequences

In the present studies, we contrasted rumination and reappraisal by having participants either ruminate about or reappraise recent, autobiographical, unresolved anger-eliciting events. Despite spending equal amounts of time thinking about the events, those who ruminated about the event (vs. those who reappraised) felt angrier when they recalled the event, and they were more likely to continue to think about the event (and feel angrier) even when told they could stop.

In line with their increased anger and preoccupation with the anger-eliciting event, those who ruminated showed greater central and peripheral sympathetic responses, a difference that actually increased over time. These effects between groups were not due to increases in positive emotion on the part of reappraisers, increases in social distance, or differential effort. This indicates that rumination leads to more sympathetic nervous system activation, with little or no habituation to the angry thoughts. Reappraisal, however, makes further thinking about the anger-eliciting event less likely and leads to decreases in self-reported anger and central and peripheral sympathetic activation, as well as increases in reports of insight and positive reinterpretation, suggesting that reappraisal makes upsetting material less arousing over time.

Implications for Emotion Regulation Processes

The findings presented here address a crucial gap in the literature on rumination by showing that even when one holds relatively constant what a person is thinking about, the way a person thinks about the event shapes his or her emotional responses. The present studies provide converging evidence for the work of Ayduk, Mischel, and Downey (2002), which has shown that cognitive representations of an event influence emotion experience reports. These studies are the first to show that changing how one thinks about life events can penetrate not only self-report but also physiological responding. It thus serves as a crucial link in understanding how different approaches to life events may have profound consequences for physical health.

There have been growing calls for a distinction between different ways of bringing upsetting content to mind (Trapnell & Campbell, 1999; Treynor, Gonzales, & Nolen-Hoeksema, 2003). Several of the possible alternatives to rumination have not focused on how one thinks about the particulars of an upsetting event, but instead operate on a level of abstraction above the emotion cognition interaction so as to drain events of their meaningfulness. For example, decentering (Watkins, Teasdale, & Williams, 2000) bypasses the situated appraisals causing a mood and works instead to recast one's mood or emotions in light of the trans-situational transience of any moment in one's life. Similarly, diffusion (Masuda, Hayes, Sackett, & Twhig, 2004) does not attempt to change one's thoughts about events, but instead attempts to change the metacognitive environment, repeating thoughts until they lose their meaning, so as to dissociate the part of the self that is experiencing events and emotions from the part that is evaluating the event. By clear contrast, reappraisal directly changes one's appraisals so as to change one's affective response. The present study provides evidence that reappraisal can be effective in decreasing the intensity of one's negative affect.

Another strategy that has been proposed in the context of anger is called "constructive anger verbal behavior" (Davidson, MacGregor, Stuhr, Dixon, & MacLean, 2000). This strategy involves interacting with another person to explore more nuanced causes for the problem and its solutions in such a way as to lead to decreased negative emotion. It is assessed by questionnaire, and use of constructive anger verbal behavior has been associated with lower resting blood pressure (Davidson et al., 2000). We suspect that constructive anger verbal behavior is a social species of reappraisal because items in the questionnaire index the extent to which discussion increases one's appreciation for the complexity of situations and thus may lead to different interpretations. Reappraisal generally, and constructive anger verbal behavior specifically, can create opportunities to integrate upsetting material and productively solve problems by maintaining a problem-solving attentional focus on the upsetting material while decreasing the intensity of the negative affect.

The present findings extend prior reappraisal research in the emerging field of emotion regulation (Gross, 1998, 2007). Researchers interested in reappraisal have directed their efforts at understanding how reappraisal changes physiological aspects of the emotional response. These studies, however, generally have been limited to standardized stimuli. The present study is the first to show that reappraisal can lessen anger experience and sympathetic activation in the ecologically central context of powerful, socially complex, and personally relevant anger episodes that are not yet resolved. Additionally, this study extends the finding by Gross and John (2003) that those who tend to reappraise experience better outcomes during stressful events by showing that such individuals are able to decrease the affective, cognitive, and physiological effects of negative emotional events.

Limitations and Future Directions

The present studies were limited in comparing rumination with one type of cognitive reappraisal in women who were angry about an unresolved interpersonal event. Although rumination about interpersonal events is more common in women (Mezulis, Abramson, & Hyde, 2002), much of the work has

been done on depressive rumination rather than on angry rumination, with women reporting using a wider range of coping strategies such as social support to deal with their anger (Linden et al., 2003). However, work by Rusting and Nolen-Hoeksema (1998) suggests that men may engage in anger rumination more often than women. Future studies should thus examine the differential effects of rumination and reappraisal in men as well as women, in the context of other negative and positive emotional states, and in the context of other, equally ecologically generalizable emotion elicitors.

Our focus here has been the immediate consequences of rumination and reappraisal on emotion, cognition, and physiology, not on functional outcomes for problem solving and interpersonal relationships. However, based on the present findings as well as on the prior literature on anger rumination and aggression and marital satisfaction, we predict that anger rumination leads to increases in hostile interpersonal interactions and decreases in productive problem solving (Bushman et al., 2005). By contrast, reappraisal, in addition to decreasing anger experience, has been associated with positive social outcomes (Gross & John, 2003) and, compared with expressive suppression, improved memory for emotionally tense discussions with dating partners (Richards, Butler, & Gross, 2003). Distraction has been associated with decreased anger reports (Bushman et al., 2005; Rusting & Nolen-Hoeksema, 1998) and better problem solving than rumination (Lyubomirsky, Tucker, Caldwell, & Berg, 1999). Consequently, we expect that the kind of cognitive reappraisal in which our participants engaged will lead to better interpersonal interactions than rumination or distraction and will better facilitate problem solving and resolution than rumination. We regard this as an important direction for research.

Finally, work by Pennebaker and colleagues (2003) suggests that differences in the way one cognitively processes upsetting events can have longer term health consequences. We captured, in miniature within the laboratory setting, aspects of the temporally extended, repetitive nature of rumination. Like any laboratory study, ours is limited in its ability to capture longer and more naturalistic rumination and reappraisal over time. Nonetheless, the pattern of emotional, cognitive, and physiological effects of anger rumination demonstrated in these studies corroborates theorizing by Brosschot, Gerin, and Thayer (2006) that rehearsal and amplification of distress over the long term may create vulnerabilities to cardiovascular disease. For example, chronic anger rumination is associated with hostility, which, in turn, has been associated with poorer survival in women with suspected coronary heart disease (Olson et al., 2005). Future research is needed to demonstrate how acute increases in sympathetic activation seen in anger rumination manifests into increases in vulnerability to cardiovascular disease.

Albeit speculative, the present studies are consistent with the idea that reappraisal may be a useful tool to mitigate some of the negative effects on emotional and physical health caused by ruminating on anger-inducing events. More generally, our results suggest the importance of investigating, over long periods of time, the cumulative effects on psychological, relational, and physical health of different primary and/or chronic strategies for thinking about life's problems.

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