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This is the author's manuscript

Original Citation:

Availability:

This version is available <http://hdl.handle.net/2318/92844> since 2015-12-29T15:19:50Z

Published version:

DOI:10.1080/02699931.2011.625403

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UNIVERSITÀ DEGLI STUDI DI TORINO

This is an author version of the contribution published on:

Questa è la versione dell'autore dell'opera:

Cognition & Emotion, 26, 5, 2012, DOI: 10.1080/02699931.2011.625403

The definitive version is available at:

La versione definitiva è disponibile alla URL:

<http://dx.doi.org/10.1080/02699931.2011.625403>

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Remembering the Silver Lining:

Reappraisal and Positive Bias in Memory for Emotion

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Keywords: emotion, emotion regulation, reappraisal, memory bias

Abstract

Reappraisal and distraction, unlike suppression, are known to decrease the intensity of negative emotion in the short term. Little is known about long term characteristics associated with emotion regulation strategies, however. In a longitudinal study, we examined the relation between the strategies people reported using to regulate emotions during a stressful situation and their later memory for their emotions. Students in Italy rated the intensity of positive and negative emotions they were experiencing as they prepared for their high school exit exam. They also rated the extent to which they were regulating emotion using reappraisal, distraction, and suppression. Six weeks later, students recalled their pre-exam emotions. The more students reported engaging in reappraisal before the exam, the more they overestimated positive emotion and underestimated negative emotion when recalling their experience. The association between reported reappraisal and memory bias was partially mediated by positive changes over time in students' appraisals of the exam preparation experience. Reports of engaging in distraction and suppression were not associated with memory bias. Because remembered emotion guides future choices, these findings suggest that reappraisal is a highly adaptive strategy for coping with stressful situations, not only in the short run, but also in the long run.

Remembering the Silver Lining:

Reappraisal and Positive Bias in Memory for Emotion

When people remember stressful experiences, what comes to mind is not just a dry account of the events that unfolded but also the feelings that were evoked by these events. This feature of autobiographical memory is tremendously important. People decide which experiences to seek out or avoid in the future based in part on their memory for how they felt during similar experiences in the past (Wirtz, Kruger, Scollon, & Diener, 2003). The fact that people remember their feelings does not mean that they remember them accurately, however. Past research shows that memory for emotion is subject to bias (e.g. Christianson & Safer, 1996; Levine, 1997; Robinson & Clore, 2002). The present study examined whether the strategies people report using to regulate emotions during stressful situations are associated with biases when they later remember their emotional reactions.

Bias in Memory for Emotion

Memory for emotion has been shown to be prone to bias in the direction of people's current appraisals of the emotion-eliciting event. According to appraisal theories, people experience emotions when they interpret or appraise events as relevant to their goals. The intensity of positive or negative emotion experienced depends on whether an event is appraised as promoting or thwarting goals and whether people believe they have the resources needed to cope with the event (e.g. Frijda, 1986; Oatley & Johnson-Laird, 1987; Scherer, 1984; Smith & Lazarus, 1993; Stein & Levine, 1987). For example, if students appraise passing an exam as promoting their goals but view themselves as unprepared or unable to do their best, they are likely to feel anxious and unhappy while preparing for the exam (e.g., Smith & Ellsworth, 1987; Schmidt, Tinti, Levine, & Testa, 2010). The same situation may elicit interest and even enjoyment if students expect to be able to do their best (Silvia, 2008).

Over time, however, memory for emotion fades. As it fades, people draw on their current appraisals of emotion-eliciting events to reconstruct how they must have felt. If people's appraisals of an event have changed over time, they tend to show a bias toward recalling their past emotions as more consistent with their current appraisals of the event than they actually were (Holmberg & Holmes, 1994; Levine, 1997; Levine, Prohaska, Burgess, Rice, & Laulhere, 2001; Levine, Safer, & Lench, 2009; Levine & Safer, 2002; Levine, Stein, & Liwag, 1999). For example, Safer, Levine, and Drapalski (2002) had college students report how anxious they felt immediately before taking a midterm exam. A week later, one group of students was asked to recall their feelings before they learned their exam grade; another group recalled their feelings immediately after they learned their grade. The results showed that, relative to students who had not yet learned their grade, those who learned that they had done well on the exam underestimated how anxious they had felt. Those who learned that they had done poorly overestimated how anxious they had felt. Thus, students' current appraisal that the exam outcome was positive or negative biased their memory for past feelings of anxiety. In summary, people's initial appraisals of a situation evoke an initial emotional reaction; their appraisals of that situation at a later time can bias their memory for their initial reaction.

Emotion Regulation

People are not simply passive observers of their emotions, however. They take an active role in shaping them. The aim of the present study was to examine whether the strategies people report using to regulate emotions during stressful experiences predict how they later remember having felt. In addressing this question, we focused on three strategies: reappraisal, distraction, and suppression. Reappraisal refers to reinterpreting a situation in a manner that decreases its negative impact (e.g., thinking about an upcoming exam as an opportunity to learn). Distraction refers to directing attention away from a stressful situation (e.g., going to a movie to take one's

mind off an upcoming exam). Suppression refers to trying to eliminate emotional expression or feelings (e.g., trying not to display or feel anxiety about an upcoming exam).

In experimental studies, participants have been instructed to engage in reappraisal, distraction, or suppression and then presented with distressing images or films. Researchers have assessed the effectiveness with which these strategies decrease subjective emotional intensity as well as the costs exacted through sympathetic nervous system arousal and impaired memory for the stimuli that elicited emotion. Results indicate that, because reappraisal intervenes in the appraisal process before an emotional response fully develops, this strategy decreases subjective emotional intensity without increasing sympathetic arousal or impairing memory for emotional stimuli (e.g., Gross, 1998; Ray, McRae, Ochsner, & Gross, 2010). Distraction also decreases emotional intensity, but directing attention away from emotion-eliciting stimuli impairs memory for those stimuli (e.g., Richards & Gross, 2006). Suppressing emotion neither alters appraisals nor redirects attention, and as a result, does not decrease subjective emotional intensity. Because this strategy is effortful, however, it increases sympathetic arousal and can impair memory for emotion-eliciting stimuli (e.g., Gross & Levenson, 1997; Richards & Gross, 1999, 2006). In the short run, then, reappraisal and distraction, but not suppression, serve to decrease the intensity of negative emotion (e.g., Gross, 1998; Gross & Levenson, 1997; Richards & Gross, 1999, 2006).

In contrast to these short term consequences, little is known about long term consequences of reported use of emotion regulation strategies in non-clinical populations (John & Gross, 2004). Gross and John (2003) had participants report how they habitually regulated emotion and how often they experienced positive and negative emotions. Participants also completed several measures of wellbeing (e.g., depression, self-esteem, life satisfaction). Reporting more frequent use of reappraisal was associated with more positive emotion, less negative emotion and depression, and greater wellbeing. In contrast, reporting greater use of

suppression was associated with less positive emotion, more negative emotion and depression, and poorer wellbeing. Long term consequences of distraction have yet to be examined in non-clinical populations. Over time, however, distracting oneself from unpleasant events may not be as beneficial as reinterpreting them in a positive manner, particularly when negative events are unavoidable and require attention to be addressed successfully.

In summary, reappraisal and distraction, unlike suppression, successfully decrease the intensity of negative emotion in the short term. Compared to suppression, greater self-reported use of reappraisal also appears to have significant long term benefits. Further research is needed to identify how reappraisal promotes long term wellbeing (John & Gross, 2004). Moreover, although researchers have assessed how emotion regulation strategies affect memory for emotion-eliciting stimuli and events (e.g., slides, films, autobiographical events), no studies have assessed the effects of these strategies on memory for the emotional reaction itself. Because memory for emotion guides future plans, such an investigation may be vitally important to understanding the long term characteristics associated with emotion regulation strategies. The present investigation was designed to address these issues.

Emotion Regulation and Bias in Memory for Emotion

We examined the relation between people's reports of engaging in reappraisal, distraction, and suppression during a stressful experience and their later memory for their emotions. As discussed above, when remembering how they felt in the past, people draw on their current appraisals of the emotion-eliciting event. If these appraisals have changed over time, they often show a bias toward recalling their feelings as more consistent with their current appraisals than they actually were (Levine, 1997). Thus, we hypothesized that emotion regulation strategies that promote changes in appraisals over time would be associated with bias in memory for emotion. Strategies that do not involve changing appraisals were not expected to be associated

with memory bias.

As the name implies, reappraisal involves changing how a person interprets a situation, reframing it, or finding the silver lining behind the clouds. When undertaken in the midst of an ongoing stressful situation, reappraisal is a dynamic process that may have cyclical and lasting effects (Fredrickson & Joiner, 2002). For example, reappraising a setback as an opportunity for learning and growth is likely to shape, not only immediate appraisals and emotional reactions, but also the likelihood of finding positive meaning in subsequent related events. Over time, then, reappraisal may lead to viewing stressful situations in an increasingly positive manner. Based on this analysis, we expected reappraisal to be associated with a positive bias in memory for emotion. We further expected this memory bias to be at least partially mediated by people's current appraisals of the stressful situation. That is, the more people report engaging in reappraisal, the more positive their appraisal of the stressful situation should become over time. In turn, the more positive their appraisals become, the more positive emotion (and the less negative emotion) they should remember having felt. In contrast, distraction and emotion suppression, do not require changing appraisals of emotion eliciting events. So reports of engaging in these strategies were not expected to be associated with bias in memory for emotion.

The Present Investigation

To test these hypotheses, we turned to students in Italy, in their final year of high school, who were in the midst of preparing for their exit exam (*esame di maturità*). This exam is a stressful rite of passage that includes a written section and an oral interview in front of a board of professors. Higher passing scores favour entry into more respected universities. About three weeks before the exam, students completed a questionnaire which asked them to rate how intensely they were feeling positive and negative emotions. They also rated how much they were engaging in reappraisal, distraction, and suppression to regulate their emotions. Approximately

three weeks after the exam, shortly after exam scores were made available, the same students were asked to recall how they had been feeling when they completed the pre-exam questionnaire.

We also assessed students' appraisals of the exam preparation experience before and after the exam. This allowed us to test our hypothesis that pre-exam reports of engaging in reappraisal, but not distraction or suppression, would be associated with students' appraisals becoming more positive over time. Positive current appraisals, in turn, were expected to mediate the association between reported reappraisal and bias in memory for emotion. To evaluate these hypotheses in a conservative manner, we assessed and controlled for other factors that might be expected to promote memory bias, including how hard students studied, how well they did the exam, and their mood at the time of recall. In addition, we were interested in the emotion regulation strategies students reported using during a specific stressful period, rather than in the strategies they reported using generally. So we also assessed and controlled for the emotion regulation strategies they reported using at the time of recall.

Finally, it is important to note that the current study focused on self-reports concerning the strategies used to regulate emotion. This approach has both drawbacks and strengths. Self-reports may be influenced by people's views about the social acceptability of particular strategies and by differences in people's awareness of their emotion regulation efforts. In addition, using a strategy frequently may differ from using a strategy effectively (Troy, Wilhelm, Shallcross, & Mauss, 2010). Instructing people to regulate emotion in the laboratory provides greater control. But such studies alone cannot inform us about the emotion, appraisal, and memory processes associated with reporting particular strategies in situations that have long term consequences. Thus the current study focused on students' self-reported use of emotion regulation strategies as they grappled with a stressful situation of great personal importance.

Method

Overview

This study was part of a larger research project that assessed Italian high school students' self-reported appraisals, emotions, and emotion regulation strategies prior to their high school exit exam (Schmidt, Tinti, Levine, & Testa, 2010). Students completed written questionnaires three weeks before the exam. A subset of these students also completed questionnaires approximately three weeks after the exam. The current study focused on how the emotion regulation strategies students reported using before the exam were related to their later memory for their pre-exam emotions.

Participants

Participants were 264 Italian students who were in their final year of high school. The mean age of the participants was 19 years ($SD = 1.16$ years) and 80% were female.¹

Procedure

Questionnaires, in Italian, were given to students in their final year of high school at two time points: three weeks before the exam and approximately three weeks after the exam had been completed. Before the exam, research assistants distributed questionnaires to students at high schools in Turin and in Florence, Italy. Students completed the questionnaires in their classrooms. Students received the second questionnaire via mail after exam scores were released and returned the questionnaires in a postage paid envelope.

Measures

Before the exam. Three weeks before the exam, students completed a questionnaire concerning their reactions to their high school exit exam. To assess their current mood, students were first asked, "We ask that you reflect on how you feel at this very moment. How are you feeling?" Students rated their feelings using a scale that ranged from -5 (*extremely bad*) to 5 (*extremely good*). Students also rated their level of tension ("What is your level of tension /

relaxation?") using a scale ranging from -5 (*extremely tense*) to 5 (*extremely relaxed*). For greater consistency with other measures, ratings of current mood and level of tension were recoded to scales ranging from 0 to 10. Students also rated their feelings about the exam. They were asked, "How are you currently feeling about the exam? For each emotion listed, please rate the intensity of your feelings, where 0 means 'not at all' and 10 means 'extremely'." Students rated how intensely they were feeling four positive emotions (happiness, pride, relief, interest; Cronbach's $\alpha = .61$) and four negative emotions (sadness, shame, fear, anger; $\alpha = .66$). These ratings were averaged to provide indexes of students' overall positive feelings, and their overall negative feelings, about the exam.

To assess emotion regulation strategies, students were asked to, "Please think now about your upcoming high school exit exam and answer the following questions. During this period, what strategies are you using to cope with the exam?" Students rated the extent to which they were using specific strategies using a scale ranging from 0 (*not at all*) to 10 (*extremely*). Mean ratings on two items each were used to assess the extent to which students were engaging in reappraisal ("I try to see the positive aspects of this experience"; "I try to learn from this experience"; $\alpha = .86$), distraction ("I take my mind off the exam"; "I engage in fun activities"; $\alpha = .36$), and suppression ("I do not show my feelings"; "I try to suppress my feelings"; $\alpha = .70$). These items were selected from measures of coping and emotion regulation in the literature; wording was adapted slightly to fit the context of preparing for an exam. Specifically, to assess reappraisal, we adapted items from the *Ways of Coping Questionnaire, Revised* (Folkman & Lazarus, 1985) which referred to reframing a situation in a positive manner. Distraction items were adapted from the *Brief Cope* (Carver, 1997). They were selected because they measure two distinct but important means of taking one's mind off a negative situation: not thinking about a situation, and thinking about something else.² Suppression items were adapted from the

Strategies Questionnaire (Ehring, Tuschen-Caffier, Schnülle, Fischer, & Gross, 2010). Students also rated, “How much are you dedicating yourself to studying?” using a scale ranging from 0 (*not at all*) to 10 (*extremely*).

Finally, using 11-point scales, students rated their appraisals of the exam preparation experience with respect to: (a) valence: “How positive or negative is this event for you?” (-5 *extremely negative* to 5 *extremely positive*); (b) preparation: “How prepared do you feel for the exam?”; (c) ability to do their best: “How much do you feel able to do your best?”; and (d) maturation: “How much do you think this experience will make you grow/mature?” (0 *not at all* to 10 *extremely*).³ These items were standardized (i.e., valence was recoded using a 0 to 10 scale) and averaged together ($\alpha = .73$) so that a higher score indicated a more positive appraisal of the exam preparation experience.

After the exam. Approximately three weeks after the exam, students completed a second questionnaire. Students first rated their current mood and level of tension using the same items as on the pre-exam questionnaire. As described above, these ratings were recoded using scales that ranged from 0 to 10. Students were then asked to, “Please think back to the period before the exam when we asked you to complete the first questionnaire. At that time, how were you feeling about the exam? For each emotion listed, please rate the intensity of your feelings, where 0 means ‘not at all’ and 10 means ‘extremely’.” Students recalled how intensely they had felt four positive emotions (happiness, pride, relief, interest; $\alpha = .69$) and four negative emotions (sadness, shame, fear, anger; $\alpha = .64$). Students were also asked, “What strategies are you using currently to cope with your exam?” They rated the extent to which they were currently engaging in reappraisal, distraction, and suppression using the same two items per strategy as on the pre-exam questionnaire ($\alpha = .87$ for reappraisal, .25 for distraction, and .66 for suppression). They also rated their current appraisals of the exam preparation experience (valence, preparation,

ability to do their best, maturation) using the same items as on the pre-exam questionnaire except that the items were phrased in the past tense. These items were standardized and averaged together ($\alpha = .74$) so that a higher score indicated a more positive post-exam appraisal of the exam preparation experience. Finally, students were asked, “What score did you receive on the exam?”

Thirteen participants had a missing value for one study variable each. Specifically, five participants were missing a value for the pre-exam appraisal composite measure, two participants were missing a value for the post-exam appraisal composite measure, and six participants were missing a value for another study variable. Because analyses included all cases with complete data for the measures in question, cell sizes vary.

Results

Preliminary Analyses

Students exam scores ranged from 60 (a passing score) to 100 (a perfect score), ($M = 80.77$, $SD = 13.42$). Thus, all students who completed questionnaires after the exam had passed the exam. We compared students' ratings of their current mood (extremely bad to extremely good) and level of tension (extremely tense to extremely relaxed) before and after the exam. Students reported feeling worse before the exam ($M = 5.08$, $SE = .15$) than after ($M = 7.98$, $SE = .16$), $t(261) = 14.35$, $p < .001$, $d = 1.16$. They also reported feeling much more tense before the exam ($M = 3.82$, $SE = .15$) than after ($M = 7.99$, $SE = .15$), $t(263) = 21.05$, $p < .001$, $d = 1.79$. These findings suggest that students found preparing for their high school exit exam to be a stressful experience.

Experienced and Recalled Emotion

We examined the mean intensity of positive and negative emotion that students experienced and recalled by conducting a repeated measures ANOVA with valence and time as

within subject factors. A main effect of time indicated that, as a group, students experienced more intense emotion than they recalled, $F(1, 260) = 83.04, p < .001$. An interaction between valence and time indicated that students underestimated more in recalling negative emotion (experienced: $M = 4.30, SE = 0.12$; recalled: $M = 3.24, SE = 0.12$), than in recalling positive emotion (experienced: $M = 4.26, SE = 0.13$; recalled: $M = 3.73, SE = 0.13$), $F(1, 260) = 16.66, p < .001$. The intensity of emotion experienced and recalled was highly correlated for both positive emotion, $r(263) = .65, p < .001$, and negative emotion, $r(263) = .62, p < .001$. Thus, as a group, students were relatively accurate in recalling how they had felt before the exam but showed a tendency to underestimate the intensity of emotion they had experienced. Individuals differed, however, with respect to whether they underestimated, accurately recalled, or overestimated pre-exam emotion. For positive emotion, 57% of students underestimated, 7% were accurate, and 36% overestimated, $\chi^2(2, N = 264) = 99.61, p < .001$; for negative emotion, 70% underestimated, 8% were accurate, and 22% overestimated, $\chi^2(2, N = 264) = 164.45, p < .001$.

Emotion Regulation

We also examined how much students reported using reappraisal, distraction, and suppression during the exam preparation period. Paired comparison t -tests, using Bonferroni adjusted alpha levels of .017 (.05/3), indicated that students reported using reappraisal ($M = 5.61, SE = 0.16$) more than suppression ($M = 2.86, SE = 0.15$), $t(262) = 12.05, p < .001, d = 1.09$. They also reported using distraction ($M = 5.11, SE = 0.14$) more than suppression: $t(262) = 12.17, p < .001, d = 0.96$. The extent to which students reported using reappraisal and distraction did not differ significantly using adjusted alpha levels, $t(263) = 2.40, p = .02, d = 0.20, n.s.$ Pearson correlations, using Bonferroni adjusted alpha levels of .017 (.05/3), indicated that the more students reported using distraction, the more they also reported using suppression, $r(262) = .18, p = .003$. However, reporting reappraisal was not significantly related to reporting distraction,

$r(263) = .09, p = .13, n.s.$, or suppression, $r(263) = -.08, p = .19, n.s.$

Table 1 presents descriptive statistics and correlations between key study variables and ratings of pre-exam emotion regulation strategies. To summarize these findings, consistent with prior research (Gross & John, 2003), reporting greater use of reappraisal was associated with experiencing and recalling more positive emotion, with more positive appraisals, and with studying more. In contrast, reporting greater use of suppression was associated with experiencing and recalling more negative emotion, and with more negative pre-exam appraisals. Reported use of suppression was also associated with studying more but with scoring more poorly on the exam nonetheless. Reported use of distraction was associated with studying less.

The primary goal of this study, however, was to find out whether reporting particular strategies predicted changes in appraisals over time, and bias in later memory for emotion. We turn to these questions next.

Emotion Regulation and Change in Appraisals

We hypothesized that students' reports of engaging in reappraisal, but not distraction or suppression, would be associated with positive change in their appraisals of the exam preparation experience over time. To test this, we conducted a regression analysis on students' post-exam appraisals. The predictors were students' pre-exam reports of how much they were using reappraisal, distraction, and suppression. Importantly, because we were interested in appraisal change over time, the analysis controlled for pre-exam appraisals. We also controlled for students' exam score because doing poorly or well on the exam would be expected to affect post-exam appraisals. The results showed that pre-exam appraisals strongly predicted post-exam appraisals, $B = .63, SE = .06, \beta = .60, t(255) = 11.22, p < .001$. In addition, scoring higher on the exam was associated with more positive post-exam appraisals, $B = .01, SE = .006, \beta = .09, t(255) = 1.95, p = .05$. After controlling for their pre-exam appraisals and exam score, however, the

more students reported using reappraisal before the exam, the more they appraised the exam preparation experience as having been positive after the exam, $B = .10$, $SE = .04$, $\beta = .15$, $t(255) = 2.83$, $p = .005$. In contrast, reported use of distraction and suppression did not predict post-exam appraisals; distraction: $B = -.02$, $SE = .04$, $\beta = -.02$, $t(255) = 0.43$, $p = .67$, *n.s.*; suppression: $B = .01$, $SE = .03$, $\beta = .02$, $t(255) = 0.42$, $p = .67$, *n.s.* As hypothesized then, self-reported reappraisal, but not distraction or suppression, was associated with appraisals of the exam preparation experience becoming more positive over time.

Emotion Regulation and Memory Bias

To find out whether the emotion regulation strategies students reported while preparing for their exam predicted bias in remembering their feelings, we conducted two separate hierarchical regression analyses: one for positive emotion and one for negative emotion. The dependent variable for these two analyses was the mean intensity of emotion recalled. In each analysis, in Step 1, we controlled for the mean intensity of emotion students reported experiencing before the exam. After accounting for how students had actually felt, the remaining variance in recalled emotion represented memory bias. In Step 2, we controlled for how much students studied, how well they did the exam, and their mood at the time of recall because these variables might be expected to promote bias in memory for pre-exam emotion (Safer et al., 2002). We were specifically interested in the strategies that students reported during the stressful pre-exam period rather than in their tendencies to report particular emotion regulation strategies generally. So we also controlled for the extent to which students reported engaging in reappraisal, distraction, and suppression at the time of recall. In Step 3, we entered the key variables of interest: students' reports of how much they engaged in reappraisal, distraction, and suppression before the exam. Table 2 summarizes the results of these analyses at Step 3, after the variables in all three steps were entered in the models.

As Table 2 shows, the intensity of emotion participants experienced was the strongest predictor of the intensity they recalled. After controlling for experienced emotion and control variables, however, pre-exam reported emotion regulation was also a significant predictor of recalled intensity. As hypothesized, reported reappraisal was associated with a positive bias in memory for emotion. That is, controlling for the intensity of emotion experienced, the more students reported using reappraised while preparing for the exam, the more positive emotion, and the less negative emotion, they later remembered having felt. Also as hypothesized, pre-exam reports of using distraction and suppression were not associated with bias in memory for emotion.

Mediation Analysis

We hypothesized that the association between reported reappraisal and memory bias would be at least partially mediated by positive changes over time in students' appraisals of the exam preparation experience. To test for mediation in a parsimonious manner, we calculated mean values for experienced emotion and for recalled emotion, taking into account all eight emotions. To do this, ratings for the four negative emotions were reverse-coded so that higher values represented a more positive response for all emotions. The mediation analysis controlled for the intensity of emotion initially experienced, pre-exam appraisals, and exam score. Assessing the intensity of emotion recalled, after controlling for the intensity of emotion initially experienced, provided a measure of memory bias. Assessing post-exam appraisals, after controlling for pre-exam appraisals, provided a measure of appraisal change.

To test for the significance of the mediation effect, we used Preacher and Hayes's (2008) method of calculating standard errors and 95% confidence intervals of the effect of reported reappraisal on recalled emotion through current appraisals. This method uses 5,000 bootstrapped samples to estimate the bias corrected and accelerated confidence intervals. This approach has

several advantages, including that it does not rely on the assumption of a normal sampling distribution, and that the number of inferential tests is minimized thus reducing the likelihood of Type 1 error (Hayes, 2009). For convenience, we also report the traditional mediation significance test (Sobel, 1982). The results are shown in Figure 1.

The bootstrap results showed that, as hypothesized, current appraisals partially mediated the relationship between reported reappraisal and recalled emotion, Mediated Effect = .02, $SE = .01$, 95% $CI = .0036$ to $.0459$, Sobel $z = 2.11$, $p = .03$. Because the confidence interval did not contain zero, we can conclude that there is a significant mediation effect of reported reappraisal on recalled emotion through current appraisals. As the top panel of Figure 1 shows, the more students reported reappraising while preparing for the exam, the more positive emotion (and the less negative emotion) they later remembered having felt. As the bottom panel shows, the more students reported engaging in reappraisal, the more positively they appraised the exam preparation experience at the time of recall. In turn, the more positive their current appraisals had become, the better they remembered having felt. After adding students' current appraisals to the model, an association between reported reappraisal and recalled emotion remained but it decreased significantly. Importantly, this analysis controlled for experienced emotion and pre-exam appraisals. Thus these findings demonstrate that the association between reported reappraisal and positive bias in memory for emotion is partially mediated by positive change over time in students' appraisals of the exam preparation experience.

Discussion

The key finding from this investigation was that the way people report regulating emotion during stressful circumstances predicts how they later remember having felt. Three weeks after completing their high school exit exam, students in Italy recalled how they had felt while preparing for the exam. The more students reported engaging in reappraisal before the

exam, the more positive emotion, and the less negative emotion, they recalled after the exam, even after controlling for their initial emotional experience, current mood, exam score, and current emotion regulation strategies. Thus, greater self-reported reappraisal was associated with a positive bias in memory for emotion. In contrast, distraction and suppression were not associated with bias in memory for emotion.

What accounted for this bias? Past research shows that, as memory for emotion fades, people draw on their current appraisals of past experiences to infer how they must have felt. Rather than being wholly accurate, then, memory for emotion is partly reconstructed based on people's interpretation of the emotion-eliciting experience at the time of recall (Levine, 1997; for reviews see Levine & Safer, 2002; Levine et al., 2009). In the present study, reported reappraisal was associated with positive change in students' appraisals of the exam preparation experience over time. Current appraisals partially mediated the association between reported reappraisal and bias in memory for emotion. Thus, the more students reported using reappraisal, the more positively they came to view the experience of preparing for the exam. In turn, the more positive their appraisals became, the greater the bias they showed when recalling how they had felt. In summary, our findings demonstrate for the first time that self-reported reappraisal is associated with changes over time in how people interpret stressful situations, which in turn are associated with positive bias in memory for emotion.

These findings have important implications for understanding how emotion regulation strategies relate to people's wellbeing more broadly. People who report habitually engaging in reappraisal experience greater happiness and wellbeing than those who report reappraising less (Gross & John, 2003; John & Gross, 2004). The short term benefits of reappraisal would certainly contribute to this wellbeing. Consistent with past research (e.g., Folkman, Lazarus, Dunkel-Schetter, DeLongis, & Gruen, 1986; Gross, 1998; Ray et al., 2010), we found that

reported reappraisal was associated with viewing the exam preparation experience more positively, and feeling better about it, prior to the exam. In contrast, reported distraction was not associated with more positive pre-exam appraisals or emotions, and reported suppression was associated with more negative pre-exam appraisals and emotions.

Extending past research, however, our findings also provide evidence of long term benefits associated with reported reappraisal that are not shared by distraction or suppression. Stressful situations in daily life extend over time and are comprised of multiple related events. Reappraisal is also an ongoing process and can have lasting effects. For example, students who are taught to reappraise their inability to solve problems as providing an opportunity to learn, rather than as a sign of impending failure, experience less distress while working on those problems. This positive reframing also influences the amount of time they devote to studying, the course of future study sessions, and the tone of subsequent interactions with teachers (Blackwell, Trzesniewski, & Dweck, 2007; Dweck & Sorich, 1999). Thus, reappraisal appears to contribute to people's wellbeing in the long term by leading them to view stressful situations in an increasingly positive manner over time. Because people draw on their current appraisals of events when remembering how they felt, this in turn promotes positive bias in memory for emotion.

Memory bias is typically viewed as problematic. But the primary function of memory for emotion may not be to keep an exact record of past experience but instead to guide people's current behavior and plans for the future (Levine, 1997; Levine et al., 2009). The fact that remembered emotion is informed by people's current understanding of the emotion-eliciting situation may make it a more useful guide. Researchers have examined people's memories for the feelings evoked by events as diverse as vacations, unpleasant medical procedures, and mountaineering expeditions. These memories have been found to be biased by people's final

appraisals concerning the outcomes of the events. People who recall such experiences more positively than initially reported are more willing to repeat them, whereas people who recall such experiences more negatively than initially reported strive to avoid them (e.g., Chen, Zeltzer, Craske, & Katz, 1999; Loewenstein, 1999; Loewenstein & Schkade, 1999; Redelmeier, Katz, and Kahneman, 2003; Wirtz et al., 2003). In the case of reappraisers, then, remembering past stressful experiences as having been “not so bad” should lead to positive expectations when they predict how they will feel during stressful situations in the future, contributing to their willingness to take on new challenges. In summary, our findings suggest that reported reappraisal is associated with greater wellbeing because it is an effective strategy for regulating emotional responses to stressful situations in the short term, and promotes more positive interpretations of these situations, and positive bias in memory for emotion, in the long term.

Assessing Italian students’ reactions to their high school exit exam allowed us to examine characteristics associated with reported use of emotion regulation strategies in a natural setting of great personal importance. But limitations of this study should also be noted. First, because this study relied on self-reports concerning emotion regulation and had a quasi-experimental design, we cannot conclude that use of specific emotion regulation strategies caused memory bias. In self-reports, people may emphasize strategies that they believe to be efficacious or socially valued. In addition, people may believe that reappraisal is a beneficial strategy, report trying to use it frequently, but be unable to implement this strategy effectively (Troy et al., 2010). Thus, in future research, it will be important to replicate these findings in experimental studies by instructing participants to engage in particular emotion regulation strategies and later assessing their memory for their emotional responses to stressful situations. Examining appraisals, attention, and emotional expression before and after emotion regulation instructions would allow investigators to determine the extent to which participants effectively used, as opposed to

reported, specific strategies.

Second, our findings closely parallel those drawn from other age groups and cultures with respect to the associations found between reported emotion regulation strategies, appraisals, and emotions. For example, consistent with previous studies, we found that reporting greater use of reappraisal was associated with more positive appraisals and emotions (Davis, DiStefano, & Schutz, 2008; Folkman et al., 1986; Gross & John, 2003; John & Gross, 2004), whereas reporting greater use of suppression was associated with more negative appraisals and emotions (Gross & John, 2003; John & Gross, 2004). Nonetheless, it would be useful to assess whether the association found between reported reappraisal and memory bias extends to other types of emotion-eliciting events and across other age groups and cultures. Finally, because our study had 80% females, we could not analyze gender differences.

In conclusion, past research has shown that reappraisal is an effective short term strategy for reducing the intensity of negative emotion. The present investigation is the first to demonstrate that the manner in which people report regulating emotion during stressful circumstances predicts later bias in their memory for how they felt. The more people reported engaging in reappraisal, finding the silver lining behind the clouds, the more they misremembered their emotional reaction to a challenging situation as positive. This memory bias may encourage people to seek out challenging (and ultimately rewarding) situations in the future. In light of prior research, these findings indicate that emotion regulation strategies must be considered, not only when examining memory for events, but also memory for emotional reactions to events. The findings also pave the way for further research on the long term consequences of emotion regulation strategies.

References

- Blackwell, L. A., Trzesniewski, K. H., & Dweck, C. S. (2007). Theories of intelligence and achievement across the junior high school transition: A longitudinal study and an intervention. *Child Development, 78*, 246-263. doi: 10.1111/j.1467-8624.2007.00995.x
- Carver, C. S. (1997). You want to measure coping but your protocol's too long: Consider the Brief COPE. *International Journal of Behavioral Medicine, 4*, 92-100. doi: 10.1207/s15327558ijbm0401_6
- Chen, E., Zeltzer, L. K., Craske, M. G., & Katz, E. R. (1999). Alteration of memory in the reduction of children's distress during repeated aversive medical procedures. *Journal of Consulting and Clinical Psychology, 67*, 481-490. doi: 10.1037/0022-006X.67.4.481
- Christianson, S.Å., & Safer, M.A. (1996). Emotional events and emotions in autobiographical memories. In D. C. Rubin (Ed.), *Remembering our past: Studies in autobiographical memory* (pp. 218-243). Cambridge University Press.
- Davis, H. A., DiStefano, C., & Schutz, P. A. (2008). College students' patterns of appraisal and emotion regulation during test taking. *Journal of Educational Psychology, 100*, 942-960. doi: 10.1037/a0013096
- Dweck, C. S., & Sorich, L. A. (1999). Mastery-oriented thinking. In C. R. Snyder (Ed.), *Coping: The psychology of what works*. New York: Oxford University Press.
- Ehring, T., Tuschen-Caffier, B., Schnülle, J., Fischer, S., & Gross, J. J. (2010). Emotion regulation and vulnerability to depression. Spontaneous versus instructed use of emotion suppression and reappraisal. *Emotion, 10*, 563-572. doi: 10.1037/a0019010
- Folkman, S., & Lazarus, R. S. (1985). If it changes it must be a process: Study of emotion and coping during three stages of a college examination. *Journal of Personality and Social Psychology, 48*, 150-170. doi: 10.1037/0022-3514.48.1.150

- Folkman, S., Lazarus, R. S., Dunkel-Schetter, C., DeLongis, A., & Gruen, R. J. (1986). Dynamics of a stressful encounter: Cognitive appraisal, coping, and encounter outcomes. *Journal of Personality and Social Psychology, 50*, 992-1003. doi: 10.1037/0022-3514.50.5.992
- Fredrickson, B. L., & Joiner, T. (2002). Positive emotions trigger upward spirals toward emotional well-being. *Psychological Science, 13*, 172-175. doi: 10.1111/1467-9280.00431
- Frijda, N. H. (1986). *The emotions*. Cambridge, England: Cambridge University Press.
- Gross, J. J. (1998). Antecedent- and response-focused emotion regulation: Divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology, 74*, 224-237. doi: 10.1037/0022-3514.74.1.224
- Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships and well-being. *Journal of Personality and Social Psychology, 85*, 348-362. doi: 10.1037/0022-3514.85.2.348
- Gross, J. J., & Levenson, R. W. (1997). Hiding feelings: The acute effects of inhibiting negative and positive emotion. *Journal of Abnormal Psychology, 106*, 95-103. doi: 10.1037/0021-843X.106.1.95
- Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs, 76*, 408-420. doi: 10.1080/03637750903310360
- Holmberg, D., & Holmes, J. G. (1994). Reconstruction of relationship memories: A mental models approach. In N. Schwarz & S. Sudman (Eds.), *Autobiographical memory and the validity of retrospective reports* (pp. 267-288). New York: Springer-Verlag.
- John, O. P., & Gross, J. J. (2004). Healthy and unhealthy emotion regulation: Personality

- processes, individual differences, and lifespan development. *Journal of Personality*, *72*, 1301-1334. doi: 10.1111/j.1467-6494.2004.00298.x
- Levine, L. J. (1997). Reconstructing memory for emotions. *Journal of Experimental Psychology: General*, *126*, 165-177. doi: 10.1037/0096-3445.126.2.165
- Levine, L. J., Lench, H. C., & Safer, M. A. (2009). Functions of remembering and misremembering emotion. *Applied Cognitive Psychology*, *23*, 1059–1075. doi: 10.1002/acp.1610
- Levine, L. J., Prohaska, V., Burgess, S. L., Rice, J. A., & Laulhere, T. M. (2001). Remembering past emotions: The role of current appraisals. *Cognition and Emotion*, *15*, 393–417. doi: 10.1080/0269993004200240
- Levine, L. J., & Safer, M. A. (2002). Sources of bias in memory for emotions. *Current Directions in Psychological Science*, *11*, 169-173. doi: 10.1111/1467-8721.00193
- Levine, L. J., Stein, N. L., & Liwag, M. D. (1999). Remembering children's emotions: Sources of concordance and discordance between parents and children. *Developmental Psychology*, *35*, 790-801. doi: 10.1037/0012-1649.35.3.790
- Loewenstein, G. (1999). Because it is there: The challenge of mountaineering ... for utility theory. *Kyklos*, *52*, 315-344. doi: 10.1111/j.1467-6435.1999.tb00221.x
- Loewenstein, G. & Schkade, D. (1999). Wouldn't it be nice? Predicting future feelings. In D. Kahneman, E. Diener & N. Schwarz (Eds.), *Well-being: The foundations of hedonic psychology* (pp. 85-105). New York: Sage.
- Oatley K., & Johnson-Laird, P. N. (1987). Towards a cognitive theory of emotions. *Cognition and Emotion*, *1*, 29-50. doi: 10.1080/02699938708408362
- Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, *40*,

879-891. doi: 10.3758/BRM.40.3.879

- Ray, R.D., McRae, K., Ochsner, K.N., & Gross, J.J. (2010). Cognitive reappraisal of negative affect: Converging evidence from EMG and self-report. *Emotion, 10*, 587-592. doi: 10.1037/a0019015
- Redelmeier, D.A., Katz, J., & Kahneman, D. (2003). Memories of colonoscopy: A randomized trial. *Pain, 104*, 187-194. doi: 10.1016/S0304-3959(03)00003-4
- Richards, J. M., & Gross, J. J. (1999). Composure at any cost? The cognitive consequences of emotion suppression. *Personality and Social Psychology Bulletin, 25*, 1033-1044. doi: 10.1177/01461672992511010
- Richards, J. M., & Gross, J. J. (2006). Personality and emotional memory: How regulating emotion impairs memory for emotional events. *Journal of Research in Personality, 40*, 631-651. doi: 10.1016/j.jrp.2005.07.002
- Robinson, M. D., & Clore, G. L. (2002). Belief and feeling: Evidence for an accessibility model of emotional self-report. *Psychological Bulletin, 128*, 934-960. doi: 10.1037/0033-2909.128.6.934
- Safer, M. A., Levine, L. J., & Drapalski, A. (2002). Distortion in memory for emotions: The contributions of personality and post-event knowledge. *Personality and Social Psychology Bulletin, 28*, 1495-1507. doi: 10.1177/014616702237577
- Scherer, K. R. (1984). On the nature and function of emotion: A component process approach. In K. R. Scherer & P. E. Ekman (Eds.), *Approaches to emotion* (pp. 293-317). Hillsdale, NJ: Erlbaum.
- Schmidt, S., Tinti, C., Levine, L. J., & Businaro, N. (2010). The high school diploma examination: Relations among appraisals, emotions, and coping. *Rassegna di Psicologia [Review of Psychology], 27*, 79-95.

- Schmidt, S., Tinti, C., Levine, L., & Testa, S. (2010). Appraisals, emotions and emotion regulation: An integrative approach. *Motivation and Emotion, 34*, 63–72. doi: 10.1007/s11031-010-9155-z
- Silvia, P. J. (2008). Interest, the curious emotion. *Current Directions in Psychological Science, 17*, 57-60. doi: 10.1111/j.1467-8721.2008.00548.x
- Smith, C. A., & Ellsworth, P. C. (1987). Patterns of appraisal and emotion related to taking an exam. *Journal of Personality and Social Psychology, 52*, 475-488. doi: 10.1037/0022-3514.52.3.475
- Smith, C. A., & Lazarus, R. S. (1993). Appraisal components, core relational themes, and the emotions. *Cognition & Emotion, 7*, 233-269. doi: 10.1080/02699939308409189
- Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural equation models. In S. Leinhardt (Ed.), *Sociological methodology 1982* (pp. 290-312). San Francisco, Jossey-Bass.
- Stein, N. L., & Levine, L. J. (1987). Thinking about feelings: The development and organization of emotional knowledge. In R.E. Snow & M. Farr (Eds.), *Aptitude, learning, and instruction: Vol. 3. Cognition, conation and affect* (pp. 165-197). Hillsdale, NJ: Erlbaum.
- Troy, A. S., Wilhelm, F.H., Shallcross A. J., & Mauss, I. B. (2010). Seeing the silver lining: Cognitive reappraisal ability moderates the relationship between stress and depressive symptoms. *Emotion, 10*, 783-795. doi: 10.1037/a0020262
- Wirtz, D. Kruger, J., Scollon, C. N., & Diener, E. (2003). What to do on spring break? The role of predicted, on-line, and remembered experience in future choice. *Psychological Science, 14*, 520-524. doi: 10.1111/1467-9280.03455

Footnotes

¹Preliminary analyses revealed no significant differences between students who completed questionnaires prior to the exam only ($N = 340$) versus students who completed questionnaires both prior to and after the exam ($N = 264$), with respect to initial emotional intensities, emotion regulation strategies, appraisals, or age. A greater proportion of females participated at both time periods (80%) than before the exam only (64%), however, $\chi^2(1, N = 604) = 18.76, p < .001$.

²Because Cronbach's α for the two distraction items was low, all analyses of the relations among emotion regulation strategies, changes in appraisals, and memory for emotion were also conducted for each distraction item separately. The results were identical to those obtained when the two distraction items were combined, so combined results are reported.

³Questionnaires also included other questions concerning students' appraisals (e.g., attributions concerning factors responsible for their exam score, importance ratings). A detailed analysis of the relation of these appraisals to students' initial emotional responses is provided elsewhere (Schmidt, Tinti, Levine, & Businaro, 2010; Schmidt, Tinti, Levine, & Testa, 2010).

Table 1

Means, Standard Errors, and Correlations of Key Study Variables with Pre-Exam Reports of Emotion Regulation Strategies (N = 264)

Variable	<i>M</i> (<i>SE</i>)	Reappraisal	Distraction	Suppression
Pre-exam				
Experienced positive emotion	4.26 (.13)	.44***	-.03	-.06
Experienced negative emotion	4.30 (.12)	-.10	-.01	.29***
Pre-exam appraisal	5.95 (.10)	.47***	-.05	-.12*
Studying	4.64 (.17)	.17**	-.23**	.19**
Post-exam				
Recalled positive emotion	3.73 (.13)	.51***	-.03	-.07
Recalled negative emotion	3.24 (.12)	-.11	-.04	.22***
Post-exam appraisal	5.85 (.11)	.44***	-.06	-.10
Exam score	80.77 (.83)	-.02	-.05	-.14*

* $p < .05$. ** $p < .01$. *** $p < .001$.

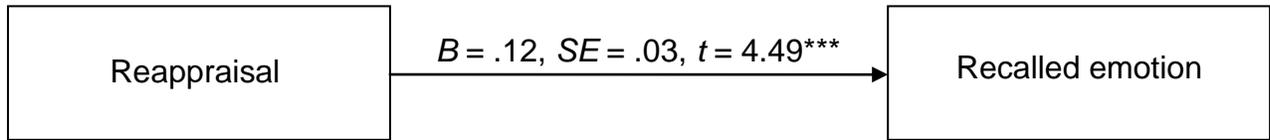
Table 2

Hierarchical Multiple Regression Analyses Predicting Recalled Intensity of Positive and Negative Emotion (N = 264)

Predictor	Positive emotion			Negative emotion		
	<i>B</i>	<i>SE B</i>	β	<i>B</i>	<i>SE B</i>	β
Step 1						
Experienced emotion	.53	.05	.50***	.51	.05	.54***
Step 2						
Studying	.08	.04	.10*	.09	.04	.14*
Exam score	-.01	.01	-.06	-.01	.01	-.10
Post-exam mood	.04	.04	.05	.01	.04	.01
Post-exam reappraisal	.18	.04	.24***	.08	.04	.12*
Post- exam distraction	.05	.04	.05	.04	.04	.06
Post-exam suppression	.09	.04	.10*	.02	.05	.03
Step 3						
Pre-exam reappraisal	.12	.05	.14*	-.10	.04	-.14*
Pre-exam distraction	.00	.05	.00	-.00	.05	-.00
Pre-exam suppression	-.08	.04	-.09	-.00	.04	-.00

Note: All values for *B*, *SE B*, and β represent values at Step 3 after all variables were entered in the models. Four participants had missing values for variables in the models. Predictors at Steps 2 and 3 were centered at their means. For the positive emotion model, $\Delta R^2 = .43^{***}$ at Step 1, $.11^{***}$ at Step 2, and $.02^*$ at Step 3. For the negative emotion model, $\Delta R^2 = .38^{***}$ at Step 1, $.02$ at Step 2, and $.02$ at Step 3. $*p < .05$. $**p < .01$. $***p < .001$.

A. Direct effect



B. Indirect effect

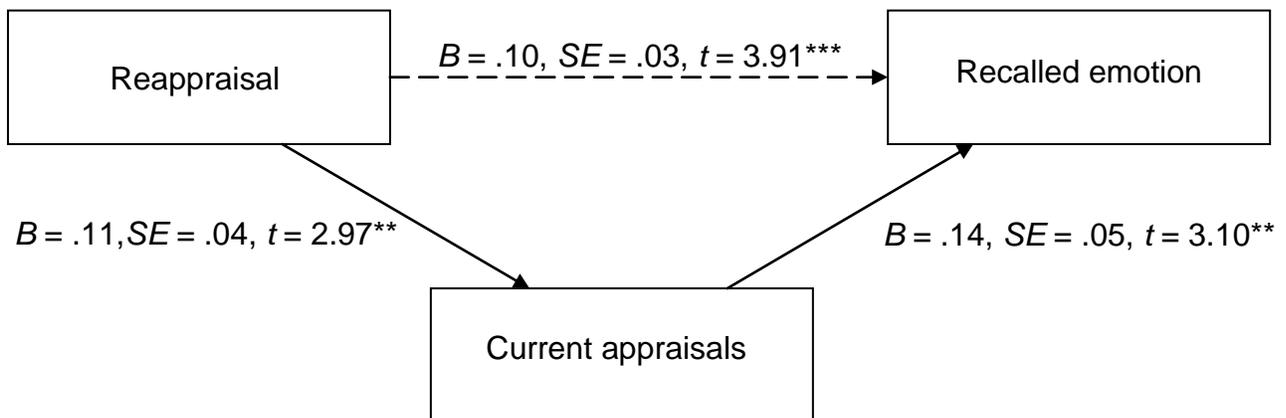


Figure 1. Mediation of the relationship between self-reported reappraisal and recalled emotion by current appraisals. All coefficients represent unstandardized regression coefficients, controlling for the intensity of emotion experienced, pre-exam appraisals, and exam score. *Adj.* $R^2 = .54^{***}$; Mediated Effect = .02, $SE = .01$, 95% $CI = .0037$ to $.0449$; Sobel $z = 2.11, p = .03$. $**p < .01$. $***p < .001$.